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Z Plant Source Aggregate Area Management Study Report

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Department of Energy
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DISCUM-1 (HRP 1-91)

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DATA MANAGEMENT PLAN

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ACRONYMS

AAMS(R)	Aggregate Area Management Study (Report)
ANSI/ASME	American National Standards Institute/American Society of Mechanical Engineers
ARARs	Applicable or Relevant and Appropriate Requirements
ASIL	Ambient Source Impact Level
BDAT	Best Demonstrated Available Technology
BWIP	Basalt Waste Isolation Project
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CCW	Constituent Concentration in Waste
CCWE	Constituent Concentration in Waste Extract
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CMS	Corrective Measures Study
CRP	Community Relations Plan
DCG	Derived Concentration Guide
DBBP	Dibutyl Butyl Phosphonate
DMP	Data Management Plan
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations
DQO	Data Quality Objective
Ecology	Washington State Department of Ecology
EII	Environmental Investigations Instructions
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ERA	Expedited Response Action
ES&H	Environment, Safety, and Health
FFS	Focused Feasibility Study
FR	Federal Register
FS	Feasibility Study
FWQC	Federal Water Quality Criteria
HRS	Hazard Ranking System
HSP	Health and Safety Plan
HVAC	Heating, Ventilation, and Air Conditioning System
HWSA	Hazardous Waste Staging Area
IRM	Interim Remedial Measure
K_d	Soil-Water Distribution Coefficient
K_{oc}	Soil-Organic Matter Partition Coefficient
LFI	Limited Field Investigation

LLWMA	Low Level Waste Management Area
MCL	Maximum Contaminant Level
mHRS	modified Hazard Ranking System
msl	Mean Sea Level
NAAQS	National Ambient Air Quality Standards
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NIOSH	National Institute for Occupational Safety and Health
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
NRC	Nuclear Regulatory Commission
NSPS	New Source Performance Standards
OP	Operation Program
OSHA	Occupational Safety and Health Administration
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
PA/SI	Preliminary Assessment/Site Inspection
PFP	Plutonium Finishing Plant
PIF	Plutonium Isolation Facility
PMP	Project Management Plan
PNL	Pacific Northwest Laboratory
PRF	Plutonium Reclamation Facility
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
RA	Risk Assessment
RAO	Remedial Action Objective
RARA	Radiation Area Remedial Action
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RI	Remedial Investigation
RI/FS	Remediation Investigation/Feasibility Study
RFI	RCRA Facility Investigation
RHO	Rockwell Hanford Operations
RM	Remote Mechanic
RMW(SF)	Radioactive Mixed Waste (Storage Facility)
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SVE	Soil Vapor Extraction
T-BACT	Best Available Control Technology for Air Toxics
TBC	To Be Considered

TCLP	Toxicity Characteristic Leaching Procedure
TLD	Thermoluminescence dosimetry
TOC	Total Organic Carbon
TSD	Treatment, Storage, and Disposal Facility
USC	U.S. Code
USGS	United States Geological Society
VOC	Volatile Organics Compounds
WAC	Washington Administrative Code
WIPP	Waste Isolation Pilot Plant
WHC	Westinghouse Hanford Company
WIDS	Waste Information Data System
WIPP	Waste Isolation Pilot Plant
WISHA	Washington State Safety and Health Act
WMP	Waste Management Plan
WPCA	Water Pollution Control Act
WPPSS	Washington Public Power Supply System
WRAP	Waste Receiving and Processing

1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA), in November 1989, included the 200 Areas of the Hanford Site on the National Priorities List (NPL) under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980. Inclusion on the NPL initiates the Remedial Investigation (RI) and Feasibility Study (FS) process for characterizing the nature and extent of contamination, assessing risks to human health and the environment, and selection of remedial actions.

This report presents the results of an aggregate area management study (AAMS) for the Z Plant Aggregate Area located in the 200 Areas of the U.S. Department of Energy (DOE) Hanford Site in Washington State. The study will provide the basis for initiating RI/FS under CERCLA or under the Resource Conservation and Recovery Act (RCRA) Facility Investigations (RFI) and Corrective Measures Studies (CMS). This report also integrates RCRA treatment, storage or disposal (TSD) closure activities with CERCLA and RCRA past practice investigations.

This chapter describes the overall AAMS approach for the 200 Areas, defines the purpose, objectives and scope of the AAMS, and summarizes the quality assurance (QA) program and contents of the report.

1.1 OVERVIEW

The Hanford Site is organized into numerically designated operational areas including the 100, 200, 300, 400, 600, and 1100 Areas (Figure 1-1). The 100, 200, 300, and 1100 Areas have been listed on the EPA's NPL. The 200 Areas, located near the center of the Hanford Site, encompasses the 200 West, East and North Areas which contain reactor fuel processing and waste management facilities.

Under the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement), signed by the Washington State Department of Ecology (Ecology), DOE, and EPA (Ecology et al. 1990), the 200 NPL Site is divided into 8 waste area groups largely corresponding to the major processing plants (e.g., B Plant and T Plant), and a number of isolated operable units located in the surrounding 600 Area. Each waste area group is further subdivided into one or more operable units based on waste disposal information,

1 location, facility type, and other site characteristics. The 200 NPL site includes a total of 44
2 operable units including 20 in the 200 East Area, 17 in the 200 West Area, 1 in the 200
3 North Area, and 6 isolated operable units. The intent of defining operable units was to
4 group associated waste management units together, such that they could be effectively
5 characterized and remediated under one work plan.
6

7 The Tri-Party Agreement also defines approximately 25 RCRA TSD groups within
8 the 200 Areas which will be closed or permitted (for operation or postclosure care) in
9 accordance with the Washington State Dangerous Waste Regulations (WAC 173-303). The
10 TSD facilities are often associated with an operable unit and are required to be addressed
11 concurrently with past-practice activities under the Tri-Party Agreement.
12

13 This AAMS is one of ten studies that will provide the basis for past practice activities
14 for operable units in the 200 Areas. In addition, the AAMS will be collectively used in the
15 initial development of an area-wide groundwater model, and conduct of an initial site-wide
16 risk assessment. Recent changes to the Tri-Party Agreement (Ecology et al. 1991), and the
17 *Hanford Past-Practice Strategy* document (Thompson 1991) establish the need and provide
18 the framework for conducting AAMS in the 200 Areas.
19
20

21 1.1.1 Tri-Party Agreement

22
23 The Tri-Party Agreement was developed and signed by representatives from the EPA,
24 Ecology, and DOE in May 1989, revised in 1990 and 1991. The scope of the agreement
25 covers all CERCLA past practice, RCRA past practice, and RCRA TSD activities on the
26 Hanford Site. The purpose of the Tri-Party Agreement is to ensure that the environmental
27 impacts of past and present activities are investigated and appropriately remediated to protect
28 human health and the environment. To accomplish this, the Tri-Party Agreement provides a
29 framework and schedule for developing, prioritizing, implementing and monitoring
30 appropriate response actions.
31

32 The 1991 revision to the Tri-Party Agreement requires that an aggregate area
33 approach be implemented in the 200 Areas based on the *Hanford Past-Practice Strategy*.
34 This strategy requires the conduct of AAMS which are similar in nature to an RI/FS scoping
35 study. The Tri-Party Agreement change package (Ecology et al. 1991) specifies that 10
36 Aggregate Area Management Study Reports (AAMSR) (major milestone M-27-00) are to be
37 prepared for the 200 Areas. Further definition of aggregate areas and the AAMS approach is
38 provided in Sections 1.2 and 1.3.
39
40

1.1.2 Hanford Site Past Practice Investigation Strategy

The *Hanford Past-Practice Strategy* was developed between Ecology, EPA, and DOE to streamline the existing RI/FS and RFI/CMS processes. A primary objective of this strategy is to develop a process to meet the statutory requirements and integrate CERCLA RI/FS and RCRA Past Practice RFI/CMS guidance into a singular process for the Hanford Site that ensures protection of human health and welfare and the environment. The strategy refines the existing past practice decision-making process as defined in the Tri-Party Agreement. The fundamental principle of the strategy is a bias-for-action by optimizing the use of existing data, integrating past practice with RCRA TSD closure investigations, focusing the RI/FS process, conducting interim remedial actions, and reaching early decisions to initiate and complete cleanup projects on both operable-unit and aggregate-area scale. The ultimate goal being the comprehensive cleanup or closure of all contaminated areas at the Hanford Site at the earliest possible date in the most effective manner.

The process under this strategy is a continuum of activities whereby the effort is defined based upon knowledge gained as work progresses. Whereas the strategy is intended to streamline investigations and documentation to promote the use of interim actions to accelerate cleanup, it is consistent with RI/FS and RFI/CMS processes. An important element of this strategy is the application of the observational approach, in which characterization data are collected concurrently with cleanup.

For the 200 Areas the first step in the strategy is the evaluation of existing information presented in AAMSR. Based on this information, decisions will be made regarding which strategy path(s) to pursue for further actions in the aggregate area. The strategy includes three paths for interim decision making and a final remedy-selection process that incorporates the three paths and integrates sites not addressed in those paths. As shown on Figure 1-2, the three paths for decision making are:

- Expedited response action (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
- Interim remedial measure (IRM) path, where existing data are sufficient to indicate that the site poses a risk through one or more pathways and additional investigations are not needed to screen the likely range of remedial alternatives for interim actions; if a determination is made that an IRM is justified, the process will proceed to select an IRM remedy, and may include a focused FS, if needed, to select a remedy

- 1 • Limited field investigation (LFI) path, where minimum site data are needed to
2 support IRM or other decisions, and can be obtained in a less formal manner
3 than that needed to support a final Record of Decision (ROD). It may be
4 determined that data generated from a LFI is sufficient to directly support an
5 interim ROD. Regardless of the scope of the LFI, it is a part of the RI
6 process, and not a substitute for it.
7

8 The process of final remedy selection must be completed for the aggregate area to
9 reach closure. The aggregation of information obtained from LFI and interim actions may be
10 sufficient to perform the cumulative risk assessment and to define the final remedy for the
11 aggregate area or associated operable units. If the data are not sufficient, additional
12 investigations and studies will be performed to the extent necessary to support final remedy
13 selection. These investigations would be performed within the framework and process
14 defined for RI/FS or RFI/CMS programs.
15

16 1.2 200 NPL SITE AGGREGATE AREA MANAGEMENT STUDY PROGRAM

17 The overall approach and scope of the 200 Areas AAMS program is based on the Tri-
18 Party Agreement and the *Hanford Past-Practice Strategy*.
19

20 21 22 23 1.2.1 Overall Approach

24 As defined in the 1991 revision to the Tri-Party Agreement, the AAMS program for
25 the 200 Areas consists of conducting a series of ten AAMS for eight source (Figures 1-3 and
26 1-4) and two groundwater aggregate areas delineated in the 200 East, West, and North
27 Areas. Table 1-1 lists the aggregate areas, the type of study and associated operable units.
28 With the exception of 200-IU-6, isolated operable units associated with the 200 NPL site
29 (Figure 1-5) are not included in the AAMS program. Generally, the quantity of existing
30 information associated with isolated operable units is not considered sufficient to require
31 study on an aggregate area basis prior to work plan development. Operable unit 200-IU-6
32 will be addressed as part of the B Plant AAMS because of similarities in waste management
33 units (i.e., ponds).
34

35 The eight source AAMS are designed to evaluate source terms on a plant-wide scale.
36 Source AAMS will be conducted for the following aggregate areas (waste area groups) which
37 largely correspond to the major processing plants including the following:
38

- 39 • U Plant
40

- 1 • Z Plant
- 2
- 3 • S Plant
- 4
- 5 • T Plant
- 6
- 7 • PUREX
- 8
- 9 • B Plant
- 10
- 11 • Semi-Works
- 12
- 13 • 200 North.
- 14

15 The groundwater beneath the 200 Areas will be investigated under two groundwater
16 AAMS on an Area-wide scale (i.e., 200 West and 200 East Areas). Groundwater aggregate
17 areas were delineated to encompass the geography necessary to define and understand the
18 local hydrologic regime, and the distribution, migration and interaction of contaminants
19 emanating from source terms which is considered an appropriate scale for developing
20 conceptual and numerical groundwater models.

21
22 The Department of Energy, Richland Operations Office (DOE-RL) functions as the
23 "lead agency" for the 200 AAMS program. Depending on the specific AAMS, EPA and/or
24 Ecology function as the "Lead Regulatory Agency" (Table 1-1). Through periodic (monthly)
25 meetings information is transferred and regulators are informed of the progress of the AAMS
26 such that decisions established under the *Hanford Past-Practice Strategy* (e.g., is an ERA
27 justified?) (Figure 1-2) can be quickly and collectively made between the three parties.
28 These meetings will continually refine the scope of AAMS as new information is evaluated,
29 decisions are made and actions taken. Completion milestones for AAMS are defined in
30 Ecology et al. (1991) and duplicated in Table 1-1. All AAMSR will be submitted as
31 secondary documents.

32 33 34 **1.2.2 Process Overview**

35
36 Each AAMS will be conducted in three steps: 1) the analysis of existing data and
37 formulation of a conceptual model, 2) identification of data needs and evaluation of remedial
38 technologies, and 3) conduct of limited field characterization activities and report
39 preparation.
40

1 The first and primary task of the AAMS investigation process involves the search,
2 compilation and evaluation of existing data. Information that will be collected for these
3 purposes include the following:

- 4
- 5 • Facility and process descriptions and operational histories for waste sources
- 6
- 7 • Waste disposal records defining dates of disposal, waste types, and waste
- 8 quantities
- 9
- 10 • Sampling events of waste effluents and effected media
- 11
- 12 • Site conditions including the site physiography, geology, hydrology,
- 13 meteorology, ecology, demography, and archaeology
- 14
- 15 • Environmental monitoring data for affected media including air, surface water,
- 16 sediment, soil, groundwater and biota
- 17

18 Collectively this information will be used to identify contaminants of concern,
19 determine the scope of future characterization efforts, and to develop a conceptual model of
20 the aggregate area. Although data collection objectives are similar, the types of information
21 collected will depend on whether the study is a source or groundwater AAMS. The data
22 collection step serves to avoid duplication of previous efforts and facilitates a more focused
23 investigation by the identification of data gaps.

24

25 Topical reports referred to as Technical Baseline Reports will be initially prepared to
26 summarize facility information. These reports will describe individual waste management
27 units and unplanned releases contained in the aggregate area as identified in the Waste
28 Information Data System (WIDS) (WHC 1991a). The reports are based on review of current
29 and historical Hanford Site reports, engineering drawings and photographs and is
30 supplemented with site inspections and employee interviews. Information contained in the
31 reports will be summarized in the AAMSR. Generally, other topical reports will be
32 generated for environmental monitoring or sampling data which have not been previously
33 compiled or summarized, or when existing reports are outdated or inadequate.

34

35 Information on waste sources, pathways, and receptors will be used to develop a
36 conceptual model of the aggregate area. If the conceptual understanding of the site is
37 considered inadequate, limited field characterization activities can be undertaken as part of
38 the study. Field screening activities planned under the AAMS include the following:

39

- 1 • Expanded groundwater monitoring programs (non Contract Laboratory
2 Program) at approximately 80 select existing wells to identify contaminants of
3 concern and refine groundwater plume maps
- 4
- 5 • In situ assaying of gamma-emitting radionuclides at approximately 10 selected
6 existing boreholes per aggregate area to develop radioelement concentration
7 profiles in the vadose zone.
- 8

9 Wells, boreholes, and analytes will be selected based on a review of existing
10 environmental data which will be undertaken early in the AAMS process. Field
11 characterization results will be presented in the AAMSR and/or topical reports.

12
13 After the conceptual model is developed, preliminary applicable or relevant and
14 appropriate requirements (ARARs), and potential remedial technologies will be identified. In
15 cases where the existing information is sufficient, the *Hanford Past-Practice Strategy* allows
16 for a focused FS or CMS to be initiated prior to the completion of the study.

17
18 Data needs will be identified by evaluating the sufficiency of existing data and by
19 determining what additional data are necessary to adequately characterize the aggregate area,
20 refine the conceptual model and ARARs, and/or narrow the range of remedial alternatives.
21 Determinations will be made regarding the level of uncertainty associated with existing data
22 and the need to verify or supplement the data. If additional data are needed, the intended
23 data uses will be identified, data quality objectives established and data priorities set.

24
25 Each AAMS will result in management recommendations for the aggregate area
26 including the following:

- 27 • The need for ERA, IRM, and LFI
- 28
- 29 • Definition and prioritization of operable units
- 30
- 31 • Prioritization of work plan activities
- 32
- 33 • Integration of RCRA TSD closure activities
- 34
- 35 • The conduct of field characterization activities
- 36
- 37 • The need for treatability studies.
- 38
- 39

1 Based on the AAMSR, a decision is made on whether the study has provided
2 sufficient information to forego further field investigations and prepare a FS. If further field
3 investigations are required, a RI/FS work plan is developed and executed. The scope of
4 future work plans will be largely limited to that of a sampling and analysis plan. The
5 background information normally required to support the preparation of a work plan (e.g.,
6 site description, conceptual model, data quality objectives, etc.) is developed in the AAMSR
7 and can be referenced accordingly.
8

9 All ten AAMS are scheduled to be completed by September 1992. This will facilitate
10 a coordinated approach to prioritizing and implementing future past practice activities for the
11 entire 200 Areas.
12

13 1.3 PURPOSE, SCOPE, AND OBJECTIVES

14 The purpose of conducting an AAMS is to compile and evaluate the existing body of
15 knowledge and conduct limited field characterization work to support the *Hanford Past*
16 *Practice Strategy* decision-making process for an aggregate area. The AAMS process is
17 similar in nature to the RI/FS scoping process prior to work plan development and is
18 intended to maximize the use of existing data to allow a more limited and focused RI/FS.
19 Deliverables for an AAMS consist of the AAMSR and health and safety, project
20 management, and data management plans.
21

22 Specific objectives of the AAMS include the following:
23

- 24 • Assemble and interpret existing data including operational and environmental
25 data
- 26 • Describe site conditions
- 27 • Conduct limited new site characterization work if data or interpretation
28 uncertainty could be reduced by the work
- 29 • Develop a conceptual model
- 30 • Identify contaminants of concern, and their distribution
- 31 • Identify preliminary ARARs
- 32
- 33
- 34
- 35
- 36
- 37
- 38
- 39

- 1 • Define preliminary remedial action objectives, screen potential remedial
- 2 technologies, and if possible provide recommendations for focused FS
- 3
- 4 • Recommend treatability studies to support the evaluation of remedial action
- 5 alternatives
- 6
- 7 • Define data needs, establish data quality objectives and set data priorities
- 8
- 9 • Provide recommendations for expedited, interim or limited actions
- 10
- 11 • Refine and prioritize operable unit boundaries
- 12
- 13 • Define and prioritize work plan and other past practice activities with emphasis
- 14 on supporting early cleanup actions and records of decisions
- 15
- 16 • Integrate RCRA TSD closure activities with past practice activities.
- 17

18 Depending on whether an aggregate area is a source or groundwater aggregate area,
19 the scope of the AAMS will vary. Source AAMSs focus on source terms, and the
20 environmental media of interest include air, biota, surface water, surface soil, and the
21 unsaturated subsurface soil. Accordingly, detailed descriptions of facilities and operational
22 information are provided in the source AAMSR. In contrast, groundwater AAMSs focus on
23 the saturated subsurface and on groundwater contamination data. Descriptions of facilities in
24 the groundwater AAMS are limited to liquid disposal facilities and reference is made to
25 source AAMS for detailed descriptions. The descriptions of site conditions in the source
26 AAMSR concentrate on site physiography, meteorology, surface water hydrology, vadose
27 zone geology, ecology, and demography. Groundwater AAMSRs summarize regional
28 geohydrologic conditions and contain detailed information regarding the local geohydrology
29 on an Area-wide scale. Correspondingly, other sections of the AAMSR vary depending on
30 the environmental media of concern.

31

32

33 **1.4 QUALITY ASSURANCE**

34

35 A limited amount of field characterization work will be performed as part of the
36 AAMS. To help ensure that data collected are of sufficient quality to support decisions, all
37 work on the Hanford Site is subject to the requirements of DOE Order 5700.1A, Quality
38 Assurance (DOE/RL 1983), which establishes broadly applicable QA program requirements
39 in compliance with American National Standards Institute/American Society of Mechanical

1 Engineers QA guidelines (ANSI/ASME 1989); the QA program requirements so defined
2 apply to all types of project activities conducted on the Hanford Site.
3

4 To ensure that the objectives of the past practice activities are met in a manner
5 consistent with DOE-RL Order 5700.1A (DOE/RL 1983), Quality Assurance, all work will
6 be performed in compliance with Westinghouse Hanford's existing QA manual, WHC-CM-4-
7 2 (WHC 1988a) and with procedures outlined in the QA program plan, WHC-EP-0383
8 (WHC 1990a) specific to CERCLA RI/FS activities. This QA program plan describes the
9 various plans, procedures, and instructions that will be used by Westinghouse Hanford to
10 implement the requirements of DOE-RL Order 5700.1A.
11

12 13 1.5 ORGANIZATION OF REPORT

14
15 In addition to this introduction, the AAMSR will consist of the following nine sections
16 and appendices:
17

- 18 • Section 2.0, Facility, Process and Operational History Descriptions, describes
19 the major facilities, waste management units and unplanned releases within the
20 aggregate area. A chronology of waste disposal activities is established and
21 waste generating processes are summarized.
22
- 23 • Section 3.0, Site Conditions, describes the physical, environmental, and
24 sociological setting including, geology, hydrology, ecology, meteorology, and
25 demography.
26
- 27 • Section 4.0, Preliminary Conceptual Model, summarizes the conceptual
28 understanding of the aggregate area with respect to types and extent of
29 contamination, exposure pathways and receptors.
30
- 31 • Section 5.0, Health and Environmental Concerns, identifies chemicals used or
32 disposed within the aggregate area that could be of concern regarding public
33 health and/or the environment.
34
- 35 • Section 6.0, Potentially Applicable or Relevant and Appropriate Requirements,
36 identifies federal and state standards, requirements, criteria, or limitations that
37 may be considered relevant to the aggregate area.
38

- 1 • Section 7.0, Preliminary Remedial Action Technologies, identifies and screens
2 potential remedial technologies and establishes remedial action objectives for
3 environmental media.
4
- 5 • Section 8.0, Data Quality Objectives, reviews QA criteria on existing data,
6 identifies data gaps or deficiencies, and identifies broad data needs for field
7 characterization and risk assessment. Data quality objectives and data
8 priorities are established.
9
- 10 • Section 9.0, Recommendations, provides guidance for future past practice
11 activities based on the results of the AAMS. Recommendations are provided
12 for ERA at problem sites, IRM, LFI, refining operable unit boundaries,
13 prioritizing work plans, and conducting field investigations and treatability
14 studies.
15
- 16 • Section 10.0, References, list reports and documents cited in the AAMSR.
17
- 18 • Appendix A, Supplemental Data, provides supplemental data supporting the
19 AAMSR.
20

21 The following plans are included and will be used to support past practice activities in
22 the aggregate area:
23

- 24 • Appendix B: Health and Safety Plan
25
- 26 • Appendix C: Project Management Plan
27
- 28 • Appendix D: Data Management Plan
29

30 Community relations requirements for the Z Plant Aggregate Area can be found in the
31 *Community Relations Plan for the Hanford Federal Facility Agreement and Consent Order*
32 (Ecology et al. 1989).
33

34 SECT-1.fr

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9 8 1 2 3 4 5 6 7 8 9 0

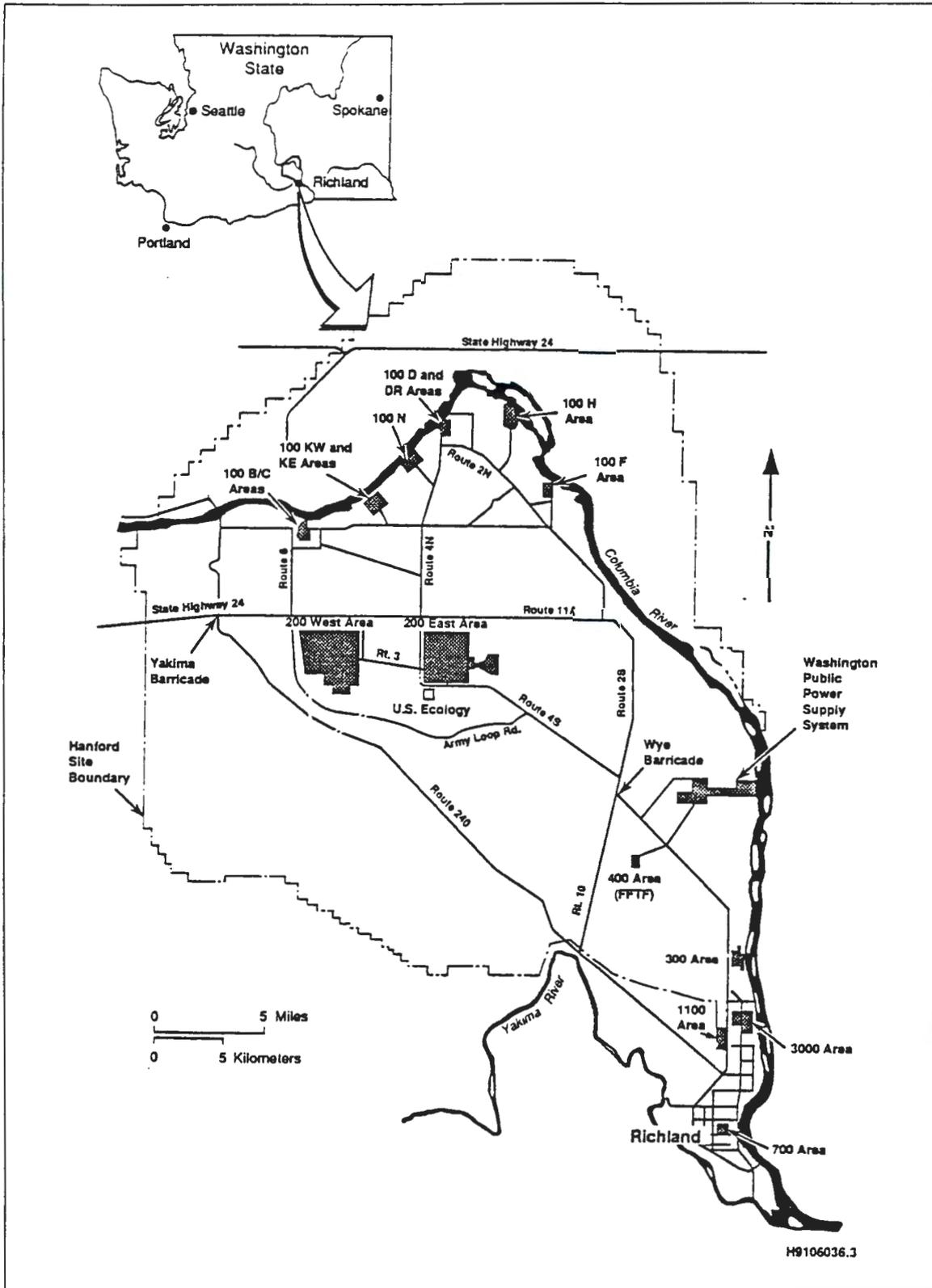
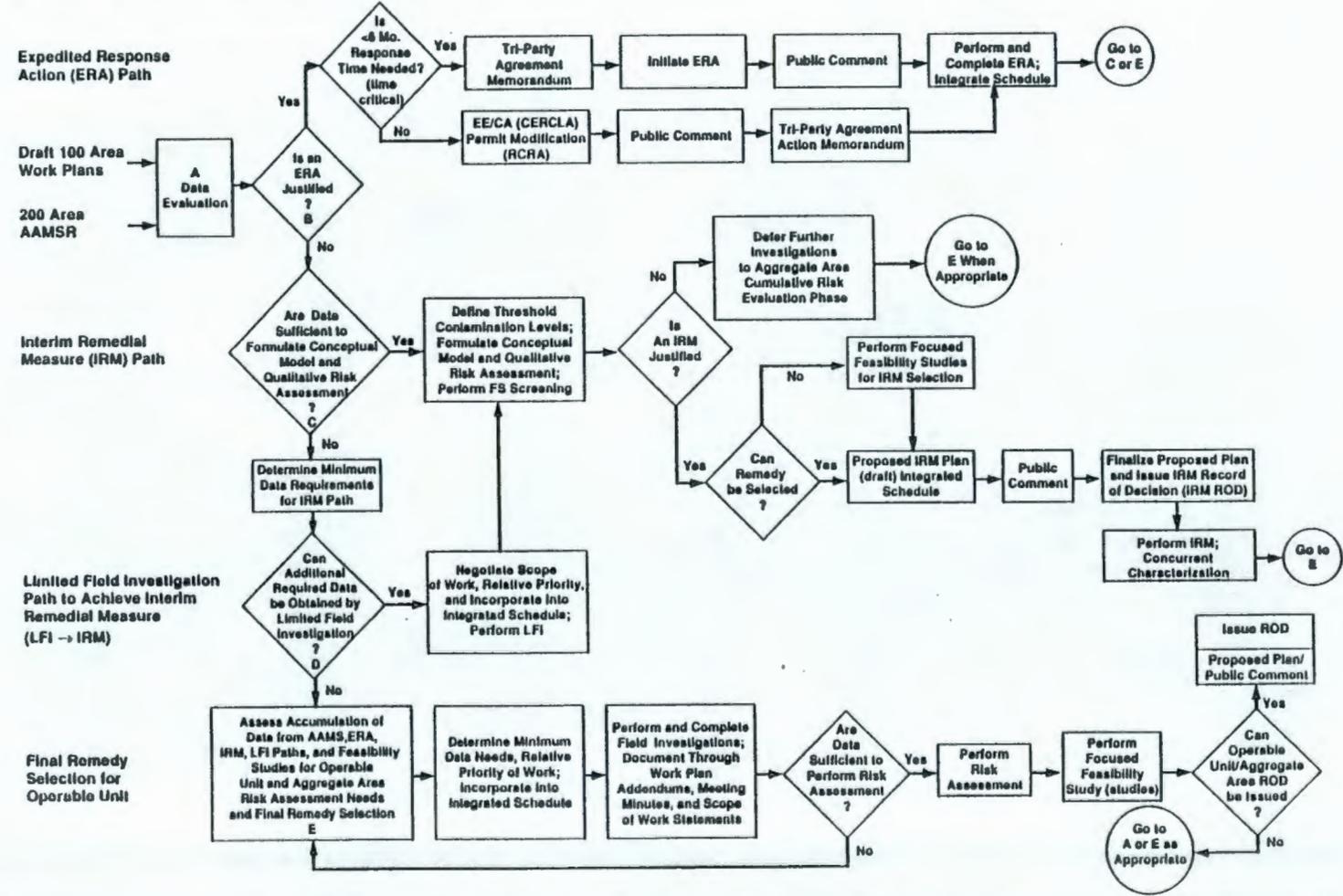


Figure 1-1. Hanford Site Map.

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

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



IF-2

DOE/RL-91-58
Draft A

Figure 1-2. Hanford Past Practice Investigation Strategy Flow Chart.

1F-3

DOE/RL-91-58
Draft A

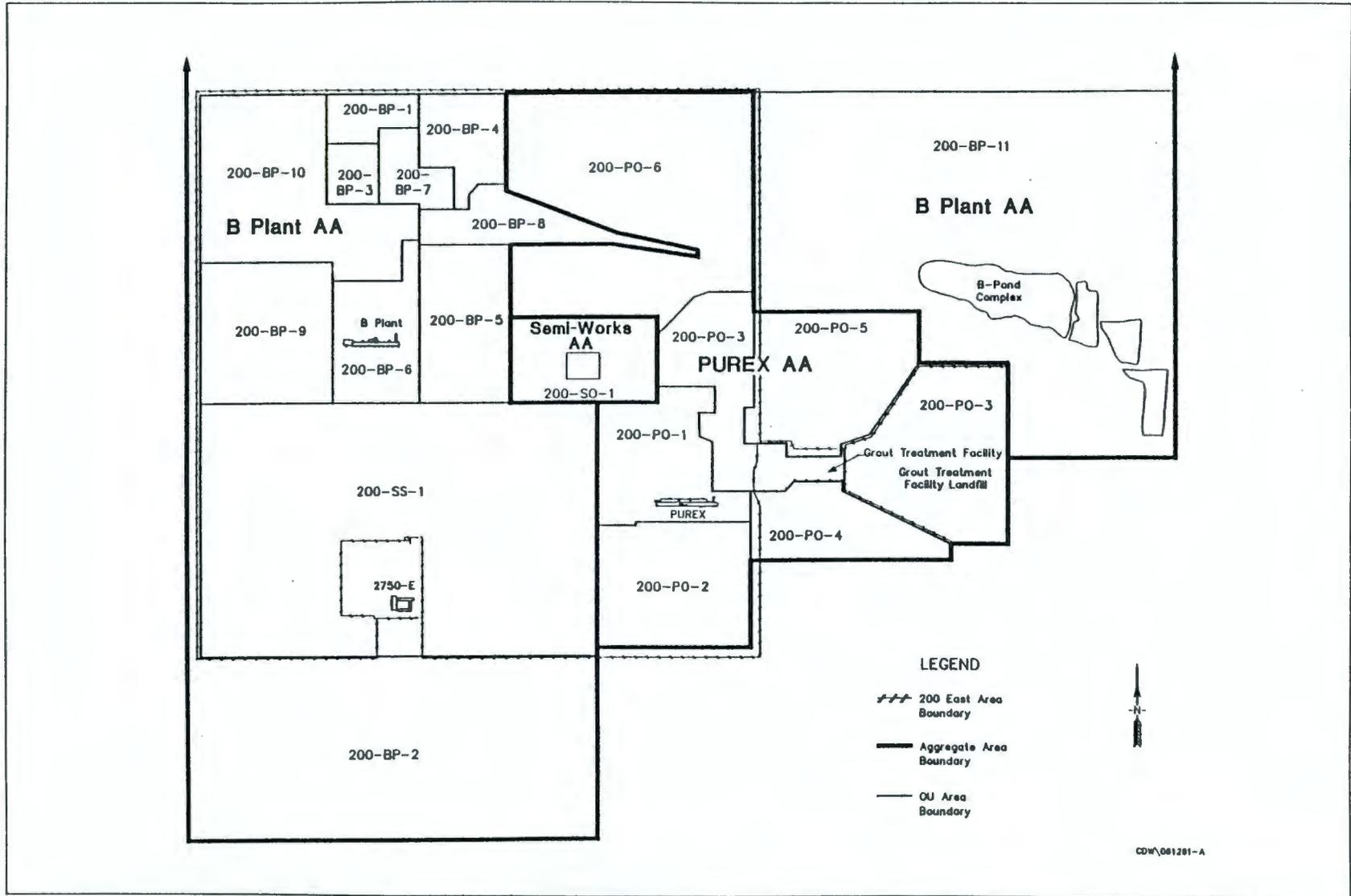


Figure 1-3. 200 East Aggregate Areas.

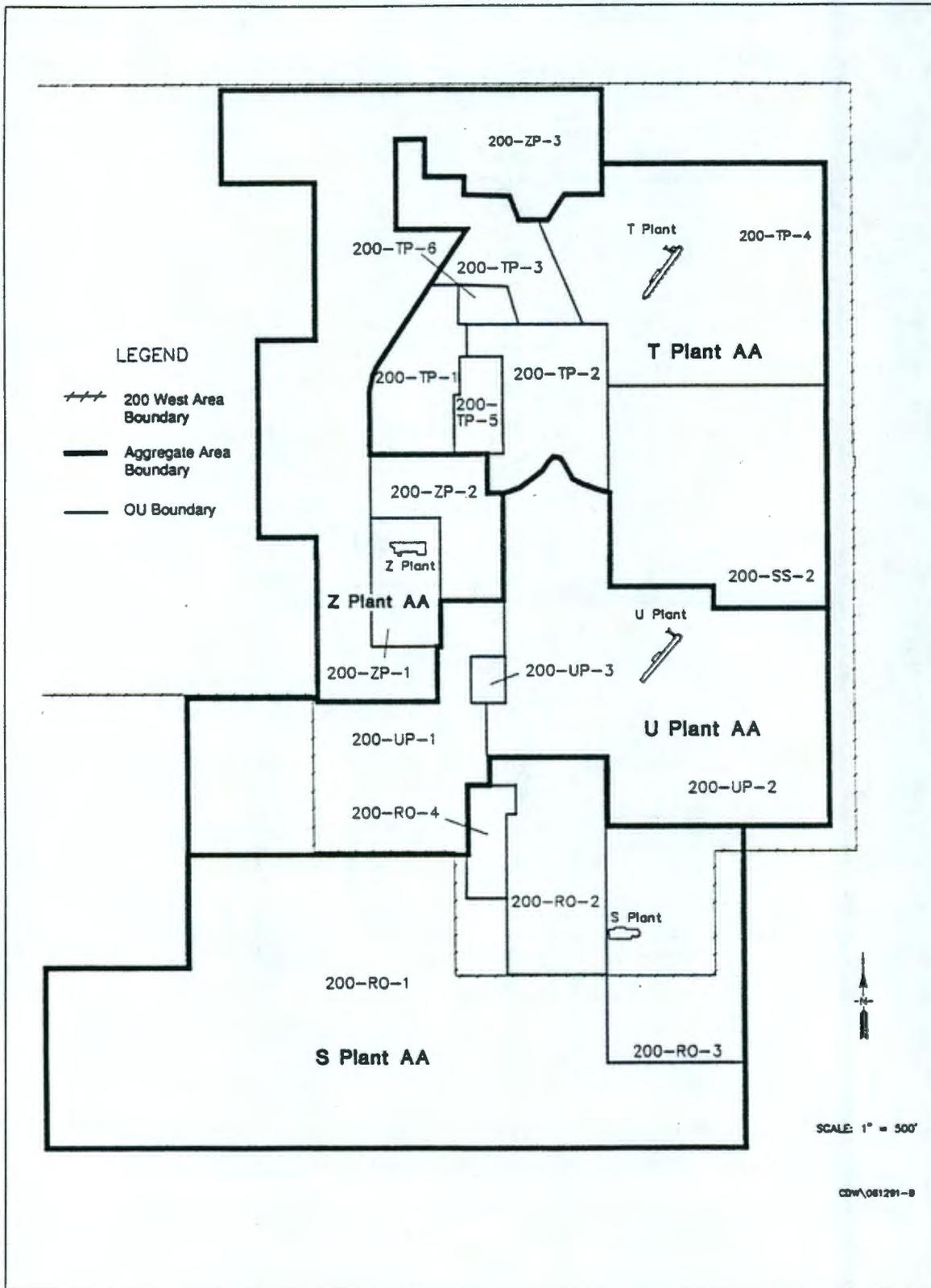


Figure 1-4. 200 West Aggregate Areas.

93128650654

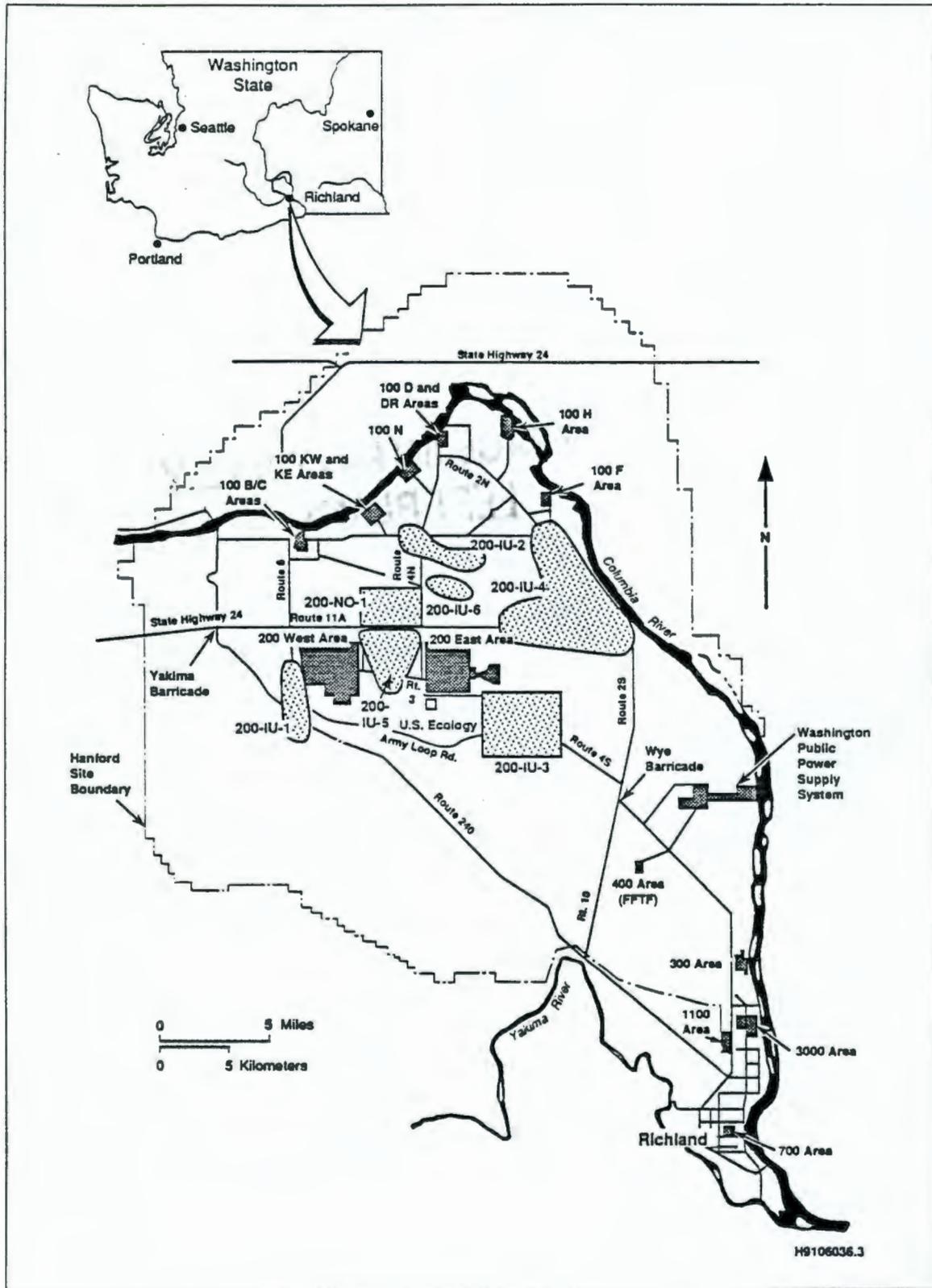


Figure 1-5. 200 NPL Site Isolated Operable Units.

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Table 1-1. Overall Aggregate Area Management Study (AAMS) Schedule for the 200 NPL Site.

AAMS Title	Operable Units	AAMS Type	Lead Regulatory Agency	M-27-00 Interim Milestones
U Plant	200-UP-1 200-UP-2 200-UP-3	Source	Ecology	M-27-02, January 1992
Z Plant	200-ZP-1 200-ZP-2 200-ZP-3	Source	EPA	M-27-03, February 1992
S Plant	200-RO-1 200-RO-2 200-RO-3 200-RO-4	Source	Ecology	M-27-04, March 1992
T Plant	200-TP-1 200-TP-2 200-TP-3 200-TP-4 200-TP-5 200-TP-6 200-SS-2	Source	EPA	M-27-05, April 1992
PUREX	200-PO-1 200-PO-2 200-PO-3 200-PO-4 200-PO-5 200-PO-6	Source	Ecology	M-27-06, May 1992
B Plant	200-BP-1 200-BP-2 200-BP-3 200-BP-4 200-BP-5 200-BP-6 200-BP-7 200-BP-8 200-BP-9 200-BP-10 200-BP-11 200-IU-6 200-SS-1	Source	EPA	M-27-07, June 1992
Semi-Works	200-SO-1	Source	Ecology	M-27-08, July 1992
200 North	200-NO-1	Source	EPA	M-27-09, August 1992
200 West	NA	Ground Water	EPA/Ecology	M-27-10, September 1992
200 East	NA	Ground Water	EPA/Ecology	M-27-11, September 1992

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2.0 FACILITY, PROCESS AND OPERATIONAL HISTORY DESCRIPTIONS

Section 2.0 of the aggregate area management study (AAMS) presents historical data on the Z Plant Aggregate Area and detailed physical descriptions of the individual waste management units and unplanned releases. These descriptions include historical data on waste sources and disposal practices and are based on a review of current and historical Hanford Site reports, engineering drawings, site inspections, and employee interviews. Section 3.0 describes the environmental setting of the waste management units. The waste types and volumes are qualitatively and quantitatively assessed at each site in Section 4.0. Data from these three sections are used to identify contaminants of concern (Section 5.0), potential applicable or relevant and appropriate requirements (ARARs) (Section 6.0) and current data gaps (Section 8.0).

This section describes the location of the Z Plant Aggregate Area (Section 2.1), summarizes the history of operations (Section 2.2), describes the facilities, buildings, and structures of the Z Plant Aggregate Area (Section 2.3), and describes Z Plant Aggregate Area waste generating processes (Section 2.4). Section 2.5 discusses interactions with other aggregate areas or operable units. Sections 2.6 and 2.7 discuss interactions with the Resource Conservation Recovery Act (RCRA) program and other Hanford programs.

2.1 LOCATION

The Hanford Site, operated by the DOE, occupies about 1,450 km² (560 mi²) of the southeastern part of Washington State north of the confluence of the Yakima and Columbia Rivers (Figure 1-1). The 200 West Area is a controlled area of approximately 8.3 km² (3.2 mi²) near the middle of the Hanford Site. The 200 West Area is about 8 km (5 mi) from the Columbia River and 11 km (6.8 mi) from the nearest Hanford boundary. There are 18 operable units grouped into four aggregate areas in the 200 West Area (Figure 1-4). The Z Plant Aggregate Area (consisting of operable units 200-ZP-1, 200-ZP-2, and 200-ZP-3) lies in the northwest corner of the 200 West Area of the Hanford Site (Figure 1-4).

Locations of 2-2 through 2-4 and 2-7 through 2-12 unplanned releases are shown on Figure 2-13. The location of the buildings and waste management units are shown on Figures. Plate 1 shows the topography of the Z Plant Aggregate Area. The media sampling locations are depicted on Plate 2.

2.2 HISTORY OF OPERATIONS

The Hanford Site, established in 1943, was originally designed, built, and operated to produce plutonium for nuclear weapons using production reactors and chemical reprocessing plants (DOE/RL 1988). In March 1943, construction began on three reactor facilities and three chemical processing facilities. After World War II, five more reactors were built. Beginning in the 1950s, waste management, energy research and development, isotope use, and other activities were added to the Hanford operation. In early 1964, a presidential decision was made to begin shut down of the reactors. Seven of the reactors were shut down by 1971 (DOE/RL 1988). The N Reactor operated in steam production mode from about 1971 to 1980 for electricity production, in weapons grade material production mode from 1980 to 1987; and was placed on cold standby status in October 1989, and was retired in 1991. Westinghouse Hanford Company (Westinghouse Hanford) was notified September 20, 1991, that they should cease preservation and proceed with activities leading to a decision on ultimate decommissioning of the reactor. These activities are scoped within the N Reactor shutdown program which is scheduled to be completed in 1999.

Operations in the 200 Areas (West and East) are mainly related to nuclear fuel separation. Spent nuclear fuel is fuel that has been withdrawn from a nuclear reactor following irradiation. The 200 West Area consists of four main processing areas (Figure 1-4):

- S Plant (REDOX) and T Plant, where initial processing to separate uranium and plutonium from irradiated fuel rods took place.
- U Plant, where uranium recovery operations took place.
- Z Plant, where plutonium conversion and scrap recovery took place.

The 200 Areas also contain nonradioactive support facilities, including transportation maintenance buildings, service stations, and coal-fired powerhouses for process steam production, steam transmission lines, raw water treatment plants, water-storage tanks, electrical maintenance facilities, and subsurface sewage disposal systems (DOE/RL 1988).

Construction of the nuclear reactors in the 100 Areas began in 1943. Irradiated fuel rods from the 100 Areas were shipped to separations facilities in the 200 Areas for initial processing to separate plutonium and uranium. Between 1945 and 1949, the output of this process, a plutonium nitrate solution, was concentrated into a plutonium nitrate paste in Z Plant before being shipped to Los Alamos for refinement into metallic plutonium. Beginning in 1949, plutonium finishing was conducted at the Z Plant Aggregate Area.

1 The major processes conducted in the Z Plant Aggregate Area included producing
2 metallic plutonium, and recovering plutonium and americium from plutonium scrap
3 solutions. A Z Plant Aggregate Area process timeline is schematically illustrated on
4 Figure 2-1.

5
6 The Plutonium Isolation Facility operated within the Z Plant Aggregate Area from
7 approximately 1945 to 1949. The primary Z Plant Aggregate Area facility is the 234-5Z
8 Building. This building housed the Plutonium Finishing Plant (PFP) and operated
9 continuously from 1949 to 1973 and intermittently between 1985 and 1988.

10
11 Beginning in 1955, additional process equipment was installed at the Z Plant
12 Aggregate Area to recover plutonium from PFP liquid waste streams. Two separate
13 types of plutonium separation operations occurred within the Z Plant Aggregate Area.
14 They included RECUPLEX and the Plutonium Reclamation Facility (PRF). The
15 RECUPLEX plutonium recovery process operated inside the 234-5Z Building from 1955
16 to 1962, at which time it was terminated after a criticality event (uncontrolled nuclear
17 reaction within the PFP). In 1964, a replacement scrap solution recovery facility, the
18 Plutonium Reclamation Facility (PRF), was brought on line in the 236-Z Building. The
19 PRF operated from 1964 to 1979 and from 1984 to 1987. The PRF was scheduled to
20 reactivate in 1991.

21
22 An additional Z Plant Aggregate Area recovery process operated in the 242-Z
23 Building between 1964 and 1976 to recover americium from the PFP waste stream. The
24 americium recovery process was shut down in 1976 after an explosion occurred in one of
25 the recovery units.

26
27 Operations of the PFP Remote Mechanical C (RMC) line and the PRF are
28 currently suspended. Pending completion of the PRF readiness review and regulatory
29 approval of the PFP Wastewater Sampling and Analysis Plan, operation of the PRF will
30 resume to stabilize scrap special nuclear material solutions. These solutions will then be
31 processed through the RMC line to produce stable Plutonium Oxide for long-term
32 storage. Future operations at PFP will be evaluated via National Environmental Policy
33 Act documentation to be prepared after the stabilization campaigns.

34 35 36 **2.3 FACILITIES, BUILDINGS, AND STRUCTURES**

37
38 The Z Plant Aggregate Area contains a large variety of waste disposal and storage
39 units in addition to its plutonium finishing and recovery facilities and support facilities.

40
41 High-level wastes were discharged to the soil column through cribs, trenches, and
42 other facilities. Low-level wastes such as cooling and condensate water were allowed to

1 infiltrate into the ground through ponds and open ditches. These waste types are defined
2 in DOE Order 5820.2:

- 3
- 4 ● High-level waste is highly radioactive waste material that results from the
5 reprocessing of spent nuclear fuel, including liquid waste produced directly
6 in reprocessing and any solid waste derived from the liquid, that contains a
7 combination of transuranic waste and fission products in concentrations as
8 to require permanent isolation.
 - 9
 - 10 ● Transuranic waste is defined as: without regard to source or form,
11 radioactive waste that at the end of institutional control periods is
12 contaminated with alpha-emitting transuranium radionuclides with half-lives
13 greater than 20 years and concentrations greater than 100 nCi/g. .
14 Regarding the Waste Isolation Pilot Plant, high-level waste and spent
15 nuclear fuel as defined by this Order are specifically excluded by this
16 definition.
 - 17
 - 18 ● Low-level waste is radioactive waste not classified as high-level waste,
19 transuranic waste, spent nuclear fuel, or byproduct material as defined by
20 the Order.
 - 21

22 Based on construction, purpose, or origin, the Z Plant Aggregate Area waste
23 management units fall into one of ten subgroups as follows:

- 24
- 25 ● Plants, Buildings, and Storage Areas (Section 2.3.1);
 - 26
 - 27 ● Tanks and Vaults (Section 2.3.2);
 - 28
 - 29 ● Cribs and Drains (Section 2.3.3);
 - 30
 - 31 ● Reverse Wells (Section 2.3.4);
 - 32
 - 33 ● Ponds, Ditches, and Trenches (Section 2.3.5);
 - 34
 - 35 ● Septic Tanks (Section 2.3.6);
 - 36
 - 37 ● Transfer Facilities, Diversion Boxes, and Pipelines (Section 2.3.7);
 - 38
 - 39 ● Basins (Section 2.3.8);
 - 40
 - 41 ● Burial Sites (Section 2.3.9); and
 - 42

- Unplanned Releases (Section 2.3.10).

Table 2-1 presents a list of the waste management units within the aggregate area. The locations of these waste management units are shown on separate figures for each waste management group (Figures 2-2 through 2-4 and 2-7 through 2-13). Figure 2-1 summarizes the operational history of each of the waste management units. Tables 2-2 and 2-3 summarize data identified regarding the quantity and types of waste disposed of to the waste management units. These data have been compiled from the Waste Information Data System (WIDS) inventory sheets (WHC 1991a) and other sources as specifically noted. The data presented in Tables 2-2 and 2-3 include all of the contaminants reported in the databases, but do not necessarily include all of the contaminants disposed of at each site. In the following sections, each waste management unit is described within the context of one of the waste management unit types.

No plants or buildings within the Z Plant Aggregate Area will be remediated as part of the general aggregate area study. However, the Z Plant plutonium separation/recovery process buildings (231-Z, 234-5Z, 236-Z, and 242-Z Buildings) and the Z Plant laboratories generated liquid wastes within the Z Plant Aggregate Area and will be described in Section 2.3.1.

Prior to 1977, liquid wastes generated in Z Plant Aggregate Area were generally disposed of to the soil column via various cribs, french drains, reverse wells, trenches, and tile fields. Subsequently, various engineering measures, not discussed in this report, were developed to reduce the overall volume of wastes generated. After 1977, high level and mixed liquid wastes were generally routed to the Tank Farms. Process condensates have not been discharged to cribs since 1972, and are currently transferred to 200 Areas tank farms for storage following treatment in the 241-Z Treatment Tank (Section 2.3.2.3). Non-process wastewater, e.g., non-contact cooling water and sanitary wastewater from standby activities is discharged to the soil column via the 216-Z-20 Crib and the 216-Z-21 Seepage Basin. The Seepage Basin is discussed in Section 2.3.8.2, and the 216-Z-20 Crib is discussed as part of the U Plant AAMS report (DOE/RL 1992). Sanitary wastes generated in the Z Plant complex are also disposed of to the soil column through septic tanks and associated drain fields. Solid wastes generated within Z Plant Aggregate Area and at other Hanford Site facilities are disposed of in the 218-W Burial Grounds. Accidental spills or releases (e.g., resulting from pipe leaks, overflows, or fires) of waste materials (unplanned releases) also occurred at various times and locations.

2.3.1 Plants, Buildings, and Storage Areas

Plants and buildings are not generally identified as past practice waste management units according to the Tri-Party Agreement and will generally be addressed

1 under the Hanford Surplus Facilities program (Section 2.7). Some plants and buildings
2 are or contain RCRA TSD facilities; a description of such facilities is provided in Section
3 2.6.
4

5 The main Z Plant Complex consists of four major facilities and a number of
6 ancillary structures which are located on Figure 2-2. The major facilities include the PFP
7 located in the 234-5Z Building, finished product inspection and testing laboratories
8 located in the 231-Z Building, the PRF located in the 236-Z Building, and the Americium
9 Recovery Facility located in the 242-Z Building. Other Z-Plant Aggregate Area facilities
10 include the 291-Z Building, the 2736-ZB Building, the 232-Z Incinerator Building, the
11 Hazardous Waste Staging Area (HWSA), and the Radioactive Mixed Waste Storage
12 Facility (RMWSF). The 232-Z Incinerator, the HWSA facility, the RMWSF facility, and
13 a waste treatment tank inside the 241-Z Building (241-Z Treatment Tank) are AAMS
14 waste management units. The 231-Z Building, the 242-Z Building, and the 232-Z
15 Building are inactive facilities. The 241-Z Treatment Tank is described in Section 2.3.2.3;
16 the 232-Z Incinerator and the HWSA and RMWSF facilities are described in Section
17 2.3.1.5. Z Plant building and facilities which are not AAMS waste management units are
18 described in Sections 2.3.1.1 through 2.3.1.5.
19

20 **2.3.1.1 234-5Z Building.** The 234-5Z Building is the site of the primary plutonium
21 finishing facility, the Plutonium Finishing Plant (PFP). First constructed in 1949, the
22 concrete and sheet metal multi-story building was later expanded to occupy 18,580 m²
23 (200,000 ft²). The 234-5Z Building housed the RECUPLEX process line which purified
24 and converted plutonium nitrate solutions to other usable plutonium forms or
25 compounds. RECUPLEX operated from 1955 through 1962 to reclaim additional
26 plutonium from the PFP liquid and solid wastes and scraps. RECUPLEX process wastes
27 included mixtures of tributylphosphate with carbon tetrachloride and acidic aqueous
28 wastes. The 216-Z-8 French Drain, the 216-Z-9 Crib, and a structure designated the 216-
29 Z-8 Settling Tank for the purpose of this study received RECUPLEX waste.
30

31 Three plutonium processing lines operated inside the 234-5Z building. They
32 included the RG-RB line (1949-1953), the RMA line (1953-1979), and the RMC line
33 (1969-1973 and 1985-1988). Section 2.4 provides a detailed description of wastes
34 generated from these process lines. Historically, liquid wastes generated from these
35 operations contained traces of plutonium and other transuranic elements which were
36 routed to the following waste sites:
37

- 38 ● 216-Z-1 & 216-Z-2 Cribs
- 39 ● 216-Z-3 Crib
- 40 ● 216-Z-12 Crib
- 41 ● 216-Z-1A Tile Field
- 42 ● 216-Z-19 Ditch

1 Wastes discharged to the 216-Z-1 and 216-Z-2 Cribs, 216-Z1A Tile Field, 216-Z-3
2 Crib, and 216-Z-12 Crib were routed through the 241-Z-361 Settling Tank prior to
3 discharge. Some of the process waste was also routed through the 241-Z Treatment
4 Tank (241-Z Building) prior to disposal.

5
6 The 216-Z-19 Ditch is discussed in the U Plant report.

7
8 In addition to the plutonium processing lines, the 234-5Z Building houses office
9 space, analytical and development laboratories, workshops, storerooms, and locker
10 rooms.

11
12 Currently, there are 80 potential contributors to the liquid effluent waste stream
13 (Jensen 1990). Potential contributors include equipment cooling water drains; heating,
14 ventilation, and air conditioning (HVAC) drains (condensate). This wastewater is
15 disposed of to the 216-Z-20 Crib, which is an active unit covered in the U Plant AAMSR.

16
17 **2.3.1.2 231-Z Building.** The 231-Z Building was the site of the Plutonium Isolation
18 Facility (PIF). The PIF operated from approximately 1945 to 1949 to condense the
19 plutonium nitrate solution from the separation process facilities into plutonium paste
20 prior to additional off-site processing. Several waste management units including the
21 216-Z-4 Trench, 216-Z-5 and 216-Z-6 Cribs, and the 216-Z-10 Reverse Well began
22 receiving liquid waste from the 231-Z Building in 1945.

23
24 After 1949, the 231-Z Building was used for metallurgical labs and offices for
25 research on plutonium and alloys. It is a 1,860 m² (20,000 ft²) structure which currently
26 houses inactive process cells and occupied office space. It is the only Z Plant building
27 located outside of the PFP Complex Protected Areas exclusion fence. Liquid process
28 wastes containing radioisotopes, dissolved metals, and other compounds were disposed of
29 from this facility via the 231-W-151 Sump to the following waste units:

- 30
31 ● 216-Z-4 Trench;
32 ● 216-Z-5 Cribs;
33 ● 216-Z-6 Crib;
34 ● 216-Z-7 Cribs;
35 ● 216-Z-16 Crib;
36 ● 216-Z-10 Reverse Well; and
37 ● 216-Z-17 Trench.

38
39 The 231-W-151 Sump has also been identified as the 231-Z-151 Diversion Box and
40 the 241-W-151 Sump Tank.

41

1 Process wastes from the 231-Z Building were previously discharged to the 216-Z-
2 1(D) Ditch, now abandoned and backfilled. The ditch was located east of the 231-Z
3 Building and ran south to the 216-U-10 Pond via the 216-Z-19 Ditch (abandoned and
4 backfilled) (Figure 2-6). The 216-U-10 Pond, discussed in the U Plant AAMSR
5 (DOE/RL 1992) was located in the southwest corner of the 200 West Area. At its
6 maximum extent, including the overflow trenches, the pond covered approximately 12
7 hectares (30 acres). The 216-Z-1(D) Ditch and 216-Z-19 Ditch are discussed in the U
8 Plant AAMSR.

9
10 Currently, the 231-Z Building is only used for office space. Routine effluents from
11 the building include cooling water and condensate from the HVAC systems. There are
12 four potential contributors to the effluent waste stream from these sources which
13 comprise 8 individual contributors. These wastes are discharged to the 216-Z-20 Crib.
14 The 216-Z-20 Crib is discussed in the U Plant AAMSR.

15
16 Sanitary wastewaters from the 231-Z Building (5.45 cubic meters per day [m^3/d])
17 discharge through the 2607-W-8 Septic Tank to a sanitary drainfield northeast of the 231-
18 Z Building (Figure 2-9).

19
20 **2.3.1.3 236-Z Building.** The 236-Z Building housed the PRF process lines. The purpose
21 of this operation was to recover plutonium from scrap solutions within the PFP and other
22 DOE facilities. The 236-Z Building is a six-story 520 m^2 (5,600 ft^2) reinforced concrete
23 structure. Multiple floor levels house process and supporting facilities used for the
24 plutonium reclamation operations.

25
26 PRF process wastes were similar to the RECUPLEX wastes; in addition, dibutyl
27 butyl phosphonate (DBBP) was used in the PRF process. Plutonium recovery process
28 wastes were routed to the 241-Z-361 Settling Tank before being discharged to cribs and
29 trenches in the Z Plant Aggregate Area. The 216-Z-1A Tile Field, the 216-Z-1 and 216-
30 Z-2 Cribs, and the 216-Z-18 Crib received PRF process waste.

31
32 The plutonium recovery facilities are currently idle. Low level wastewater
33 including equipment cooling water, HVAC condensate, process cooling water, and steam
34 condensate discharge to three piping drain headers which route the effluents to the 216-
35 Z-20 Crib. The 216-Z-20 Crib is an active liquid waste disposal unit which is a U Plant
36 Aggregate Area waste management unit, and is not discussed further in this report.
37 There are currently 41 potential contributors to the effluent waste stream. Potential
38 contributors include equipment cooling water drains and HVAC drains.

39
40 **2.3.1.4 242-Z Building.** The 242-Z Building housed the Americium Recovery process
41 line. The 93 m^2 (1,000 ft^2) building was used from 1964 to 1976 to recover americium
42 from the PFP process line.

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1 Liquid wastes from the Americium Recovery process line consisted of
2 concentrated nitric acid with traces of transuranic elements and metals. DBBP was also
3 used in the americium recovery process. This waste stream was routed to the 241-Z-361
4 Settling Tank and then discharged to the 216-Z-1A Tile Field and the 216-Z-18 Crib.
5 Beginning in 1973, these wastes were routed to the 242-T Evaporator.
6

7 Currently, there are no routine effluent contributors from this building. The
8 building has been idle since 1962. A single piping drain header carries condensate
9 effluent from this building to the 216-Z-20 Crib (discussed in U Plant AAMSR, DOE/RL
10 1992).
11

12 **2.3.1.5 241-Z Building.** The 241-Z Treatment Tank, also referred to as Tank D-5 and
13 TK-5, is an active waste management unit located inside the 241-Z Building. The 241-Z
14 Building is located south of the 234-5Z Building (Figure 2-2). The building houses the
15 241-Z Treatment Tank and four waste sumps. The 241-Z Building structure is also
16 referred to as a storage tank pit. The General Electric Co. drawing shows the 241-Z
17 Building as a subsurface structure with a concrete floor, side walls, and internal walls
18 separating each tank compartment. The structure has a ground-level concrete cover, and
19 above-ground sheet-metal housing for utility piping and electrical components. The 241-
20 Z (D-5) Treatment Tank is the easternmost of the tanks within the building.
21

22 **2.3.1.6 Other Buildings and Facilities.**

23 **2.3.1.6.1 232-Z Incinerator.** The 232-Z Incinerator is an inactive Aggregate Area
24 waste management unit located on the southwest side of the 234-5Z Building (Figure 2-
25 2). The 186 m² (2,000 ft²) building housed the dry waste incinerator from 1961 to 1973
26 to incinerate plutonium-contaminated solid wastes in preparation for plutonium recovery.
27 The building also housed equipment used for supporting operations such as offgas
28 treatment and leaching. The first floor contained a storage room, electrical equipment
29 room, a process room containing waste handling equipment, a chemical mixing room, and
30 a change room. The second story housed the building heating and ventilation equipment.
31 The building has been inactive since 1973 and there are currently no routine contributors
32 to the effluent waste stream. The 232-Z Incinerator Building is scheduled for
33 decommissioning in Fiscal Year 1999 under the Hanford Surplus Facilities Program.
34
35

36
37 Historically, the 216-Z-1A Tile Field received aqueous wastes from the 232-Z
38 Incinerator, but the nature and quantity of these wastes is unknown.
39

40 A piping drain header leads from this building to the 216-Z-20 Crib. There is no
41 process solution contact with the 216-Z-20 Crib effluents under normal operating

1 conditions. The drain header is a condensate drain header. The 216-Z-20 Crib is a U
2 Plant AAMS (DOE/RL 1992) waste management unit.

3
4 No releases to the soil column have been reported at this site.

5
6 **2.3.1.6.2 234-5Z Hazardous Waste Staging Area (HWSA).** The HWSA facility is
7 an active RCRA generator waste accumulation area. Alternately called the Hazardous
8 Waste Storage Area, this asphalt pad is located on the east side of the 234-5Z Building
9 (Figure 2-2). The eastern pad is located about 15.3 m (50 ft) east of the eastern wall of
10 the building, along the inner security fence line and has stored containerized wastes.
11 Wastes typically contained in the staging area over the course of a year included waste
12 nitrates and other oxidizers, benzenes, process chemicals, and carbon tetrachloride. No
13 releases are known to have occurred at this site.

14
15 **2.3.1.6.3 Radioactive Mixed Waste Storage Facility (RMWSF).** The RMWSF is
16 an active RCRA TSD facility which consists of twelve small buildings used to temporarily
17 store designated mixed waste (Figure 2-2). The unit was started in 1988 on the west side
18 of Dayton Avenue, west of the 218-W-2 Burial Ground. The site has handled 287 m³ of
19 waste (Table 2-2).

20
21 No spills or releases have been reported at this facility.

22
23 **2.3.1.6.4 291-Z Building.** The 291-Z Building houses the ventilation exhaust fans,
24 instrument air compressors, and vacuum pumps to handle all ventilation exhaust from the
25 234-5Z, 236-Z, 242-Z Buildings and formerly the 232-Z Building. It is a 1,300 m² (14,000
26 ft²) building.

27
28 Routine effluents from the 291-Z Building include non-contact cooling and
29 condensate wastewater from HVAC equipment, cooling water for the compressors, and
30 vacuum-pump seal water. These wastes were discharged to the following units:

- 31
- 32 ● 216-Z-13 French Drain
 - 33 ● 216-Z-14 French Drain
 - 34 ● 216-Z-15 French Drain
 - 35 ● 216-Z-1(D) Ditch
- 36

37 Currently, there is one drain header which discharges effluents from the 291-Z
38 Building to the 216-Z-20 Crib. There are 12 potential contributors to the waste stream
39 including floor drains and sinks (WHC 1990b). As previously discussed (Section 2.3.1.2),
40 the 216-Z-1(D) Ditch and the 216-Z-20 Crib to which 291-Z Building effluents were
41 discharged are a U Plant Aggregate Area waste management unit (DOE/RL 1992).

1 **2.3.1.6.5 2736-ZB Building.** The 2736-ZB Building, constructed in 1983, was used
2 for plutonium product handling operations. The 1,950 m² (21,000 ft²) building is
3 separated into a front section and a back section. The front section consists of
4 administrative areas. The back section was where storage and handling of the finished
5 plutonium product occurred. This process included the storage and handling of
6 radioactive solid waste product material.

7
8 Routine effluents from the building currently are limited to cooling and
9 condensation wastewater from HVAC equipment and air compressors. There are no
10 potential contributors to the effluent waste stream.

11
12 **2.3.1.6.6 Waste Receiving and Processing (WRAP) Facility.** The proposed
13 WRAP will be a permitted RCRA TSD facility designed to process existing drummed
14 mixed waste. The first phase of the project, drum recovery and repackaging is expected
15 to come online in mid-1993. A second phase of the project will include constructing a
16 mixed waste incinerator and incinerating the repackaged drums. The proposed WRAP
17 facility will be located in the general vicinity of the Radioactive Mixed Waste Storage
18 Facility, west of the 218-W-2 Burial Ground (Figure 2-2).

19
20 No wastes are currently associated with this proposed facility.

21 22 23 **2.3.2 Tanks and Vaults**

24
25 Tanks and vaults were constructed to handle and store liquid wastes generated by
26 uranium and plutonium processing activities. Several types of tanks are present in the Z
27 Plant Aggregate Area including settling tanks, septic tanks, and a treatment tank. Septic
28 tanks are discussed in Section 2.3.6. No vaults were identified with the Z Plant
29 Aggregate Area.

30
31 Z Plant tanks are fully enclosed above-ground or underground containment
32 vessels. The liquid waste settlement and treatment tanks were generally connected by
33 underground pipelines to other Z Plant waste management units.

34
35 WHC (1991a) identifies two liquid waste holding (settling and treatment) tanks
36 within the Z Plant Aggregate Area, the 241-Z-361 Settling Tank and the 241-Z
37 Treatment Tank. A review of Hanford drawings identified a third tank, commonly
38 referred to as the Silica Gel Settling Tank which has been designated as the 216-Z-8
39 Settling Tank for the purposes of this report.

40
41 Sections 2.3.2.1 through 2.3.2.3 describe the history, construction, and operation of
42 each of these facilities.

1 **2.3.2.1 216-Z-8 Settling Tank.** The 216-Z-8 Settling Tank is an inactive waste
2 management unit located on the east side of the 234-5Z Building, 6.1 m (20 ft) west of
3 the 216-Z-8 French Drain (Figure 2-3). The 57,000-liter (15,000-gallon) carbon steel tank
4 was used as a solids settling tank for a backflush of the feed filters for the RECUPLEX
5 process. Liquid waste overflowed from the 216-Z-8 Settling Tank to the 216-Z-8 French
6 Drain where it was disposed of to the soil column. Use of the tank was discontinued in
7 April 1962, when the RECUPLEX process line was shut down.

8
9 No releases are associated with this tank. Fluid level measurements in April 1974,
10 indicated that the tank contained 29,081.4 liters (7,653 gallons) of liquid and 1,888.6 liters
11 (497 gallons) of sludge. The plutonium content of the tank was estimated to be 1.6 kg in
12 1974.

13
14 The 216-Z-8 Settling Tank has also been identified as the Silica Gel Settling Tank.

15
16 **2.3.2.2 241-Z-361 Settling Tank.** The 241-Z-361 Settling Tank is an inactive waste
17 management unit located approximately 106.8 m (350 ft) south of the 234-5Z Building
18 (Figure 2-3). The underground, steel-lined, concrete tank is 4.6 m (15 ft) wide by 8.5 m
19 (28 ft) long with a sloping bottom. The height of the tank varies between 5.8 m (19 ft)
20 and 6.1 m (20 ft). The 241-Z-361 Settling Tank served as a settling tank for liquid wastes
21 routed to the 216-Z-1A Tile Field and the 216-Z-1, 216-Z-2, 216-Z-3, 216-Z-12, and 216-
22 Z-18 Cribs from the PFP (234-5Z Building), PRF (236-Z Building), and 242-Z Building.
23 The 241-Z-361 Settling Tank was used between 1949 and 1976 (Figure 2-1).

24
25 No releases are associated with this tank. The WIDS (WHC 1991a) indicates that
26 this unit received liquid waste estimated to contain 30 to 75 kg of plutonium (1 mrem/hr
27 gamma; 0.8 mrem/hr neutron). However, information as to what part of that waste was
28 retained in the settling tank was not found.

29
30 The 241-Z-361 Settling Tank has also been identified as 207-Z Settling Tank.

31
32 **2.3.2.3 241-Z Treatment Tank.** The 241-Z Treatment Tank is a RCRA TSD facility.
33 The Treatment Tank receives and treats corrosive liquid waste from the PFP in the 234-
34 5Z Building. The corrosive liquid waste is treated by addition of caustic soda, to increase
35 aluminum compound solubility in the tank. The WIDS indicated that the 241-Z
36 Treatment Tank is designed to treat a maximum of 20,140 liters (5,300 gallons) per day.
37 The nominal outflow from the tank was approximately 58,900 liters (10,200 gallons) per
38 week. After treatment, the liquid wastes are transferred via pipeline to a receiver tank in
39 the 244TX Tank Farm north of Z Plant. The wastes are then rerouted to various
40 Hanford Site tank farms. Currently, PFP wastes are routed to tank 102-SY.

41

9 3 1 2 8 6 5 0 6 6 8

1 No known releases are directly associated with the 241-Z Treatment Tank. An
2 unplanned release, UN-200-W-79 (Table 2-5), occurred when an influent pH line (D-6
3 transfer line) failed adjacent to the 241-Z Treatment Tank. Section 2.3.10 describes the
4 unplanned release in more detail.
5
6

7 **2.3.3 Cribs and Drains**

8

9 The cribs and drains were designed to inject or percolate wastewater into the
10 ground without exposing it to the open air. The locations of cribs and drains in the Z
11 Plant Aggregate Area are shown on Figure 2-4. Cribs are shallow excavations that are
12 either backfilled with permeable material or held open by wood structures. Both types of
13 cribs are covered with an impermeable layer. Water flows directly into the backfilled
14 material or covered open space and percolates into the vadose zone soils. A typical crib
15 is illustrated on Figure 2-5. French drains inject wastewater into the ground at a greater
16 depth than the cribs. They are generally constructed of steel or concrete pipe and may
17 either be open or filled with gravel. A typical French drain is illustrated on Figure 2-6.
18 The 216-Z-1A Tile Field is similar in design and operation to the cribs and is thus also
19 discussed in this section.
20

21 WHC 1990a identifies nine cribs, four french drains, and one tile field within the
22 Z Plant Aggregate Area. The cribs, drains, and tile fields identified include the following:
23

- 24 ● 216-Z-1 and 216-Z-2 Cribs
 - 25 ● 216-Z-3 Crib
 - 26 ● 216-Z-5 Crib
 - 27 ● 216-Z-6 Crib
 - 28 ● 216-Z-7 Crib
 - 29 ● 216-Z-12 Crib
 - 30 ● 216-Z-16 Crib
 - 31 ● 216-Z-18 Crib
 - 32 ● 216-Z-8 French Drain
 - 33 ● 216-Z-13 French Drain
 - 34 ● 216-Z-14 French Drain
 - 35 ● 216-Z-15 French Drain
 - 36 ● 216-Z-1A Tile Field
- 37

38 Sections 2.3.3.1 through 2.3.3.14 describe the history, construction, and operation
39 of each of these facilities. Tables 2-2, 2-3, and 2-4 present available information
40 regarding sources of and inventories of wastes disposed of to these waste management
41 units. Locations of these waste management units are identified on Figure 2-4.
42

1 **2.3.3.1 216-Z-1 and 216-Z-2 Cribs.** The 216-Z-1 and 216-Z-2 Cribs are inactive waste
2 management units located approximately 122 m (400 ft) south of the 234-5Z Building.
3 Each crib consists of a wood-lined box 3.7 by 3.7 by 4.3 m (12 by 12 by 14 ft) high set
4 and backfilled with gravel in a 6.4 m (21 ft) deep excavation.
5

6 The cribs received liquid process wastes from the 234-5Z Building from June 1949
7 until June 1952. The cribs received aqueous and organic wastes from the PRF for one
8 month in 1966 and one month in 1967. The cribs received PRF process waste and
9 americium recovery line wastes from the 236-Z and 242-Z Buildings from March 1968 to
10 April 1969. From March 1968 to April 1969, the cribs received uranium wastes from
11 236-Z Building (Stenner et al. 1988).
12

13 Figure 2-10 shows the location of the pipeline which carried process wastes from
14 the 234-5Z Building to the 216-Z-2 Crib via the 216-Z-361 Settling Tank. The 216-Z-2
15 Crib overflowed into the 216-Z-1 Crib which then overflowed into the 216-Z-1A Tile
16 Field.
17

18 No unplanned releases were associated with these cribs.
19

20 The 216-Z-1 and 216-Z-2 Cribs have also been identified as the 234-5 No. 2 Crib
21 and the "216-Z-7".
22

23 **2.3.3.2 216-Z-3 Crib.** The 216-Z-3 Crib is an inactive waste management unit located
24 approximately 122 m (400 ft) south of the 234-5Z Building, due east of the 216-Z-1 and
25 216-Z-2 Cribs. The 216-Z-3 Crib consists of three 1.2 m diameter (4 ft) by 6.7 m (22 ft)
26 long perforated corrugated culverts laid end to end in a 7.6 m (25 ft) deep excavation.
27 The culverts were laid horizontally on gravel fill 4.6 m (15 ft) above the crib bottom.
28 The excavation was then backfilled to surrounding grade.
29

30 The 216-Z-3 Crib received neutral/basic process waste and analytical and
31 development laboratory wastes from the 234-5Z Building via the 207-Z-361 Settling Tank
32 from June 1952 to March 1959.
33

34 No unplanned releases were associated with this crib.
35

36 The 216-Z-3 Crib has also been identified as the 216-Z-3 Culvert, the 234-5 No. 3
37 and No. 4 Cribs, and the 216-Z-8 Crib.
38

39 **2.3.3.3 216-Z-5 Crib.** The 216-Z-5 Crib is an inactive waste management unit located
40 approximately 660 m (200 ft) northeast of the 231-Z Building. The 216-Z-5 Crib consists
41 of two wooden boxes, each 3.7 by 3.7 by 1.2 m (12 by 12 by 4 ft) high, placed in 5.6 m
42 (18 ft) deep excavations constructed with 1:1 side slopes.

9 3 1 2 8 6 5 0 6 7 0

1 The 216-Z-5 Crib received 231-Z Building process waste via the 231-W-151 Sump.
2 The 216-Z-5 Crib was used to dispose of liquid waste to the soil column from June 1945
3 until February 1947. Use of the 216-Z-5 Crib was discontinued when sludge in the waste
4 plugged the soil. The cap on the 216-Z-5 Crib has reportedly weakened (WHC 1991a)
5 creating a cave-in potential.

6
7 No unplanned releases were associated with this crib.

8
9 The 216-Z-5 Crib has also been identified as the 231-W-1 and 231-W-2 Cribs and
10 the 231-W Sumps.

11
12 **2.3.3.4 216-Z-6 Crib.** The 216-Z-6 Crib is an inactive waste management unit located
13 approximately 91.5 m (300 ft) east of the 231-Z Building and 61 m (200 ft) north of 19th
14 Street. The Crib consists of a wooden box 15.3 m (50 ft) long by 2.0 m (6.5 ft) wide by
15 0.6 m (2 ft) high, placed in a 2.4 m (8 ft) deep excavation.

16
17 The 216-Z-6 Crib received process waste from the 231-Z Building via the 231-W-
18 151 Sump for one month in June 1945. Use of the crib was discontinued due to plugging
19 of the surrounding soil by process sludge and precipitates. The cap on the 216-Z-6 Crib
20 has reportedly weakened (WHC 1991a) creating a cave-in potential.

21
22 No unplanned releases were associated with this crib.

23
24 The 216-Z-6 Crib has also been identified as the 231-W-4 Crib, the 226-W-4 Crib,
25 and the 231-Z-6 Crib.

26
27 **2.3.3.5 216-Z-7 Crib.** The 216-Z-7 Crib is an inactive waste management unit located
28 approximately 152.5 m (500 ft) east of the 231-Z Building and about 137.3 m (450 ft)
29 north of 19th Street. The 216-Z-7 Crib consists of two parallel wooden structures 45.7 m
30 (150 ft) long by 1.5 m (5 ft) wide by 0.6 m (2 ft) high, placed in a 1.5 m (5 ft) deep
31 excavation. Each wooden structure was constructed of three overlapping tiers. A 45.8 m
32 (150 ft) long 7.5 or 10 cm (3 or 4 inch) diameter perforated distribution pipe runs above
33 the second tier. Each of the two trenches is covered by 503.3 m (1,650 ft) of 5 cm (2-
34 inch) planking, then tar paper. The excavation was backfilled with gravel.

35
36 The 216-Z-7 Crib received process waste from the 231-Z Building via the 231-W-
37 151 Sump from February 1947 to February 1967. The 216-Z-7 Crib replaced the 216-Z-5
38 Crib. It also received Hanford Laboratory waste from the 231-Z Building, via the 231-W-
39 151 Sump. In addition, the site received waste from PNL operations in 231-Z Building,
40 and 300 Area laboratory waste from the 340 Facility (WHC 1991a). In total, the site
41 received an estimated 79,900,000 liters of liquid waste.

42

1 No unplanned releases were associated with this crib.
2

3 The 216-Z-7 Crib has also been identified as the 231-W Trench, the 231-W Crib,
4 and the 231-Z-6 Crib.
5

6 **2.3.3.6 216-Z-12 Crib.** The 216-Z-12 Crib is an inactive waste management unit located
7 approximately 122 m (400 ft) southwest of the 234-5Z Building. The 216-Z-12 Crib
8 consists of a 91.5 by 6.1 by 6.1 m (300 by 20 by 20 ft) deep excavation with 1.5 m (5 ft)
9 of gravel in the bottom backfilled to grade. A 30 cm (12 inch) diameter, perforated,
10 vitrified clay pipe runs the length of the crib, 1.2 m (4 ft) above the crib bottom. In July
11 1968, a 15 cm (6 inch) diameter schedule 10 pipe was run parallel to and 9.2 m (30 ft)
12 west of the original line. The new line bypassed 30.5 m (100 ft) of the original line. The
13 original line was plugged upstream from the junction of the two lines.
14

15 The site received PFP process waste and analytical and development laboratory
16 waste from the 234-5Z Building via the 241-Z-361 Settling Tank. The crib's active life
17 was from 1959 to 1973. The slightly acidic, low-salt waste was adjusted to a pH range of
18 8 to 10 before disposal. The 216-Z-12 Crib reportedly received 281,000,000 liters of
19 liquid waste which included 25.1 kg of plutonium (WHC 1991a).
20

21 No unplanned releases were associated with this crib.
22

23 The 216-Z-12 Crib has also been identified as the 207-Z-12 Crib.
24

25 **2.3.3.7 216-Z-16 Crib.** The 216-Z-16 Crib is an inactive waste management unit located
26 about 76.3 m (250 ft) northwest of the 231-Z Building. The 216-Z-16 Crib consists of an
27 excavation 54.9 by 3.1 by 4.6 m (180 by 10 by 15 ft) deep with 1.5 m (5 ft) of gravel in
28 the bottom. A perforated 10 cm (4 inch) diameter PVC pipe runs down the crib center,
29 1.2 m (4 ft) above the bottom of the excavation. A polyethylene vapor barrier was
30 placed over the gravel, then covered with 10 cm (4 inches) of sand, and earth backfill to
31 grade.
32

33 The 216-Z-16 Crib received 231-Z Building laboratory waste from PNL operations
34 from March 1968 to January 1977. The WIDS (WHC 1991a) indicates that the 216-Z-16
35 Crib received 102,000,000 liters of neutral/basic liquid waste containing approximately
36 0.072 kg of plutonium.
37

38 No unplanned releases are associated with this crib.
39

40 This waste management unit has not been identified by any other designation than
41 the 216-Z-16 Crib.
42

1 **2.3.3.8 216-Z-18 Crib.** The 216-Z-18 Crib is an inactive waste management unit located
2 approximately 183 m (600 ft) south of the 234-5Z Building which received wastes via the
3 241-Z-361 Settling Tank. The 216-Z-18 Crib consists of five parallel excavations, each
4 63.1 m (207 ft) by 3.1 m (10 ft) with depths ranging from 4.6 to 5.5 m (15 to 18 ft). A
5 91.5 m (300 ft) long 7.5 cm (3 inch) diameter steel pipe runs east and west, bisecting the
6 length of each excavation. Two 30.5 m (100 ft) long, 7.5 cm (3 inch) diameter,
7 perforated, fiberglass-reinforced epoxy pipes exit each side of the steel pipe in each
8 excavation (2 lines north, 2 lines south). The distribution pipes are 0.3 m (1 ft) above
9 the crib bottom in a 0.6 m (2 ft) thick bed of 3.8 to 7.5 cm (1.5 to 3 inch) gravel. Each
10 excavation was backfilled to grade.

11
12 From April 1969 to May 1973, the 216-Z-18 Crib received both extraction column
13 solvent and acidic aqueous waste from the PRF in the 236-Z Building. The WIDS
14 (WHC 1991a) indicates that the 216-Z-18 Crib received 3.86 million liters of high salt,
15 acidic, organic liquid waste. The wastes disposed of to the crib included approximately
16 175,000 kg of carbon tetrachloride, 22,000 kg of tributyl phosphate, and 15,000 kg of
17 DBBP (Stenner et al. 1988). Approximately 23,000 grams of plutonium were disposed of
18 to the 216-Z-18 Crib.

19
20 No unplanned releases are associated with this crib.

21
22 This waste management unit has not been identified by any other designation than
23 the 216-Z-18 Crib.

24
25 **2.3.3.9 216-Z-8 French Drain.** The 216-Z-8 French Drain is an inactive liquid waste
26 management unit located 41.5 m (300 ft) east of the 234-5Z Building and 61 m (200 ft)
27 south of 19th street. The 216-Z-8 French Drain consists of two 90 cm (36 inch) diameter
28 tile culverts stacked on end in a 5.2 m (17 ft) deep gravel-backfilled excavation. The unit
29 received neutral to basic RECUPLEX process waste via the adjacent 216-Z-8 Settling
30 Tank (Silica Gel Tank) between July 1955 and April 1962.

31
32 No unplanned releases are associated with the 216-Z-8 French Drain.

33
34 The 216-Z-8 French Drain has also been identified as the 234-5 RECUPLEX
35 French Drain, "216-Z-9", and the 216-Z-8 Crib.

36
37 **2.3.3.10 216-Z-13 French Drain.** The 216-Z-13 French Drain is an active non-contact
38 wastewater management unit located 58.0 m (190 ft) south of the 234-5Z Building on the
39 southeast side of the 291-Z Building. The 216-Z-13 French Drain consists of two 90 cm
40 (36 inch) diameter tile culverts stacked on end in a 4.6 m (15 ft) deep gravel-backfilled
41 excavation. The unit has operated continuously from 1949 to present (Figure 2-1). The

1 216-Z-13 French Drain receives steam condensate from the ET-8 Exhaust fan turbine
2 and floor drainage from the 291-Z Building.

3
4 No releases of hazardous materials or radionuclides have been reported for this
5 unit. However, due to accidents or unusual events in the process areas, Owens (1981)
6 reports that low level contamination can be assumed.

7
8 This waste management unit has not been identified by any other designation than
9 the 216-Z-13 French Drain.

10
11 **2.3.3.11 216-Z-14 French Drain.** The 216-Z-14 French Drain is an active non-contact
12 wastewater management unit located 58 m (190 ft) south of the 234-5Z Building on the
13 southwest side of the 291-Z ventilation equipment building. The 216-Z-14 French Drain
14 consists of two 90 centimeter (36 inch) diameter tile culverts stacked on end in a 4.6 m
15 (15 ft) deep gravel-backfilled excavation. The unit has operated continuously from 1949
16 to present (Figure 2-1). The 216-Z-14 French Drain receives steam condensate from the
17 ET-9 Exhaust fan turbine and floor drainage from the 291-Z Building.

18
19 No releases of hazardous materials or radionuclides have been reported for this
20 unit. However, due to accidents or unusual events in the process areas, Owens (1981)
21 reports that low level contamination can be assumed.

22
23 This waste management unit has not been identified by any other designation than
24 the 216-Z-14 French Drain.

25
26 **2.3.3.12 216-Z-15 French Drain.** The 216-Z-15 French Drain is an active non-contact
27 wastewater disposal unit located 15.3 m (50 ft) south of the 234-5Z Building on the north
28 side of the 291-Z ventilation equipment building. The 216-Z-15 French Drain consists of
29 two 90 centimeter (36 inch) diameter tile culverts stacked on end in a 4.9 m (16 ft) deep
30 gravel-backfilled excavation. The unit has operated continuously from 1949 to present
31 (Figure 2-2). The 216-Z-15 French Drain receives drainage from the S-12 evaporator
32 cooler.

33
34 No releases of hazardous materials or radionuclides have been reported for this
35 unit. However, due to accidents or unusual events in the process areas, Owens (1981)
36 low level contamination can be assumed.

37
38 This waste management unit has not been identified by any other designation than
39 the 216-Z-15 French Drain.

1 **2.3.3.13 Other French Drains.** A "french drain/dry well" (0.92 m [3 ft] diameter) is
 2 reportedly located north of the 234-5Z Building and west of the 241-Z Building. The dry
 3 well is connected to piping leading beneath an adjacent fire suppression water tank and
 4 may be a drainage structure for the tank overflow. No other information was identified.
 5

6 **2.3.3.14 216-Z-1A Tile Field.** The 216-Z-1A Tile Field is an inactive waste management
 7 unit located about 152.5 m (500 ft) south of the 234-5Z Building and immediately south
 8 of the 216-Z-1 and 216-Z-2 Cribs. The 216-Z-1A Tile Field consists of a 85.4 m (280 ft)
 9 long north-south running trunk with seven pairs of 21.4 m (70 ft) laterals spaced at 10.7
 10 m (35 ft) intervals in a herring-bone pattern (WIDS; WHC 1991a). The tile field piping
 11 consists of 20 cm (8 inch) diameter perforated vitrified clay pipe placed on a 1.5 m (5 ft)
 12 deep gravel bed, 5.8 m (19 ft) below ground surface (Figure 2-10).
 13

14 The 216-Z-1A Tile Field's active life was from June 1949 to April 1969. As
 15 originally constructed, the 216-Z-1A Tile Field received liquid waste as overflow from the
 16 216-Z-1 and 216-Z-2 Cribs. In later years, liquid waste was routed directly to the tile
 17 field. Available information indicates that the discharge history of the 216-Z-1A Tile
 18 Field proceeded roughly as follows:
 19

SERVICE DATES		FUNCTION
FROM	TO	
6/49	6/52	216-Z-1 and 216-Z-2 Cribs and the 216-Z-1A Tile Field received process, analytical, and development lab wastes from 234-5Z Building via the 241-Z-361 Settling Tank.
6/52	3/59	216-Z-1 and 216-Z-2 Cribs were bypassed. 216-Z-1A Tile Field received the above wastes via overflow from 216-Z-3 Crib.
3/59	5/64	All portions of this site were inactive.
5/64	8/64	216-Z-1 and 216-Z-2 Cribs were still inactive. 216-Z-1A Tile Field received aqueous and organic waste from PRF (236-Z Building).
8/64	5/66	Same as above plus received 242-Z Building Waste and Americium Recovery (242-Z) waste.
5/66	6/66	216-Z-1 and 216-Z-2 Cribs and 216-Z-1A Tile Field received 236-Z Building aqueous and organic waste and 242-Z Building waste while the distribution point in 216-Z-1A Tile Field was moved from the A section 30.5 m (100 ft) down the main trunk to the B section.

SERVICE DATES		FUNCTION
FROM	TO	
6/66	10/67	216-Z-1 and 216-Z-2 Cribs were inactive; section B of the 216-Z-1A Tile Field received aqueous and organic waste from 236-Z Building and from the 242-Z Building, while the discharge point on 216-Z-1A was moved 23 m (75 ft) further down the main trunk.
10/67	10/67	216-Z-1 and 216-Z-2 Cribs received 236-Z and 242-Z Building wastes while the discharge point in the 216-2-1A Tile Field was moved 23 m (75 ft) further down the main trunk from the B section to the C section.
10/67	3/68	216-Z-1 and 216-Z-2 Cribs were inactive; 216-Z-1A Tile Field received 236-Z and 242-Z Building wastes.
3/68	4/69	216-Z-1A Tile Field continued to receive the above wastes; 216-Z-1 and 216-Z-2 Cribs received uranium wastes from 236-Z Building.
4/69	-	All portions of the 216-Z-1, 216-Z-2, 216-Z-3 Cribs and 216-Z-1A Tile Field were retired.

The 216-Z-1A Tile Field received approximately 6.2 million liters of liquid waste. Other sources report only 5.21 million liters of fluid disposed of to the 216-Z-1A Tile Field and the WIDS reports only 1.0 million liters of fluid disposed. Material discharged to the tile field reportedly included 268,000 kg of carbon tetrachloride, 30,000 kg of TBP, and 20,300 kg of DBBP.

No unplanned releases were associated with the 216-Z-1A Tile Field.

The 216-Z-1A Tile Field has also been identified as the 234-5 Tile Field and the "216-Z-7".

2.3.4 Reverse Wells

Reverse wells are buried or covered encased drilled holes with the lower end perforated or open to allow liquid to seep to the ground. These units injected waste water into the ground at depths greater than the cribs and drains described above. Reverse wells are generally constructed of steel or concrete pipe and may either be open or filled with gravel.

Reverse wells were used for the disposal of low-level liquid wastes in the early phases of Hanford Site (and Z Plant) operations, but proved unsatisfactory because they plugged easily and introduced the waste into the ground at or near the water table

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1 (Brown and Ruppert 1950). Therefore, by 1954, all reverse wells at the Hanford Site
2 had been removed from service; associated wastes were re-routed to cribs and other
3 types of ground disposal units (Fecht et al. 1977).
4

5 One reverse well, the 216-Z-10 Reverse Well, is located within the Z Plant
6 Aggregate Area (Figure 2-7). Sources of waste disposed of to the reverse well are
7 summarized in Table 2-1. Tables 2-2 and 2-3 summarize available information regarding
8 quantities and types of chemical constituents disposed of to this waste management unit.
9

10 The 216-Z-10 Reverse Well is an inactive, wastewater management unit. It is a
11 145.8 m (50 ft) deep underground injection well constructed of 15.2 cm (6 inch) diameter
12 schedule 50 steel pipe. The 216-Z-10 Reverse Well is located 30.5 m (100 ft) east of the
13 231-Z Building and 122 m (400 ft) north of 19th Street. The reverse well received 231-Z
14 Building process and laboratory waste via the 231-W-151 Sump for four months between
15 February and June 1945 (Figure 2-1). Brown and Ruppert (1948) reported that the well
16 received about 1,000,000 liters of transuranic-contaminated process waste at the rate of
17 about 75 liters (20 gallons) per minute. The well was deactivated after it became
18 plugged with sludge. The pipeline to the well was capped west of the 231-W-151 Sump.
19

20 No unplanned releases are associated with the 216-Z-10 Reverse Well.
21

22 The 216-Z-10 Reverse Well has also been identified as "216-Z-2", 231-W Reverse
23 Well, and 231-W-150 Dry Well or Reverse Well.
24
25

26 **2.3.5 Ponds, Ditches, and Trenches**

27

28 The Z Plant Aggregate Area includes two ditches and three trenches as shown on
29 Figure 2-8. There are no ponds within the Z Plant Aggregate Area. The two ditches,
30 the 216-Z-1(D) Ditch and the 216-Z-19 Ditch are U Plant Aggregate Area waste
31 management units and will not be discussed herein. Table 2-1 lists salient features of
32 each of the trenches, which are Z Plant Aggregate Area waste management units.
33 Tables 2-2 and 2-3 summarize information identified with respect to radionuclide and
34 chemical wastes received by each unit.
35

36 **2.3.5.1 216-Z-4 Trench.** The 216-Z-4 Trench is an inactive waste management unit
37 located 152.2 (500 ft) north of the 2704-Z Building. The 216-Z-4 Trench consisted of a
38 3.1 by 3.1 by 4.6 m (10 by 10 by 15 ft) deep unlined excavation.
39

40 The 216-Z-4 Trench received process and laboratory waste from the 231-Z
41 Building for one month in June 1945. The site was deactivated and backfilled when the

1 effluent flow exceeded the infiltration capacity of the pit. The pipeline from the 231-Z
2 Building to the trench was capped west of the 231-W-151 Sump.

3
4 The WIDS indicates that the 216-Z-4 Crib received approximately 11,000 liters of
5 neutral/basic liquid waste containing approximately 0.002 kg of plutonium and small
6 amounts of other transuranic elements.

7
8 No unplanned releases are associated with this crib.

9
10 The 216-Z-4 Trench has also been identified as the 231-W-3 Pit, Sump, or Crib;
11 the 216-Z-4 Crib; and the 231-W-Sump.

12
13 **2.3.5.2 216-Z-9 Trench.** The 216-Z-9 Trench is an inactive waste management unit
14 located about 213.5 m (700 ft) east of the 234-5Z Building, and 152.5 m (500 ft) south of
15 19th Street. The 216-Z-9 Trench consists of a 6.4 m (21 ft) deep excavation with a 36.6
16 m (120 ft) by 22.5 m (90 ft) concrete cover. The walls of the crib slope inward and
17 downward to the 18.3 m (60 ft) by 9.2 m (30 ft) floor space. The sloping walls of the
18 crib were paved with acid-resistant brick. The cover of the crib is supported by six
19 concrete columns.

20
21 The 216-Z-9 Trench operated from July 1955 to June 1962, receiving all solvent
22 and aqueous wastes from the RECUPLEX facility in the 234-5Z Building. Reportedly
23 the 216-Z-9 Trench received 4.05 million liters of low salt, acidic, aqueous, and organic
24 liquid waste from the RECUPLEX facility. It is estimated that 83,000 to 300,000 liters
25 (132,000 to 477,000 kg) of carbon tetrachloride may have been disposed of to the soil
26 column at this location. The waste stream included trace levels of plutonium and other
27 transuranic elements. The total volume of liquid wastes disposed of to the soil was
28 4,090,000 liters.

29
30 By the time the 216-Z-9 Trench was retired in 1962, it had received 50 to 150 kg
31 of plutonium. The bulk of this material was expected to be bound up in the upper few
32 inches of sediments and sludge in the bottom of the trench. In 1963 and 1969, the
33 reactivity of the material at the bottom of the trench was measured using the pulsed
34 neutron source technique. Based on these measurements and other data, it was decided
35 in 1973 to actively mine the 216-Z-9 Trench to remove plutonium. This measure was
36 intended to reduce the risk of environmental contamination and to reduce the criticality
37 potential (e.g., the potential for uncontrolled nuclear reactions). The 216-Z-9 Trench was
38 mined with remote mechanical equipment between August 1976 and January 1977. The
39 mining operation removed an estimated 58 kg of plutonium. Based on new data
40 acquired during the mining operation, an estimated 38 to 48 kg of plutonium remained in
41 the 216-Z-9 Trench after the mining operation.

42

9 3 1 2 8 6 5 0 6 7 8

1 No unplanned releases were associated with this crib.
2

3 The 216-Z-9 Trench has also been identified as the 216-Z-9 Crib, the 216-Z-9
4 Cavern, the 234-5 RECUPLEX Cavern, and the 216-Z-10 Crib.
5

6 **2.3.5.3 216-Z-17 Trench.** The 216-Z-17 Trench is an inactive waste management unit
7 located about 76.3 m (250 ft) north of 19th Street and 91.5 m (300 ft) east of the 231-Z
8 Building. The 216-Z-17 Trench consisted of a 61 by 3.1 by 2.4 m (200 by 10 by 8 ft)
9 deep excavation with 1:1 side slopes. It was parallel to and 12.2 m (40 ft) west of the
10 216-Z-1 Ditch. The 216-Z-1 Ditch is an inactive waste site associated with the U Plant
11 Aggregate Area (see DOE/RL 1992). The site was deactivated and backfilled when the
12 effluent flow exceeded the infiltration capacity of the pit.
13

14 The 216-Z-17 Trench received laboratory waste from PNL operations in the 231-Z
15 Building for a one-year period between February 1967 and February 1968. The WIDS
16 indicated that the 216-Z-17 Trench received 36.8 million liters of neutral/basic liquid
17 waste which contained 0.05 kg of plutonium. The trench remained open for about seven
18 years before being backfilled in 1975. Field surveys measured in the 216-Z-17 Trench
19 before backfilling indicated 2,000 dis/min of alpha activity.
20

21 No unplanned releases were associated with this crib.
22

23 The 216-Z-17 Trench has also been identified as the 216-Z-17 Ditch.
24
25

26 **2.3.6 Septic Tanks and Associated Drain Fields**

27

28 Five septic tanks and their associated drain fields were identified within the Z
29 Plant Aggregate Area.
30

- 31 ● 2607-Z Septic Tank
 - 32 ● 2607-Z-1 Septic Tank
 - 33 ● 2607-WA Septic Tank
 - 34 ● 2607-WB Septic Tank
 - 35 ● 2607-W-8 Septic Tank
- 36

37 The locations of these waste management units are shown on Figure 2-9.
38

39 **2.3.6.1 2607-Z Septic Tank and Drain Field.** The 2607-Z Septic Tank and Drain Field is
40 an active waste management unit located about 33.6 m (110 ft) east of the 236-Z
41 Building. The site receives sanitary wastewater and septic waste from 234-5Z and 2704-Z
42 Buildings at a nominal rate of 23 m³/day. The drain field is located 18.6 m (61 ft) east of

1 the 2607 Septic Tank. The 2607-Z Septic Tank is an 11 by 3.4 by 7 m (36 by 11 by 23 ft)
2 deep concrete box with a 95,000-liter (25,000-gallon) capacity two chamber tank. The
3 drain field consists of 36 rows of 15-cm (6-inch) drain tile spaced at 2.4 m (8 ft) intervals.
4 It lies in a gravel bed which extends a minimum of 46 cm (18 inches) below the drain
5 pipe. The excavation is backfilled forming a surface that is below original grade. The
6 drainfield is therefore identifiable as a large rectangular recess in an otherwise flat field.

7
8 No radionuclides or hazardous chemicals have been associated with this unit.

9
10 **2.3.6.2 2607-Z-1 Septic Tank and Drain Field.** The 2607-Z-1 Septic Tank and Drain
11 Field is an inactive waste management unit located on the west side of the 234-5Z
12 Building (Figure 2-9). The source of the sanitary waste was not specified.

13
14 No radionuclides or hazardous chemicals have been directly associated with this
15 waste management unit.

16
17 **2.3.6.3 2607-WA Septic Tank and Drain Field.** The 2607-WA Septic Tank and Drain
18 Field is an active waste management unit located immediately south of the Z Plant
19 mobile office complex (WHC 1991a). The site receives sanitary wastes from the mobile
20 office trailers at a nominal rate of 6 m³/day. The site includes two 3,800-liter (1,000-
21 gallon) septic tanks and an abandoned septic tank plus one active and one abandoned
22 drain field. The site began operating in 1968.

23
24 No radionuclides or hazardous chemicals have been associated with this waste
25 management unit.

26
27 **2.3.6.4 2607-WB Septic Tank and Drain Field.** The 2607-WB Septic Tank and Drain
28 Field is an active waste management unit located approximately 30 m south and east of
29 the Z Plant mobile office complex. The site receives sanitary wastewater and septic
30 waste from the mobile office complex.

31
32 No radionuclides or hazardous chemicals have been associated with this waste
33 management unit.

34
35 **2.3.6.5 2607-W-8 Septic Tank and Drain Field.** The 2607-W-8 Septic Tank and Drain
36 Field is an active waste management unit located northeast of the 231-Z Building. The
37 unit receives sanitary wastewater and septic waste from the 231-Z Building at a nominal
38 rate of 5.5 m³/day. The reinforced concrete septic tank has a capacity of 19,266 liters
39 (5,070 gallons). The site began operating in 1959.

40
41 No radionuclides or hazardous chemicals have been associated with this waste
42 management unit.

9 3 1 2 8 6 5 0 6 8 0

1
2 **2.3.7 Transfer Facilities, Diversion Boxes, and Pipelines**
3

4 Transfer facilities (also referred to as process lines or process sewer lines) connect
5 the major processing facilities with each other and with the various waste disposal and
6 storage facilities. Most lines are 7.6 cm (3 in.) diameter stainless steel pipes with welded
7 joints. Process lines are generally enclosed in steel reinforced concrete encasements and
8 are set below grade. The major process lines in the Z Plant Aggregate Area, and the
9 facilities that they connect are shown on Figure 2-10. The pipelines are not waste
10 management units according to the Tri-Party Agreement and they will be addressed in
11 detail under the Hanford Surplus Facilities program.
12

13 Diversion boxes or sumps house the switching facilities where waste can be routed
14 from one process line to another. They are concrete boxes that were designed to contain
15 any waste that leaks from the waste transfer line connections. The diversion boxes
16 generally drain by gravity to nearby catch tanks where any spilled waste is stored. There
17 are three diversion boxes in the Z Plant Aggregate Area:
18

- 19 ● 241-Z Diversion Box No. 1
- 20 ● 241-Z Diversion Box No. 2
- 21 ● 231-Z-151 Sump
- 22

23 Various pipelines carried high level, mixed, and sanitary wastes from Z Plant
24 process buildings to on-site and off-site disposal units. Flow of liquid process wastes to
25 many of the cribs was channeled through several diversion boxes.
26

27 Z Plant pipelines are concentrated in the vicinity of Z Plant processing buildings
28 (e.g., the 231-Z and 234-5Z Buildings). As shown on Figure 2-10, a process waste
29 discharge line exited the east side of the 231-Z Building, running due east to the 231-Z-
30 151 Sump. Stainless steel and, in later years, PVC pipe, connected the sump to the 216-
31 Z-4 Trench; the 216-Z-5, 216-Z-6, and 216-Z-7 Cribs; the 216-Z-10 Reverse Well; the
32 216-Z-16 Crib; and to the 216-Z-17 Trench.
33

34 An unplanned release, UN-200-W-130, was identified near the 216-Z-151 Sump in
35 January 1967. The unplanned release involved a leaking waste line from the 231-Z
36 Building. The WIDS indicated that the waste line was repaired; soil cleanup activities, if
37 any, were not identified.
38

39 Also as shown on Figure 2-10, various process waste lines ran from the 234-5Z
40 Building to the 216-Z-1 and 216-Z-2 Cribs; the 216-Z-1A Tile Field, the 216-Z-3 Crib;
41 the 216-Z-9 Crib; the 216-Z-12 Crib; and the 216-Z-18 Crib. The process line

1 discharging to the 216-Z-9 Crib also discharged to the 216-Z-8 Settling Tank and French
2 Drain (Figure 2-10).

3
4 Non-contact wastewater exited the 231-Z Building and 234-5Z Building through
5 vitrified clay pipes which initially discharged to the 216-Z-1/216-Z-11 Ditch system. The
6 216-Z-1 and 216-Z-11 Ditches are U Plant Aggregate Area waste management units.
7 Near the 234-5Z Building, additional non-contact wastewater was discharged to the
8 ground through french drains (216-Z-13, 216-Z-14, and 216-Z-15) located around the
9 291-Z Building (Figure 2-10).

10
11 Two diversion boxes were used to control flow of liquid wastes to cribs south of
12 the Z Plant building complex. 241-Z Diversion Box No. 1 is located just north of the
13 216-Z-1A Tile Field (Figure 2-10). 241-Z Diversion Box No. 1 is located at the piping
14 junction between the 216-Z-1, 216-Z-2, 216-Z-3, 216-Z1-A Tile Field complex and the
15 216-Z-12 Crib. A second diversion box (241-Z Diversion Box No. 2) is identified just
16 north of the 216-Z-12 Crib. 241-Z Diversion Box No. 2 was used to route liquid wastes
17 to a western bypass line, when the original line became plugged.

18
19 In addition to the Z Plant waste pipelines, a steam heating pipe line (not shown)
20 connects the central steamplant to various structures in 200 West Area. The steam is
21 used for building heating purposes. After use, condensate water was discharged to the
22 on-site french drains.

23 24 25 **2.3.8 Basins**

26
27 Two basins, the 207-Z Retention Basin and the 216-Z-21 Seepage Basin were
28 identified in the Z Plant Aggregate Area (Figure 2-11). The 216-Z-21 Seepage Basin was
29 not identified as a Z Plant Aggregate Area waste management unit by the Tri-Party
30 Agreement, but is recommended for inclusion in the AAMS (DOE/RL 1992).

31
32 **2.3.8.1 207-Z Retention Basin.** The 207-Z Retention Basin is an inactive waste site
33 located approximately 60 m (200 ft) southeast of the 236-Z Building. The 15.3 by 12.2 by
34 3.1 m (50 by 40 by 10 ft) concrete structure is divided into two basins separated by a 0.3
35 m (1 ft)-thick concrete wall. There is a 1.8 m (6 ft) woven wire fence around the top of
36 the basins. Each basin contains a sump and a pump.

37
38 The 207-Z Retention Basin operated from 1949 to 1959 receiving potentially
39 contaminated liquid waste including steam condensate and cooling water from the 234-5Z
40 Building via the D-3 piping system. Waste sent to this holding facility was then released
41 to the 216-Z-1(D)Z11 Ditch systems. This ditch system is an inactive wastewater

1 conveyance ditch which is a U Plant Aggregate Area waste management unit. Figure 2-1
2 shows the period of use of the 207-Z Retention Basin.

3
4 No releases are associated with this waste management unit.

5
6 The 207-Z Retention Basin has also been identified as the 207-Z Sump, 207-Z-
7 Pond, and 207-Z Retention Pond. Hanford drawings also identify the 206-Z Retention
8 Basin as the 241-Z Retention Basin.

9
10 **2.3.8.2 216-Z-21 Seepage Basin.** The 216-Z-21 Seepage Basin is an active waste
11 management unit located approximately 100 m east of the 234-5Z Building and 40 m
12 south of the 216-Z-9 Crib (Figure 2-11). The 216-Z-21 Seepage Basin was constructed in
13 the 1980s for discharge of non-contact condensate from the 234-5Z HVAC system and
14 storm water runoff. It also received wastewater from inlet air washing. The seepage
15 basin was constructed following backfilling of the 216-Z-19 Ditch system and construction
16 of the 216-Z-20 Crib. The seepage basin was constructed to alleviate backup of the 216-
17 Z-20 Crib from HVAC condensate and storm water runoff originally routed to the latter
18 crib. Storm drain lines connecting to the seepage basin run from catch basins on the
19 north side of the 234-5Z Building, and from an overflow line from the water tank
20 described at the location of the "French drain/dry well" north of the 234-5Z Building (see
21 Section 2.3.3.6). A storm drain connection from the east side of the 234-5Z Building is
22 also present. The draft Carbon Tetrachloride ERA Proposal (DOE/RL 1991b) indicated
23 that wastewater is discharged to the unit at a rate of approximately 9.8×10^7 liters/yr.
24 The draft ERA proposal concluded that seepage from this basin could have an impact on
25 groundwater levels in the underlying unconfined aquifer.

26
27 Historical information indicative of radionuclide or hazardous chemical waste
28 discharges to this site was not found in our review of available documents.

29
30 The 216-Z-21 Seepage Basin has also been identified as Seepage Basin 207-Z.

31 32 **2.3.9 Burial Sites**

33
34 The Z Plant Aggregate Area solid waste burial sites were established
35 independently of the main Z Plant process facilities and have operated from
36 approximately 1944 to present. The location of the burial sites are shown on Figure
37 2-12. The burial sites have received wastes from the Z Plant and from various sources
38 throughout the Hanford Site. Solid waste disposal facilities include caissons and various
39 types of burial trenches. Burial grounds generally consist of one or more of these solid
40 waste disposal facilities. Caissons consist of concrete/steel chambers set below ground
41 surface with an associated steel riser pipe through which waste packages were dropped

1 into the caisson. Caissons are typically ventilated to reduce exposures to personnel
2 depositing waste packages. Drop chutes consist of vertical steel casing or open-ended
3 55-gallon drums welded end-to-end set vertically in an excavation. After filling with solid
4 waste packages, the drop chutes were backfilled and capped with concrete.

5
6 The following solid waste burial grounds are located within the Z Plant Aggregate
7 Area. These include:

- 8
9 ● 218-W-1 Burial Ground
10 ● 218-W-1A Burial Ground
11 ● 218-W-2 Burial Ground
12 ● 218-W-2A Burial Ground
13 ● 218-W-3 Burial Ground
14 ● 218-W-3A Burial Ground
15 ● 218-W-3AE Burial Ground
16 ● 218-W-4A Burial Ground
17 ● 218-W-4B Burial Ground
18 ● 218-W-4C Burial Ground
19 ● 218-W-5 Burial Ground
20 ● 218-W-6 Burial Ground
21 ● 218-W-11 Burial Ground
22 ● Z Plant Burn Pit

23
24 Several of the above units including the 218-W-3, 218-W-3AE, 218-W-4B, 218-W-
25 4C, 218-W-5, and 218-W-6 Burial Grounds are currently being permitted under a RCRA
26 Part B permit. Burial Grounds 218-W-3A, 218-W-3AE, and 218-W-5 are part of the Low
27 Level Waste Management Area (LLWMA) 3. The 218-W-4B Burial Ground is part of
28 the LLWMA 4. The 218-W-6 Burial Ground is part of the LLWMA 5 (Barton et al.
29 1990).

30
31 Many of the wastes disposed of in the burial grounds were placed in Radioactive
32 Retrieval Storage Units which were facilities used to store 55-gallon drums or boxes
33 containing radioactive mixed wastes. Waste containers were stored on underground
34 asphalt pads and polyethylene-lined underground trenches. An earthen cover over the
35 trenches provided radiological protection. The wastes were packaged in steel, concrete,
36 or wood containers and then placed into burial trenches.

37
38 Monthly or semiannual physical and radiological surveys are made of the 200
39 Areas burial sites. The monitoring includes investigating for undesirable weed growth,
40 burial ground cave-ins, soil erosion, damaged radiation postings, boundary markers and
41 fencing, damage caused by wild life, and any other undesirable changes that may have
42 occurred since the previous survey. The radiological survey includes burial ground

1 monitoring or activity level monitoring to identify loose contamination, contamination
2 spread, and radioactivity uptake in plant life. These monitoring programs are described
3 in Section 4.0.

4
5 Sections 2.3.9.1 through 2.3.9.14 describe available data regarding the use and
6 operational history of each of these facilities. Tables 2-2 and 2-3 summarize available
7 information regarding the inventory of radioisotopes and other chemical compounds
8 disposed of at the burial ground facilities. Table 2-4 presents a partial inventory of
9 hazardous constituents disposed of to the 218-W-3A, 218-W-3AE, 218-W-4C, and
10 218-W-5 Burial Grounds.

11
12 **2.3.9.1 218-W-1 Burial Ground.** The 218-W-1 Burial Ground is an inactive waste
13 management unit located on the east side of Dayton Avenue opposite the Radioactive
14 Mixed Waste Storage Facility. The 158.9 m (521 ft) by 139.7 m (458 ft) site consists of
15 15 trenches running in an east-west direction. Twelve of these trenches are 2.4 m (8 ft)
16 deep, 1.5 m (5 ft) wide at the bottom, and 4.9 m (16 ft) wide at ground level. The other
17 three are 2.7 m (9 ft) deep flat bottom trenches with a 7.3 m (24 ft) surface width.
18 There are two gravel roads running east-west through the burial ground. The site has
19 been retired and stabilized.

20
21 The 218-W-1 Burial Ground received transuranic and mixed solid waste from 1944
22 to 1953.

23
24 An unplanned release, UPR-200-W-11, is associated with this waste management
25 unit (Table 2-5). In 1952, a fire released plutonium contamination to 200,000 dis/min
26 inside and 30,000 dis/min outside the burial ground (WHC 1991a). No other releases are
27 associated with this waste management unit.

28
29 The 218-W-1 Burial Ground has also been identified as the Dry Waste Burial
30 Ground No. 001 (Elder et al. 1987).

31
32 **2.3.9.2 218-W-1A Burial Ground.** The 218-W-1A Burial Ground is an inactive waste
33 management unit located in the northeast part of the Z Plant Aggregate Area, near the
34 218-W-6 Burial Ground. This site contains approximately 10 trenches. There are also
35 several areas used as individual burial holes, but definite locations are not known. Total
36 reported depths are only available for Trench 6, which is 1.5 m (5 ft) deep, and trench 7,
37 which is 6.1 m (20 ft) deep.

38
39 The 218-W-1A Burial Ground received industrial wastes including some
40 radioisotopes from 1944 to 1954. This burial ground was the first large equipment burial
41 site used in the 200 West Area. Most of the equipment was buried in wooden boxes

1 which eventually rotted and caused settling of the ground surface. Most of these
2 depressions were filled in 1975.

3
4 No releases are associated with this waste management unit.

5
6 The 218-W-1A Burial Ground has also been identified as the Industrial Waste
7 Burial Ground No. 1.

8
9 **2.3.9.3 218-W-2 Burial Ground.** The 218-W-2 Burial Ground is an inactive waste
10 management unit located east of Dayton Avenue and 610 m (2,000 ft) north of 19th
11 Street. The 218-W-2 Burial Ground consists of 20 miscellaneous dry waste trenches,
12 running east-west with bottom widths of 1.5 m (5 ft) and lengths ranging from 141.2 to
13 143.7 m (463 to 471 ft).

14
15 The 218-W-2 Burial Ground received miscellaneous unsegregated dry waste from
16 1953 to 1956. The site has been retired and stabilized.

17
18 No releases are associated with this waste management unit.

19
20 The 218-W-2 Burial Ground has been identified as the Dry Waste Burial Ground
21 No. 002.

22
23 **2.3.9.4 218-W-2A Burial Ground.** The 218-W-2A Burial Ground is an inactive waste
24 management unit located about 457.5 m (1,500 ft) north of 23rd Street and 457.5 m
25 (1,500 ft) east of Dayton Avenue. The 218-W-2A Burial Ground consists of 19 trenches
26 of various lengths, numbered 1 through 11, and 20 through 27. Trenches numbered 11
27 through 15 were used to bury construction cell blocks. The trenches were 4.6 m (15 ft)
28 deep and 4.9 m (16 ft) wide at the bottom.

29
30 The 218-W-2A Burial Ground received mixed solid waste between 1954 and 1986.
31 Conflicting accounts of the total volume of waste disposed of to the unit included: 19,000
32 m³ and 25,000 m³ by WIDS. The burial ground contains miscellaneous radioactive solid
33 waste from facilities in the 200 West Area, including tanks, concrete blocks, facility
34 wastes, and process equipment. Sixteen trenches were filled with dry industrial waste.
35 Trench 27 contains contaminated soil scraped from the 216-T-4-1 Pond. Waste buried
36 since November 1980 does not contain hazardous materials (Elder et al. 1987). The
37 WIDS indicates that of the 25,000 m³ of waste contained in the unit, only 340 m³ were
38 disposed of after November 1980. The waste disposed of before November 1980 is both
39 low-level and byproduct, while the waste disposed of since that date is strictly low level.

40
41 In 1957, the collapse of a burial box caused 1,800 acres of transuranic
42 contamination to the area (Elder et al. 1987).

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1 The 218-W-2A Burial Ground has also been identified as the Industrial Waste
2 Burial Ground No. 2, the 218-W-02A Burial Ground, and the 200-W Industrial Waste
3 No. 02A.

4
5 This burial ground has been identified in a RCRA Part B permit application as a
6 TSD facility and will undergo RCRA closure. A final cap and cover in accordance with
7 the RCRA landfill standards has been proposed.

8
9 **2.3.9.5 218-W-3 Burial Ground.** The 218-W-3 Burial Ground is an inactive waste
10 management unit located on the northeast corner of the intersection of Dayton Avenue
11 and 23rd Street. The 218.4 by 155.6 m (716 by 510 ft) site consists of 20 dry waste
12 trenches. Trenches 1 through 3 are 122 m (400 ft) in length; trenches 4 through 20 are
13 144.9 m (475 ft) in length. Each trench is identified by a permanent concrete post with
14 brass name plate. This site is now retired and has been stabilized.

15
16 The 218-W-3 Burial Ground received transuranic/mixed solid waste from 1957 to
17 1960 or 1961. The site received almost 11,000 m³ of miscellaneous unsegregated mixed
18 transuranic and non-transuranic waste from various Hanford Site operations.

19
20 No releases are associated with this waste management unit.

21
22 The 218-W-3 Burial Ground has also been identified as the Dry Waste Burial
23 Ground No. 003.

24
25 **2.3.9.6 218-W-3A Burial Ground.** The 218-W-3A Burial Ground is an active waste
26 management unit located immediately southeast of the intersection of Dayton Avenue
27 and 27th Street. The 381.3 m (1,250 ft) long, irregularly shaped site consists of 61 dry
28 and industrial waste trenches which run in an east-west direction. Seven of the trenches
29 are 163.2 m (535 ft) long, thirty-five are 283.7 m (930 ft) long, and ten are 274.5 m (900
30 ft) long. The remaining trenches range in length from 122.9 to 156.1 m (403 to 512 ft).
31 Trench depths range from 3.7 to 5.8 m (12 to 19 ft). Each trench location is identified
32 by a permanent concrete post with a brass nameplate. Seven of the 61 trenches have
33 been fully backfilled and the surface has been stabilized.

34
35 Since 1971, the 218-W-3A Burial Ground site has received over 99,000 m³ of
36 transuranic/mixed solid waste from various Hanford Site operations.

37
38 No releases are associated with this waste management unit.

39
40 The 218-W-3A Burial Ground has also been identified as the Dry Waste Burial
41 Ground No. 03A.

42

9 3 1 2 8 6 5 0 6 8 7

1 This burial ground has been identified in a RCRA Part B permit application as a
2 TSD facility and will undergo RCRA closure. A final cap and cover in accordance with
3 the RCRA landfill standards has been proposed.

4
5 **2.3.9.7 218-W-3AE Burial Ground.** The 218-W-3AE Burial Ground is an active waste
6 management unit bordered on the north by 27th Street and on the west by Dayton
7 Avenue. The irregularly shaped site consists of 28 trenches of varying sizes. Trench 2E
8 is 380 by 5.5 m (1,246 by 18 ft) (bottom), 405.7 by 14 m (1,330 by 46 ft) (surface), and
9 14.9 m (6 ft) deep with a minimum of 2.4 m (8 ft) of backfill. Trench 5E is 327.9 x 14.6
10 m (1,075 x 48 ft) (bottom), 422.4 x 32.9 m (1,385 x 108 ft) (surface), and 6.1 m (20 ft)
11 deep with a minimum of 2.4 m (8 ft) of backfill. Trench 10 E is 364.5 x 12.2 m (1,195 x
12 40 ft) (bottom), 459 x 28.7 m (1,505 x 94 ft) (surface), and 5.5 m (18 ft) deep, with a
13 minimum of 2.4 m (8 ft) of backfill. Each trench location is identified with a concrete
14 post with brass name plate.

15
16 Since 1982, the 218-W-3A Burial Ground has received 21,390 m³ mixed solid
17 waste. Wastes disposed of to the site include miscellaneous wastes such as rags, paper,
18 rubber gloves, disposal supplies, broken tools, and industrial waste such as failed
19 equipment, tanks, pumps, ovens, agitators, heaters, hoods, jumpers, and accessories.

20
21 No releases are associated with this waste management unit.

22
23 The 218-W-3AE Burial Ground has also been identified as the Industrial Waste
24 Burial Ground No. 3AE and Dry Waste Burial Ground No. 3AE.

25
26 This burial ground has been identified in a RCRA Part B permit application as a
27 TSD facility and will undergo RCRA closure. A final cap and cover in accordance with
28 the RCRA landfill standards has been proposed.

29
30 **2.3.9.8 218-W-4A Burial Ground.** The 218-W-4A Burial Ground is an inactive waste
31 management unit located near the southeast corner of the intersection of 27th Avenue
32 and Dayton Avenue. The site consists of 21 filled trenches which run east-west and eight
33 drop chutes. A small miscellaneous trench runs north-south at the east end of trench 11.
34 All trenches are 9.2 m (30 ft) wide and 4.9 m (16 ft) deep and range in length from 149.5
35 to 295.5 m (490 to 969 ft). Each trench location is identified by a permanent concrete
36 post with a brass name plate.

37
38 Two caissons are located between Trenches 17, 18, and 19 at their east end. Both
39 consist of 6.5 cm (26 inch) diameter, 12 gauge well casing extended 14.6 m (48 ft) below
40 grade. Both have 82.5 cm (33 inch) thick concrete cover blocks. Six 4.6 m (15 ft) deep
41 caissons were installed in Trench 16. These are made of 55-gallon steel drums welded
42 together with the ends cut out (except the bottom of the lower drum) and placed on end

1 with the upper surface at ground level. After use, soil was shoveled into these wells to
2 absorb the high gamma radiation given off by the wastes deposited.

3
4 The 218-W-4A Burial Ground received transuranic/mixed solid waste from 1958 to
5 1968. The site received almost 18,000 m³ of miscellaneous dry, unsegregated mixed
6 transuranic and non-transuranic waste.

7
8 Four unplanned releases are associated with this burial ground: UPR-20-W-16,
9 UPR-200-W-26, UPR-200-W-53, and UPR-200-W-72.

10
11 This waste management unit has not been identified by any other designation than
12 the 218-W-4A Burial Ground.

13
14 **2.3.9.9 218-W-4B Burial Ground.** The 218-W-4B Burial Ground is an active waste
15 management unit for transuranic/mixed waste located near the northeast corner of the
16 intersection of Dayton Avenue and 19th Street. The 218-W-4B Burial Ground consists of
17 13 trenches and 12 caissons. Caissons which received transuranic waste consist of
18 concrete and steel covered vaults. Caissons which received low level waste were
19 constructed of corrugated pipe with a concrete bottom and top. Both types of caissons
20 were used for the disposal of solid wastes from hot cell operations. Two trenches and
21 four caissons (contained in a third trench) contain retrievably stored transuranic waste.
22 Of the remaining eleven trenches, ten contain unsegregated low level and transuranic
23 waste and one contains low level waste. Within the trench containing the four
24 transuranic caissons are an additional seven low level caissons. Trenches 1 through 6 and
25 8 contain unsegregated mixed transuranic and non-transuranic waste. Trench 9 contains
26 unsegregated transuranic waste. Trenches 10, 12, and 13 contain non-transuranic waste.
27 No information was available concerning Trenches 7 and 11.

28
29 The row of 12 caissons includes 5 alpha caissons for transuranic waste, one UNI
30 silo type caisson (for high activity waste from N Reactor), and six MFP caissons (for non-
31 transuranic and nonsegregated waste). The six MFP caissons consist of 1 silo type, 1
32 alpha type, and 4 dry waste caissons. The alpha type caissons weigh 11,804 kg (26,000
33 pounds). They have an 2.7 m (8.75 ft) diameter and are 3.1 m (10 ft) high, constructed
34 primarily of concrete and have a steel cover fitted with lifting lugs. The silo type caissons
35 are 9.2 m (30 ft) tall with a 3.1 m (10 ft) diameter and have a concrete base. Waste is
36 placed beneath a concrete slab 4.6 m (15 ft) below grade. Dry waste caissons are 2.4 m
37 (8 ft) in diameter and 3.1 m (10 ft) high, constructed of corrugated metal with a concrete
38 top and bottom. Caissons are ventilated with electric blowers. Caisson air is exhausted
39 through filters to prevent contamination from occurring when wastes are dropped into
40 the caissons. The caisson trench is the only active area of the site. All caissons are
41 inactive except the MFP caisson 6 and Alpha Caissons 4 and 5.

42

1 The 218-W-4B Burial Ground began operations in 1967 and has received an
2 estimated 10,000 m³ of waste. Of this amount, approximately 3,250 m³ consists of
3 retrievably stored transuranic waste. The site receives miscellaneous radioactive solid
4 waste, the majority of which is from facilities located in the 200 West Area. The solid
5 waste consists of rags, paper, cardboard, plastic, pumps, tanks, process equipment, and
6 other miscellaneous dry waste. The only nonsegregated waste received by this site was
7 deposited between January 1, 1967 and May 1, 1970. Records prior to May 1968 are
8 incomplete.

9
10 Radiation monitoring readings of 12,000 dis/min (WIDS) have been reported in a
11 small area of mulch (presumably placed to enhance revegetation of the area). No other
12 releases have been identified at this waste management unit.

13
14 The 218-W-4B Burial Ground has also been identified as the Dry Waste Burial
15 Ground No. 04B.

16
17 This burial ground has been identified in a RCRA Part B permit application as a
18 TSD facility and will undergo RCRA closure. A final cap and cover in accordance with
19 the RCRA landfill standards has been proposed.

20
21 **2.3.9.10 218-W-4C Burial Ground.** The 218-W-4C Burial Ground is an active waste
22 management unit located east of Dayton Avenue between 16th Street and 19th Street.
23 Hanford Drawing H-2-3743765 indicates that the site consists of 65 trenches with space
24 allocated for several more. Forty-eight of the trenches run east-west. Twenty-four of
25 these are 183.6 m (602 ft) long, nineteen are 219.3 m (719 ft) long, four are 181.2 m,
26 (594 ft) long and one trench is 91.2 m (299 ft) long. Seventeen trenches run north-south.
27 Of these, fourteen are 202.8 m (665 ft) long and three are 154.96 m (508 ft) long. The
28 average trench depth is about 7.6 m (25 ft).

29
30 Beginning in 1974, the 218-W-4C Burial Ground has received over 16,000 m³ of
31 transuranic and mixed solid waste from Hanford Site facilities and several off-site
32 sources. The northernmost trench is the Naval Reactor Core Trench and also contains a
33 number of core barrels from Bettis Naval Station. Trench No. 1 contains drums with
34 plutonium-contaminated soil from the 216-Z-9 Crib mining operation and noncombustible
35 transuranic waste. Trench No. 4 contains drums of assorted combustible transuranic
36 waste and one module of noncombustible transuranic waste. Trenches No. 1, 4, 7, 20, 24,
37 and 25 and the easterly end of No. 19 contain retrievable waste. Trenches No. 23, 28,
38 48, 53, and 58 and the remainder of No. 19 receive low level waste.

39
40 No releases are associated with this waste management unit.

41

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1 The 218-W-4C Burial Ground has also been identified as the Dry Waste Burial
2 Ground No. 01C.

3
4 This burial ground has been identified in a RCRA Part B permit application as a
5 TSD facility and will undergo RCRA closure. A final cap and cover in accordance with
6 the RCRA landfill standards has been proposed.

7
8 **2.3.9.11 218-W-5 Burial Ground.** The 218-W-5 Burial Ground is an active waste
9 management unit for low level/mixed solid waste located at the southwest corner of the
10 intersection of 27th Street and Dayton Avenues. The site consists of 56 active or
11 planned trenches, all oriented east-west. Twenty-seven of the trenches are 4.6 m (15 ft)
12 wide at the bottom and 5.2 m (17 ft) deep. Of these, eighteen are 353.8 m (1,160 ft)
13 long, four are 131.2 m (430 ft) long, three are 161.65 m (530 ft) long, and two are 323.3
14 m (1,060 ft) long. Seven trenches are 353.8 m (1,160 ft) long, 12.2 m (40 ft) wide
15 (bottom) and 5.185 to 6.1 m (17 to 20 ft) deep. Each trench location is identified by a
16 permanent concrete post with a brass name plate.

17
18 The 218-W-5 Burial Ground has operated since 1986, receiving 32,500 m³ of
19 mixed and retrievable transuranic wastes. The WIDS indicates that 204.3 kg (450
20 pounds) of lead are buried in Trench 21 and 1,684.34 kg (3,710 pounds) in Trench 9.
21 The 218-W-5 Burial Ground may also receive defueled decommissioned nuclear
22 submarine reactor compartments in the future, each of which contains approximately
23 83,536 kg (184,000 pounds) of lead.

24
25 No releases are associated with this waste management unit.

26
27 This waste management unit has not been identified by any other designation than
28 the 218-W-5 Burial Ground.

29
30 This burial ground has been identified in a RCRA Part B permit application as a
31 TSD facility and will undergo RCRA closure. A final cap and cover in accordance with
32 the RCRA landfill standards has been proposed.

33
34 **2.3.9.12 218-W-6 Burial Ground.** The 218-W-6 Burial Ground is a proposed waste
35 management unit for low-level/mixed solid waste which will include 28 trenches. It will
36 be located north of the 218-W-1A Burial Ground. No wastes have been disposed of at
37 this site. No releases are associated with this proposed waste management unit.

38
39 This burial ground has been identified in a RCRA Part B permit application as a
40 TSD facility. When it begins operating, it will be subject to RCRA landfill and closure
41 standards.

1 **2.3.9.13 218-W-11 Burial Ground.** The 218-W-11 Burial Ground is an inactive waste
2 management unit located immediately north of the 218-W-1 Burial Ground. The site
3 consists of two filled burial trenches running east-west. Trench 1 is 78.69 m (258 ft) long.
4 Trench 2 is 45.75 m (150 ft) long. The site has been stabilized and reseeded with grass.
5

6 The 218-W-11 Burial Ground received low-level and mixed solid waste in 1960
7 (Elder et al. 1987). The site received an estimated 1,160 m³ of low level/mixed waste
8 (WIDS). The waste disposed of to this site includes low level contaminated sluicing
9 equipment that had been used for the uranium recovery program at the 221-U Building.
10

11 Radiation monitoring readings of 12,000 dis/min (WIDS) have been reported in a
12 small area of mulch (presumably placed to enhance revegetation of the area). No other
13 releases have been identified at this waste management unit.
14

15 This waste management unit has not been identified by any other designation than
16 the 218-W-11 Burial Ground.
17

18 **2.3.9.14 Z Plant Burn Pit.** The Z Plant Burn Pit is an inactive facility used between
19 1950 and 1960 to burn miscellaneous nonradioactive waste material. Such materials
20 included office and non-hazardous laboratory waste. The burn pit was reportedly 15.3 by
21 12.2 by 3.1 m (50 by 40 by 10 ft) deep. Reportedly the unit received 2,000 m³ of waste
22 material of which less than 1,000 m³ was chemical waste. The former Burn Pit is
23 believed to be located approximately 50 m south of 19th Street and 150 m east of the
24 231-Z Building.
25

26 **2.3.10 Unplanned Releases**

27
28
29 Twenty-one unplanned releases were identified in the Z Plant Aggregate Area as
30 shown on Figure 2-13. With one exception, UPR-200-W-103, no waste inventory
31 information was identified for the unplanned releases. Table 2-5 summarizes the known
32 information regarding each unplanned release and, where applicable, lists the waste
33 management unit to which it is related. Most of the information available for the
34 unplanned releases is derived from the WIDS (WHC 1991a).
35
36

37 **2.4 WASTE GENERATING PROCESSES**

38
39 Z Plant began operations in 1945 to assist in the processing of irradiated fuel rods
40 into metallic plutonium. The process history of the Z Plant Aggregate Area is illustrated
41 on Figure 2-14. The process began with the irradiation of uranium-bearing fuel rods in
42 one of Hanford's 100 Areas production reactors. This process creates plutonium from

1 uranium. Using a concentrated nitric acid solution, the plutonium was extracted from the
2 irradiated fuel rods in one of Hanford's chemical separation facilities (B Plant or T Plant)
3 to produce a plutonium nitrate solution. Z Plant processed the plutonium nitrate
4 solution into plutonium metal. This section describes the primary waste generating
5 process areas and the associated building locations at the Z Plant Aggregate Area which
6 include:

- 7
- 8 ● The Plutonium Isolation Facility (PIF) (231-Z Building)
- 9 ● The Plutonium Finishing Plant (PFP) (234-5Z Building)
- 10 ● The RECUPLEX plutonium recovery process (234-5Z Building)
- 11 ● The Plutonium Reclamation Facility (PRF) (236-Z Building)
- 12 ● The Americium Recovery facility (242-Z Building)
- 13 ● The Analytical and Development Laboratory
- 14

15 Table 2-6 summarizes available information regarding the chemical characteristics
16 of each of the waste streams produced by Z Plant Aggregate Area. The chemicals and
17 radionuclides that have been detected or which are known to be present in Z Plant
18 Aggregate Area waste streams are summarized in Table 2-7. Table 2-8 lists chemicals
19 used or stored in the Z Plant Aggregate Area laboratory. The chemicals identified in
20 Table 2-8 represent potential contributors to the Z Plant Aggregate Area waste stream if
21 they are spilled or otherwise enter effluents, but most cannot be considered routine waste
22 stream components. Table 2-9 lists radionuclides, organic, and inorganic chemicals
23 disposed of at Z Plant Aggregate Area waste management units based on several sources
24 listed at the bottom of the table. Sections 2.4.1 through 2.4.6 describe the Z Plant
25 Aggregate Area process facilities identified above.

26

27

28 **2.4.1 Plutonium Isolation Facility (PIF)**

29

30 **2.4.1.1 Process Description.** The 231-Z Building (described in Section 2.3.1.2) was the
31 primary location of the PIF process line. The 231-Z Building is also known as the
32 Concentration Building. The exact dates of PIF operation were from 1945 to 1949. The
33 PIF was described as being a seventh production step where concentrated plutonium
34 nitrate solution was further reduced to a paste. This process consisted of the following
35 steps:

- 36
- 37 ● Ammonium nitrate was added to the plutonium nitrate solution, reducing
38 the plutonium to the +4 valence state;
- 39
- 40 ● Sulfates and peroxide were added to the mixture, causing plutonium to
41 precipitate as plutonium peroxide;
- 42

- 1 ● Nitric acid was added to this precipitate, forming a purer more
2 concentrated plutonium nitrate solution; and
3
4 ● This product was placed in small shipping containers and boiled using hot
5 air to form a wet plutonium nitrate paste.
6

7 Until 1949, the plutonium nitrate paste was shipped to Los Alamos, New Mexico
8 for final processing into plutonium metal. Apparently, after 1949 this concentration step
9 was moved to the 234-5Z Building. The wet plutonium paste output by PFP was then
10 processed as discussed in the following subsection.
11

12 **2.4.1.2 PIF Waste Streams.** Little information was identified regarding PIF waste
13 streams. PIF waste streams probably included process wastes and non-contact
14 wastewater. The process wastes can be characterized as acidic and corrosive, high in
15 salts, and low in organic content. The PIF process wastes likely contained minor
16 amounts of fission products, plutonium, and other transuranic elements. Process wastes
17 were discharged through the 231-W-151 Sump to various waste management units
18 including:
19

- 20 ● 216-Z-4 Trench
21 ● 216-Z-5 Crib
22 ● 216-Z-6 Crib
23 ● 216-Z-7 Crib
24 ● 216-Z-10 Reverse Well
25
26

27 **2.4.2 Plutonium Finishing Plant (PFP)** 28

29 **2.4.2.1 Process Description.** The 234-5Z Building (described in Section 2.3.1.1) was the
30 primary location of the PFP process lines. DOE operated three successive PFP process
31 lines to convert plutonium nitrate to plutonium metal:
32

- 33 ● The RG-RB line which operated from 1949 to 1953;
34 ● The Remote Mechanical A line which operated from 1953 to 1979; and
35 ● The Remote Mechanical C line which operated from 1960 to 1973.
36

37 Each of these process lines created waste streams which contained detectable
38 quantities of plutonium and other transuranic elements (Jensen 1990).
39

40 The PFP facility contained chemical processing equipment used to convert
41 plutonium nitrate to plutonium oxide and then to the metal, if metal was the desired
42 product. Plutonium oxide was produced by precipitating plutonium as plutonium oxalate,

1 and then filtering and calcining the precipitate. To produce the metal, plutonium oxide
2 was first converted to plutonium fluoride by reacting it with hydrofluoric acid. The
3 fluoride was placed in a container, which was placed in a magnesium oxide crucible with
4 calcium. A reducing charge was then applied to the crucible to convert the plutonium
5 fluoride to plutonium metal, which was then molded into a button. Sometimes the
6 buttons were remelted and cast into a finished shape. Cast forms were coated with
7 nickel and polished to enable them to be handled without spreading plutonium
8 contamination.

9
10 **2.4.2.2 PFP Waste Streams.** Wastes produced by the PFP fall into two categories:

- 11
- 12 ● Process wastes and condensates; and
- 13 ● Non-contact wastewater.
- 14

15 **2.4.2.2.1 Process Wastes.** The PFP liquid process wastes can be characterized as
16 acidic and corrosive (pH 2), high in salts, and low in organic content. The wastes contain
17 only minor amounts of fission products and low concentrations of plutonium and other
18 transuranic elements (Jensen 1990). The waste is high in nitrates in the form of nitric
19 acid, aluminum nitrate, magnesium nitrate, ferric nitrate, and calcium nitrate. Other
20 components are aluminum fluoride, potassium hydroxide, potassium fluoride, chromium,
21 lead, and other trace metal ions.

22
23 Process wastes, including process condensates, are discharged through the 207-Z
24 Treatment Tank where they undergo addition of sodium hydroxide, ferric nitrate, and
25 sodium nitrite for solubilization and neutralization purposes. Corrosion inhibitors such as
26 sodium nitrite and aluminum compounds for solubilization were also added in this tank.
27 The effluent from this tank has a neutral pH. The treated wastes are currently
28 transferred via pipeline to receiving Tank 102-SY at the TX-244 Tank Farm north of Z
29 Plant.

30
31 Prior to 1973, the waste was discharged via cribs to the soil column. The 216-Z-3
32 and 216-Z-12 Cribs were used to dispose of PFP process waste. Beginning in 1973, the
33 ultimate destination of these treated wastes was originally in single-shell, then later in
34 double-shell tanks.

35
36 **2.4.2.2.2 Non-Contact Wastewater.** Non-contact wastewater e.g., wastewater
37 which does not come into direct contact with any of the plutonium separation processes,
38 is characterized as low salt, low organic, neutral to basic aqueous waste. Jensen (1990)
39 identified 80 inputs to the wastewater stream, including sanitary wastewater from drinking
40 fountains, sinks, and toilets; cooling water; steam condensate; air conditioning
41 condensate; and wastes from chemical laboratory sinks, nonradiological laboratory sinks
42 in radiation zones, wound flushing stations, eyewash stations, safety showers, floor drains,

1 roof drains, and storm sewers. The bulk of the wastewater is equipment cooling water
2 and HVAC steam condensate.

3
4 Jensen (1990) did not identify any routine contributors of chemicals to the
5 wastewater effluent and concludes that concentrations will depend on plant operations,
6 possible chemicals spills, and water quality of the river water used in the plant. Direct
7 measurement of effluent concentrations is not feasible because there is no access for
8 sampling before the wastewater exiting PFP enters the common sanitary/stormwater drain
9 system for the Z Plant. Sampling and analysis of the combined effluent during periods of
10 PFP operation has identified a number of constituents that are elevated above
11 background (i.e., river water); however, many of these constituents are also elevated
12 during periods when PFP is not in operation (Jensen 1990). Chemicals and surrogate
13 parameters that are consistently elevated are:

- 14
15 ● barium ● alpha activity
16 ● calcium ● beta activity
17 ● fluoride ● conductivity
18 ● magnesium ● total dissolved solids
19 ● potassium ● TOC
20 ● sodium ● TOX (as Cl)
21 ● strontium
22 ● sulfate
23 ● uranium
24 ● zinc
25

26 In addition, the organic compounds acetone, methylene chloride, and chloroform
27 have been detected in plant effluent.
28

29 Non-contact wastewater is currently discharged to the 216-Z-21 Seepage Basin and
30 the 216-Z-20 Ditch. The 216-Z-20 Ditch is an active waste management unit which is not
31 a Z Plant Aggregate Area waste management unit. Prior to September 1981, the
32 wastewater flowed to the 216-U-10 Pond through the 216-Z-19 Ditch. Prior to the
33 construction of the 216-Z-19 Ditch, wastewater was discharged to the 216-Z-1 and 216-Z-
34 11 Ditches. The 216-Z-1, 216-Z-11, and 216-Z-19 Ditches are inactive waste
35 management units discussed in the U Plant AAMSR (DOE/RL 1992).
36
37

38 2.4.3 RECUPLEX Plutonium Recovery Process

39
40 2.4.3.1 Process Description. DOE recovered plutonium from PFP waste streams using
41 the RECUPLEX process from 1955 to 1962. The process used solvent extraction column

1 technology to remove plutonium from the PFP waste streams. The RECUPLEX facility
2 was housed in the 234-5Z Building.

3
4 The RECUPLEX solvent extraction technology is based on the formation of an
5 organic-plutonium complex which is preferentially soluble in an organic solvent. This
6 process used nitric acid and hydrofluoric acid to convert plutonium solids to plutonium
7 nitrate and a TBP-carbon tetrachloride solvent to recover plutonium from the purified
8 plutonium nitrate solutions. An 85:15 ratio by volume of carbon tetrachloride to TBP
9 was used. Other ratios were tested during the pilot plant treatability tests, but the ratio
10 of 85:15 gave the most satisfactory results for plutonium recovery.

11
12 Silica gel was used as a settling agent on the dissolved feed for the RECUPLEX
13 process. A silica gel waste settling tank (the 216-Z-8 Settling Tank), was used to hold the
14 backflush solution from the filters.

15
16 **2.4.3.2 RECUPLEX Waste Streams.** The RECUPLEX process produced three primary
17 waste streams:

- 18
- 19 ● Spent aqueous extractant
- 20 ● Spent organic solvents
- 21 ● Waste silica gel
- 22

23 Other waste streams produced by RECUPLEX include fabrication oil and non-
24 contact wastewater from the building sinks and equipment wash areas.

25
26 **2.4.3.2.1 Spent Aqueous Extractant.** The aqueous process waste is characterized
27 as acidic, high-salt, low-level radioactive liquid waste containing low levels of plutonium
28 and other transuranic elements. Major components of the waste are nitric acid, fluoride,
29 and phosphate. Carbon tetrachloride was used in combination with DBBP to remove
30 residual plutonium from the aqueous solution prior to its discharge.

31
32 **2.4.3.2.2 Spent Organic Solvent.** The organic process waste is characterized as
33 slightly acidic, low salt, high organic, radioactive liquid waste with intermediate levels of
34 plutonium and other transuranic elements. Major components of the waste are carbon
35 tetrachloride/tributylphosphate, and DBBP.

36
37 With continued use, the carbon tetrachloride/tributyl phosphate extraction solvent
38 would gradually degrade into carbon tetrachloride/dibutyl phosphate and lose its capacity
39 as an extractant. The mixture was periodically replaced with fresh solvent and the
40 degraded solvent discharged to the 216-Z-9 Trench. This trench was the only waste site
41 used for solvent disposal during RECUPLEX operation. The 216-Z-9 Trench received
42 approximately 4 million liters of waste from RECUPLEX (WHC 1991a). The quantity of

1 carbon tetrachloride discharged to the trench is estimated to be approximately 83,000 to
2 300,000 liters.

3
4 **2.4.3.2.3 Spent Silica Gel.** The disposal history of the settled solids in the 216-Z-8
5 Settling Tank is not known. Available information suggests that the tank has never been
6 pumped out. The WIDS indicated that 1.6 kg of plutonium were present in the tank as
7 of 1974. Historically, liquid overflow from the 216-Z-8 (Silica Gel) Settling Tank was
8 discharged to the 216-Z-8 French Drain. Both units have been idle since RECUPLEX
9 shut down in 1962.

10
11 **2.4.3.2.4 Other RECUPLEX Waste Streams.** Other RECUPLEX waste streams
12 include fabrication oil and non-contact wastewater. Non-contact wastewater is currently
13 discharged to the 216-Z-20 Ditch. Prior to September 1981, the wastewater flowed to
14 the 216-U-10 Pond through the 216-Z-19 Ditch. Prior to the construction of the 216-Z-
15 19 Ditch, wastewater was discharged to the 216-Z-1 and 216-Z-11 Ditches.

16
17
18 **2.4.4 Plutonium Reclamation Facility (PRF)**

19
20 **2.4.4.1 Process Description.** The PRF replaced the RECUPLEX process line after a
21 criticality accident forced the closure of the RECUPLEX unit in April 1962. The PRF
22 operated from 1964 to 1978 and again from 1984 to May 1991 in the 236-Z Building of
23 the Z Plant. This facility is currently idle but is planned to restart operation in the near
24 future. The PRF was designed to reclaim plutonium from solutions and solids from PFP
25 waste streams. The recoverable material is treated to produce soluble plutonium as
26 plutonium nitrate. PRF has essentially the same mission as RECUPLEX and utilizes a
27 similar solvent extraction column technology. The extraction solvent used is carbon
28 tetrachloride/TBP in a 80:20 ratio by volume, whereas the ratio in the RECUPLEX
29 process was 85:15.

30
31 **2.4.4.2 PRF Waste Streams.** The primary waste streams generated by the PRF were
32 similar to those produced by RECUPLEX:

- 33
34
 - Spent aqueous solutions
 - Spent organic wastes
 - Non-contact wastewater

35
36
37
38 The characteristics of these wastes are essentially the same as those of the
39 RECUPLEX wastes described in Section 2.4.3.2.

40

1 Spent aqueous and organic wastes from the PRF were disposed of to the soil
2 column through a series of cribs until 1973. Cribs that are known to have received PRF
3 wastes include:

- 4
- 5 ● 216-Z-1A Tile Field - 5/64 to 5/66, 6/66 to 10/67, 10/67 to 4/69
- 6 ● 216-Z-1 & 216-Z-2 Cribs - 5/66 to 6/66, 10/67
- 7 ● 216-Z-18 Crib - 4/69 to 5/73
- 8

9 Organic wastes from PRF processing operations in the 1980s have been
10 containerized and shipped to the Z Plant RMW storage complex. The organic wastes
11 containers are currently awaiting disposal. The carbon tetrachloride ERA proposal
12 (DOE/RL 1991b) estimated the total volume of all types of PRF liquid waste deposited
13 to PRF waste management unit as follows:

- 14
- 15 ● 216-Z-1 & 216-Z-2 Cribs 211,000 liters
- 16 ● 216-Z-1A Tile Field 5,260,000 liters
- 17 ● 216-Z-18 Crib 3,860,000 liters
- 18

19 The total amount of spent carbon tetrachloride disposed of from the PRF facility
20 to soil was approximately 280,000 liters.

21

22

23 2.4.5 Americium Recovery

24
25 **2.4.5.1 Americium Recovery Process Description.** The recovery of americium from PRF
26 waste streams started in 1964 in the 242-Z Building of the Z Plant. After an explosion in
27 the exchange process, this facility was shut down in 1976.

28
29 The process used an ion exchange technique to recover americium from the waste
30 streams. Elutriation and regeneration of the ion exchange resin was done with nitric
31 acid.

32
33 Americium was also recovered in the PRF using DBBP in a carbon tetrachloride
34 diluent as an extractant solvent. DBBP was subsequently replaced with tributylphosphate
35 in the process.

36
37 **2.4.5.2 Americium Recovery Waste Streams.** Information on wastes generated from the
38 americium recovery process was not available. Presumably, these waste streams would
39 have included spent ion exchange resins, waste organic solvent, and recovered americium.

40
41

2.4.6 Analytical and Development Laboratories

The Z Plant analytical and development laboratories are currently housed in the 234-5Z Building of the Z Plant. Historically, analytical and development laboratories are also reported to have been housed in the 231-Z Building (Stenner et al. 1988).

2.4.6.1 Laboratory Processes. The Z Plant laboratory currently provides analytical services and supports research and development activities for the Plutonium Finishing Operations. Historically, the laboratory provided the same services for the PFP. This support was provided in the following ways:

- Quality assurance/quality control (QA/QC) for the plutonium processing lines;
- Liquid scintillation counting; and
- Preparation work for solvent extraction tests.

Present activities of this unit are limited to research and development, and associated analyses needed to support production processing operations (Jensen 1990). Table 2-8 lists all the chemicals and reagents known to have been used or stored in the laboratory area. Exact quantities of these chemicals and reagents stored or used is not known.

2.4.6.2 Laboratory Waste Streams. There are three types of wastes produced in the laboratory area:

- Laboratory process wastes;
- Used or discarded analytical reagents and chemicals; and
- Wastewater from laboratory sinks and emergency showers.

2.4.6.2.1 Laboratory Process Wastes. Laboratory process wastes were characterized as slightly acidic, low salt radioactive wastes. These wastes were routed through the 241-Z-361 Tank to various cribs. The 216-Z-3 and 216-Z-12 Cribs received laboratory process wastes. The pH of these wastes were adjusted to between 8 and 10 in the 241-Z Treatment Tank prior to disposal.

2.4.6.2.2 Analytical Reagents and Chemicals. Information on the disposition of used or discarded analytical reagents is not available. A large number of chemicals are in use or are stored in the laboratory, as listed in Table 2-8. Laboratory chemicals are known to have been stored in the 234-5Z Hazardous Waste Staging Area prior to disposal.

1 **2.4.6.2.3 Laboratory Wastewater.** Nonradiological laboratory sinks and emergency
2 showers in the laboratory area drain to the main sanitary wastewater system in the
3 234-5Z Building. The contents of this wastewater have not been determined, but are
4 likely to contain intermittent releases from laboratory procedures, cleaning glassware, and
5 chemical spills. Wastewater containing hazardous chemicals is routed to the 241-Z
6 Building. This wastewater is combined with non-process wastewater and roof drain
7 runoff from other buildings at Z Plant. The combined effluent is currently discharged to
8 the 216-Z-20 Crib, which is discussed in the U Plant AAMSR (DOE/RL 1992).
9 Formerly, wastewater was discharged in sequence to the 216-Z-1, 216-Z-11, and 216-Z-19
10 Ditches.

11 12 13 **2.5 INTERACTION WITH OTHER AGGREGATE AREAS OR OPERABLE UNITS**

14
15 This part of the report discusses the interaction of the Z Plant Aggregate Area
16 with other 200 Areas facilities and the disposal of the wastes generated. The 200 Areas
17 has two distinct operational areas, 200 East and 200 West (Figures 1-3 and 1-4). These
18 are dedicated to chemical separations and waste management.

- 19
20 ● The B Plant, one of the original fuel separation facilities was in operation
21 from 1945 to 1952. The bismuth phosphate process was used to separate
22 plutonium from irradiated uranium fuel. The plutonium was precipitated
23 on a bismuth-phosphate carrier in B Plant and later converted to plutonium
24 nitrate; this took place in the 231-Z Building and 234-5Z Building of the Z
25 Plant Aggregate Area (Rai et al. 1981).
- 26
27 ● The PUREX facility separates uranium, plutonium, and neptunium from
28 fission products found in the production reactors' irradiated uranium fuel.
29 The plutonium stream after a series of purification steps, is concentrated
30 and sent to the PFP as plutonium nitrate to be converted to metal form.
31 This facility was in operation from 1956 to 1972, and was placed in a
32 standby mode until 1983. Operations were resumed in 1983 and then
33 shutdown in 1988. From December 1989 to the spring of 1990, a
34 stabilization run was operated at PUREX. Currently, the PUREX facility
35 is in standby mode.

36
37 The 200 West Area Plants consists of the U Plant, REDOX (St. Plant), T Plant,
38 and Z Plant. The interaction of the U Plant, REDOX, and T Plants with Z Plant
39 Aggregate Area are as follows:

- 40
41 ● The U Plant was used to recover uranium from stored radioactive waste
42 from 1952 to 1958. This operational area has a series of tanks located in

1 the 241-U Tank Farm. This tank farm has single-shelled tanks used for the
2 storage of radioactive waste from the U Plant and other plants. The 216-U
3 Pond area is a pond just south of the Z Plant area which served as a sink
4 for wastes, both nonradioactive and radioactive, from other units (Rai et al.
5 1981). The following is a summary of these releases into the 216-U Pond:

- 6
- 7 • Effluents from the 231-Z Building containing cooling water and
8 condensation from HVAC equipment, and inactive operation cells.
9 This building also sent laboratory wastes to this pond.
- 10
- 11 • Wastewater from the overflow 261-Z-19 Ditch and its predecessors
12 216-Z-1 and Z-11 Ditches was sent to 216-U Pond. This wastewater
13 came from the 231-Z and 234-5Z Buildings (main processing facility
14 of the Z Plant Aggregate Area). The 216-Z-1 Ditch received
15 cooling water and steam condensate from 231-Z, 234-5Z, and 291-Z
16 Buildings. The 216-Z-19 Ditch also received uncontaminated water
17 from the 200 West Area High Tank Overflow. This water eventually
18 was sent to the 216-U Pond. Long-term use of the 216-Z-19 Ditch
19 resulted in localized accumulation of transuranic and fission products
20 due to sorption and filtration into the upper sediments. These
21 products included Plutonium 239, 240, and 241 and Americium 241
22 discharges from 234-5Z and 231-Z facilities. Process waste
23 containing small quantities of plutonium was also released to the
24 216-U Pond from the 236-Z Building (PRF).
- 25
- 26 • The T Plant was one of the original bismuth phosphate fuels separation
27 facilities and was in operation from 1944 to 1956. The final concentration
28 processing to final plutonium product was done in the 234-5Z Building and
29 the 231-Z Building (Rai et al. 1981).
- 30
- 31 • The REDOX process (S Plant) succeeded the bismuth-phosphate and
32 preceded the PUREX process for fuel separation. It was in operation from
33 1951 to 1967. The final product from this process, plutonium nitrate was
34 sent to Z Plant for separation (Rai et al. 1981).
- 35

36 Solid wastes from Hanford Site-wide sources were routed to Z Plant burial
37 grounds for disposal.
38
39

1 **2.6 INTERACTION WITH RESOURCE CONSERVATION RECOVERY ACT**
2 **PROGRAM**

3
4 Several waste management units located within the Z Plant Aggregate Area
5 boundaries are subject to RCRA (and corresponding Washington State) regulations.
6 These includes:

- 7
- 8 ● The Radioactive Mixed Waste (RMW) Storage Facility is a TSD facility
9 subject to a RCRA Part B permit;
 - 10
11 ● The 241-Z Treatment Tank is a TSD facility subject to a RCRA Part B
12 permit. Currently, only Tank D-5 is identified in the facility Part A, but
13 Tanks D-4, D-7, and D-8 are expected to be added;
 - 14
15 ● Solid Waste Burial Grounds 218-W-2A, 218-W-3A, 218-W-3AE, 218-W-4B,
16 218-W-4C, 218-W-5, and 218-W-6 are included in a RCRA Part B permit
17 application and will be closed in accordance with the TSD facility closure
18 requirements;
 - 19
20 ● The proposed Waste Receiving and Processing (WRAP) facility, when it
21 begins operating, will be a TSD facility subject to a RCRA Part B permit;
22 and,
 - 23
24 ● The Hazardous Waste Staging Area (HWSA) is a generator accumulation
25 activity, not a TSD facility, so it is not required to have a RCRA Part B
26 permit.
- 27

28 Two unplanned releases are located within the boundaries of waste management
29 units that are TSD facilities regulated under RCRA:

- 30
- 31 ● UPR-200-158 resulted in contamination in Solid Waste Burial Grounds 218-
32 W-3A and 218-W-6; and
 - 33
34 ● UN-200-132 resulted in contamination in Solid Waste Burial Ground 218-
35 W-4C.
- 36

37 Three unplanned releases are indirectly associated with the 241-Z Treatment Tank
38 system and could be considered relevant for purposes of RCRA corrective action:

- 39
- 40 ● UN-200-W-74;
 - 41
42 ● UN-200-W-75; and

- 1 • UN-200-W-79.

2
3 Remediation actions recommended later in this report for the waste management
4 units and unplanned releases identified above will consider necessary interactions with
5 RCRA program requirements and activities.
6
7

8 **2.7 INTERACTIONS WITH OTHER HANFORD PROGRAMS**

9

10 In addition to RCRA, there are several other ongoing programs that affect
11 buildings and waste management units in the Z Plant Aggregate Area. These programs
12 include: the Hanford Surplus Facilities Program; the Radiation Area Remedial Action
13 Program; the Hanford Site Single-Shell Tank Program; and the Defense Waste
14 Management Program; and the Expedited Response Action Proposed for the 200 West
15 Area Carbon Tetrachloride Plume (DOE/RL 1991b).
16

17 The Hanford Surplus Facilities Program is responsible for the safe and cost-
18 effective surveillance, maintenance, and decommissioning of surplus facilities at the
19 Hanford Site. All of the major inactive buildings within the Z Plant Aggregate Area are
20 covered under this program.
21

22 The Radiation Area Remedial Action Program is conducted as part of the Surplus
23 Facilities Program, and is responsible for the surveillance, maintenance, decontamination,
24 and/or interim stabilization of inactive burial grounds, cribs, ponds, trenches, and
25 unplanned releases at the Hanford Site. A major concern associated with these
26 requirements is the management and control of surface soil contamination. All of the
27 controlled access surface radiation zones and the cribs with collapse potential in the Z
28 Plant Aggregate Area are covered by this program.
29

30 The Defense Waste Management Program is responsible for all actively operating
31 waste management units in the Z Plant Aggregate Area.
32

33 The Expedited Response Action Proposal (DOE/RL 1991b) is currently out for
34 public comment. If approved, the proposal would entail constructing and operating a soil
35 vapor extraction system to recovery carbon tetrachloride in soil beneath the 216-Z-1A
36 Tile Field, 216-Z-18 Crib, and the 216-Z-9 Trench.
37

2F-1a

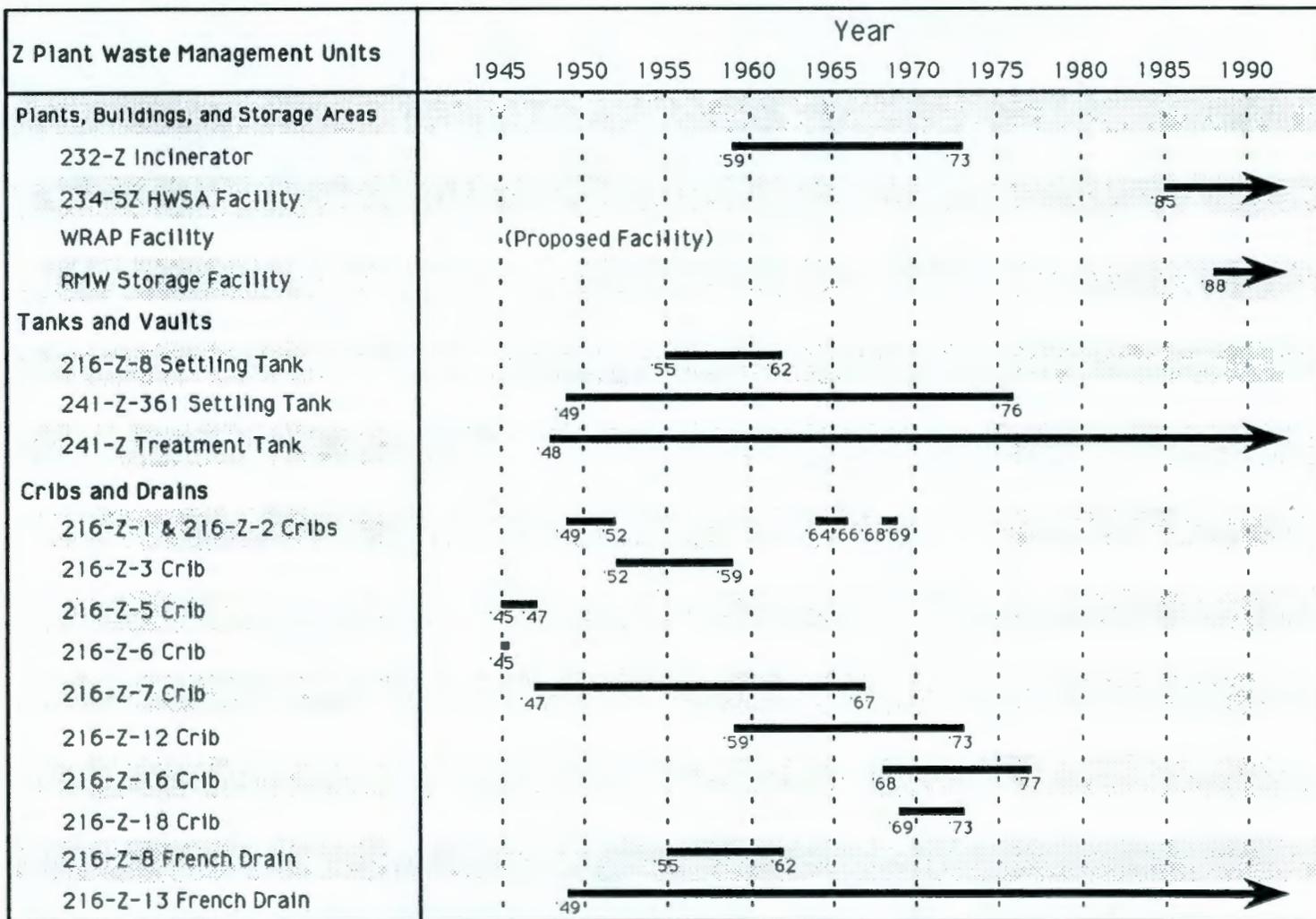
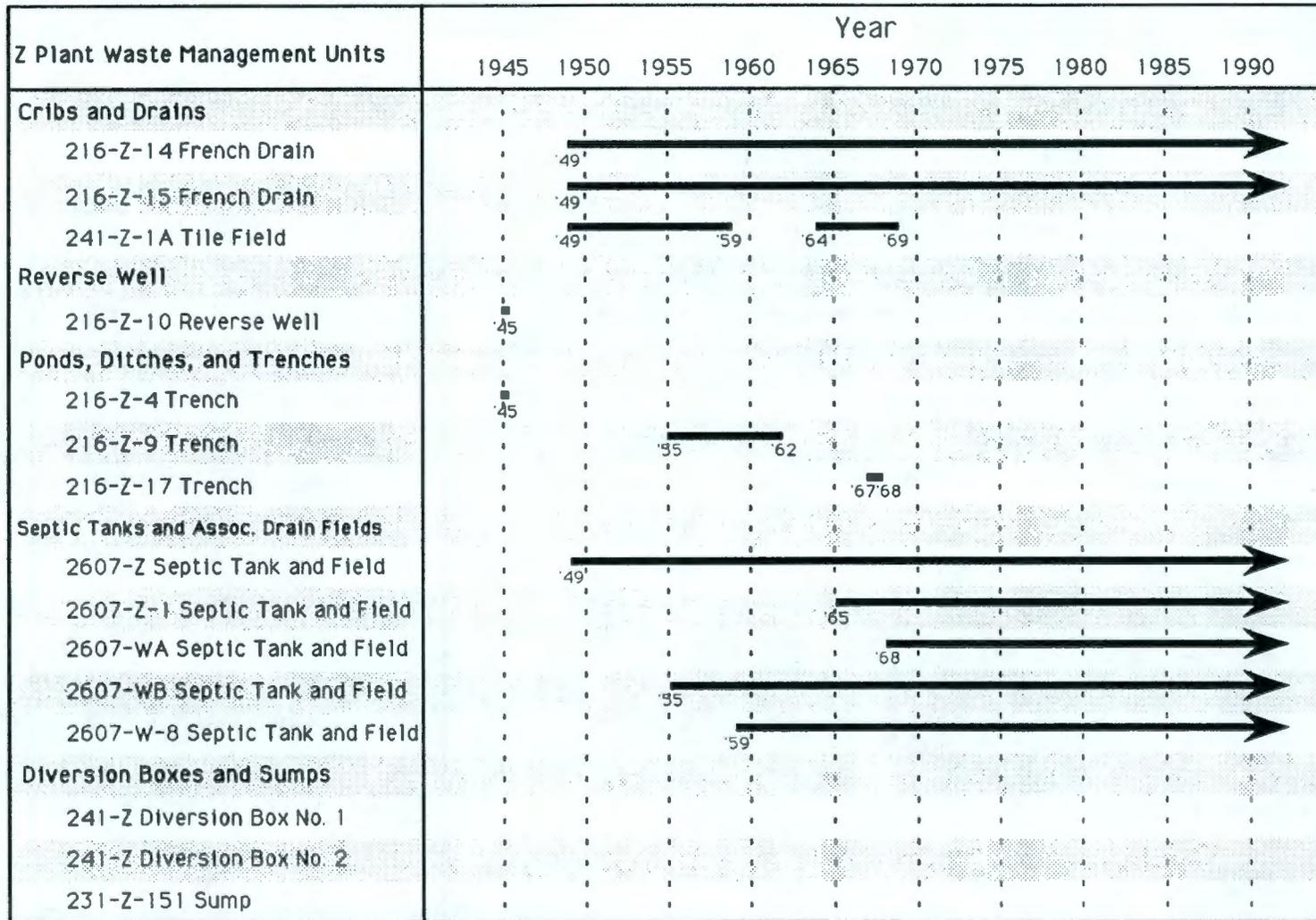


Figure 2-1. Waste Management Unit Operational History. (Sheet 1 of 4)

2F-1b



DOE/RL-91-58
Draft A

Figure 2-1. Waste Management Unit Operational History. (Sheet 2 of 4)

2F-1c

DOE/RL-91-58
Draft A

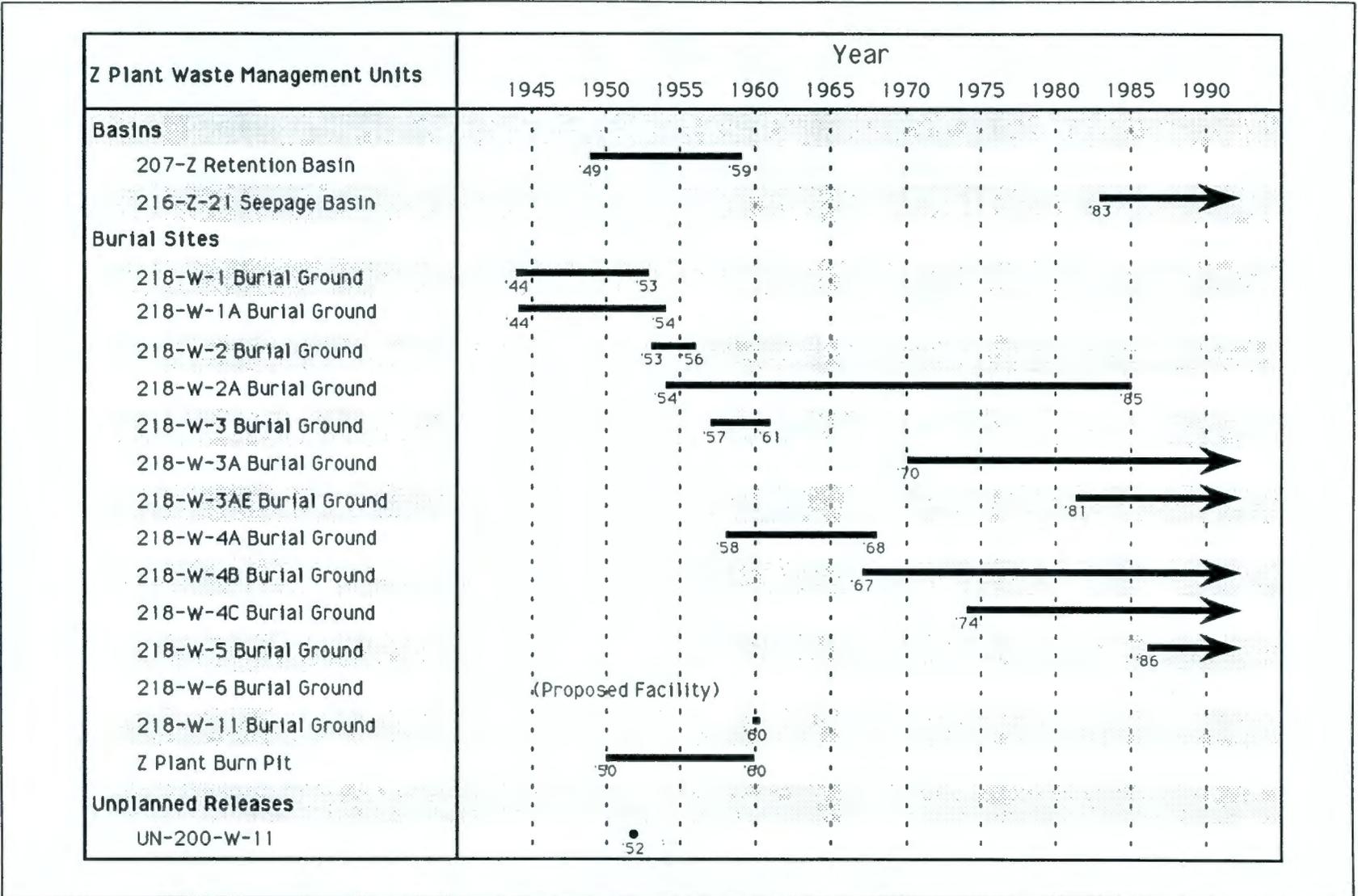
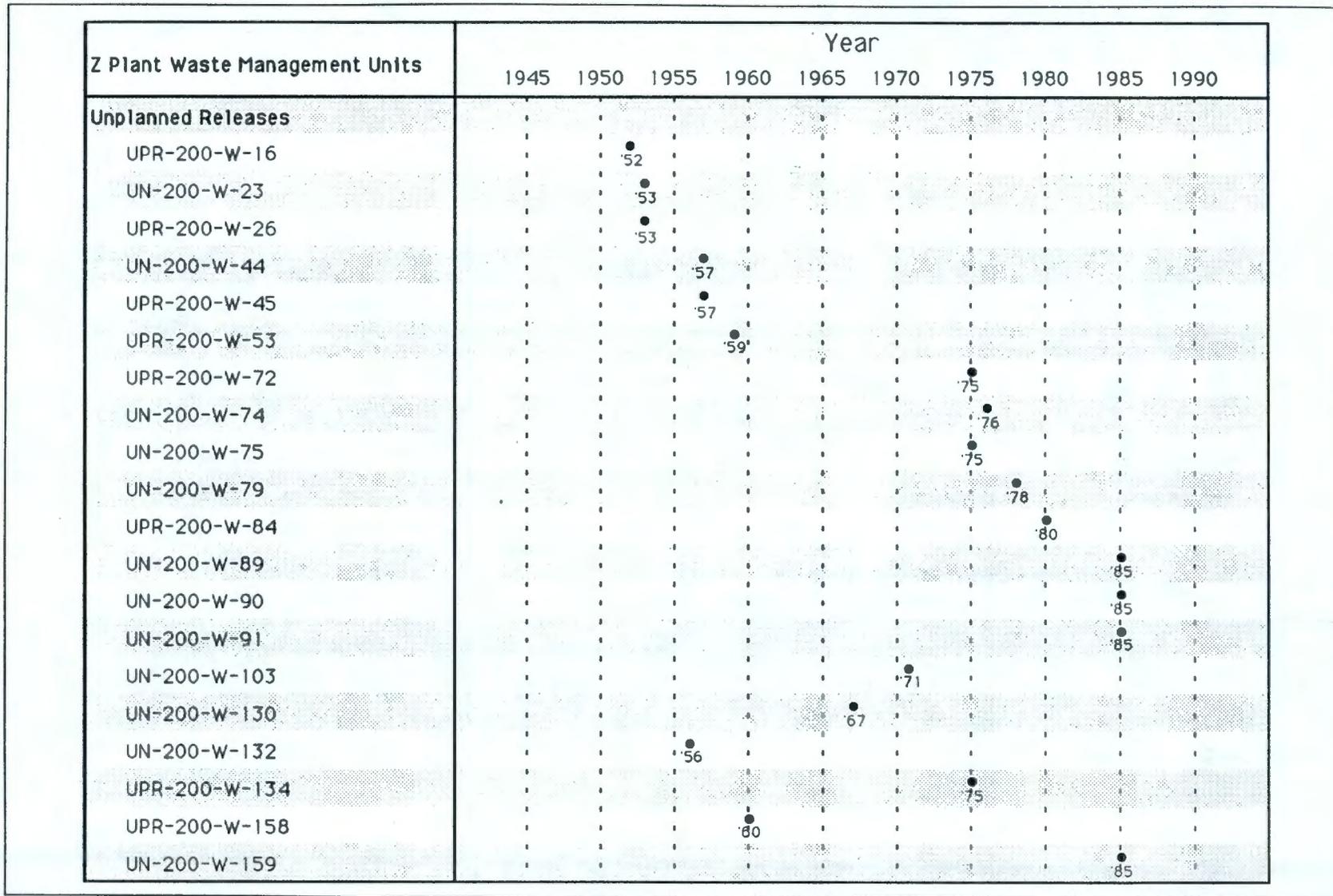


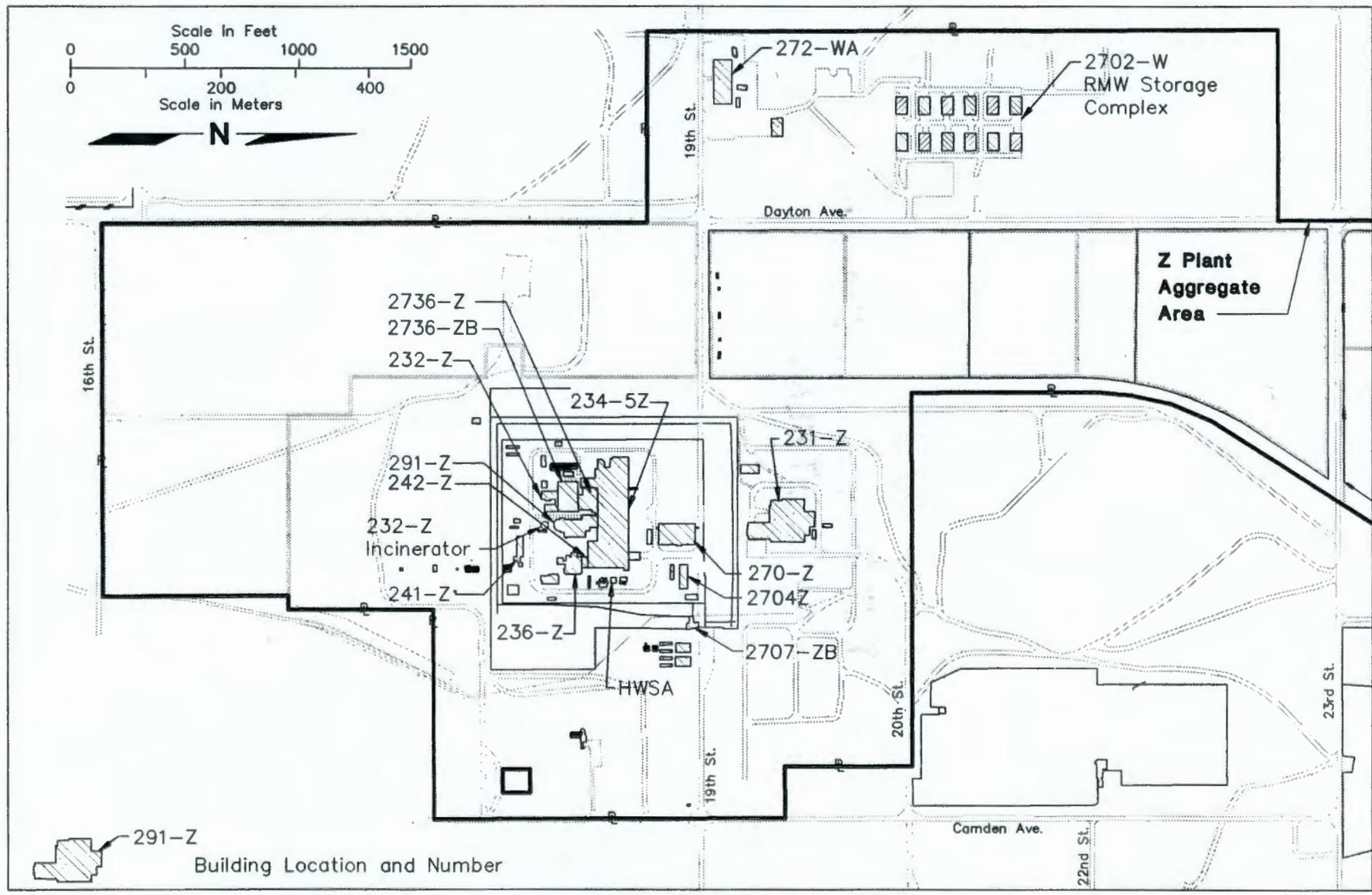
Figure 2-1. Waste Management Unit Operational History. (Sheet 3 of 4)



2F-1D

DOE/RL-91-58
Draft A

Figure 2-1. Waste Management Unit Operational History. (Sheet 4 of 4)

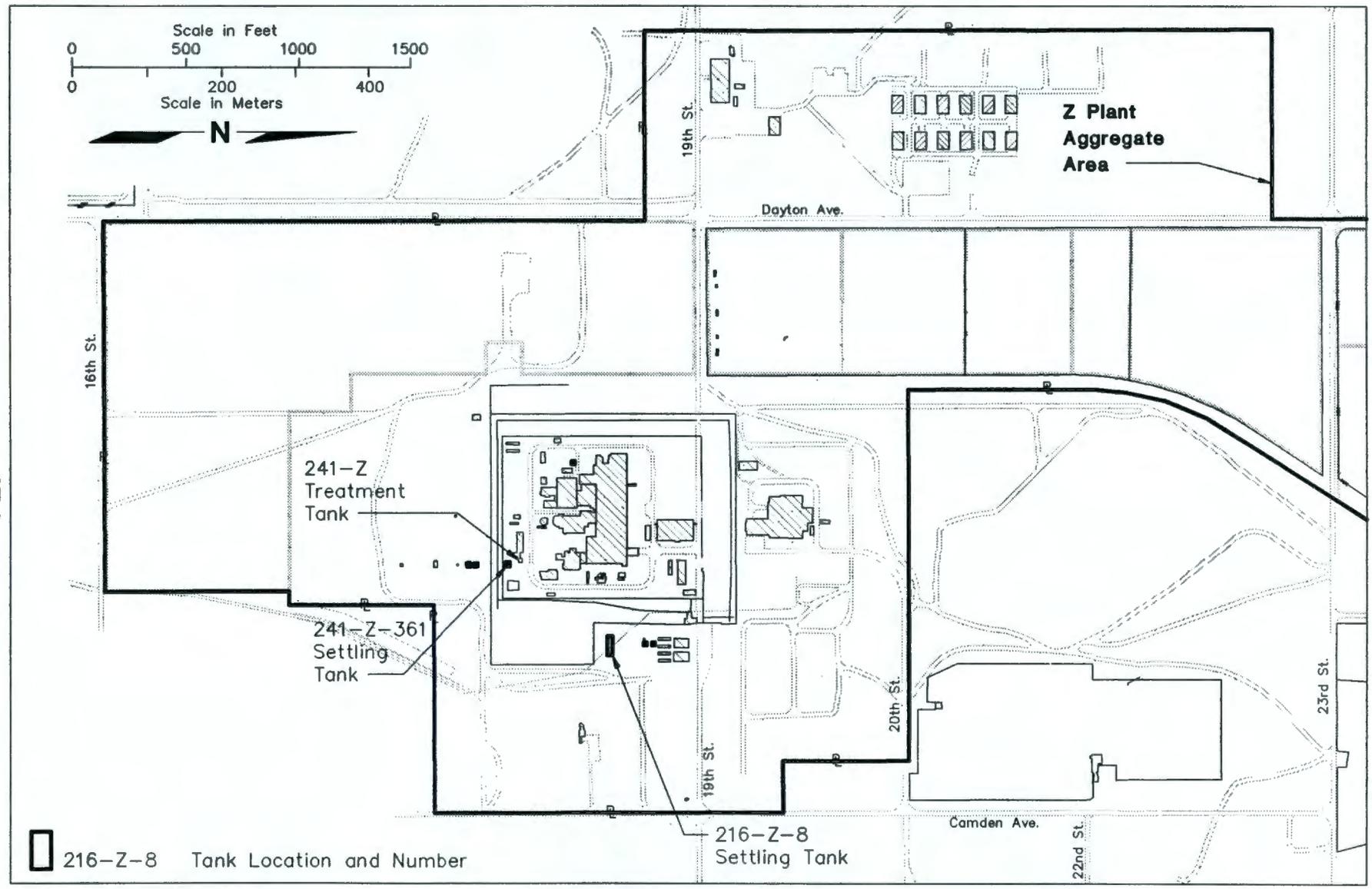


2F-2

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Draft A

Figure 2-2. Location of Plants, Buildings, and Storage Areas.

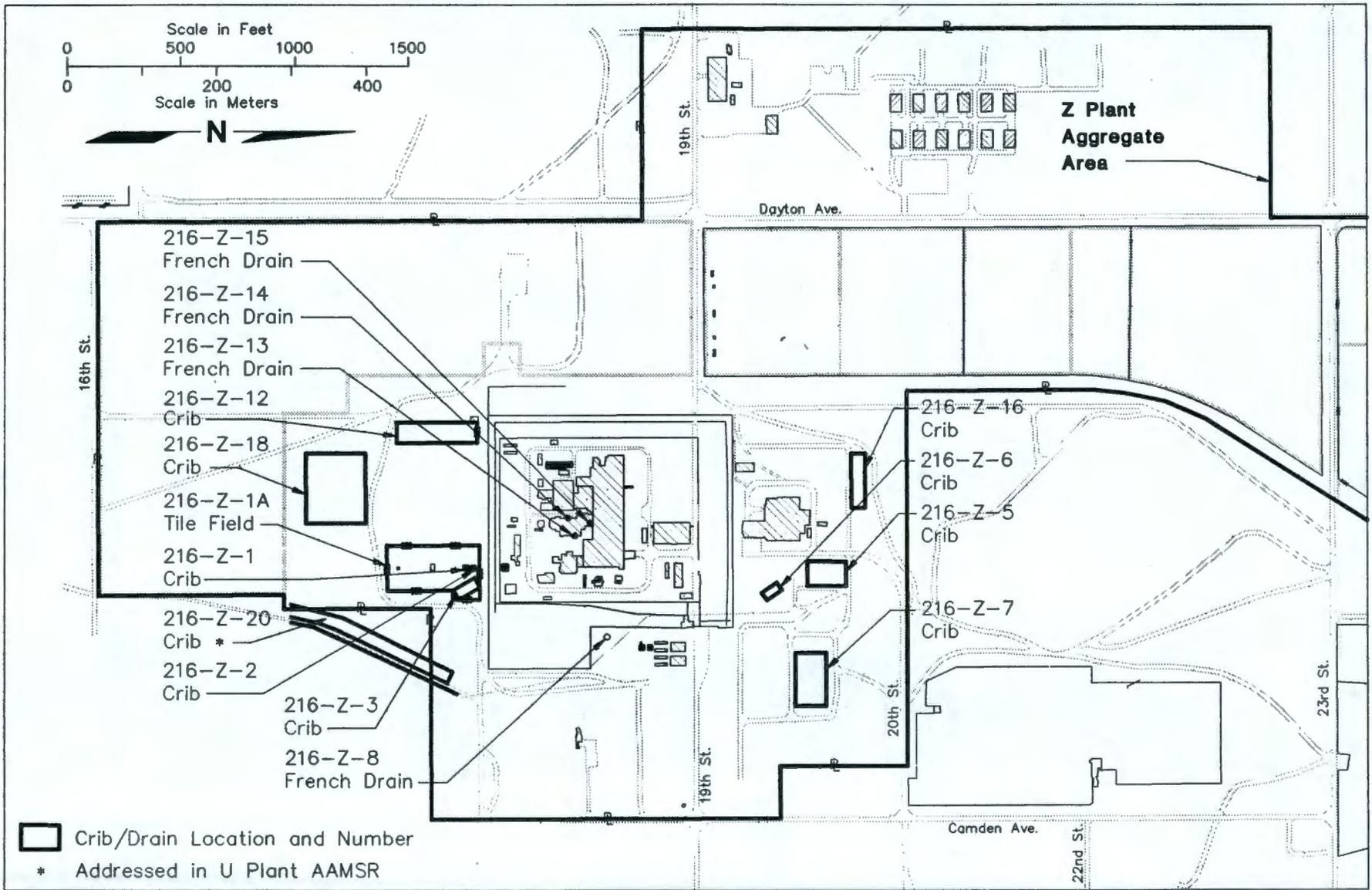
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2F-3

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Figure 2-3. Location of Tanks and Vaults.



2F-4

DOE/RL-91-58
Draft A

Figure 2-4. Location of Cribs and Drains.

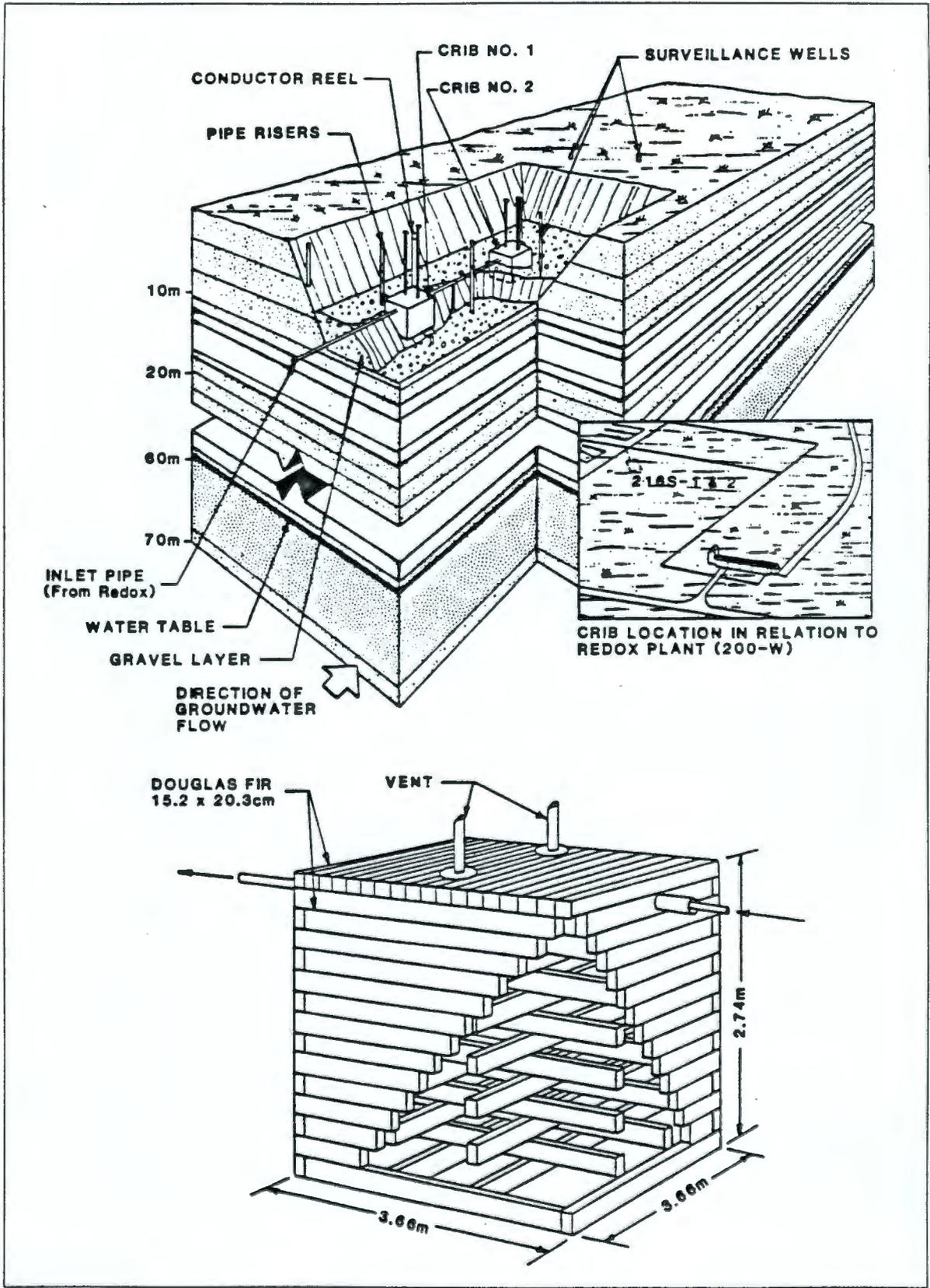
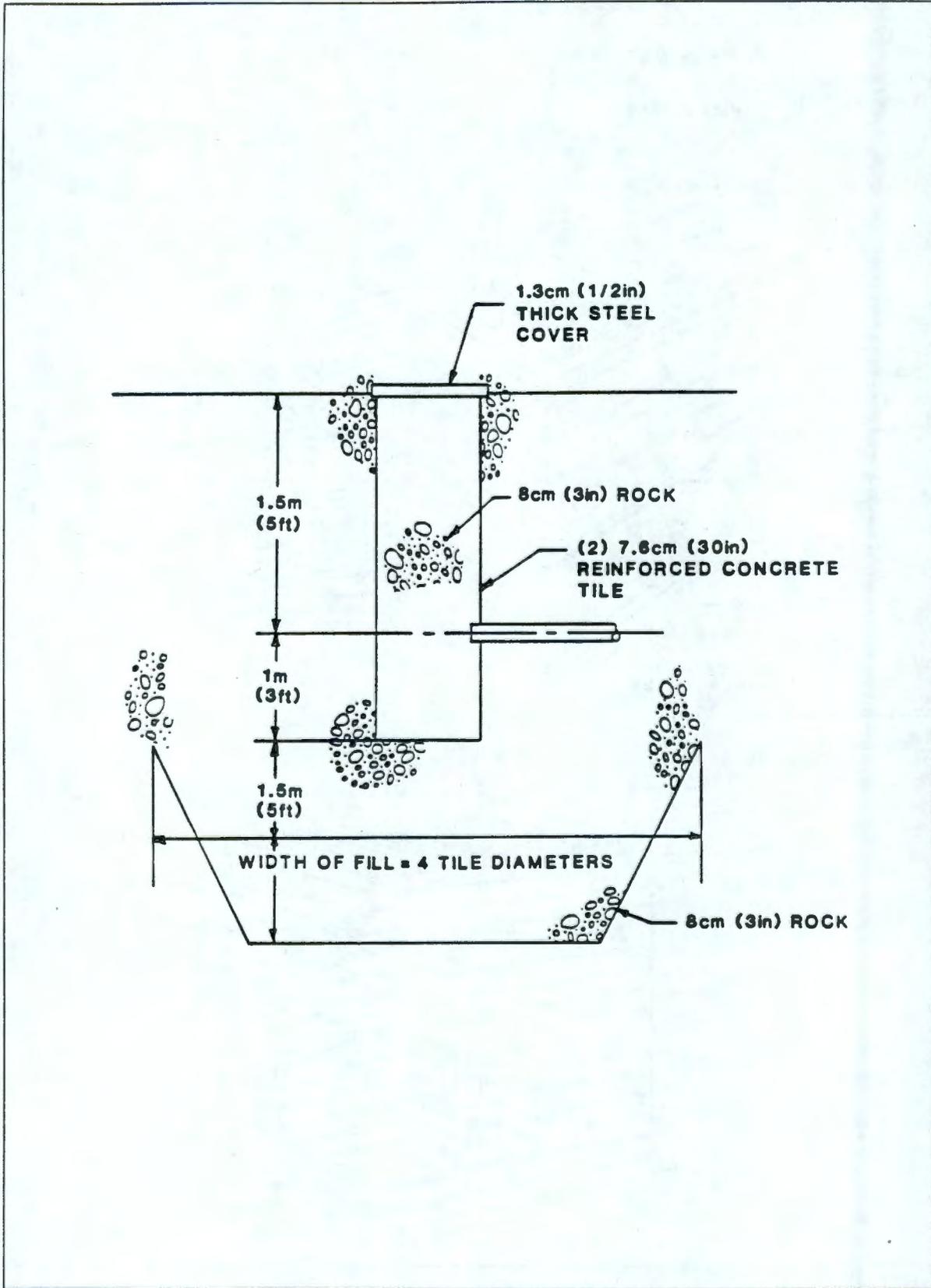


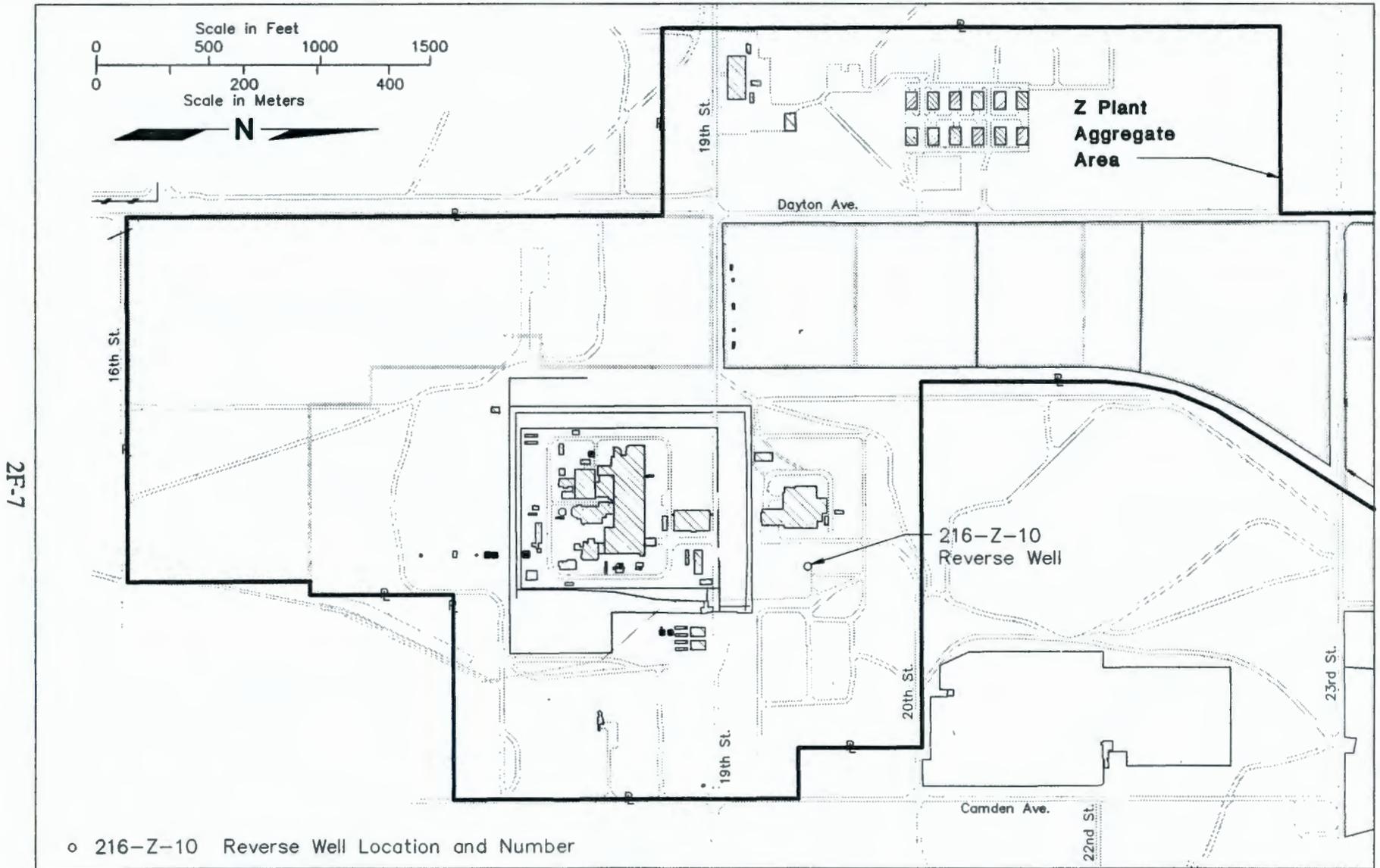
Figure 2-5. Typical Crib.

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93128650713

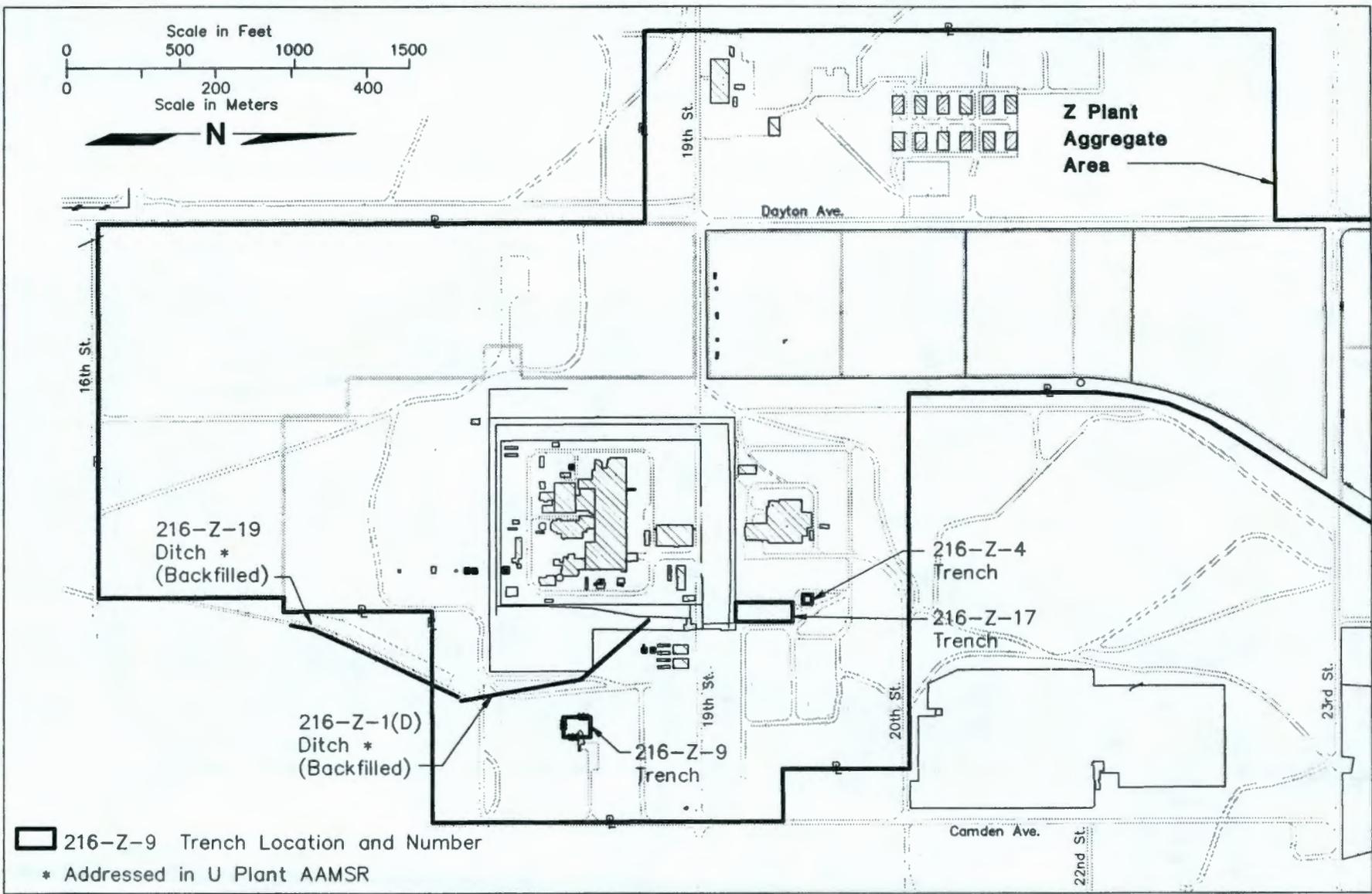
Figure 2-6. Typical French Drain



2F-7

DOE/RL-91-58
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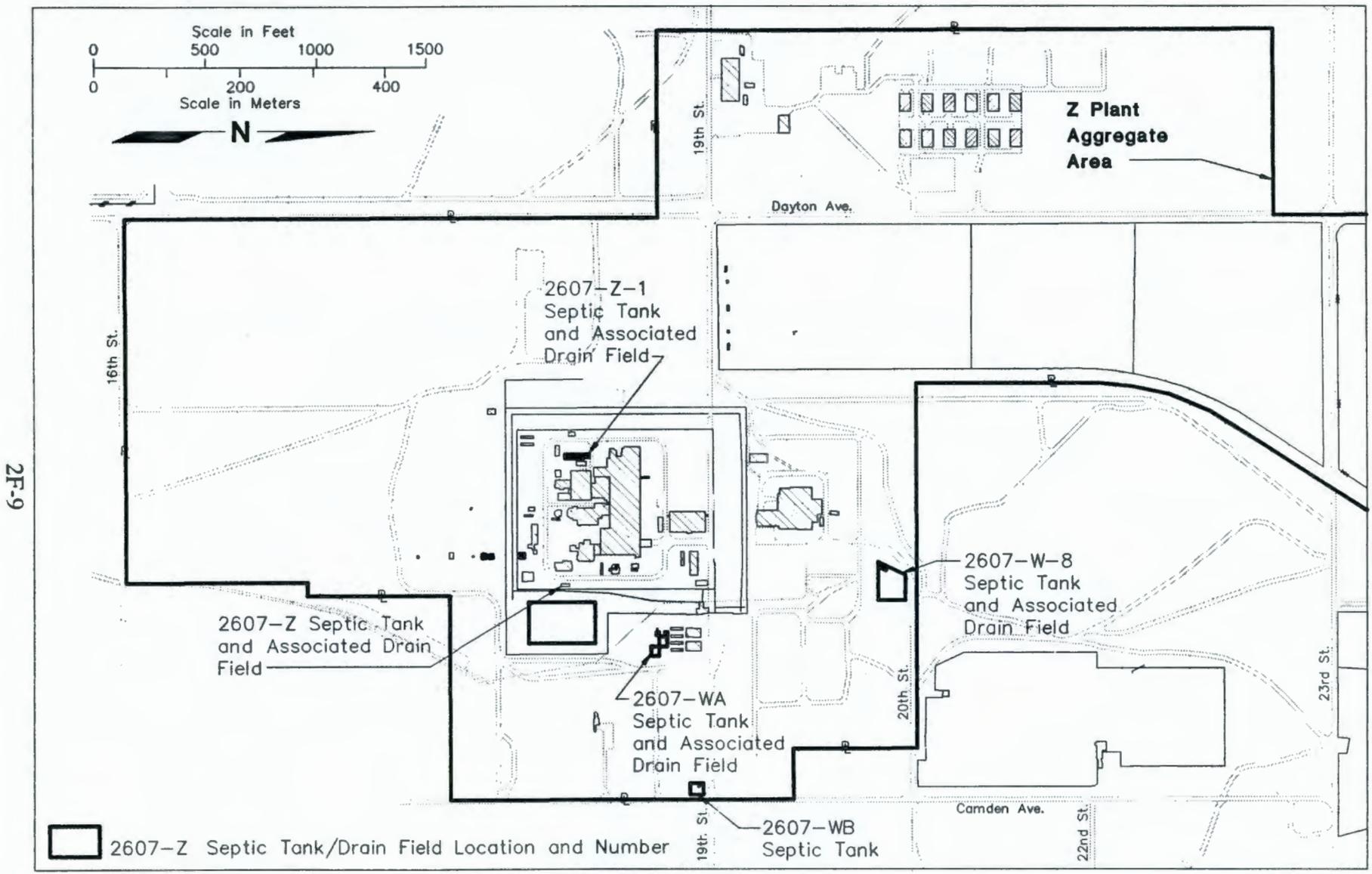
Figure 2-7. Location of Reverse Wells.



2F-8

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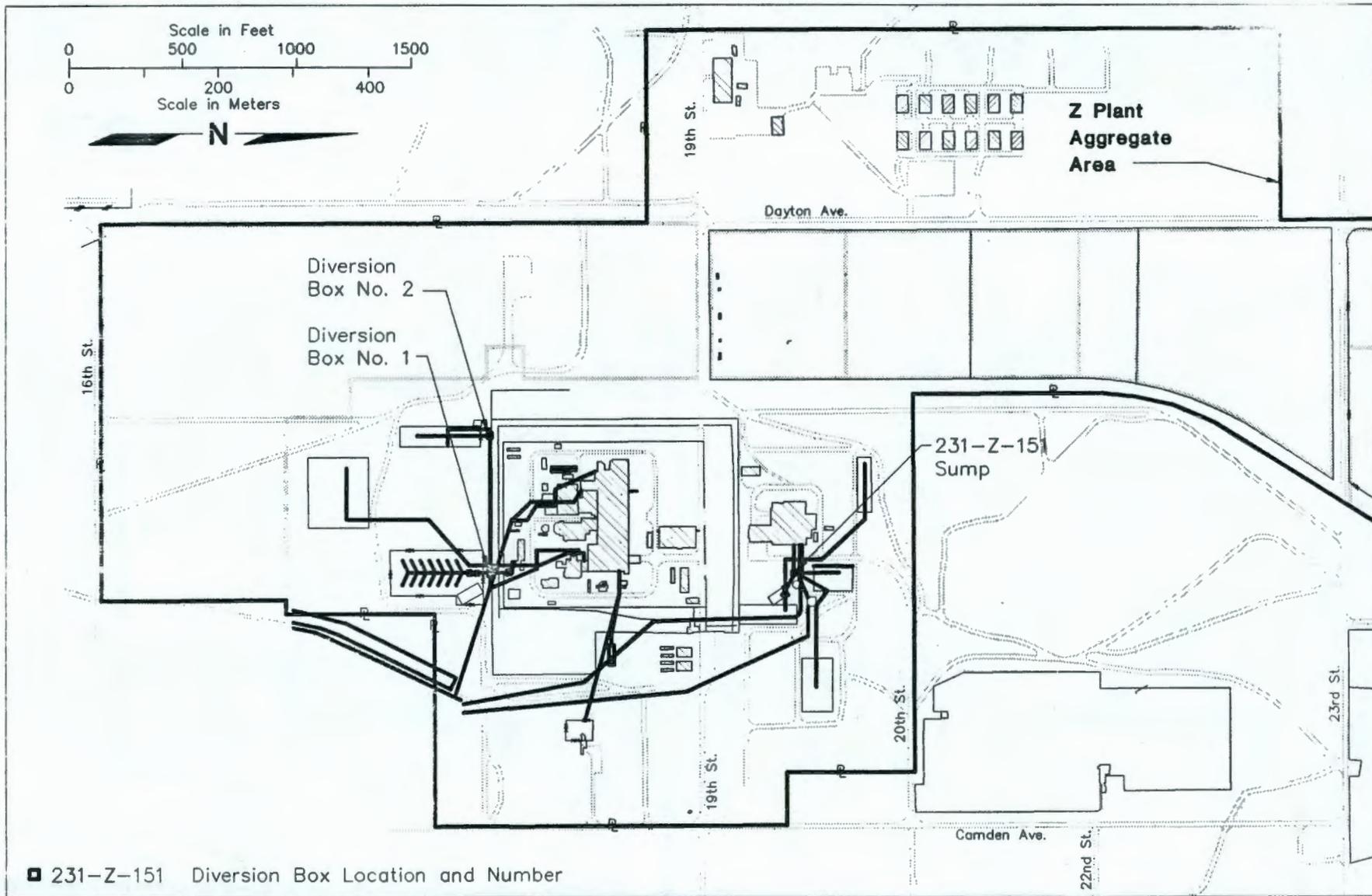
Figure 2-8. Location of Ponds, Ditches, and Trenches.



2F-9

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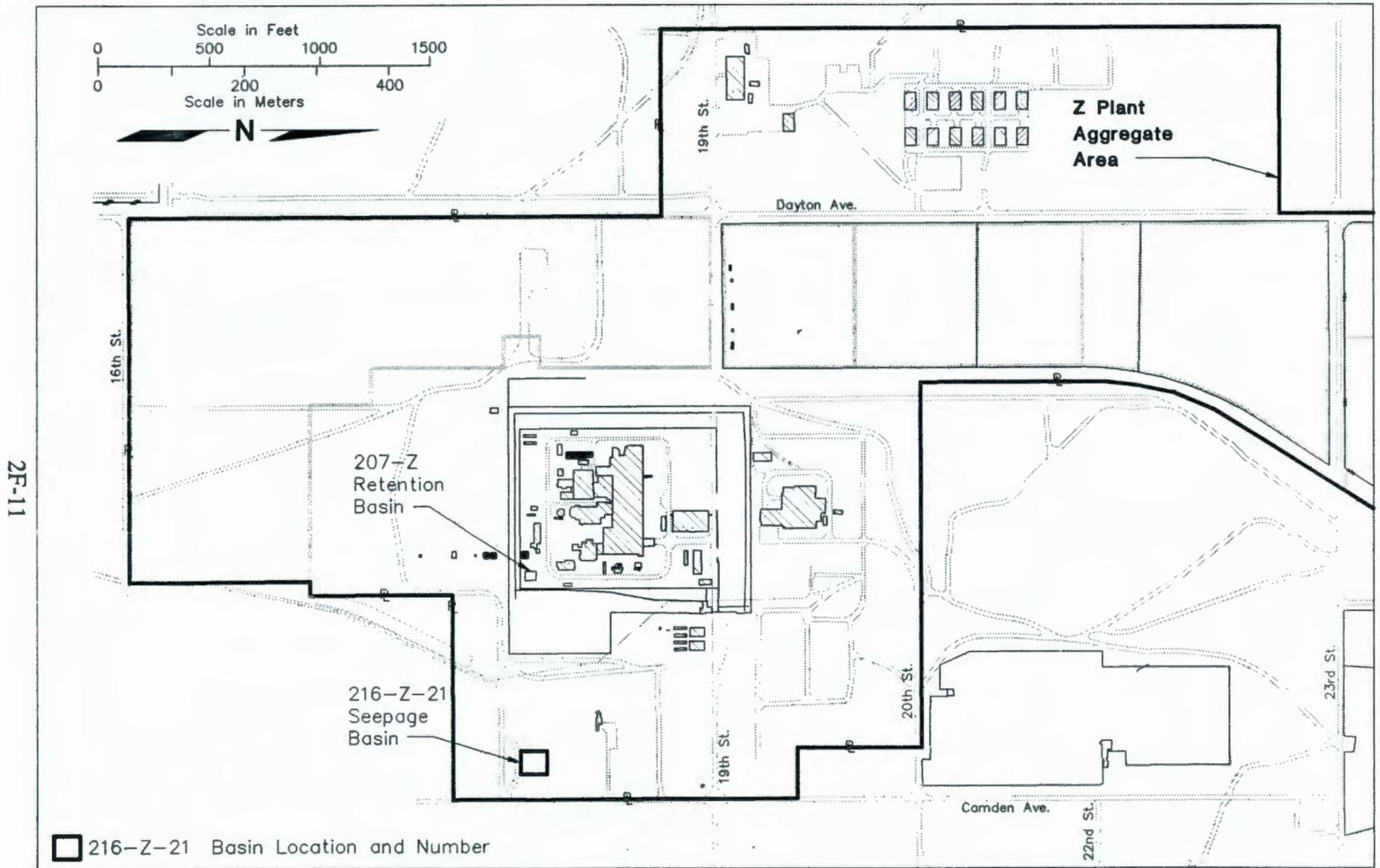
Figure 2-9. Location of Septic Tanks and Associated Drain Fields.



2F-10

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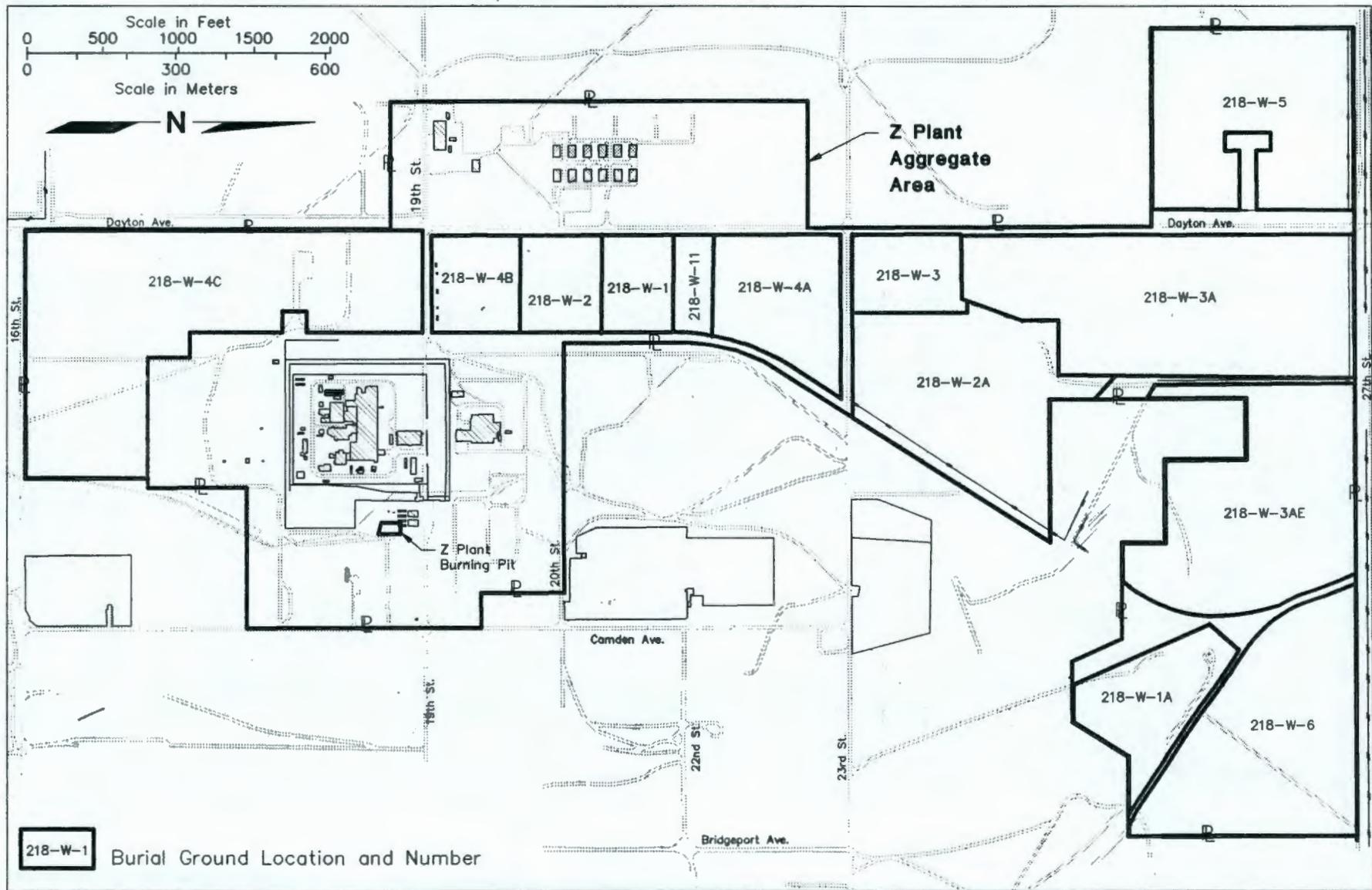
Figure 2-10. Location of Transfer Facilities, Diversion Boxes, and Pipelines.



2F-11

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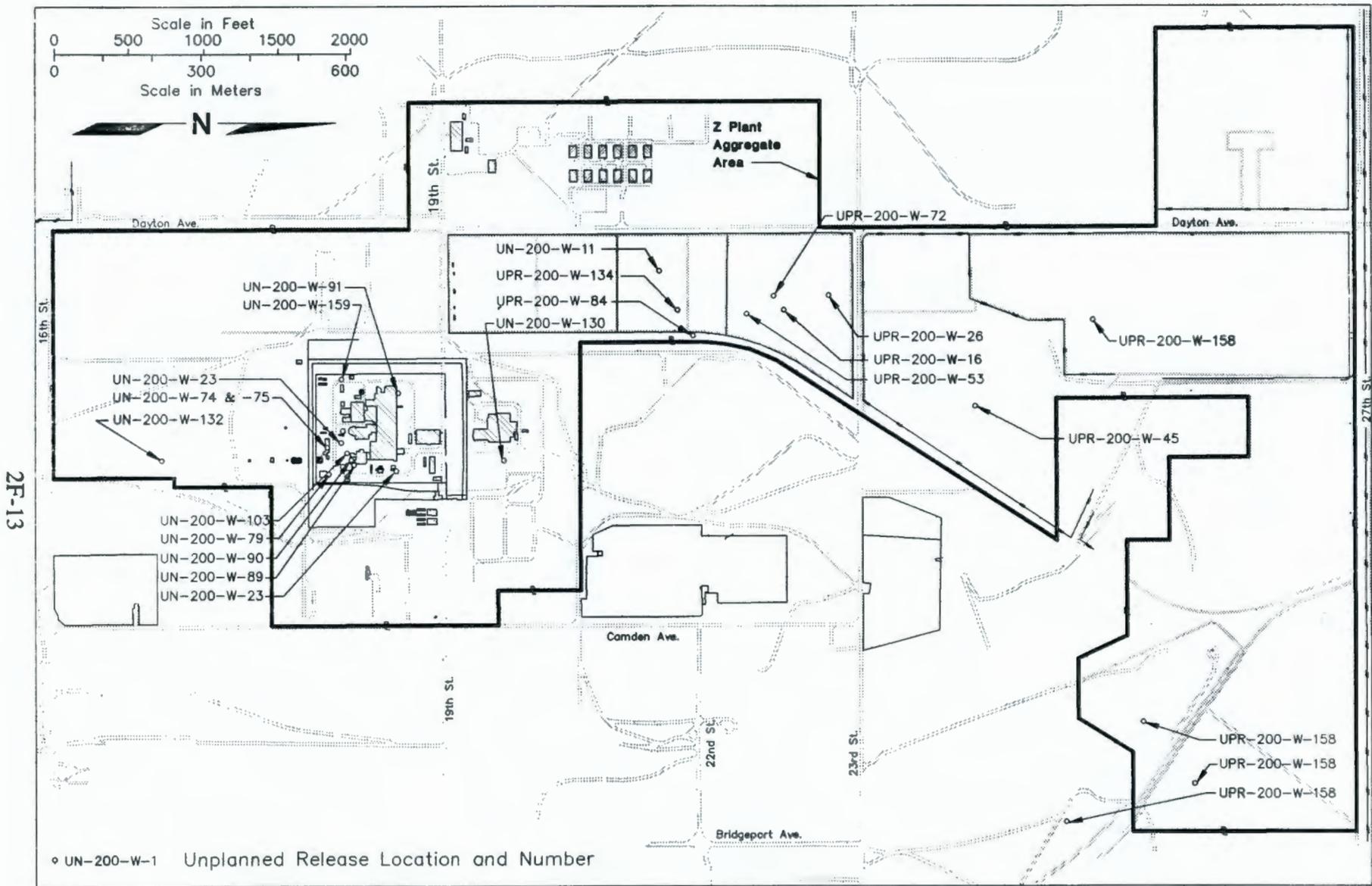
Figure 2-11. Location of Basins.



2F-12

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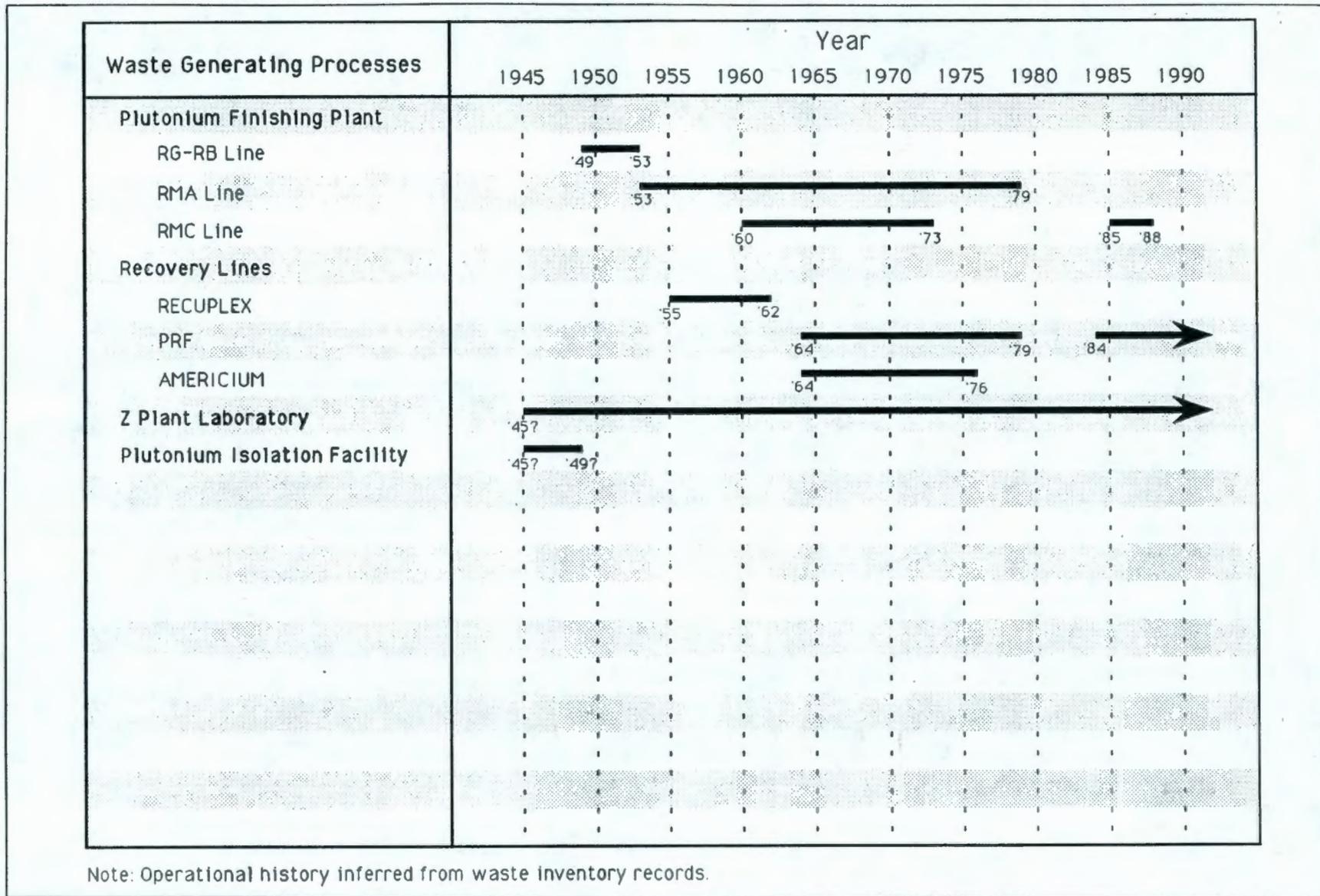
Figure 2-12. Location of Burial Sites.



2F-13

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Figure 2-13. Location of Unplanned Releases.



2F-14

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Figure 2-14. Z Plant Process History.

Table 2-1. Summary of Z Plant Aggregate Area Waste Management Units. (Sheet 1 of 4)

Waste Management Unit	Years in Service/ Status	Source Description	Total Fluid Volume Received in Liters	Solid Waste Volume Received in m ³	Operable Unit
Plants, Buildings, and Storage Areas					
232-Z Incinerator	1959-73/Inactive	Low level radioactive waste and TRU waste	na	na	200-ZP-1
234-5Z HWSA	1985-/Active	Miscellaneous hazardous materials handling	na	na	200-ZP-1
WRAP		Proposed facility	none	none	200-ZP-3
RMW Storage Facility	1988-/Active	Solid TRU/Mixed Waste from various Hanford facilities		287	200-ZP-3
Tanks and Vaults					
216-Z-8 Settling Tank	1955-62/Inactive	Organic, radioactive waste from RECUPLEX process (234-5Z)	10,000	na	200-ZP-2
241-Z-361 Settling Tank	1949-76/Inactive	Acidic, organic, radioactive waste from PFP and plutonium recovery processes (234-5Z Building, RECUPLEX process, and 242-Z Building)		(30,000-75,000)	200-ZP-1
241-Z Treatment Tank	1948-/Active	Corrosive aqueous waste from 234-5Z PFP		na	200-ZP-2
Cribs and Drains					
216-Z-1 & 216-Z-2 Cribs	1949-52; 1964-66; 1968-69 /Inactive	PRF (236-Z) and 242-Z process waste 234-5Z lab wastes	33,700,000 (38,900,000)	na	200-ZP-1
216-Z-3 Crib	1952-59/Inactive	234-5Z process, analytical, and development wastes via 241-Z-361 Settling Tank	178,000,000	na	200-ZP-1
216-Z-5 Crib	1945-47/Inactive	Process waste from 231-Z Building via 231-W-151 sump	31,000,000 (30,000,000)	na	200-ZP-2
216-Z-6 Crib	1945/Inactive	Process waste from 231-Z Building via 231-W-151 sump	98,000	na	200-ZP-2
216-Z-7 Crib	1946-67/Inactive	Laboratory waste from 231-Z Building and 340 laboratory	79,000,000	na	200-ZP-2
216-Z-12 Crib	1959-73/Inactive	234-5Z process, analytical, and development wastes via 241-Z-361 Settling Tank	281,000,000	na	200-ZP-1

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Table 2-1. Summary of Z Plant Aggregate Area Waste Management Units. (Sheet 2 of 4)

Waste Management Unit	Years in Service/ Status	Source Description	Total Fluid Volume Received in Liters	Solid Waste Volume Received in m ³	Operable Unit
216-Z-16 Crib	1968-79/Inactive	Radioactive process waste from 231-Z Building	102,000,000	na	200-ZP-2
216-Z-18 Crib	1969-73/Inactive	High salt, acidic, organic waste from 236-Z Building	3,860,000	na	200-ZP-1
216-Z-8 French Drain	1955-62/Inactive	Overflow from Z-8 Settling Tank	9,590	na	200-ZP-2
216-Z-13 French Drain	1949-/Active	ET-8 turbine steam condensate and 291-Z Building floor drain		na	200-ZP-1
216-Z-14 French Drain	1949-/Active	ET-9 turbine steam condensate and 291-Z Building floor drain		na	200-ZP-1
216-Z-15 French Drain	1949-/Active	Aqueous waste from S-12 evaporative cooler (291-Z Building)		na	200-ZP-1
216-Z-1A Tile Field	1949-59; 1964-69 /Inactive	Overflow from 216-Z-1, 216-Z-2, or 216-Z-3 Cribs, PFP process wastes (234-5Z Building), PRF process waste (236-Z Building), and 242-Z process wastes	5,210,000 6,200,000	na	200-ZP-1
Reverse Well					
216-Z-10 Reverse Well	1945/Inactive	Process and laboratory waste from 231-Z Building via 231-W-151 sump	1,000,000	na	200-ZP-2
Ponds, Ditches, and Trenches					
216-Z-4 Trench	1945/Inactive	Process and laboratory waste from 231-Z Building	11,000		200-ZP-2
216-Z-9 Trench	1955-62/Inactive	Radioactive, acidic, organic wastes from RECUPLEX process (234-5Z Building), 242-Z Building inorganic process wastes, and 236-Z CAW	4,090,000	na	200-ZP-2
216-Z-17 Trench	1967-68/Inactive	Process waste from 231-Z Building via 231-W-151 sump	36,800,000 (36,700,000)	na	200-ZP-2
Septic Tanks					
2607-Z Septic Tank & Field	1949-/Active	Sanitary wastewater for 234-5Z and 2704-Z Buildings		na	200-ZP-2
2607-Z-1 Septic Tank & Field	1965-/Active	Sanitary wastewater		na	200-ZP-2

ZT-1b

DOE/RL-91-58
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Table 2-1. Summary of Z Plant Aggregate Area Waste Management Units. (Sheet 3 of 4)

Waste Management Unit	Years in Service/ Status	Source Description	Total Fluid Volume Received in Liters	Solid Waste Volume Received in m ³	Operable Unit
2607-WA Septic Tank & Field	1968-/Active	Sanitary wastewater		na	200-ZP-2
2607-WB Septic Tank & Field	1955-/Active	Sanitary wastewater from 272-WA Building		na	200-ZP-2
2607-W-8 Septic Tank & Field	1959-/Active	Sanitary wastewater from 231-Z Building		na	200-ZP-2
Transfer Facilities, Diversion Boxes, and Pipelines					
241-Z Diversion Box No. 1				na	200-ZP-1
241-Z Diversion Box No. 2				na	200-ZP-1
231-Z-151 Sump		Process and laboratory waste from 231-Z Building		na	200-ZP-1
Basins					
207-Z Retention Basin	1949-59/Inactive	May have received contaminated waste, steam condensate, and/or cooling water		na	200-ZP-2
216-Z-21 Seepage Basin	1983-/Active	Storm water runoff from north of 234-5Z building	10 ⁶ liters/yr	na	200-ZP-2
Burial Sites					
218-W-1 Burial Ground	1944-53/Inactive	Transuranic mixed solid waste		7,000	200-ZP-3
218-W-1A Burial Ground	1944-54/Inactive	Mixed industrial solid waste		16,000	200-ZP-3
218-W-2 Burial Ground	1953-56/Inactive	Transuranic mixed solid waste		8,200	200-ZP-3
218-W-2A Burial Ground	1954-85/Inactive	Mixed industrial solid waste		19,000	200-ZP-3
218-W-3 Burial Ground	1957-61/Inactive	Transuranic mixed solid waste		11,000	200-ZP-3
218-W-3A Burial Ground	1970-/Active	Transuranic mixed solid waste		24,000	200-ZP-3
218-W-3AE Burial Ground	1981-/Active	Mixed industrial solid waste			200-ZP-3
218-W-4A Burial Ground	1958-68/Inactive	Transuranic mixed solid waste		18,000	200-ZP-3

2T-1c

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Table 2-1. Summary of Z Plant Aggregate Area Waste Management Units. (Sheet 4 of 4)

Waste Management Unit	Years in Service/ Status	Source Description	Total Fluid Volume Received in Liters	Solid Waste Volume Received in m ³	Operable Unit
218-W-4B Burial Ground	1967-/Active	Transuranic mixed solid waste	na	10,000	200-ZP-3
218-W-4C Burial Ground	1974-/Active	Transuranic mixed solid waste	na	16,000	200-ZP-3
218-W-5 Burial Ground	1986-/Active	Low level/mixed solid waste	na	32,500	200-ZP-3
218-W-6 Burial Ground	Proposed	Low level/mixed solid waste (Proposed Facility)	none	none	200-ZP-3
218-W-11 Burial Ground	1960/Inactive	Low level/mixed solid waste	na	1,160	200-ZP-3
Z Plant Burn Pit	1950-60/Inactive	Office and non-hazardous waste	na	2,000	200-ZP-2

Notes:

Volume data derived from Waste Information Data System (WIDS) - WHC 1990a.
 (30,000,000) Parenthetical data from Stenner et al. 1988.
 na Not applicable.

297028/TABLE 2-1

2T-1d

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Table 2-2. Z Plant Aggregate Area Waste Management Unit Radionuclide Waste Inventory Summary. (Sheet 1 of 4)

Waste Management Unit	Total Pu in gm	Quantity of Reported Radionuclides in Unit in Ci ^a											
		²³⁸ U	¹³⁷ Cs	¹⁰⁶ Ru	⁹⁰ Sr	⁶⁰ Co	³ H	¹⁴ C	¹⁵⁴ Eu	Other ^b Radionuclides	²³⁹ Pu	²⁴⁰ Pu	²⁴⁰ Pu
Plants, Buildings, and Storage Areas													
232-Z Incinerator	—	—	—	—	—	—	—	—	—	—	—	—	—
234-5Z HWSA	—	—	—	—	—	—	—	—	—	—	—	—	—
WRAP	—	—	—	—	—	—	—	—	—	—	—	—	—
RMW Storage Facility	—	—	—	—	—	—	—	—	—	—	—	—	—
Tanks and Vaults													
216-Z-8 Settling Tank	48	—	—	—	—	—	—	—	—	—	—	—	—
241-Z-361 Settling Tank	30,000 to 75,000	—	—	—	—	—	—	—	—	—	—	—	—
241-Z Treatment Tank	—	—	—	—	—	—	—	—	—	—	—	—	—
Cribs and Drains													
216-Z-1 & 216-Z-2 Cribs	7,000	0.027	0.04 (0.165)	1.6 x 10 ⁻¹¹	0.037 (0.0159)	0.0171	—	—	—	—	—	2,680	992
216-Z-3 Crib	5,700	1.7 x 10 ⁻⁵	0.048	6.0 x 10 ⁻⁹ (16.9)	0.045 (0.097)	—	—	—	—	—	—	325	87.8
216-Z-5 Crib	340	1.7 x 10 ⁻⁵ 2.0 x 10 ⁻⁵	3.6 (3.92)	5.2 x 10 ⁻¹²	1.7 1.83	0.0026	—	—	—	—	—	19.4	5.24
216-Z-6 Crib	5	1.7 x 10 ⁻⁵ 2.0 x 10 ⁻⁵	0.035	2.7 x 10 ⁻¹⁴	0.033 (0.0361)	0.00048	—	—	—	0.0385	—	0.28	0.077
216-Z-7 Crib	2,000	0.0015	200 (224)	5.1 x 10 ⁻⁶	200 (223)	0.0765	—	—	—	—	—	114	30.8
216-Z-12 Crib	25,000	1.7 x 10 ⁻⁵	0.053 (0.0528)	9.3 x 10 ⁻⁷	0.051 0.0562)	0.00515	—	—	—	—	—	1,430	386

2T-2a

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Table 2-2. Z Plant Aggregate Area Waste Management Unit Radionuclide Waste Inventory Summary. (Sheet 2 of 4)

Waste Management Unit	Total Pu in gm	Quantity of Reported Radionuclides in Unit in Ci ^a											
		²³⁸ U	¹³⁷ Cs	¹⁰⁶ Ru	⁹⁰ Sr	⁶⁰ Co	³ H	¹⁴ C	¹⁵⁴ Eu	Other ^{***} Radionuclides	²³⁸ Pu	²³⁹ Pu	²⁴⁰ Pu
216-Z-16 Crib	72	—	—	—	—	—	—	—	—	—	—	4.09	1.1
216-Z-18 Crib	23,000	—	—	—	—	—	—	—	—	—	—	1,310	353
216-Z-8 French Drain	2	—	—	—	—	—	—	—	—	1,373 (²⁴¹ Am)	0.13	2.76	0.745
216-Z-13 French Drain	—	—	—	—	—	—	—	—	—	—	—	—	—
216-Z-14 French Drain	—	—	—	—	—	—	—	—	—	—	—	—	—
216-Z-15 French Drain	—	—	—	—	—	—	—	—	—	—	—	—	—
216-Z-1A Tile Field	57,000	—	0.16	5.2 x 10 ⁻⁶	0.15	—	—	—	—	3,432 (²⁴¹ Am)	—	137	37
Reverse Well													
216-Z-10 Reverse Well	50	—	—	—	—	—	—	—	—	bb	0.14	2.85	0.77
Ditches and Trenches													
216-Z-4 Trench	2	1.7 x 10 ⁻⁵	0.035	2.7 x 10 ⁻¹⁴	0.033	—	—	—	—	—	—	—	—
216-Z-9 Trench	48,000	1.7 x 10 ⁻⁵ 2.0 x 10 ⁻⁵	0.052 (0.0556)	1.9 x 10 ⁻⁸	0.049 (0.0535)	0.00395	—	—	—	8,580 (²⁴¹ Am)	—	2,190	590
216-Z-17 Trench	50	5.0 x 10 ⁻⁵	—	—	—	—	—	—	—	—	—	2.87	0.225
Septic Tanks and Drain Fields													
2607-Z Septic Tank & Field	—	—	—	—	—	—	—	—	—	—	—	—	—
2607-Z-1 Septic Tank & Field	—	—	—	—	—	—	—	—	—	—	—	—	—
2607-WA Septic Tank & Field	—	—	—	—	—	—	—	—	—	—	—	—	—
2607-WB Septic Tank & Field	—	—	—	—	—	—	—	—	—	—	—	—	—

2T-2b

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Table 2-2. Z Plant Aggregate Area Waste Management Unit Radionuclide Waste Inventory Summary. (Sheet 3 of 4)

Waste Management Unit	Total Pu in gm	Quantity of Reported Radionuclides in Unit in Ci ^a											
		²³⁸ U	¹³⁷ Cs	¹⁰⁶ Ru	⁹⁰ Sr	⁶⁰ Co	³ H	¹⁴ C	¹⁵⁴ Eu	Other TM Radionuclides	²³⁹ Pu	²⁴⁰ Pu	²⁴⁰ Pu
2607-W-8 Septic Tank & Field	—	—	—	—	—	—	—	—	—	—	—	—	—
Transfer Facilities, Diversion Boxes, and Pipelines													
241-Z Diversion Box No. 1													
241-Z Diversion Box No. 2													
231-Z-151 Sump													
Basins													
207-Z Retention Basin	—	—	—	—	—	—	—	—	—	—	—	—	—
216-Z-21 Seepage Basin	—	—	—	—	—	—	—	—	—	—	—	—	—
Burial Sites													
218-W-1 Burial Ground	94,000	0.0235	1.63 (4.15)	8.83×10^{-12} (4.3)	1.44 (3.88)	—	—	—	—	—	—	5,370	1,450
218-W-1A Burial Ground	2,000	0.302	359 (997)	5.23×10^{-9} (1,030)	359 (932)	—	—	—	—	—	—	114	30.8
218-W-2 Burial Ground	126,000	46.9	4.86 (10.4)	5.72×10^{-10} (10.8)	4.1 (9.7)	—	—	—	—	—	—	7,190	1,940
218-W-2A Burial Ground	—	—	2,766	0.0025	2,467	0.33	—	—	—	—	—	—	—
218-W-3 Burial Ground	68,000	23.5	9.15 (18.7)	1.31×10^{-8} (19.3)	8.15 (17.5)	—	—	—	—	—	—	3,880	1,050
218-W-3A Burial Ground	29,300	—	302,000	12.7	101,000	9,840	178,000	1.74	0.145	3,960	—	—	—
218-W-3AE Burial Ground	122	—	14,300	0.0268	4,240	299	19,500	0.321	0.141	10.5	—	—	—
218-W-4A Burial Ground	35,400	—	39.3	8.42×10^{-4}	35.4	—	—	—	—	1.18	—	—	—

2T-2c

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Table 2-2. Z Plant Aggregate Area Waste Management Unit Radionuclide Waste Inventory Summary. (Sheet 4 of 4)

Waste Management Unit	Total Pu in gm	Quantity of Reported Radionuclides in Unit in Ci ^a											
		²³⁸ U	¹³⁷ Cs	¹⁰⁶ Ru	⁹⁰ Sr	⁶⁰ Co	³ H	¹⁴ C	¹⁵⁴ Eu	Other ^{aa} Radionuclides	²³⁸ Pu	²³⁹ Pu	²⁴⁰ Pu
218-W-4B Trenches	48,800 [2089.74]	—	6,410	390	89,700	—	68,500	—	—	60	—	—	—
218-W-4B Caissons	7,290	—	12,340	216	11,000	76,000	786	—	0.211	—	—	—	—
218-W-4C Burial Ground	383,000 [3613.80]	—	165,000	927	111,000	221,000	25.1	7.85	288	11,600	—	—	—
218-W-5 Burial Ground	154	—	1,500	1.58	1,350	3,410	15,200	4.29	108	67.7	—	—	—
218-W-6 Burial Ground	—	—	—	—	—	—	—	—	—	—	—	—	—
218-W-11 Burial Ground	—	—	0.0020	1.6 x 10 ⁻⁹	0.0009	—	—	—	—	—	—	—	—
Z Plant Burn Pit	—	—	—	—	—	—	—	—	—	—	—	—	—

21-2d
Notes:

^a Curies decayed through 1989, except burial ground waste units, which are decayed through December 31, 1990.

Data obtained from WHC 1990a and Anderson et al. 1991; blank indicates no available data.

Data presented in parentheses obtained from Stenner et al. 1988.

Data presented in brackets obtained from Jensen 1990.

^{aa} Also received 1.0 Ci of ²⁴¹Am, 1.9 Ci of ²⁴¹Pu, and 0.00004 Ci of ²⁴²Cm.

^{bb} Also received 1.0 Ci of ²⁴¹Am, 2.0 Ci of ²⁴¹Pu, and 0.00004 Ci of ²⁴²Cm.

^{**} Other radionuclides are discussed in Section 2.3.9.

297028 TABLE 2-2

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Table 2-3. Z Plant Aggregate Area Waste Management Unit Chemical Waste Inventory Summary. (Sheet 1 of 3)

Waste Management Unit	Quantity of Reported Chemical in Unit in kg ¹													
	CCl ₄	TBP	DBBP	Nitrate	Sodium	Fluoride	Calcium Nitrate	Magnesium Nitrate	Nitric Acid	Aluminum Fluoride Nitrate	Aluminum Nitrate	Ferric Nitrate	Sulfate	Sodium Hydroxide
Plants, Buildings, and Storage Areas														
232-Z Incinerator	—	—	—	—	—	—	—	—	—	—	—	—	—	—
234-SZ HWSA(c) (Storage Area Only)	14	—	—	2,481	—	—	—	—	—	—	—	—	—	1,720
WRAP	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RMW Storage Facility	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Tanks and Vaults														
216-Z-8 Settling Tank	—	—	—	—	—	—	—	—	—	—	—	—	—	1,000
241-Z-361 Settling Tank	—	—	—	—	—	—	—	—	—	—	—	—	—	—
241-Z Treatment Tank	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cribs and Drains														
216-Z-1 & 216-Z-2 Cribs	—	—	—	100,000	80,000	30,000	—	—	—	—	—	—	—	—
216-Z-3 Crib	—	—	—	600,000	400,000	160,000	—	—	—	—	—	—	—	—
216-Z-5 Crib	—	—	—	100,000	100,000	—	—	—	—	—	—	—	—	—
216-Z-6 Crib	—	—	—	130	50	—	—	—	—	—	—	—	—	—
216-Z-7 Crib	—	—	—	20,000	—	—	—	—	—	—	—	—	—	—
216-Z-12 Crib	—	—	—	900,000	600,000	300,000	—	—	—	—	—	—	—	—
216-Z-16 Crib	—	—	—	—	—	—	—	—	—	—	—	—	—	—
216-Z-18 Crib	173,800	22,000	15,000	500,000	200,000	—	130,000	170,000	37,000	200,000	170,000	37,000	10,000	—
216-Z-8 French Drain	—	—	—	—	—	—	—	—	—	—	—	—	—	—
216-Z-13 French Drain	—	—	—	—	—	—	—	—	—	—	—	—	—	—
216-Z-14 French Drain(b)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
216-Z-15 French Drain(b)	—	—	—	—	—	—	—	—	—	—	—	—	—	—

2T-3a

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Table 2-3. Z Plant Aggregate Area Waste Management Unit Chemical Waste Inventory Summary. (Sheet 2 of 3)

Waste Management Unit	Quantity of Reported Chemical in Unit in kg ¹													
	CCl ₄	TBP	DBBP	Nitrate	Sodium	Fluoride	Calcium Nitrate	Magnesium Nitrate	Nitric Acid	Aluminum Fluoride Nitrate	Aluminum Nitrate	Ferric Nitrate	Sulfate	Sodium Hydroxide
216-Z-1A Tile Field	268,000	30,000	20,300	3,000	900	900	—	—	—	—	—	—	—	—
Reverse Well														
216-Z-10 Reverse Well	—	—	—	100	30	—	—	—	—	—	—	—	—	—
Ditches and Trenches														
216-Z-4 Trench	—	—	—	—	—	—	—	—	—	—	—	—	—	—
216-Z-9 Trench	131,140 471,000	—	—	500,000	200,000	—	130,000	180,000	39,000	210,000	190,000	40,000	10,000	—
216-Z-17 Trench	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Septic Tanks														
2607-Z Septic Tank & Field	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2607-Z-1 Septic Tank & Field	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2607-WA Septic Tank & Field	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2607-WB Septic Tank & Field	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2607-W-6 Septic Tank & Field	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Transfer Facilities, Diversion Boxes, and Pipelines														
241-Z Diversion Box No. 1														
241-Z Diversion Box No. 2														
231-Z-151 Sump														
Basins														
241-Z Retention Basin	—	—	—	—	—	—	—	—	—	—	—	—	—	—
216-Z-21 Seepage Basin	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Burial Sites														
218-W-1 Burial Ground	—	—	—	—	—	—	—	—	—	—	—	—	—	—

2T-3b

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Table 2-3. Z Plant Aggregate Area Waste Management Unit Chemical Waste Inventory Summary. (Sheet 3 of 3)

Waste Management Unit	Quantity of Reported Chemical in Unit in kg ^a													
	CCl ₄	TBP	DBBP	Nitrate	Sodium	Fluoride	Calcium Nitrate	Magnesium Nitrate	Nitric Acid	Aluminum Fluoride Nitrate	Aluminum Nitrate	Ferric Nitrate	Sulfate	Sodium Hydroxide
218-W-1A Burial Ground	--	--	--	--	--	--	--	--	--	--	--	--	--	--
218-W-2 Burial Ground	--	--	--	--	--	--	--	--	--	--	--	--	--	--
218-W-2A Burial Ground	--	--	--	--	--	--	--	--	--	--	--	--	--	--
218-W-3 Burial Ground	--	--	--	--	--	--	--	--	--	--	--	--	--	--
218-W-3A Burial Ground	--	--	--	--	--	--	--	--	--	--	--	--	--	--
218-W-3AE Burial Ground	--	--	--	--	--	--	--	--	--	--	--	--	--	--
218-W-4A Burial Ground	--	--	--	--	--	--	--	--	--	--	--	--	--	--
218-W-4B Burial Ground	--	--	--	--	--	--	--	--	--	--	--	--	--	--
218-W-4C Burial Ground	--	--	--	--	--	--	--	--	--	--	--	--	--	--
218-W-5 Burial Ground	--	--	--	--	--	--	--	--	--	--	--	--	--	--
218-W-6 Burial Ground	--	--	--	--	--	--	--	--	--	--	--	--	--	--
218-W-11 Burial Ground	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Z Plant Burn Pit	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

- a Not all sites have reported inventories. These inventories do not necessarily list all the contaminants disposed of at a site.
- b Additional organics received
 - 65 kg benzenes and halobenzenes
 - 840 kg toxic process chemicals
 - 437 kg acids
 - 14.06 kg poison lab chemicals
 - 7.51 kg misc. and lab chem
 - 127 kg paints, thinners, resins, asphalt
 - 280 kg nonflammable refrigerant gas
 Amounts indicated are units that have been stored on the 234-5Z-1/W5A. They do not represent a release or disposal to the unit.

- c Additional inorganics received
 - 50 kg NaCr₂
 - 100 kg Na₂C₂O₄
 - 100 kg NaNH₂SO₄
- d Maximum of range estimated in DOE RL 1991b.

^a Value obtained using density of CCl₄ = 1.58 kg/L.
Data obtained from WHC 1990a.

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Table 2-4. Partial Inventory of Hazardous Constituents Disposed of to the 218-W-3A, 218-W-3AE, 218-W-4C, and 218-W-5 Burial Grounds. (Sheet 1 of 3)

218-W-3A	
Constituent	Minimum Inventory in kg (lb)
Lead	6,764.10 (14,899.0)
Beryllium	0.16 (0.36)
Mercury	0.95 (2.09)
Oil	4.99 (11.00)
Xylene-toluene	213.38 (470.00)
Slaked lime	14.07 (31.00)
Tar	124.85 (275.00)
Copper	18.43 (40.60)
Uranium hexafluoride	0.09 (0.20)
Hexanol	317.80 (700.00)
Toluene	2,236.86 (4,927.00)
Polyurethane	22.70 (50.00)
Cadmium	1.11 (2.44)
Naphthylamine tritium	102.15 (225.00)
Xylene/pseudocumene	13.62 (30.00)
Naphthalene	135.29 (298.00)
Pseudocumene	150.27 (331.00)
Ethylene glycol	4.99 (11.00)
Glycerine	9.99 (22.00)
Isopropanol	8.76 (19.30)
Tributyl phosphate	19.02 (41.90)
Xylene	281.03 (619.00)
Dibutyl phosphate	4.20 (9.26)
Isopropyl alcohol	30.15 (66.40)
Tetrahydro furan	0.90 (1.98)
DDCP	18.34 (40.40)
Hexane	4.99 (11.00)
Normal parafin hydrocarbons	7.40 (16.30)
Trioctyl phosphine	5.86 (12.90)
Acetonitrile	75.36 (166.00)
Carbon tetrachloride	7.49 (16.50)
Kerosene	3.75 (8.27)
Barium	9.08 (20.00)
Chromium	3.63 (8.00)
Silver	2.27 (5.00)
Aliquat 336	0.81 (1.79)
Butyl acetate	2.36 (5.20)
Ethanol	0.83 (1.83)
Methanol	23.84 (52.50)

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Table 2-4. Partial Inventory of Hazardous Constituents Disposed of to the 218-W-3A, 218-W-3AE, 218-W-4C, and 218-W-5 Burial Grounds. (Sheet 2 of 3)

218-W-3A	
Constituent	Minimum Inventory in kg (lb)
Cyclohexane	1.02 (2.29)
Cyclohexanone	4.34 (9.57)
Ethanolamine	1.02 (2.29)
Amalgamated Mercury	0.45 (1.00)
Lead shielding	8,006.74 (17,636.00)
218-W-3A-E	
Constituent	Minimum Inventory in kg (lb)
Lead	7,028.37 (15,481.00)
Asbestos	1.36 (3.00)
Copper	2,464.31 (5,428.00)
Freon II	127.12 (280.00)
Mercury	98.06 (216.00)
Charcoal	2,179.20 (4,800.00)
Sulfuric acid	0.23 (0.50)
Chromium	202.03 (445.00)
Sodium fluoride	24,836.07 (54,705.00)
Sodium hydroxide	3,250.19 (7,159.00)
Sodium nitrate	16,612.77 (36,592.00)
Beryllium	301.91 (665.00)
Potassium chloride	3,704.64 (8,160.00)
Potassium nitrate	2,288.16 (5,040.00)
Sodium chloride	3,704.64 (8,160.00)
Sodium nitrite	1,797.84 (3,960.00)
Perchloroethylene	3,622.92 (7,980.00)
Trichloroethene	905.73 (1,995.00)
Tar	5,059.38 (11,144.00)
Aluminum nitrate	9.08 (20.00)
Silver	0.90 (1.98)
Zirconium	2,304.50 (5,076.00)

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Table 2-4. Partial Inventory of Hazardous Constituents Disposed of to the 218-W-3A, 218-W-3AE, 218-W-4C, and 218-W-5 Burial Grounds. (Sheet 3 of 3)

218-W-4C	
Constituent	Minimum Inventory in Kg (lb)
Lead	265,775.23 (585,408.00)
Zirconium	136.2 (300.00)
Sodium	0.0045 (0.01)
Uranium hexafluoride	123.03 (271.00)
Nitric acid	0.67 (1.48)
Chromium	0.91 (2.00)
Mercury	0.91 (2.00)
Vinyl chloride	0.91 (2.00)
Paint thinner	4.54 (10.00)
Lead shielding	2,727.18 (6,007.00)
Sodium hydroxide	0.10 (0.22)
Slaked lime	8.17 (18.00)
Copper sulfate	26,395.56 (58,140.00)
Sodium diuranate	2,928.3 (6,450.00)
Sodium fluoride	17,597.04 (38,760.00)
Sodium nitrate	216,476.28 (476,820.00)
218-W-5	
Constituent	Minimum Inventory in Kg (lb)
Oil	113.50 (250.00)
Lead	181.60 (400.00)
Lead brick	1,480.04 (3,260.00)
Lead shielding	227.00 (500.00)

Source: Solid Waste Information Management System (SWIMS).
Westinghouse Hanford Company, Richland, Washington.

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Table 2-5. Summary of Unplanned Releases at the Z Plant Aggregate Area. (Sheet 1 of 7)

Unplanned Release No.	Location (Operable Unit)	Date	Associated Waste Management Unit	Reported Waste-Related History
UN-200-W-23	234-5 Building (200-ZP-1)	June 1953	N/A	<ul style="list-style-type: none"> Waste box fire resulted in plutonium contamination of up to 10,000 d/m affecting 27.9 square meters (300 square feet) (Stenner et al. 1988). Area was covered with black top and posted with access control signs. PNL Hazard Ranking: 0.86
UN-200-W-74	241-Z Building (200-ZP-1)	May 18, 1976	N/A	<ul style="list-style-type: none"> The line from the effluent header D-3 to the D-8 tank inside the building leaked alpha waste to a small area of approximately 125 square centimeters (20 square inches) below an overground polyethylene line. Maximum readings of the waste were 8,000 d/m. Contaminated soil was picked up and packaged for burial. PNL Hazard Ranking: 0.98
UN-200-W-75	241-Z Building (200-ZP-1)	January 9, 1975	N/A	<ul style="list-style-type: none"> Equipment in the D-7 Sample Cabinet contaminated by an unidentified beta/gamma source resulted in contamination of 21.35 square meters (70 square feet) near 241-Z Building. Direct readings ranged from 2,000 to greater than 40,000 d/m and smearable readings reached 20,000 dis/min. Contaminated dirt was removed and placed in 55 gallon drums for burial. PNL Hazard Ranking: 0.82
UN-200-W-79	pH line leading to 241-Z Treatment Tank (200-ZP-1)	October 6, 1978	241-Z Treatment Tank	<ul style="list-style-type: none"> Two 5-foot-square areas were affected by leak in pH line: an area under the pH meter lines and an area north of the D-7 and D-8 sample cabinets (WIDS-WHC 1990a). Alpha readings indicated 500 to 2,000 d/m. Decontamination at the areas was reportedly completed October 30, 1978 (WIDS-WHC 1990a). PNL Hazard Ranking: 1.20

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Table 2-5. Summary of Unplanned Releases at the Z Plant Aggregate Area. (Sheet 2 of 7)

Unplanned Release No.	Location (Operable Unit)	Date	Associated Waste Management Unit	Reported Waste-Related History
N-200-W-89	236-Z Building (200-ZP-1)	May 29, 1985	N/A	<ul style="list-style-type: none"> Recycle Container fell from forklift platform spilling onto 0.239 m² (3 ft²) area of asphalt at southeast corner of 236-Z Building. Alpha readings indicated contamination up to 50,000 d/m. The Recycle Container was double-bagged and placed in a burial box. WIDS-WHC (1990a) reports that area was decontaminated to background levels and released April 4, 1985. PNL Hazard Ranking: Not scored
UN-200-W-90	236-Z Building (200-ZP-1)	May 2, 1985	N/A	<ul style="list-style-type: none"> Radioactive material spilled while loading pipe sections into burial boxes affecting about 6.51 square meters (70 square feet) of 236-Z Building. Alpha readings of contamination reached 10,000 d/m. Area was decontaminated to background levels (WIDS-WHC 1990a). PNL Hazard Ranking: Not scored
UN-200-W-91	234-5Z Building (200-ZP-1)	December 11, 1985	N/A	<ul style="list-style-type: none"> Recycle Container overturned during transport affecting area of unknown size near the 234-5Z Building. Alpha readings in affected area reached 20,000 d/m. Due to snow cover on the ground, the area was covered and contained with plastic. PNL Hazard Ranking: Insufficient information to score

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Table 2-5. Summary of Unplanned Releases at the Z Plant Aggregate Area. (Sheet 3 of 7)

Unplanned Release No.	Location (Operable Unit)	Date	Associated Waste Management Unit	Reported Waste-Related History
UN-200-W-103	236-Z Building (200-ZP-1)	April 1971	N/A	<ul style="list-style-type: none"> Approximately 0.01 kg of plutonium was released from a broken crib line running from the 234-5Z Building to the 216-Z-18 Crib about 3.66 meters (12 feet) west and 1.83 meters (6 feet) south of the 236-Z Building. Gross alpha contamination was found to be at 76 million d/m per 100 cubic centimeters of ground. For remedial action, approximately one hundred 55-gallon drums of soil were removed and buried in one of the 200 West burial grounds. Plutonium contamination may still be present under 1.83 meters (6 feet) of clean fill soil. PNL Hazard Ranking: 1.04
UN-200-W-159	Near Z Plant (200-ZP-1)	May 1985	N/A	<ul style="list-style-type: none"> Unknown amount of 50 percent aqueous sodium hydroxide spilled to the ground from the PFP process line (WIDS-WHC 1990a). The soil was removed, packaged, and disposed of off site. PNL Hazard Ranking: Not scored
UN-200-W-130	231-Z-151 Sump near 231-Z Building (200-ZP-2)	January 20, 1967	231-Z-151 Sump	<ul style="list-style-type: none"> An excavation uncovered a leaking flange. Extent of contamination limited to soil around the waste line on the east side of the 231-Z-151 Sump. Alpha, beta, and gamma readings of up to 40,000 d/m alpha, 100 mrem/hr beta, and 500 mrem/hr gamma were reported. For remediation, the waste line was repaired and covered with 15 centimeters of clean soil. PNL Hazard Ranking: Potentially low scoring; insufficient information to score
UN-200-W-11	218-W-1 Burial Ground (200-ZP-3)	1952	218-W-1	<ul style="list-style-type: none"> A fire in the Burial Ground spread plutonium contamination in the vicinity of Z Plant (Stenner et al. 1988). Remedial actions, if any, were not identified. PNL Hazard Ranking: Potentially low scoring; insufficient information to score.

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Table 2-5. Summary of Unplanned Releases at the Z Plant Aggregate Area. (Sheet 4 of 7)

Unplanned Release No.	Location (Operable Unit)	Date	Associated Waste Management Unit	Reported Waste-Related History
UPR-200-W-16	218-W-4A Burial Ground (200-ZP-3)	July 9, 1952	218-W-4A Burial Ground	<ul style="list-style-type: none"> • A dry waste fire in the burial ground spread contamination outside the burial trench (Stenner et al. 1988). • Contamination extended over area in the burial ground and to the east and west of the trench. • Maximum readings for plutonium were 200,000 d/m inside the burial ground and 30,000 d/m outside. • Contaminated soil on south side of trench was bulldozed into the trench. Ground on the north side was stabilized with road oil. Nearby roads were washed down with water to remove spotty contamination. • PNL Hazard Ranking: 0.86
UPR-200-W-26	218-W-4A Burial Ground (200-ZP-3)	November 27, 1953	218-W-4A Burial Ground	<ul style="list-style-type: none"> • Burial operations caused spotty contamination in burial ground (Stenner et al. 1988). Ruthenium affected an area near the burial ground and along the 200 West Area railroad line. • Ruthenium readings in affected area outside burial ground were from 600 mrem/hr to 2 rem/hr. • Remedial actions were not identified. • PNL Hazard Ranking: Not scored
UN-200-W-44	Between REDOX facility and T Plant (200-ZP-3)	October 25, 1957	N/A	<ul style="list-style-type: none"> • Burial box fell from flat car while in transit contaminating area of 6.1 by 7.625 meters (20 by 25 feet) along railroad tracks between REDOX facility and T Plant. • Release was of unidentified beta/gamma source with readings of 2 R/hr. • Remedial actions were not identified. • Location not indicated. • PNL Hazard Ranking: 0.86

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Table 2-5. Summary of Unplanned Releases at the Z Plant Aggregate Area. (Sheet 5 of 7)

Unplanned Release No.	Location (Operable Unit)	Date	Associated Waste Management Unit	Reported Waste-Related History
UPR-200-W-45	218-W-2A Burial Ground (200-ZP-3)	November 6, 1957	218-W-2A Burial Ground	<ul style="list-style-type: none"> • Wooden burial box collapsed during burial (Stenner et al. 1988) affecting an estimated 200 acres within the 200 West Area and 1,600 acres outside the 200 West Area with ruthenium contamination. • Maximum ruthenium contamination readings were 1,100 mR/hr (WIDS-WHC 1990a). • Most of grossly-contaminated burial ground was restored to normal use by plowing, road grading, and water flushing. Adjacent road surfaces were flushed with water. Uncleaned contaminated areas were posted as radiation zones (WIDS-WHC 1990a). • PNL Hazard Ranking: Not scored due to radionuclide decay
UPR-200-W-53	218-W-4A Burial Ground (200-ZP-3)	January 8, 1959	218-W-4A	<ul style="list-style-type: none"> • Burial box containing REDOX cell jumpers collapsed during backfilling operations in the burial ground affecting about 250 areas, primarily with ruthenium (Stenner et al. 1988). • Readings ranged from 50 mR/hr at the burial site to 60,000 c/m at T Plant. Readings east of the limited area fence were up to 400 c/m. • Contamination occurred in area extending east from the burial ground to within 274.5 meters (300 yards) of the east perimeter fence. • For remediation, contaminated roads were washed down with water from tank truck. Contamination was generally fixed in a 5-centimeter (2-inch) layer of snow. Burial ground and several hundred yards to the east were plowed to further fix contamination. • PNL Hazard Ranking: Not scored because of radionuclide decay

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Table 2-5. Summary of Unplanned Releases at the Z Plant Aggregate Area. (Sheet 6 of 7)

Unplanned Release No.	Location (Operable Unit)	Date	Associated Waste Management Unit	Reported Waste-Related History
UPR-200-W-72	218-W-4A Burial Ground (200-ZP-3)	October 21, 1975	218-W-4A Burial Ground	<ul style="list-style-type: none"> • Buried lab waste described as gross alpha and mixed fission products was accidentally disturbed resulting in contamination of a 15.25- by 15.25-meter (50-by 50-foot) area (Stenner et al. 1988). • Beta/gamma readings of 100,000 c/m and alpha readings of up to 70,000 d/m were obtained. • For remedial action, the contaminated waste was picked up and the area was covered with 15 centimeters (6 inches) of sand, a layer of urea bone, a layer of 10 mil plastic, 30 to 35 centimeters (12 to 14 inches) of dirt, and 7.5 to 10 centimeters (3 to 4 inches) of rock. • PNL Hazard Ranking: Not scored
UPR-200-W-84	200 West Area Burial Ground (200-ZP-3)	July 23, 1980	N/A	<ul style="list-style-type: none"> • A liquid spill of an unknown beta/gamma source during burial of a pump resulted in contamination of the floor of the burial trench (Stenner et al. 1988). • Readings indicated maximum contamination of 2,000 mR/hr. • For remediation, contaminated soil was picked up and placed in the burial trench. • Location indicated on Figure 2-13-suspect. • PNL Hazard Ranking: Release disposed to engineering facility - not scored
UN-200-W-132	241-UR-151 Diversion Box (U Plant)	July 6, 1956	241-UR-151 Diversion Box	<ul style="list-style-type: none"> • An estimated 1,900 liters of uranium feed solution for the TBP process overflowed the 241-UR-151 Diversion Box (WIDS-WHC 1990a) affecting two areas approximately 11.2 and 41.92 square meters (120 and 145 square feet). • Remedial measures, if any, were not identified. • PNL Hazard Ranking: 1.04

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Table 2-5. Summary of Unplanned Releases at the Z Plant Aggregate Area. (Sheet 7 of 7)

Unplanned Release No.	Location (Operable Unit)	Date	Associated Waste Management Unit	Reported Waste-Related History
UPR-200-W-134	218-W-1 Burial Ground (200-ZP-3)	October 27, 1975	N/A	<ul style="list-style-type: none"> • A waste drum labeled "transuranic" was inappropriately buried in the 218-W-1 Burial Ground (WIDS-WHC 1990a). • Although no release to the environment occurred at this time, the handling and storage of the material did not meet standards. • For remedial actions, Atlantic Richfield Hanford Company (ARHCO) personnel were contacted to assure that the location of the burial was determined as accurately as possible and that no operations would be performed that might make retrieval of the drum move difficult. • PNL Hazard Ranking: Release disposed of to engineering facility - not scored
UPR-200-W-158	218-W-1A Burial Ground (200-ZP-3)	June 10, 1960	N/A	<ul style="list-style-type: none"> • A burial box containing solid mixed waste collapsed during burial causing spotty ground contamination (WIDS-WHC 1990a). Contamination reportedly spread generally east and southeast as far as 4.85 kilometers (3 miles) beyond the limited fence area. • Beta/gamma readings ranged from 60 mR/hr at the burial site to approximately 1,000 ct/min outside the limited area. • PNL Hazard Ranking: 0.82

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Table 2-6. Summary of Waste-Producing Processes in the Z Plant Aggregate Area

Process	Waste Generated	Major Chemical Constituents	Ionic Strength	pH	Organic Concentration	Radioactivity
Plutonium Finishing Plant (PFP)	Process Waste	Nitric acid, nitrate salts, fluoride	high	acidic (pH 2) neutralized before disposal	low	low (Pu and TRU)
	Wastewater	Sodium, fluoride, sulfate	low	neutral	low	trace alpha
RECUPLEX	Aqueous process waste	Nitric acid, fluorides, nitrates, phosphate	high	acidic	low	low
	Organic solvent waste	CCl ₄ , TBP, DBBP	low	slightly acidic	high	intermediate (Pu and TRU)
	Spent silica gel	Silica gel, Pu	unknown	unknown	unknown	unknown
Plutonium Reclamation Facility (PRF)	Aqueous process waste	Nitric acid, fluorides, nitrates, phosphate	high	acidic	low	low
	Organic process waste	CCl ₄ , TBP, DBBP	low	slightly acidic	high	intermediate (Pu and TRU)
Americium Recovery	Spent ion exchange resin	²⁴¹ Am, resin	high	unknown	unknown	unknown (²⁴¹ Am)
Analytical laboratory	Laboratory process wastes	Unknown	low	slightly acidic	unknown	unknown
	Used or discarded reagents	see Table 2-9 for potential contributors	unknown	unknown	moderate to low	unknown
	Wastewater	sanitary and lab water	low	neutral/basic after adjust	unknown	unknown
Plutonium Isolation Facility (PIF)	Process Waste	Nitric acid	unknown	unknown	low	low (Pu and TRU)
	Wastewater	Unknown	unknown	unknown	unknown	unknown

Table 2-7. Chemicals Used or Produced in Separation/Recovery Processes.

Inorganic Constituents	
Aluminum nitrate	
Barium	
Boron	
Calcium	
Chloride	
Chromium	
Copper	
Fluoride	
Hydrofluoric acid	
Iron	
Magnesium	
Mercury	
Nickel	
Nitrate	
Nitrate salts	
Potassium	
Silicon	
Sodium	
Sulfate	
Zinc	
Organic Constituents	Radionuclides
Acetone	Plutonium fluoride
Caffeine	Plutonium nitrate
Carbon tetrachloride(CCl ₄)	Plutonium oxide
Chloroform	Uranium
Decane	²⁴¹ Am
Dibutyl phosphate (DBP)	¹³⁷ Cs
Dibutyl butyl phosphonate (DBBP)	²³⁸ Pu
Monobutyl phosphate	²³⁹ Pu
Tributyl phosphate (TBP)	²⁴⁰ Pu
	Ra
	⁹⁰ Sr
	²³⁴ U
	²³⁸ U

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Table 2-8. Chemicals Used in Z Plant Laboratories. (Sheet 1 of 3)

Compound Name	Formula
Acetic Acid	$\text{CH}_3\text{CO}_2\text{H}$
Acetone	$\text{CH}_3\text{C}_2\text{H}_3\text{O}$
Alizarin Yellow	$\text{C}_{14}\text{H}_8\text{O}_4$
Aluminum Nitrate Nonahydrate	$\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$
Aluminum Nitrate (Mono Basic)	$\text{Al}(\text{OH})(\text{NO}_3)_2$
Aluminum Sulfate	$\text{Al}(\text{SO}_4)_3$
Ammonium Chloride	NH_4Cl
Ammonium Hydroxide	NH_4OH
Ammonium Oxalate	$(\text{NH}_4)_2\text{C}_2\text{O}_4$
Ammonium Sulfate	$(\text{NH}_4)_2\text{SO}_4$
Arsenazo III ⁽¹⁾	Arsenic compounds
Boric Acid	H_3BO_3
Bromocresol Purple	$\text{C}_7\text{H}_6\text{O}_2\text{HBr}$
Carbon Tetrachloride	CCl_4
Ceric Ammonium Nitrate	$\text{Ce}(\text{NH}_4)_2(\text{NO}_3)_6$
Dibutyl Phosphate	$(n\text{-C}_4\text{H}_9)_2\text{HPO}_4$
Ferric Ammonium Sulfate	FeNH_4SO_4
Ferric Nitrate	$\text{Fe}(\text{NO}_3)_3 \cdot 6\text{H}_2\text{O}$
Ferrous Ammonium Sulfate	$(\text{NH}_4)_2\text{SO}_4 \cdot \text{FeSO}_4 \cdot 6\text{H}_2\text{O}$
Ferrous Sulfamate	$\text{Fe}(\text{SO}_3\text{NH}_2)_2$
Hydrazine	$\text{N}_2\text{H}_4 \cdot \text{H}_2\text{O}$
Hydrobromic Acid	HBr
Hydrochloric Acid	HCl
Hydrofluoric Acid	HF
Hydrogen Peroxide	H_2O_2
Hydroiodic Acid	HI
Hydroxylamine Hydrochloride	$\text{NH}_2\text{OH} \cdot \text{HCl}$

Table 2-8. Chemicals Used in Z Plant Laboratories. (Sheet 2 of 3)

Compound Name	Formula
Hydroxylamine Nitrate	$\text{NH}_2\text{OH}\cdot\text{HNO}_3$
Methanol	CH_3OH
Naphthylamine	$\text{C}_{10}\text{H}_9\text{N}$
Nitric Acid	HNO_3
Oxalic Acid	$\text{HO}_2\text{CCO}_2\text{H}\cdot 2\text{H}_2\text{O}$
Phosphoric Acid	H_3PO_4
Potassium Acetate	$\text{KC}_2\text{H}_3\text{O}_2$
Potassium Dichromate	K_2CrO_7
Potassium Iodate	KIO_3
Potassium Permanganate	KMnO_4
Silver Oxide	Ag_2O
Sodium Bisulfate	NaHSO_4
Sodium Carbonate	Na_2CO_3
Sodium Fluoride	NaF
Sodium Hydroxide	NaOH
Sodium Nitrate	NaNO_3
Sodium Nitrite	NaNO_2
Sodium Oxalate	$\text{Na}_2\text{C}_2\text{O}_4$
Sodium Tartrate	$\text{Na}_2\text{C}_2\text{H}_4\text{O}_6\cdot 2\text{H}_2\text{O}$
Sulfamic Acid	$\text{NH}_2\text{SO}_3\text{H}$
Sulfonic Acid (chloro)	ClHSO_3
Sulfuric Acid	H_2SO_4
Thenoyltrifluoroacetone	$(\text{CH}_3)_3\text{SCOCH}_2\text{COCF}_3$
Thymolphthalein	$\text{C}_{28}\text{H}_{30}\text{O}_4$
Toluene	$\text{C}_6\text{H}_5\text{CH}_3$
Tributyl Phosphate	$(\text{C}_4\text{H}_9)_3\text{PO}_4$
Tri-Iso-Octylamine	$\text{C}_{24}\text{H}_{51}\text{N}$

Table 2-8. Chemicals Used in Z Plant Laboratories. (Sheet 3 of 3)

Compound Name	Formula
Tris (hydroxymethyl)Amino Methane	$(\text{CH}_2\text{OH})_3\text{CNH}_2$
Xylene	$\text{C}_6\text{H}_4(\text{CH}_3)_2$

(1) Product name.

9 1 1 9 1 1 5 1 7 1 7

Table 2-9. Radionuclides and Chemicals Disposed of to Z Plant Aggregate Area Waste Management Units. (Sheet 1 of 2)

Radionuclides		
¹⁰⁸ Ag	⁸⁵ Kr	⁸² Sr
¹¹⁰ Ag	⁵⁴ Mn	⁹⁰ Sr
²⁸ Al	⁹³ Mo	¹⁸² Ta
²⁴¹ Am	²² Na	⁹⁹ Tc
²⁴³ Am	⁹¹ Nb	^{125m} Te
¹⁹⁵ Au	^{93m} Nb	¹²⁷ Te
¹³³ Ba	⁹⁴ Nb	^{129m} Te
⁷ Be	⁹⁵ Nb	¹²¹ Te
¹⁰ Be	⁵⁹ Ni	²⁰⁴ Ti
¹⁴ C	⁶³ Ni	²³² Th
⁴⁵ Ca	²³⁷ Np	²³⁴ Th
¹⁰⁹ Cd	³² P	¹⁷⁰ Tm
¹⁴¹ Ce	²³¹ Pa	²³³ U
¹⁴⁴ Ce	²¹² Pb	²³⁴ U
³⁶ Cl	²¹⁴ Pb	²³⁵ U
²⁴³ Cm	¹⁴⁷ Pm	²³⁶ U
²⁴⁴ Cm	²¹⁰ Po	²³⁸ U
²⁴⁵ Cm	²³⁸ Pu	⁴⁹ V
⁵⁷ Co	²³⁹ Pu	⁸⁷ Y
⁵⁸ Co	²⁴⁰ Pu	⁸⁸ Y
⁶⁰ Co	²²⁶ Ra	⁹⁰ Y
⁵¹ Cr	²²⁸ Ra	⁶⁵ Zn
¹³⁴ Cs	⁸⁶ Rb	⁹⁵ Zr
¹³⁷ Cs	¹⁸⁷ Re	
²⁵⁴ Es	¹⁰³ Ru	
¹⁵² Eu	¹⁰⁶ Ru	
¹⁵⁴ Eu	³⁵ S	
¹⁵⁵ Eu	¹²² Sb	
⁵⁵ Fe	¹²⁴ Sb	
⁵⁹ Fe	¹²⁵ Sb	
¹⁵³ Gd	¹²⁶ Sb	
⁶⁸ Ge	⁴⁶ SC	
³ H	⁷⁵ Se	
¹²³ I	⁷⁹ Se	
¹²⁵ I	¹⁵¹ Sm	
¹²⁹ I	¹¹³ Sn	
¹³¹ I	^{123m} Sn	
⁴⁰ K		

Table 2-9. Radionuclides and Chemicals Disposed of to Z Plant Aggregate Area Waste Management Units. (Sheet 2 of 2)

Inorganic Chemicals	Organic Chemicals
Aluminum	Acetonitrile
Asbestos	Butyl acetate
Beryllium	Carbon tetrachloride
Aluminum fluoride	Charcoal
Aluminum nitrate	Creosote
Cadmium	Cyclohexane
Calcium nitrate	Cyclohexanone
Chromium	DDCP
Copper	Dibutyl butyl phosphonate
Copper sulfate	Dibutyl phosphate
Ferric nitrate	Ethanol
Fluoride	Ethanolamine
Lead	Ethylene glycol
Magnesium nitrate	Freon II
Mercury	Glycerine
Mercury - amalgamated	Graphite
Nitrate	Hexane
Nitric acid	Hexanol
Potassium chloride	Isopropanol
Potassium nitrate	Kerosene
Silver	Methanol
Slaked lime	Naphthylamine tritium
Sodium	Normal paraffins
Sodium chloride	Oil
Sodium diuranate	Paint thinner
Sodium fluoride	Perchloroethylene
Sodium hydroxide	Polychlorinated biphenyls
Sodium nitrate	Polyurethane
Sodium nitrite	Pseudocumene
Sulfate	Tar
Sulfuric acid	Tetrahydrofuran
Uranium hexafluoride	Toluene
Zirconium	Tributyl phosphate
	Trichloroethene
	Trioctyl phosphine
	Vinyl chloride
	Xylenes

Sources:

- WIDS; Anderson et al. 1991;

3.0 SITE CONDITIONS

The following sections describe the physical nature and setting of the Hanford Site, the 200 West Area, and the Z Plant Aggregate Area. The site conditions are presented in the following sections:

- Physiography and Topography (Section 3.1)
- Meteorology (Section 3.2)
- Surface Water (Section 3.3)
- Geology (Section 3.4)
- Hydrogeology (Section 3.5)
- Environmental Resources (Section 3.6)
- Human Resources (Section 3.7).

Sections describing topography, geology, and hydrogeology have been taken from standardized texts provided by the Westinghouse Hanford Company (e.g., Delaney et al. 1991 and Lindsey et al. 1991) for that purpose.

3.1 PHYSIOGRAPHY AND TOPOGRAPHY

The following subsections describe the physical nature of the Hanford Site and the Z Plant Aggregate Area with regard to surface features and topographic characteristics.

The Hanford Site (Figure 3-1) is situated within the Pasco Basin of southcentral Washington. The Pasco Basin is one of a number of topographic depressions located within the Columbia Basin Subprovince of the Columbia Intermontane Province (Figure 3-2), a broad basin located between the Cascade Range and the Rocky Mountains. The Columbia Intermontane Province is the product of Miocene continental flood basalt volcanism and regional deformation that occurred over the past 17 million years. The Pasco Basin is bounded on the north by the Saddle Mountains, on the west by Umtanum Ridge, Yakima

1 Ridge, and the Rattlesnake Hills, on the south by Rattlesnake Mountain and the Rattlesnake
2 Hills, and on the east by the Palouse slope (Figure 3-1).
3

4 The physiography of the Hanford Site is dominated by the low-relief plains of the
5 Central Plains physiographic region and anticlinal ridges of the Yakima Folds physiographic
6 region (Figure 3-3). Surface topography seen at the Hanford Site is the result of (1) uplift of
7 anticlinal ridges, (2) Pleistocene cataclysmic flooding, (3) Holocene eolian activity, and (4)
8 landsliding. Uplift of the ridges began in the Miocene epoch and continues to the present.
9 Cataclysmic flooding occurred when ice dams in western Montana and northern Idaho were
10 breached, allowing large volumes of water to spill across eastern and central Washington.
11 The last major flood occurred about 13,000 years ago, during the late Pleistocene Epoch.
12 Anastomosing flood channels, giant current ripples, bergmounds, and giant flood bars are
13 among the landforms created by the floods. Since the end of the Pleistocene Epoch, winds
14 have locally reworked the flood sediments, depositing dune sands in the lower elevations and
15 loess (windblown silt) around the margins of the Pasco Basin. Generally, sand dunes have
16 been stabilized by anchoring vegetation except where they have been reactivated where
17 vegetation is disturbed (Figure 3-4).
18

19 A series of numbered areas have been delineated at the Hanford Site. The 100 Areas
20 are situated in the northern part of the Site adjacent to the Columbia River in an area
21 commonly called the "Horn." The elevation of the Horn is between 119 and 143 m (390 and
22 470 ft) above mean sea level (msl) with a slight increase in elevation away from the river.
23 The 200 Areas are situated on a broad flat area called the 200 Areas plateau. The 200 Areas
24 plateau is near the center of the Hanford Site at an elevation of approximately 198 to 229 m
25 (650 to 750 ft) above msl. The plateau decreases in elevation to the north, northwest, and
26 east toward the Columbia River, and plateau escarpments have elevation changes of between
27 15 to 30 m (50 to 100 ft).
28

29 The 200 West Area is situated on the 200 Areas plateau on a relatively flat prominent
30 terrace (Cold Creek Bar) formed during the late Pleistocene flooding (Figure 3-5). Cold
31 Creek Bar trends generally east to west and is essentially bisected by a flood channel that
32 trends north to south. This terrace drops off rather steeply to the north and northwest with
33 elevation changes between 15 and 30 m (50 to 100 ft).
34

35 The topography of the 200 West Area is generally flat (Figure 3-1). Within the Z
36 Plant Aggregate Area, elevation ranges from about 218 m (715 ft) along the western edge of
37 the area near the 2702-W RMW storage complex, to about 210 m (690 ft) east of the 231-Z
38 Building (Plate 1). Much of the Aggregate Area slopes gently from west to east, although
39 the northeastern part of the Aggregate Area slopes westward, toward the 216Y-9 Pond west
40 of the T Plant complex. Topography in the southwestern corner of the Aggregate Area, near

1 the 218-W-4C Burial Ground slopes to the west and southwest. There are no natural surface
2 drainage channels within the Z Plant Aggregate Area.
3

4 5 **3.2 METEOROLOGY** 6

7 The following subsections provide information on Hanford Site meteorology including
8 precipitation (Section 3.2.1), wind conditions (Section 3.2.2), and temperature variability
9 (Section 3.2.3).
10

11 The Hanford Site lies east of the Cascade Mountains and has a semiarid climate
12 because of the rainshadow effect of the mountains. The weather is monitored at the Hanford
13 Meteorology Station, located between the 200 East and 200 West Areas, and at other points
14 situated through the reservation. The following sections summarize the Hanford Site
15 meteorology.
16

17 18 **3.2.1 Precipitation** 19

20 The Hanford Site receives an annual average of 16 cm (6.3 in.) of precipitation.
21 Precipitation falls mainly in the winter, with about half of the annual precipitation occurring
22 between November and February. Average winter snowfall ranges from 13 cm (5.3 in.) in
23 January to 0.8 cm (0.31 in.) in March. The record snowfall of 62 cm (24.4 in.) occurred in
24 February 1916 (Stone et al. 1983). During December through February, snowfall accounts
25 for about 38% of all precipitation in those months.
26

27 The average yearly relative humidity at the Hanford Site for 1946 to 1980 was
28 54.4%. Humidity is higher in winter than in summer. The monthly averages for the same
29 period range from 32.2% for July to 80% in December. Atmospheric pressure averages are
30 higher in the winter months and record absolute highs and lows also occur in the winter.
31

32 33 **3.2.2 Winds** 34

35 The Cascade Mountains have considerable effect on the wind regime at the Hanford
36 Site by serving as a source of cold air drainage. This gravity drainage results in a northwest
37 to west-northwest prevailing wind direction (WPPSS 1977). The average mean monthly
38 speed for 1945 to 1980 is 3.4 m/s (7.7 mph). Peak gust speeds range from 28 to 36 m/s (63
39 to 80 mph) and are generally southwest or west-southwest winds (Stone et al. 1983).
40

1 Figure 3-6 shows wind roses for the Hanford Telemetry Network (Stone et al. 1983).
2 The gravity drainage from the Cascades produces a prevailing west-northwest wind in the
3 200 West Area. In July, hourly average wind speeds range from a low of 2.3 m/s (5.2 mph)
4 from 9 to 10 a.m. to a high of 6 m/s (13.0 mph) from 9 to 10 p.m.
5
6

7 3.2.3 Temperature

8
9 Based on data from 1914 to 1980, minimum winter temperatures vary from -33°C
10 (-27°F) to -6°C (+22°F), and maximum summer temperatures vary from 38°C (100°F) to
11 46°C (115°F). Between 1914 and 1980, a total of 16 days with temperatures -29°C (-20°F)
12 or below were recorded. There are 10 days of record when the maximum temperature failed
13 to go above -18°C (0°F). Prior to 1980, there were three summers on record when the
14 temperatures were 38°C (100°F) or above for 11 consecutive days (Stone et al. 1983).
15
16

17 3.3 SURFACE WATER

18
19 The following subsections provide information on regional (Section 3.3.1), Hanford
20 Site (Section 3.3.2), and Z Plant Aggregate Area (Section 3.3.3) surface water including
21 surface water features and their relationship to Hanford areas.
22
23

24 3.3.1 Regional Surface Hydrology

25
26 Surface drainage enters the Pasco Basin from several other basins, which include the
27 Yakima River Basin, Horse Heaven Basin, Walla Walla River Basin, Palouse/Snake Basin,
28 and Big Bend Basin (Figure 3-7). Within the Pasco Basin, the Columbia River is joined by
29 major tributaries including the Yakima, Snake, and Walla Walla Rivers. No perennial
30 streams originate within the Pasco Basin. Columbia River inflow to the Pasco Basin is
31 recorded at the United States Geological Survey (USGS) gage below Priest Rapids Dam, and
32 outflow is recorded below McNary Dam. Average annual flow at these recording stations is
33 approximately $1.1 \times 10^{11} \text{ m}^3$ (8.7×10^7 acre-ft) at the USGS gage and $1.6 \times 10^{11} \text{ m}^3$ ($1.3 \times$
34 10^8 acre-ft) at the McNary Dam gage (DOE 1988).
35

36 Total estimated precipitation over the basin averages less than 15.8 cm/yr (6.2 in./yr).
37 Mean annual runoff from the basin is estimated to be less than $3.1 \times 10^7 \text{ m}^3/\text{yr}$ (2.5×10^4
38 acre-ft/yr), or approximately 3% of the total precipitation. The remaining precipitation is
39 assumed to be lost through evapotranspiration with a small component (perhaps less than 1%)
40 recharging the groundwater system (DOE 1988).

3.3.2 Hanford Site Surface Hydrology

Primary surface water features associated with the Hanford Site, located near the center of the Pasco Basin, are the Columbia and Yakima Rivers and their major tributaries, the Snake and Walla Walla Rivers. West Lake, about 4 hectares (10 acres) in size and less than 0.9 m (3 ft) deep, is the only natural lake within the Hanford Site (DOE 1988).

Wastewater ponds, cribs, and ditches associated with nuclear fuel reprocessing and waste disposal activities are also present on the Hanford Site.

The Columbia River flows through the northern part of the Hanford Site and along the eastern border of the Hanford Site. This section of the river, the Hanford Reach, extends from Priest Rapids Dam to the headwaters of Lake Wallula (the reservoir behind McNary Dam). Flow along the Hanford Reach is controlled by Priest Rapids Dam. Several drains and intakes are also present along this reach, including irrigation outfalls from the Columbia Basin Irrigation Project, the Washington Public Power Supply System (WPPSS) Nuclear Project 2, and Hanford Site intakes for onsite water use. Much of the northern and eastern parts of the Hanford Site are drained by the Columbia River.

Routine water-quality monitoring of the Columbia River is conducted by DOE for both radiological and nonradiological parameters and has been reported by Pacific Northwest Laboratory (PNL) since 1973. Ecology has issued a Class A (excellent) quality designation for Columbia River water along the Hanford Reach from Grand Coulee Dam, through the Pasco Basin, to McNary Dam. This designation requires that all industrial uses of this water be compatible with other uses, including drinking, wildlife habitat, and recreation. In general, the Columbia River water is characterized by a very low suspended load, a low nutrient content, and an absence of microbial contaminants (DOE 1988).

Approximately one-third of the Hanford Site is drained by the Yakima River system. Cold Creek and its tributary, Dry Creek, are ephemeral streams on the Hanford Site that are within the Yakima River drainage system. Both streams drain areas along the western part of the Hanford Site and cross the southwestern part of the Site toward the Yakima River. Surface flow, which may occur during spring runoff or after heavier-than-normal precipitation, infiltrates and disappears into the surface sediments. Rattlesnake Springs, located on the western part of the Hanford Site, forms a small surface stream that flows for about 2.9 km (1.8 mi) before infiltrating into the ground.

3.3.3 Z Plant Aggregate Area Surface Hydrology

No natural surface water bodies exist in the Z Plant Aggregate Area. The only existing man-made surface water bodies are the 216-Z-21 Seepage Basin and the 207-Z Retention Basin (Figure 2-11). As discussed in Section 2.3.8, the 216-Z-21 Seepage Basin is an unlined infiltration basin located approximately 100 m southeast of the 234-5Z building. The 207-Z Retention Basin consists of a pair of concrete-lined basins located approximately 60 m southeast of the 236-Z building.

The 200 West Area and specifically, the Z Plant Aggregate Area, is not in a designated floodplain. Calculations of probable maximum floods for the Columbia River and Cold Creek Watershed indicate that the 200 West Area is not expected to be inundated under maximum flood conditions (DOE/RL 1991a). The 216-Z-21 Seepage Basin represents minor, if any, flooding potential due to the permeable nature of the underlying soil which allows for rapid infiltration of surface water into the ground. The 207-Z Retention Basin may present some potential for flooding; no current outlets from the basin were identified. However, the low precipitation potential (0.16 m annual average) at the site suggests little likelihood of flooding of the 3.1 m deep basin.

3.4 GEOLOGY

The following subsections provide information pertaining to geologic characteristics of southcentral Washington, the Hanford Site, the 200 West Area, and the Z Plant Aggregate Area. Topics included are the regional tectonic framework (Section 3.4.1), regional stratigraphy (Section 3.4.2), and 200 West Area and Z Plant Aggregate Area geology (Section 3.4.3).

The geologic characterization of the Hanford Site, including the 200 West Area and Z Plant Aggregate Area is the result of many previous site investigation activities at Hanford. These activities include the siting of nuclear reactors, characterization activities for the Basalt Waste Isolation Project (BWIP), waste management activities, and related geologic studies supporting these efforts. Geologic investigations have included regional and Hanford Site surface mapping, borehole/well sediment logging, field and laboratory sediment classification, borehole geophysical studies (including gamma radiation logging), and in situ and laboratory hydrogeologic properties testing.

3.4.1 Regional Tectonic Framework

The following subsections provide information on regional (southcentral Washington) geologic structure, structural geology of the Pasco Basin and the Hanford Site, and regional and Hanford Site seismology.

3.4.1.1 Regional Geologic Structure. The Columbia Plateau is a part of the North American continental plate and lies in a back-arc setting east of the Cascade Range. It is bounded on the north by the Okanogan Highlands, on the east by the Northern Rocky Mountains and Idaho Batholith, and on the south by the High Lava Plains and Snake River Plain (Figure 3-8).

The Columbia Plateau can be divided into three informal structural subprovinces (Figure 3-9): Blue Mountains, Palouse, and Yakima Fold Belt (Tolan and Reidel 1989). These structural subprovinces are delineated on the basis of their structural fabric, unlike the physiographic provinces that are defined on the basis of landforms. The Hanford Site is located in the Yakima Fold Belt Subprovince near its junction with the Palouse Subprovinces.

The principal characteristics of the Yakima Fold Belt (Figure 3-10) are a series of segmented, narrow, asymmetric anticlines that have wavelengths between 5 and 31 km (3 and 19 mi) and amplitudes commonly less than 1 km (0.6 mi) (Reidel et al. 1989a). The northern limbs of the anticlines generally dip steeply to the north, are vertical, or even overturned. The southern limbs generally dip at relatively shallow angles to the south. Thrust or high-angle reverse faults with fault planes that strike parallel or subparallel to the axial trends are principally found on the north sides of these anticlines. The amount of vertical stratigraphy offset associated with these faults varies but commonly exceeds hundreds of meters. These anticlinal ridges are separated by broad synclines or basins that, in many cases, contain thick accumulations of Neogene- to Quaternary-age sediments. The Pasco Basin is one of the larger structural basins in the Yakima Fold Belt Subprovince.

Deformation of the Yakima folds occurred under a north-south compression and was contemporaneous with the eruption of the basalt flows (Reidel 1984; Reidel et al. 1989a). Deformation occurred during the eruption of the Columbia River Basalt Group and continued through the Pliocene Epoch, into the Pleistocene Epoch, and perhaps to the present.

3.4.1.2 Pasco Basin and Hanford Site Structural Geology. The Pasco Basin, in which the Hanford Site is located, is bounded on the north by the Saddle Mountains anticline, on the west by the Umtanum Ridge, Yakima Ridge, and Rattlesnake Hills anticlines, and on the south by the Rattlesnake Mountain anticline (Figure 3-11). The Pasco Basin is divided into the Wahluke syncline on the north, and Cold Creek syncline on the south, by the Gable

1 Mountain anticline, the easternmost extension of the Umtanum Ridge anticline. The Cold
2 Creek syncline is bounded on the south by the Yakima Ridge anticline. Both the Cold Creek
3 and Wahluke synclines are asymmetric and relatively flat-bottomed structures. The north
4 limbs of both synclines dip gently (approximately 5°) to the south and the south limbs dip
5 steeply to the north. The deepest parts of the Cold Creek syncline, the Wye Barricade
6 depression, and the Cold Creek depression are approximately 12 km (7.5 mi) southeast of the
7 Hanford Site 200 Areas, and just to the west-southwest of the 200 West Area, respectively.
8 The deepest part of the Wahluke syncline lies just north of Gable Gap.
9

10 The 200 West Area is situated on the generally southward dipping north limb of the
11 Cold Creek syncline 1 to 5 km (0.6 to 3 mi) north of the syncline axis. The Gable
12 Mountain-Gable Butte segment of the Umtanum Ridge anticline lies approximately 4 km (2.5
13 mi) north of the 200 West Area. The axes of the anticline and syncline are separated by a
14 distance of 9 to 10 km (5.6 to 6.2 mi) and the crest of the anticline (as now exposed) is over
15 200 m (656 ft) higher than the uppermost basalt layer in the syncline axis. As a result, the
16 basalts and overlying sediments dip to the south and southwest beneath the 200 West Area.
17

18 **3.4.1.3 Regional and Hanford Site Seismology.** Eastern Washington, especially the
19 Columbia Plateau region, is a seismically inactive area when compared to the rest of the
20 western United States (DOE 1988). The historic seismic record for eastern Washington
21 began in approximately 1850, and no earthquakes large enough to be felt had epicenters on
22 the Hanford Site. The closest regions of historic moderate-to-large earthquake generation are
23 in western Washington and Oregon and western Montana and eastern Idaho. The most
24 significant event relative to the Hanford Site is the 1936 Milton-Freewater, Oregon,
25 earthquake that had a magnitude of 5.75 and that occurred more than 90 km (54 mi) away.
26 The largest Modified Mercalli Intensity for this event was felt about 105 km (63 mi) from
27 the Hanford site at Walla Walla, Washington, and was VII.
28

29 Geologic evidence of past moderate or possibly large earthquake activity is shown by the
30 anticlinal folds and faulting associated with Rattlesnake Mountain, Saddle Mountain, and
31 Gable Mountain. The currently recorded seismic activity related to these structures consists
32 of micro-size earthquakes. The suggested recurrence rates of moderate and larger-size
33 earthquakes on and near the Hanford Site are measured in geologic time (tens of thousands of
34 years).
35

36 37 **3.4.2 Regional Stratigraphy** 38

39 The following subsections summarize regional stratigraphic characteristics of the
40 Columbia River Basalt and Suprabasalt sediments. Specific references to the Hanford Site

1 and 200 West Area are made where applicable to describe the general occurrence of these
2 units within the Pasco Basin.
3

4 The principal geologic units within the Pasco Basin include the Miocene age basalt of
5 the Columbia River Basalt Group, and overlying late Miocene to Pleistocene suprabasalt
6 sediments (Figure 3-12). Older Cenozoic sedimentary and volcanoclastic rocks underlying
7 the basalts are not exposed at the surface near the Hanford Site. The basalts and sediments
8 thicken into the Pasco Basin and generally reach maximum thicknesses in the Cold Creek
9 syncline. The sedimentary sequence at the Hanford Site is up to approximately 230 m (750
10 ft) thick in the west-central Cold Creek syncline, but pinches out against the anticlinal
11 structures of Saddle Mountains, Gable Mountain/Umtanum Ridge, Yakima Ridge, and
12 Rattlesnake Hills.
13

14 The suprabasalt sediments are dominated by laterally extensive deposits assigned to
15 the late Miocene to Pliocene age Ringold Formation and the Pleistocene age Hanford
16 formation (Figure 3-13). Locally occurring strata described as pre-Missoula gravels, a
17 discontinuous Plio-Pleistocene unit, and early "Palouse" soil comprise the remainder of the
18 sedimentary sequence. The pre-Missoula gravels underlie the Hanford formation in the east-
19 central Cold Creek syncline and at the east end of Gable Mountain anticline east and south of
20 200 East Area. The pre-Missoula gravels have not been identified in the 200 West Area.
21 The nature of the contact between the pre-Missoula gravels have not been identified in the
22 200 West Area. The nature of the contact between the pre-Missoula gravels and the
23 overlying Hanford formation has not been completely delineated, based on available
24 subsurface data. In addition, it is unclear whether the pre-Missoula gravels overlie or
25 interfinger with the early "Palouse" soil and Plio-Pleistocene unit. Magnetic polarity data
26 indicate the unit is no younger than early Pleistocene in age (> 1 Ma) as reported in Lindsey
27 (1991).
28

29 Relatively thin surficial deposits of eolian sand, loess, alluvium, and colluvium
30 discontinuously overlie the Hanford formation.
31

32 **3.4.2.1 Columbia River Basalt Group.** The Columbia River Basalt Group (Figure 3-12)
33 comprises an assemblage of tholeiitic, continental flood basalts of Miocene age. These flows
34 cover an area of more 163,000 km² (63,000 mi²) in Washington, Oregon, and Idaho and
35 have an estimated volume of about 174,000 km³ (40,800 mi³) (Tolan et al. 1989). Isotopic
36 age determinations indicate that basalt flows were erupted approximately 17 to 6 Ma (million
37 years before present), with more than 98% by volume being erupted in a 2.5 million year
38 period (17 to 14.5 Ma) (Reidel et al. 1989b).
39

1 Columbia River basalt flows were erupted from north-northwest-trending fissures of
2 linear vent systems in north-central and northeastern Oregon, eastern Washington, and
3 western Idaho (Swanson et al. 1979). The Columbia River Basalt Group is formally divided
4 into five formations (from oldest to youngest): Imnaha Basalt, Picture Gorge Basalt, Grande
5 Ronde Basalt, Wanapum Basalt, and Saddle Mountains Basalt. Of these, only the Picture
6 Gorge Basalt is not known to be present in the Pasco Basin. The Saddle Mountains Basalt,
7 divided into the Ice Harbor, Elephant Mountain, Pomona, Esquatzel, Asotin, Wilbur Creek
8 and Umatilla members (Figure 3-12), forms the uppermost basalt unit throughout most of the
9 Pasco Basin. The Elephant Mountain member is the uppermost unit beneath most of the
10 Hanford Site except near the 300 Area where the Ice Harbor member is found and north of
11 the 200 Areas where the Saddle Mountains Basalt has been eroded down to the Umatilla
12 member locally. On anticlinal ridges bounding the Pasco Basin, erosion has removed the
13 Saddle Mountains Basalt, exposing the Wanapum and Grande Ronde Basalts.

14
15 **3.4.2.2 Ellensburg Formation.** The Ellensburg Formation consists of all sedimentary units
16 that occur between the basalt flows of the Columbia River Basalt Group in the central
17 Columbia Basin. The Ellensburg Formation generally displays two main lithologies:
18 volcanoclastics, and siliciclastics. The volcanoclastics consist mainly of primary pyroclastic
19 air fall deposits and reworked epiclastics derived from volcanic terrains west of the Columbia
20 Plateau. Siliciclastic strata in the Ellensburg Formation consists of clastic, plutonic, and
21 metamorphic detritus derived from the Rocky Mountain terrain. These two lithologies occur
22 as both distinct and mixed in the Pasco Basin. A detailed discussion of the
23 Ellensburg Formation in the Hanford Site is given by Reidel and Fecht (1981). Smith et al.
24 (1989) provide a discussion of age equivalent units adjacent to the Columbia Plateau.

25
26 The stratigraphic names for individual units of the Ellensburg Formation are given in
27 Figure 3-12. The nomenclature for these units is based on the upper- and lower- bounding
28 basalt flows and thus the names are valid only for those areas where the bounding basalt
29 flows occur. Because the Pasco Basin is an area where most bounding flows occur, the
30 names given in Figure 3-12 are applicable to the Hanford Site. At the Hanford Site the three
31 uppermost units of the Ellensburg Formation are the Selah interbed, the Rattlesnake Ridge
32 interbed, and the Levey interbed.

33
34 **3.4.2.2.1 Selah Interbed.** The Selah interbed is bounded on the top by the Pomona
35 member and on the bottom by the Esquatzel member. The interbed is a variable mixture of
36 silty to sandy vitric tuff, arkosic sands, tuffaceous clays, and locally thin stringers of
37 predominantly basaltic gravels. The Selah interbed is found beneath most of the Hanford
38 Site.

1 **3.4.2.2.2 Rattlesnake Ridge Interbed.** The Rattlesnake Ridge interbed is bounded
2 on the top of the Elephant Mountain member and on the bottom by the Pomona member.
3 The interbed is up to 33 m (108 ft) thick and dominated by three facies at the Hanford Site:
4 1) a lower clay or tuffaceous sandstone, 2) a middle, micaceous-arkosic and/or tuffaceous
5 sandstone, and 3) an upper, tuffaceous siltstone to sandstone. The unit is found beneath most
6 of the Hanford Site.
7

8 **3.4.2.2.3 Levey Interbed.** The Levey interbed is the uppermost unit of the
9 Ellensburg Formation and occurs between the Ice Harbor member and the Elephant Mountain
10 member. It is confined to the vicinity of the 300 Area. The Levey interbed is a tuffaceous
11 sandstone along its northern edge and a fine-grained tuffaceous siltstone to sandstone along
12 its western and southern margins.
13

14 **3.4.2.3 Ringold Formation.** The Ringold Formation at the Hanford Site is up to 185 m
15 (607 ft) thick in the deepest part of the Cold Creek syncline south of the 200 West Area and
16 170 m (558 ft) thick in the western Wahluke syncline near the 100-B Area. The Ringold
17 Formation pinches out against the Gable Mountain, Yakima Ridge, Saddle Mountains, and
18 Rattlesnake Mountain anticlines. It is largely absent in the northern and northeastern parts of
19 the 200 East Area and adjacent areas to the north in the vicinity of West Pond. The Ringold
20 Formation is assigned a late Miocene to Pliocene age (Fecht et al. 1987; DOE 1988).
21

22 Recent studies of the Ringold Formation (Lindsey and Gaylord 1989) indicate that it
23 is best described and divided on the basis of sediment facies associations and their
24 distribution. Facies associations in the Ringold Formation (defined on the basis of lithology,
25 petrology, stratification, and pedogenic alteration) include fluvial gravel, fluvial sand,
26 overbank deposits, lacustrine deposits, and alluvial fan. The facies associations are
27 summarized as follows:
28

- 29 • Fluvial gravel - Clast-supported granule to cobble gravel with a sandy matrix
30 dominates the association. Intercalated sands and muds also are found. Clast
31 composition is very variable, with common types being basalt, quartzite,
32 porphyritic volcanics, and greenstones. Silicic plutonic rocks, gneisses, and
33 volcanic breccias also are found. Sands in this association are generally
34 quartzo-feldspathic, with basalt contents generally in the range of 5 to 15%.
35 However, basalt contents as high as 25% (or locally more) are encountered.
36 Low angle to planar stratification, massive channels, and large-scale cross-
37 bedding are found in outcrops. The association was deposited in a gravelly
38 fluvial system characterized by wide, shallow shifting channels.
39

- 1 • Fluvial sand - Quartzo-feldspathic sands displaying cross-bedding and cross-
2 lamination in outcrop dominate this association. These sands usually contain
3 less than 15% basalt. Intercalated strata consist of lenticular silty sands and
4 clays up to 3 m (10 ft) thick and thin (<0.5 m) gravels. Fining upwards
5 sequences less than 1 m (3.3 ft) to several meters thick are common in the
6 association. Strata comprising the association were deposited in wide, shallow
7 channels incised into a muddy floodplain.
8
- 9 • **Overbank** - This association dominantly consists of laminated to massive silt,
10 silty fine-grained sand, and paleosols containing variable amounts of calcium
11 carbonate. These sediments record deposition in a floodplain under proximal
12 levee to more distal floodplain conditions.
13
- 14 • **Lacustrine** - Plane laminated to massive clay with thin silt and silty sand
15 interbeds displaying some soft-sediment deformation characterize this
16 association. Coarsening upwards packages less than 1 m (3.3 ft) to 10 m (33
17 ft) thick are common in the association. Strata comprising the association
18 were deposited in a lake under standing water to deltaic conditions.
19
- 20 • **Alluvial fan** - Massive to crudely stratified, weathered to unweathered basaltic
21 detritus dominates this association. This association was deposited largely by
22 debris flows in alluvial fan settings.
23

24 The lower half of the Ringold Formation contains five separate stratigraphic intervals
25 dominated by fluvial gravels. These gravels, designated units, A, B, C, D, and E
26 (Figure 3-13), are separated by intervals containing deposits typical of the overbank and
27 lacustrine facies associations. The lowermost of the fine-grained sequences, overlying unit
28 A, is designated the lower mud sequence. The uppermost gravel unit, unit E, grades
29 upwards into interbedded fluvial sand and overbank deposits. These sands and overbank
30 deposits are overlain by lacustrine-dominated strata.
31

32 Fluvial gravel units A and E correspond to the lower basal and middle Ringold units
33 respectively as defined by DOE (1988). Gravel units B, C, and D do not correlate to any
34 previously defined units. The lower mud sequence corresponds to the upper basal and lower
35 units as defined by DOE (1988). The upper basal and lower units are not differentiated.
36 The sequence of fluvial sands, overbank deposits, and lacustrine sediments overlying unit E
37 corresponds to the upper unit as seen along the White Bluffs in the eastern Pasco Basin.
38 This essentially is the same usage as originally proposed by Newcomb (1958) and Myers et
39 al. (1979).
40

1 **3.4.2.4 Plio-Pleistocene Unit.** Unconformably overlying the Ringold Formation in the
2 western Cold Creek syncline in the vicinity of 200 West Area (Figures 3-11, 3-12, and 3-13)
3 is the laterally discontinuous Plio-Pleistocene unit (DOE 1988). The unit is up to 25 m (82
4 ft) thick and divided into two facies: (1) basaltic detritus and (2) calcic paleosol (Stage III
5 and Stage IV) (DOE 1988). The calcic paleosol facies generally consists of interfingering
6 calcium carbonate-cemented silt, sand, gravel, and carbonate-poor silt and sand. The basaltic
7 detritus facies consists of weathered and unweathered basaltic gravels deposited as locally
8 derived slope wash, colluvium, and sidestream alluvium. The Plio-Pleistocene unit appears
9 to be correlative to other sidestream alluvial and pedogenic deposits found near the base of
10 the ridges bounding the Pasco Basin on the north, west, and south. These sidestream alluvial
11 and pedogenic deposits are inferred to have a late Pliocene to early Pleistocene age on the
12 basis of stratigraphic position and magnetic polarity of interfingering loess units.

13
14 **3.4.2.5 Pre-Missoula Gravels.** Quartzose to gneissic clast-supported pebble to cobble
15 gravel with a quartzo-feldspathic sand matrix underlies the Hanford formation in the east-
16 central Cold Creek syncline and at the east end of Gable Mountain anticline east and south of
17 the 200 East Area (Figures 3-11, 3-12, and 3-13). These gravels, called the pre-Missoula
18 gravels (PSPL 1982), are up to 25 m (82 ft) thick, contain less basalt than underlying
19 Ringold gravels and overlying Hanford deposits, have a distinctive white or bleached color,
20 and sharply truncate underlying strata. The nature of the contact between the pre-Missoula
21 gravels and the overlying Hanford formation is not clear. In addition, it is unclear whether
22 the pre-Missoula gravels overlie or interfinger with the early Palouse soil and Plio-
23 Pleistocene unit. Magnetic polarity data indicates the unit is no younger than early
24 Pleistocene in age (> 1 Ma) (Bjornstad et al. 1987).

25
26 **3.4.2.6 Early "Palouse" Soil.** The early "Palouse" soil consists of up to 20 m (66 ft) of
27 massive, brown yellow, and compact, loess-like silt and minor fine-grained sand (Tallman et
28 al. 1981; Bjornstad 1984; DOE 1988). These deposits overlie the Plio-Pleistocene unit in the
29 western Cold Creek syncline around the 200 West Area (Figures 3-11, 3-12, and 3-13). The
30 unit is differentiated from overlying graded rhythmites (Hanford formation) by greater
31 calcium carbonate content, massive structure in core, and high natural gamma response in
32 geophysical logs (Bjornstad 1984; DOE 1988). The upper contact of the unit is poorly
33 defined, and it may grade up-section into the lower part of the Hanford formation. Based on
34 a predominantly reversed polarity the unit is inferred to be early Pleistocene in age.

35
36 **3.4.2.7 Hanford Formation.** The Hanford formation consists of pebble to boulder gravel,
37 fine- to coarse-grained sand, and silt. These deposits are divided into three facies: (1)
38 gravel-dominated, (2) sand-dominated, and (3) slackwater or normally graded rhythmite.
39 The slackwater deposits also are referred to as the "Touchet Beds," while the gravelly facies
40 are generally referred to as the Pasco Gravels. The Hanford formation is thickest in the

1 Cold Creek bar in the vicinity of 200 West and 200 East Areas where it is up to 65 m (213
2 ft) thick (Figures 3-11, 3-12, and 3-13). Hanford deposits are absent on ridges above
3 approximately 385 m (1,263 ft) above sea level. The following subsections describe the
4 three Hanford formation facies.
5

6 **3.4.2.7.1 Gravel Dominated Facies.** The gravel-dominated facies is dominated by
7 coarse-grained sand and granule to boulder gravel. These deposits display massive bedding,
8 plane to low-angle bedding, and large-scale cross-bedding in outcrop, while the gravels
9 generally are matrix-poor and display an open-framework texture. Lenticular sand and silt
10 beds are intercalated throughout the facies. Gravel clasts in the facies generally are
11 dominated by basalt (50 to 80%). Other clast types include Ringold and Plio-Pleistocene rip-
12 ups, granite, quartzite, and gneiss clasts. The relative proportion of gneissic and granitic
13 clasts in Hanford gravels versus Ringold gravels generally is higher (up to 20% as compared
14 to less than 5%). Sands in this facies usually are very basaltic (up to 90%), especially in the
15 granule size range. Locally Ringold and Plio-Pleistocene rip-up clasts dominate the facies
16 comprising up to 75% of the deposit. The gravel facies dominates the Hanford formation in
17 the 100 Areas north of Gable Mountain, the northern part of 200 East Area, and the eastern
18 part of the Hanford Site including the 300 Area. The gravel-dominated facies was deposited
19 by high-energy flood waters in or immediately adjacent to the main cataclysmic flood
20 channelways.
21

22 **3.4.2.7.2 Sand-Dominated Facies.** The sand-dominated facies consists of fine-
23 grained to granular sand displaying plane lamination and bedding and less commonly plane
24 cross-bedding in outcrop. These sands may contain small pebbles in addition to pebble-
25 gravel interbeds and silty interbeds less than 1 m (3.3 ft) thick. The silt content of these
26 sands is variable, but where it is low an open framework texture is common. These sands
27 are typically very basaltic, commonly being referred to as black or gray or salt and pepper
28 sands. This facies is most common in the central Cold Creek syncline, in the central to
29 southern parts of the 200 East and 200 West Areas, and in the vicinity of the WPPSS
30 facilities. The laminated sand facies was deposited adjacent to main flood channelways as
31 water in the channelways spilled out of them, losing their competence. The facies varied
32 between gravel-dominated facies and rhythmite facies.
33

34 **3.4.2.7.3 Slackwater Facies.** The slackwater facies consists of thinly bedded, plane
35 laminated and ripple cross-laminated silt and fine- to coarse-grained sand that commonly
36 display normally graded rhythmites a few centimeters to several tens of centimeters thick in
37 outcrop (Myers et al. 1979; DOE 1988). This facies is found throughout the central,
38 southern, and western Cold Creek syncline within and south of 200 East and West Areas.
39 These sediments were deposited under slackwater conditions and in backflooded areas (DOE
40 1988).

1 **3.4.2.8 Holocene Surficial Deposits.** Holocene surficial deposits consist of silt, sand, and
2 gravel that form a thin (<10 m, 33 ft) veneer across much of the Hanford Site. These
3 sediments were deposited by a mix of eolian and alluvial processes.
4
5

6 **3.4.3 200 West Area and Z Plant Aggregate Area Geology**

7

8 The following subsections describe the occurrence of the uppermost basalt unit and
9 the suprabasalt sediments in the 200 West Area. The subsection discuss notable stratigraphic
10 characteristics, thickness variations, and the geometric relationships of the sediments.
11 Stratigraphic variations pertinent to the Z Plant Aggregate Area are presented in the overall
12 context of stratigraphic trends throughout the 200 West Area.
13

14 Geologic cross sections depicting the distribution of basalt and sedimentary units
15 within and near the Z Plant Aggregate Area are presented on Figures 3-16 through 3-20.
16 Figure 3-14 illustrates the cross sections locations. A legend for symbols used on the cross
17 sections is provided on Figure 3-15. The cross sections are based on geologic information
18 from wells shown on the figures, as interpreted in Lindsey et al. (1991). To develop these
19 stratigraphic interpretations, logs for all the wells in the Z Plant Aggregate Area were
20 reviewed and a selection was made of the most relevant to the AAMS. Chamness et al.
21 (1991) provide a compilation of these 13 geologic logs from the Z Plant Aggregate Area, and
22 a listing of other logs which are available and additional geological, geochemical, and
23 geophysical data available from these and other boreholes. This information was compiled in
24 support of the Z Plant Aggregate Area Management Study. The cross sections depict
25 subsurface geology in the Z Plant Aggregate Area. For each cross section, locations of Z
26 Plant Aggregate Area waste management units are identified for reference. Figures 3-21
27 through 3-38 present structure maps of the top of the sedimentary units, and isopach maps
28 illustrating the thickness of each unit in the 200 West Area and Z Plant Aggregate Area.
29 The structure and isopach maps are included from Lindsey et al. (1991). Plate 1 should be
30 consulted to identify locations of Z Plant Aggregate Area buildings referenced in the text.
31

32 **3.4.3.1 Elephant Mountain Basalt.** The Elephant Mountain member of the Saddle
33 Mountains Basalt is continuous beneath the entire 200 West Area. The top of the Elephant
34 Mountain member dips to the southwest and south into the Cold Creek syncline, reflecting
35 the structure of the area (Figure 3-16). There is little evidence of significant erosion into the
36 top of the Elephant Mountain member and no indication of erosional "windows" through the
37 basalt into the underlying Rattlesnake Mountain interbed within the 200 West Area.
38

39 **3.4.3.2 Ringold Formation.** Within the 200 West Area, the Ringold Formation includes
40 the fluvial gravels of unit A, the paleosol and lacustrine muds of the lower mud sequence,

1 the fluvial gravels of unit E, and the sands and minor muds of the upper unit. Ringold units
2 B, C, and D are not found in the immediate vicinity of the 200 West Area.

3
4 Several observations can be made regarding the variation of sediment types within the
5 Ringold units in the 200 West Area. In the Ringold unit A gravels, intercalated lenticular
6 sand and silt are most common in the western portion of the 200 West Area (including the Z
7 Plant Aggregate Area), and in the southern part of the 200 West Area. In the overlying
8 lower mud sequence, stratigraphic trends seen elsewhere in the Pasco Basin suggest that
9 paleosols in the unit become more common progressing structurally up-dip (Lindsey et al.
10 1991). In the Ringold unit E gravels, intercalated lenticular beds of sand and silt occur
11 throughout the 200 West Area, although predicting where they will occur is difficult. The
12 upper unit of the Ringold in the 200 West Area tends to be dominated by sand, unlike the
13 upper unit elsewhere in the Pasco Basin where paleosols tend to dominate the upper unit.

14
15 Beneath the 200 West Area, the fluvial gravels of Ringold unit A, and the Ringold
16 lower mud sequence tend to thicken and dip to the south-southwest, toward the axis of the
17 Cold Creek Syncline (Figures 3-16, 3-22, and 3-23). The top of unit A is relatively flat in
18 the 200 Areas, dipping gently to the west and southwest. Like the unit A gravels, the
19 Ringold lower mud sequence thickens and dips to the south and southeast over the 200 West
20 Area (Figures 3-24 and 3-25). The top of the lower mud unit is less regular, however, and
21 the unit pinches out in the northeastern corner of the 200 West Area. Within the Z Plant
22 Aggregate Area, unit A reaches a thickness of more than 17 meters (57 feet) in the southern
23 part of the aggregate area, and apparently pinches out just north of the Z Plant Aggregate
24 Area boundary. The lower mud sequence ranges in thickness from about 3.4 meters (11
25 feet) in the northeast corner of the Z Plant Aggregate Area to about 33 meters (110 feet) at
26 the southwest corner of the aggregate area.

27
28 Isopach and structure contour maps of fluvial gravel unit E (Figures 3-26 and 3-27)
29 and the upper unit (Figures 3-28 and 3-29) show trends not seen in the underlying unit A and
30 the lower mud sequence. The gravels of unit E generally thin from north-northwest to the
31 east-southeast. The top of the unit is irregular, displaying several highs in the northern and
32 southern parts of the area and several lows in the central part of the 200 West Area. These
33 highs include the northern part of the Z Plant Aggregate Area. Several structural lows in the
34 unit E gravels occur across the 200 West Area, including prominent depressions in the Z
35 Plant Aggregate Area north and east of the main Z Plant building complex. Unit E thickness
36 varies from about 109 meters (358 feet) at the northern boundary of the Z Plant Aggregate
37 Area to about 73 meters (239 feet) at the southern boundary of the aggregate area.
38 Intercalated lenticular beds of sand and silt occur throughout the 200 West Area, although
39 predicting where they will occur is very difficult.

40

1 The upper unit of the Ringold Formation is present only in the western, northern, and
2 central portion of the 200 West Area (Figures 3-16, 3-18 through 3-20, 3-28, and 3-29).
3 Where the upper unit is present, the top generally dips to the south-southwest. The upper
4 unit is absent on the west central and southern parts of the Z Plant Aggregate Area. The
5 upper unit reaches of thickness of about 12 to 15 meters (40 to 50 feet) at the northwest and
6 northeast corners of the Z Plant Aggregate Area, and just north of the main Z Plant building
7 complex.

8
9 **3.4.3.3 Plio-Pleistocene Unit.** The carbonate-rich strata of the Plio-Pleistocene unit largely
10 is restricted to the vicinity of 200 West Area, pinching out near the northern, eastern, and
11 southern boundaries of the area (Figures 3-30 and 3-31). Thickness variations in the unit
12 are very irregular. It is thickest in the southeast, southwest, and northcentral parts of the
13 200 West Area while it thins in the south-central and central parts of the area. Relatively
14 thick portions of the unit (up to about 8 meters (25 feet)) also occur near the main Z Plant
15 building complex, and near the northern boundary of the aggregate area (about 12 meters (39
16 feet)). Several prominent thin areas (about 1.5 meters (5 feet) or less) occur south and west
17 of the main Z Plant building complex. Although undocumented, potential eroded zones
18 through the unit may exist, especially where the unit thins. The top of the unit generally
19 dips to the southwest, although irregularities occur, especially in the southern part of the Z
20 Plant Aggregate Area. In addition, fracturing in the carbonate is potentially common and
21 interbedded carbonate-poor lithologies are found at many locations.

22
23 **3.4.3.4 Pre-Missoula Gravels.** As discussed in the Regional Stratigraphy section (Section
24 3.4.2) the Pre-Missoula Gravels are present only in the eastcentral Cold Creek syncline and
25 at the east end of Gable Mountain anticline east and south of the 200 East Area. The gravels
26 have not been identified in the 200 West Area.

27
28 **3.4.3.5 Early "Palouse" Soil.** Like the Plio-Pleistocene unit, the early "Palouse" soil is
29 largely restricted to the vicinity of the 200 West Area (Figures 3-32 and 3-33). The unit
30 pinches out in the west-central part of the 200 West Area and near the southern, eastern, and
31 northern boundaries. Limited data from a small number of boreholes located west of the 200
32 West Area suggest that the unit extends to the west. The early "Palouse" Soil is also
33 apparently absent at two locations within the 200 West Area, north and west of the main Z
34 Plant building complex in the Z Plant Aggregate Area. The thickness of the Early "Palouse"
35 Soil in the 200 Areas varies irregularly. The unit is thickest in the southeast and southwest
36 parts of the 200 West Area. Within the Z Plant Aggregate Area, the unit reaches a thickness
37 of about 6 to 5.5 meters (15 to 18 feet) in the southern part of the aggregate area. Across
38 the 200 Areas, the top of the unit dips to the south, although it becomes fairly irregular over
39 the southern part of the Z Plant Aggregate Area.
40

1 Although carbonate is present in the unit in the 200 Areas, no obvious caliches like
2 those seen in the underlying Plio-Pleistocene unit are documented. The loess-like sediments
3 of the early "Palouse" soil are uncemented.
4

5 **3.4.3.6 Hanford Formation.** As discussed in the regional geology section, the cataclysmic
6 flood deposits of the Hanford formation are divided into three facies, gravel-dominated,
7 sand-dominated, and slackwater. Typical lithologic successions consist of fining upwards
8 packages, major fine-grained intervals, and laterally persistent coarse-grained sequences.
9 Mineralogic and geochemical data were not used in differentiating units because of the lack
10 of a comprehensive mineralogic and geochemical data set. The Hanford formation is divided
11 into two units, upper coarse-grained and lower fine-grained, based on lithology. These are
12 essentially the same units as defined in Last et al. (1989). Neither of these units are
13 continuous across the entire 200 West Area, they both display marked changes in thickness
14 and continuity, and they are very heterogeneous.
15

16 The lower fine-grained unit of the Hanford formation in the 200 West Area is thick,
17 but locally discontinuous (Figures 3-34 and 3-35). The lower unit is 0 to 32 m (0 to 105 ft)
18 thick and consists dominantly of silt, silty sand, and sand typical of the slackwater facies
19 interbedded with coarser sands like those comprising the sand-dominated facies. This lower
20 unit is cross-cut in places by vertical clastic dikes. These dikes, believed to be the product
21 of dynamic loading from floodwaters, are distributed randomly throughout this lower unit.
22 They are commonly filled with fine sands and silts and oriented near vertical. Thin (<3 m,
23 10 ft) intervals dominated by the gravel facies are found locally. The distribution of facies
24 within the unit is variable, although the unit generally fines to the south where slackwater
25 deposits become more common. The lower unit is not present over much of the northern
26 part of the 200 West Area, and an area which includes the central north-south spine of the Z
27 Plant Aggregate Area. Eroded zones through the lower fine unit are present to the east and
28 west of the southern part of the Z Plant Aggregate Area. The eroded zones are elongate in a
29 north-south direction. The lower unit dips irregularly across the 200 West Area. The lower
30 unit is up to about 19 meters (62 feet) thick toward the western edge of the Z Plant
31 Aggregate Area, and generally dips to the north, toward the area where the unit is not
32 present.
33

34 The upper coarse-grained unit of the Hanford formation consists of interstratified
35 gravel, sand, and lesser silt. Gravel-dominated deposits typical of the gravel facies generally
36 dominate the upper unit. However, at some localities the unit is dominated by deposits
37 typical of the sand-dominated facies that consists of sand containing lesser silt and gravel.
38 Minor silty deposits such as those forming the slackwater facies are found locally. The
39 thickness and distribution of these facies is very variable. Fining upwards sequences going
40 from coarser to finer gravel and gravel, sand and/or silt are present at some locations. The

1 upper coarse unit is up to 45 m (148 ft) thick and laterally discontinuous, being found in the
2 northern, east-central, and eastern parts of the area (Figures 3-36 and 3-37). Local areas
3 occur where thickness of the upper coarse unit exceeds 38 meters (125 feet), including the
4 southern part of the Z Plant Aggregate Area. The base of the upper coarse unit is incised
5 into the underlying lower fine unit, and fills scour areas where the lower unit is absent. The
6 contact between the upper coarse unit and underlying strata is generally sharp, consisting of
7 gravel facies strata overlying the fines of the lower unit, the early Palouse soil, and the Plio-
8 Pleistocene unit. Over most of the Aggregate Area the top of the upper coarse-grained unit
9 of the Hanford formation is at the ground surface.

10
11 **3.4.3.7 Holocene Surficial Deposits.** Holocene-age surficial deposits in the 200 West Area
12 are dominated by eolian sands. These deposits have been removed from much of the area by
13 construction activities. Where the eolian sands are found they tend to consist of
14 thin (<3 m, 10 ft) sheets that cover the ground (Figure 3-38). Dunes are not generally well
15 developed within the 200 West Area. In the Z Plant Aggregate Area these Holocene deposits
16 are found only in localized areas.

17 18 19 **3.5 HYDROGEOLOGY**

20
21 The following subsections present discussions of regional hydrogeology (Section
22 3.5.1), Hanford Site hydrogeology (Section 3.5.2), and Z Plant Aggregate Area
23 hydrogeology (Section 3.5.3). Sections 3.5.2 and 3.5.3 also discuss Hanford Site and Z
24 Plant Aggregate Area vadose zone characteristics.

25 26 27 **3.5.1 Regional Hydrogeology**

28
29 The hydrogeology of the Pasco Basin is characterized by a multiaquifer system that
30 consists of four hydrogeological units that correspond to the upper three formations of the
31 Columbia River Basalt Group (Grande Ronde Basalt, Wanapum Basalt, and Saddle
32 Mountains Basalt) and the suprabasalt sediments. The basalt aquifers consist of the tholeiitic
33 flood basalts of the Columbia River Basalt Group and relatively minor amounts of
34 intercalated fluvial and volcanoclastic sediments of the Ellensburg Formation. Confined
35 zones in the basalt aquifers are present in the sedimentary interbeds and/or interflow zones
36 that occur between dense basalt flows. The main water-bearing portions of the interflow
37 zones are networks of interconnecting vesicles and fractures of the flow tops and flow
38 bottoms (DOE 1988). The suprabasalt sediment or uppermost aquifer system consists of
39 fluvial, lacustrine, and glaciofluvial sediments. This aquifer is regionally unconfined and is
40 contained largely within the Ringold Formation and Hanford formation. The position of the

1 water table in the southwestern Pasco Basin is generally within Ringold fluvial gravels of unit
2 E. In the northern and eastern Pasco Basin the water table is generally within the Hanford
3 formation. Table 3-1 presents hydraulic parameters for various water-bearing geologic units
4 at the Hanford Site.
5

6 Local recharge to the shallow basalt aquifers results from infiltration of precipitation
7 and runoff along the margins of the Pasco Basin, and in areas of artificial recharge where a
8 downward gradient from the unconfined aquifer systems to the uppermost confined basalt
9 aquifer may occur. Regional recharge of the deep basalt aquifers is inferred to result from
10 interbasin groundwater movement originating northeast and northwest of the Pasco Basin in
11 areas where the Wanapum and Grande Ronde Basalts crop out extensively (DOE 1988).
12 Groundwater discharge from shallow basalt aquifers is probably to the overlying aquifers and
13 to the Columbia River. The discharge area(s) for the deeper groundwater system is
14 uncertain, but flow is inferred to be generally southeastward with discharge thought to be
15 south of the Hanford Site (DOE 1988).
16

17 Erosional "windows" through dense basalt flow interiors allow direct interconnection
18 between the uppermost aquifer systems and underlying confined basalt aquifers. Graham et
19 al. (1984) reported that some contamination was present in the uppermost confined aquifer
20 (Rattlesnake Ridge interbed) south and east of Gable Mountain Pond. Graham et al. (1984)
21 evaluated the hydrologic relationships between the Rattlesnake Ridge interbed aquifer and the
22 unconfined aquifer in this area and delineated a potential area of intercommunication beneath
23 the northeast portion of the 200 East Area.
24

25 The base of the uppermost aquifer system is defined as the top of the uppermost
26 basalt flow. However, fine-grained overbank and lacustrine deposits in the Ringold
27 Formation locally form confining layers for Ringold fluvial gravels underlying unit E. The
28 uppermost aquifer system is bounded laterally by anticlinal basalt ridges and is approximately
29 152 m (500 ft) thick near the center of the Pasco Basin.
30

31 Sources of natural recharge to the uppermost aquifer system are rainfall and runoff
32 from the higher bordering elevations, water infiltrating from small ephemeral streams, and
33 river water along influent reaches of the Yakima and Columbia Rivers. The movement of
34 precipitation through the unsaturated (vadose) zone has been studied at several locations on
35 the Hanford Site (Gee 1987; Routson and Johnson 1990; Rockhold et al. 1990). Conclusions
36 from these studies vary. Gee (1987) and Routson and Johnson (1990) conclude that no
37 downward percolation of precipitation occurs on the 200 Areas Plateau where the sediments
38 are layered and vary in texture, and that all moisture penetrating the soil is removed by
39 evapotranspiration. Rockhold et al. (1990) suggest that downward water movement below

1 the root zone is common in the 300 Area, where soils are coarse-textured and precipitation
2 was above normal.

3 4 5 **3.5.2 Hanford Site Hydrogeology**

6
7 This section describes the hydrogeology of the Hanford Site with specific reference to
8 the 200 Areas.

9
10 **3.5.2.1 Hydrostratigraphy.** The hydrostratigraphic units of concern in the 200 Areas are
11 (1) the Rattlesnake Ridge interbed (confined water-bearing zone), (2) the Elephant Mountain
12 Basalt member (confining horizon), (3) the Ringold Formation (unconfined and confined
13 water-bearing zones and lower part of the vadose zone), (4) the Plio-Pleistocene unit and
14 early "Palouse" soil (primary vadose zone perching horizons and/or perched groundwater
15 zones) and (5) the Hanford formation (vadose zone) (Figure 3-39). The Plio-Pleistocene unit
16 and early "Palouse" soil are only encountered in the 200 West Area. Strata below the
17 Rattlesnake Ridge interbed are not discussed because the more significant water-bearing
18 intervals, relating to environmental issues, are primarily closer to ground surface. The
19 hydrogeologic designations for the 200 Areas were determined by examination of borehole
20 logs and integration of these data with stratigraphic correlations from existing reports.

21
22 **3.5.2.1.1 Vadose Zone.** The vadose zone beneath the 200 Areas ranges from
23 approximately 55 m (180 ft) beneath the former U Pond to approximately 100 m (340 ft)
24 west of the 200 East Area (Last et al. 1989). Sediments in the vadose zone consist of the (1)
25 upper part of the fluvial gravel of Ringold unit E, (2) the upper unit of the Ringold
26 Formation, (3) Plio-Pleistocene unit, (4) early "Palouse" soil, and (5) Hanford formation.
27 Only the Hanford formation is continuous throughout the vadose zone in the 200 Areas. The
28 upper unit of the Ringold Formation, the Plio-Pleistocene unit, and the early "Palouse" soil
29 only occur in 200 West Area. The unconfined aquifer water table (discussed in Section
30 3.5.2.1.3) lies within the Ringold unit E.

31
32 The transport of water through the vadose zone depends in complex ways on several
33 factors, including most significantly the moisture content of the soils and their hydraulic
34 properties. Darcy's law, although originally conceived for saturated flow only, was extended
35 by Richards to unsaturated flow, with the provisions that the soil hydraulic conductivity
36 becomes a function of the water content of the soil and the driving force is predominantly
37 differences in moisture content. The moisture flux, q , in centimeters per second in one

1 direction is then described by a modified form of Darcy's law commonly referred to as
 2 Richards' Equation (Hillel 1971) as follows:

$$3 \quad q = K(\theta) \times \frac{\partial \varphi}{\partial \theta} \times \frac{\partial \theta}{\partial x} \text{ (Richards' Equation)}$$

4
 5
 6 where

- 7
- 8 • $K(\theta)$ is the water-content-dependent unsaturated hydraulic conductivity in cm/s
- 9
- 10 • $\frac{\partial \varphi}{\partial \theta}$ is the slope of the soil-moisture retention curve $\varphi(\theta)$ at a particular
- 11 volumetric moisture content θ (a soil-moisture retention curve plots volumetric
- 12 moisture content observed in the field or laboratory against suction values for
- 13 a particular soil, see Figure 3-41 from Gee and Heller [1985] for an example)
- 14
- 15 • $\frac{\partial \theta}{\partial x}$ is the water content gradient in the x direction.
- 16

17 More complicated forms of this equation are also available to account for the effects
 18 of more than one dimensional flow and the effects of other driving forces such as gravity.

19
 20 The usefulness of Richards' Equation is that knowing the moisture content distribution
 21 in soil, having measured or estimated values for the unsaturated hydraulic conductivity
 22 corresponding to these moisture contents, and having developed a moisture retention curve
 23 for this soil, one can calculate a steady state moisture flux. With appropriate algebraic
 24 manipulation or numerical methods, one could also calculate the moisture flux under transient
 25 conditions.

26
 27 In practice, applying Richards' Equation is quite difficult because the various
 28 parameters involved are difficult to measure and because soil properties vary depending on
 29 whether the soil is wetting or drying. As a result, soil heterogeneities affect unsaturated flow
 30 even more than saturated flow. Several investigators at the Hanford Site have measured the
 31 vadose zone moisture flux directly using lysimeters (e.g., Rockhold et al. 1990; Routson and
 32 Johnson 1990). These direct measurements are discussed in Section 3.5.2.2 under the
 33 heading of natural groundwater recharge.

34
 35 An alternative to direct measurement of unsaturated hydraulic conductivity is to use
 36 theoretical methods which predict the conductivity from measured soil moisture retention
 37 data.

38
 39 Thirty-five soil samples from the 200 West Area have had moisture retention data
 40 measured. These samples were collected from Wells 299-W18-21, 299-W15-16, 299-W15-2,

1 299-W10-13, 299-W7-9, and 299-W7-2. Eleven of these samples were reported by
2 Bjornstad (1990). The remaining 24 were analyzed as part of an ongoing performance
3 assessment of the low-level burial grounds. For each of these samples saturated hydraulic
4 conductivity was measured in the laboratory. Van Genuchten's computer program RETC
5 was then used to develop wetting and drying curves for the Hanford, early "Palouse," Plio-
6 Pleistocene, upper Ringold, and Ringold Gravel lithologic units. Examples of wetting and
7 drying curves, and corresponding grain size distributions, are provided on Figures 3-40 and
8 3-41.

9
10 The unsaturated hydraulic conductivities may vary by orders of magnitude with
11 varying moisture contents and among differing lithologies with significantly different soil
12 textures and hydraulic conductivities. Therefore, choosing a moisture retention curve should
13 be made according to the particle size analyses of the samples and the relative density of the
14 material.

15
16 Once the relationship between unsaturated hydraulic conductivity and moisture content
17 is known for a particular lithologic unit, travel time can also be estimated for a steady-state
18 flux passing through each layer by assuming a unit hydraulic gradient. Under the unit
19 gradient condition, only the force of gravity is acting on water and all other forces are
20 considered negligible. These assumptions may be met for flows due to natural recharge
21 since moisture differences become smoothed out after sufficient time. Travel time for each
22 lithologic unit of a set thickness and calculated for any given recharge rate and the total
23 travel time is equivalent to the sum of the travel times for each individual lithologic unit. To
24 calculate the travel time for any particular site the detailed layering of the lithologic units
25 should be considered. For sites with artificial recharge (e.g., cribs and trenches) more
26 complicated analyses would be required to account for the effects of saturation.

27
28 Several other investigators have measured vadose zone soil hydraulic conductivities
29 and moisture retention characteristics at the Hanford Site both in situ (i.e., in lysimeters) and
30 in specially prepared laboratory test columns. Table 3-2 summarizes data identified for this
31 study by stratigraphic unit. Rockhold et al. (1988) presents a number of moisture retention
32 characteristic curves and plots of hydraulic conductivity versus moisture content for various
33 Hanford soils. For the Hanford formation, vadose zone hydraulic conductivity values at
34 saturation range from 10^{-4} to 10^{-2} cm/s. These saturated hydraulic conductivity values were
35 measured at volumetric water contents of 40 to 50%. Hydraulic conductivity values
36 corresponding to volumetric water contents ranging from 2 to 10% ranged from 2×10^{-11} to 7
37 $\times 10^{-7}$ cm/s.

38
39 An example of the potential use of this vadose zone hydraulic parameter information
40 is presented by Smoot et al. (1989) in which precipitation infiltration and subsequent

1 contaminant plume movement near a prototype single-shell tank was evaluated using a
2 numerical computer code. Smoot et al. (1989) used the UNSAT-H one-dimensional finite-
3 difference unsaturated zone water flow computer code to predict the precipitation infiltration
4 for several different soil horizon combinations and characteristics. The researchers used
5 statistically generated precipitation values which were based on actual daily precipitation
6 values recorded at the Hanford Site between 1947 and 1989 to simulate precipitation
7 infiltration from January 1947 to December 2020. The same authors also used the
8 PORFLO-3 computer code to simulate ^{106}Ru and ^{137}Cs movement through the unsaturated
9 zone.

10
11 Smoot et al. (1989) concluded that 68 to 86% of the annual precipitation infiltrated
12 into a gravel-capped soil column while less than 1% of the annual precipitation infiltrated
13 into a silt loam-capped soil column. For the gravel-capped soil column, the simulations
14 showed the ^{106}Ru plume approaching the water table after 10 years of simulated precipitation
15 infiltration. The simulated ^{137}Cs plume migrated a substantially shorter distance due to
16 greater adsorption on soil particles. In both cases, the simulated plume migration scenarios
17 are considered to be conservative due to the relatively low soil absorption coefficients used
18 for the study.

19
20 Graham et al. (1981) estimated that historical artificial recharge from liquid waste
21 disposal in the 200 (Separations) Areas exceeded all natural recharge by a factor of ten. In
22 the absence of ongoing artificial recharge, i.e., liquid waste disposal to the soil column,
23 natural recharge could potentially be a driving force for mobilizing contaminants in the
24 subsurface. Natural sources of recharge to the vadose zone and the underlying water table
25 aquifer are discussed in Section 3.5.2.2. Additional discussion of the potential for natural
26 and artificial recharge to mobilize subsurface contaminants is presented in Section 4.2.

27
28 Another facet of moisture migration in the vadose zone is moisture retention above
29 the water table. Largely due to capillary forces, some portion of the moisture percolating
30 down from the ground surface to the unconfined aquifer will be held against gravity in soil
31 pore space. Finer-grained soils retain more water (against the force of gravity) on a
32 volumetric basis than coarse-grained soils (Hillel 1971). Because unsaturated hydraulic
33 conductivity increases with increasing moisture content, finer-grained soils may be more
34 permeable than coarse-grained soils at the same water content. Also, because the moisture
35 retention curve for coarse-grained soils is generally quite steep (Smoot et al. 1989), the
36 permeability contrast between fine-grained and coarse-grained soils at the same water content
37 can be substantial. The occurrence of interbedded fine-grained and coarse-grained soils may
38 result in the formation of "capillary barriers" and can in turn lead to the formation of
39 perched water zones. General conditions leading to the formation of perched water zones at

1 the Hanford Site are discussed in Subsection 3.5.2.1.2. Potential perched water zones in the
2 Z Plant Aggregate Area are discussed in Subsection 3.5.3.1.2.
3

4 **3.5.2.1.2 Perched Water Zones.** Moisture moving downward through the vadose
5 zone may accumulate on top of highly cemented horizons and may accumulate above the
6 contact between a fine-grained horizon and an underlying coarse-grained horizon as a result
7 of the "capillary barrier" effect. If sufficient moisture accumulates, the soil pore space in
8 these perching zones may become saturated. In this case, the capillary pressure within the
9 horizon may locally exceed atmospheric pressure, i.e., a water table condition may develop.
10 Additional input of downward percolating moisture to this horizon may lead to a hydraulic
11 head buildup above the top of the horizon. Consequently, a monitoring well screened within
12 or above this horizon would be observed to contain free water.
13

14 The lateral extent and composition of the Plio-Pleistocene and early "Palouse" soil
15 units may provide conditions amenable to the formation of perched water zones in the vadose
16 zone above the unconfined aquifer. The calcrete facies of the Plio-Pleistocene unit,
17 consisting of calcium-carbonate-cemented silt, sand, and gravel, is a potential perching
18 horizon due to its likely low hydraulic conductivity. However, the Plio-Pleistocene unit is
19 typically fractured and may have erosional scours in some areas, potentially allowing deeper
20 infiltration of groundwater, a factor which may limit the lateral extent of accumulated
21 perched groundwater. The early "Palouse" soil horizon, consisting of compact, loess-like silt
22 and minor fine-grained sand, is also a likely candidate for accumulating moisture percolating
23 downward through the sand and gravel-dominated Hanford formation.
24

25 An example of perching conditions is a perched zone that appears to exist under the
26 216-U-1 and 216-U-2 Cribs area and extends at least as far as the 216-U-16 Crib. The zone
27 apparently exists because of historical waste water disposal to the 216-U-16 Crib. No wells
28 appear to screen this zone in this portion of the site. The existence of the perched zone was
29 inferred from the detection of contaminants disposed of to the 216-U-1 and 216-U-2 Cribs in
30 a groundwater monitoring well completed downgradient of the 216-U-16 Crib.
31

32 Another area of known perched water is below the active portion of the 216-U-14
33 Ditch approximately 150 m southeast of the 241-U Tank Farm. Wells 299-W19-91, -92, and
34 -93 are screened in the same stratigraphic position at depth of about 30 to 36 m (100 to 120
35 ft) below ground surface (bottom of screened interval elevation around 169 m (555 ft) above
36 mean sea level). This elevation is about 3 m (10 ft) above the top of the early Palouse soil,
37 based on the contours shown on Figures 3-25 and 3-31, and, thus, is located in the Hanford
38 formation. Water levels in these wells were measured in December 1989 through September
39 1990 with the result that Wells 299-W19-91 and 299-W19-92 had an average water level of
40 172 m (563 ft) above sea level and Well 299-W19-93 (the most southerly of the three) had a

1 level of about 176 m (576 ft), some 4 m (13 ft) higher. The water levels measured in these
2 wells are probably indicative of perched water zones in the early Palouse soil above
3 impermeable caliche layers in the Plio-Pleistocene unit.
4

5 Apparently the calcareous cementation in the Plio-Pleistocene unit greatly reduces the
6 permeability. The downward movement of water is thereby inhibited and perched water
7 zones may locally form.
8

9 **3.5.2.1.3 Unconfined Aquifer.** The uppermost aquifer system in the 200 Areas
10 occurs primarily within the sediments of the Ringold Formation and Hanford formation. In
11 the 200 West Area the upper aquifer is contained within the Ringold Formation and displays
12 unconfined to locally confined or semiconfined conditions. In the 200 East Area the upper
13 aquifer occurs in the Ringold Formation and Hanford formation. The depth to groundwater
14 in the upper aquifer underlying the 200 Areas ranges from approximately 60 m (197 ft)
15 beneath the former U Pond in 200 West Area to approximately 105 m (340 ft) west of the
16 200 East Area. The saturated thickness of the unconfined aquifer ranges from approximately
17 67 to 112 m (220 to 368 ft) in the 200 West Area and approximately 61 m (200 ft) in the
18 southern 200 East Area to nearly zero in the northeastern 200 East Area where the aquifer
19 thins out and terminates against the basalt located above the water table in that area.
20

21 The upper part of the uppermost aquifer in the 200 West Area consists of generally
22 unconfined groundwater within the Ringold unit E. The lower part of the uppermost aquifer
23 consists of confined to semi-confined groundwater within the gravelly sediments of Ringold
24 unit A. The Ringold unit A is generally confined by fine-grained sediments of the lower
25 mud sequence. The thickness of this confined zone ranges from greater than 38 m (125 ft)
26 in the southeastern portion of the 200 West Area to nearly zero where it pinches out just
27 north of the northern 200 West Area boundary. The lower mud sequence confining zone
28 overlying unit A is up to 30 m (100 ft) thick below the south-central section of the 200 West
29 Area before pinching out in the northeastern corner of the 200 West Area. Where it is
30 absent, the Ringold units A and E combine to form a single thick unconfined aquifer.
31

32 Due to its importance with respect to contaminant transport, the unconfined aquifer is
33 generally the most characterized hydrologic unit beneath the Hanford Site. A number of
34 observation wells have been installed and monitored in the unconfined aquifer. Additionally,
35 in situ aquifer tests have been conducted in a number of the unconfined aquifer monitoring
36 wells. Results of these in situ tests vary greatly depending on the following:
37

- 38 • Horizontal position/location between areas across the Hanford Site and even
39 smaller areas (such as across portions of the 200 Areas)
40

- 1 • Depth, even within a single hydrostratigraphic unit
- 2
- 3 • Analytical methods for estimating hydraulic conductivity.
- 4

5 Details regarding this aquifer system can be found in the 200 West Groundwater
6 AAMSR.

7

8 **3.5.2.2 Natural Groundwater Recharge.** Sources of natural recharge to groundwater at
9 the Hanford Site include precipitation infiltration, runoff from higher bordering elevations
10 and subsequent infiltration within the Hanford Site boundaries, water infiltrating from small
11 ephemeral streams, and river water infiltrating along influent reaches of the Yakima and
12 Columbia Rivers (Graham et al. 1981). The principal source of natural recharge is believed
13 to be precipitation and runoff infiltration along the periphery of the Pasco Basin. Small
14 streams such as Cold Creek and Dry Creek, west of the 200 West Area, also lose water to
15 the ground as they spread out on the valley plain. Considerable debate exists as to whether
16 any recharge to groundwater occurs from precipitation falling on broad areas of the 200
17 Areas Plateau.

18

19 Natural precipitation infiltration at or near waste management units or unplanned
20 releases may provide a driving force for the mobilization of contaminants previously
21 introduced to surface or subsurface soils. For this reason, determination of precipitation
22 recharge rates at the Hanford Site has been the focus of many previous investigations.
23 Previous field programs have been designed to assess precipitation, infiltration, water storage
24 changes, and evaporation to evaluate the natural water balance during the recharge process.
25 Precipitation recharge values ranging from 0 to 10 cm/yr have been estimated from various
26 studies.

27

28 The primary factors affecting precipitation recharge appear to be surface soil type,
29 vegetation type, topography, and year-to-year variations in seasonal precipitation. A
30 modeling analysis (Smoot et al. 1989) indicated that 68 to 86% of the precipitation falling on
31 a gravel-covered site might infiltrate to a depth greater than 2 m (6 ft). As discussed below,
32 various field studies suggest that less than 25% of the precipitation falling on typical Hanford
33 Site soils actually infiltrates to any depth.

34

35 Examples of precipitation recharge studies include:

- 36 • A study by Gee and Heller (1985) described various models used to estimate
37 natural recharge rates. Many of the models use a water retention relationship
38 for the soil. This relates the suction required to remove (or move) water to its
39 dryness (saturation or volumetric moisture content). Two of these have been
40

1 developed by Gee and Heller (1985) for soils in lysimeters on the Hanford
2 Site. As an example of available data, the particle size distribution and the
3 water retention curves of these two soils are shown on Figure 3-41.
4 Additional data and information about possible models for unsaturated flow
5 may be found in Brownell et al. (1975), and Rockhold et al. (1990).
6

- 7 • Moisture contents have been obtained from a number of core-barrel samples in
8 the 200 Areas (East and West) and varied from 1 to 18%, with most in the
9 range of 2 to 6% (Last et al. 1989). The data appear to indicate zones of
10 increased moisture content at depth that could be interpreted as signs of
11 moisture transport. A number of the boreholes that this study used (for
12 moisture content or other parameters) are located in the vicinity of the Z Plant
13 Aggregate Area burial grounds.
14
- 15 • A lysimeter study reported by Routson and Johnson (1990) was conducted at a
16 location 1.6 km south of the 200 East Area. During much of the lysimeters'
17 13-year study period between 1972 and 1985, the surface of the lysimeters
18 were maintained unvegetated with herbicides. No information regarding the
19 soil types in the lysimeters was found. To a precision of +/- 0.2 cm, no
20 downward moisture movement was observed in the instruments during periodic
21 neutron-moisture measurements or as a conclusion of a final soil sample
22 collection and moisture content analysis episode.
23
- 24 • An assessment of precipitation recharge involving the redistribution of ¹³⁷Cs in
25 vadose zone soil was also reported by Routson and Johnson (1990). In this
26 study, split-spoon soil samples were collected beneath a solid waste burial
27 trench in the T Plant Aggregate Area. The trench, apparently located just
28 south and west of the 218-W-3AE Burial Ground, received soil containing
29 ¹³⁷Cs from an unspecified spill. Cesium-137 was not detected below the
30 bottom of the burial trench. However, increased ¹³⁷Cs activity was observed
31 above the top of the waste fill which Routson and Johnson concluded indicated
32 that net negative recharge (loss of soil moisture to evapotranspiration) had
33 occurred during the 10-year burial period.
34

35 Sparse Russian thistle was observed at the burial trench area in 1980.
36 Rockhold et al. (1990) noted that ¹³⁷Cs appears to strongly sorb to Hanford
37 Site soils indicating that the absence of the radionuclide at depth below the
38 burial trench may not support the conclusion that no downward moisture
39 movement occurred.
40

- 1 • A weighing lysimeter study reported by Rockhold et al. (1990) which was
2 conducted at a grassy plot approximately 5 km northwest of the 300 Areas.
3 The grass test site was located in a broad, shallow topographic depression
4 approximately 900 m wide, several hundred meters long, trending southwest.
5 The area is covered with annual grasses (cheatgrass and bluegrass). The upper
6 3.5 m of the soil profile consists of slightly silty to silty sand (sandy loam)
7 with an estimated saturated hydraulic conductivity of 9×10^{-3} cm/s. Rockhold
8 et al. (1990) estimated that approximately 0.8 cm of downward moisture
9 movement occurred between July 1987 and June 1988. This represents
10 approximately 7% of the total precipitation recorded in that area during that
11 time period.
- 12
- 13 • A gravel-covered lysimeter study discussed by Rockhold et al. (1990) which
14 was conducted at the 622 Area Lysimeter Site, approximately 0.5 km east of
15 the 200 West Area. Approximately 4 cm of downward moisture movement
16 was observed in two gravel-covered lysimeters during 1988 and 1989. This
17 represented approximately 25% of the total precipitation recorded in the area
18 during the study period. The authors concluded that gravel placed on the soil
19 surface reduces evaporation and facilitates precipitation infiltration.

20

21 The drainage (downward moisture movement) observed in these studies may represent
22 potential recharge to deeper vadose zone soils and/or the underlying water table.

23

24 **3.5.2.3 Groundwater Flow.** Groundwater flow in the unconfined aquifer beneath the 200
25 West Area is generally toward the north and east, away from the groundwater mound
26 observed in the northern part of the Z Plant Aggregate Area. Groundwater elevations in
27 June 1990 for the unconfined aquifer in the 200 Areas are shown on Figure 3-42 (Kasza et
28 al. 1990). Graham et al. (1981) calculated horizontal hydraulic gradients for the 200 West
29 Area of 0.004 to 0.015 for data collected in December 1979. Graham et al. (1981) estimated
30 that vertical hydraulic gradients in the unconfined aquifer exceed 10% in some areas of the
31 unconfined aquifer.

32

33 Natural groundwater inflow to the unconfined aquifer primarily occurs along the
34 western boundary of the Hanford Site. Currently, man-made recharge occurs in several
35 active waste management units (e.g., the 216-U-14 Ditch, 216-U-17 Crib, 216-Z-20 Crib,
36 and the 216-Z-21 Seepage Basin) located within the U Plant and Z Plant Aggregate Areas in
37 the 200 West Area. Historically, much greater recharge occurred from a number of waste
38 management units in the 200 Areas. Man-made recharge probably substantially exceeds
39 natural precipitation recharge in these areas. The unconfined aquifer ultimately discharges to
40 the Columbia River, either near the 100 Areas, north of the 200 Areas through Gable Gap,

1 or between the 100 Areas and the 300 Area, east of the 200 Areas. The precise path is
2 strongly dependent on the hydrologic conditions in the 200 East Area (Delaney et al. 1991).
3 If recharge in the 200 East Area is large, more of the recharge from the 200 West Area is
4 diverted north through Gable Gap toward the 100 Areas. Generally, however, the easterly
5 route appears to be more likely for recharge from the 200 West Area.
6

7 **3.5.2.4 Historical Effects of Operations.** Historical effluent disposal at the Hanford Site
8 altered previously prevailing groundwater hydraulic gradients and flow directions. Before
9 operations at the Hanford Site began in 1944, groundwater flow was generally toward the
10 east, and the groundwater hydraulic gradient in the 200 West Area was on the order of 0.001
11 (Delaney et al. 1991). Prior to disposing liquid waste to the soil column in the Separations
12 Areas, groundwater elevations in the 200 West Area may have been as much as 20 m (65 ft)
13 lower in 1944 than at present. As seen on Figure 3-42, a distinct groundwater mound is still
14 apparent beneath the 200 West Area. The horizontal hydraulic gradient is expected to
15 increase and shift to the east as the mound continues to dissipate.
16

17 **3.5.3 Z Plant Aggregate Area Hydrogeology**

18
19
20 This section presents additional hydrogeologic information identified with specific
21 application to the Z Plant Aggregate Area.
22

23 **3.5.3.1 Hydrostratigraphy.** As shown on Figure 3-43, the hydrostratigraphic units of
24 concern beneath the Z Plant Aggregate Area are (1) the Rattlesnake Ridge Interbed, (2) the
25 Elephant Mountain Basalt Member, (3) the Ringold Formation units A and E, (4) the Plio-
26 Pleistocene unit and early "Palouse" soil, and (5) the Hanford formation. The hydrogeologic
27 designations for the Z Plant Aggregate Area were determined by examination of borehole
28 logs from Lindsey et al. (1991) and Chamness et al. (1991) and integration of these data with
29 stratigraphic correlations from existing reports. For the purposes of the Z Plant AAMS
30 Report, this discussion will be limited to the vadose zone and possible perching horizons with
31 the vadose zone underlying the aggregate area. Additional information on the aquifer
32 systems is presented in the 200 West Groundwater AAMSR.
33

34 **3.5.3.1.1 Vadose Zone.** The vadose zone beneath the Z Plant Aggregate Area
35 ranges in thickness from about 67 m (220 ft) along the southern part of the western
36 Aggregate Area boundary to 58 m (190 ft) in the vicinity of the 216-Z-9 Crib based on
37 December 1990 groundwater elevation data (DOE/RL 1991b). The observed variation in
38 vadose zone thickness is the result of variable surface topography and the variable elevation
39 of the water table in the underlying unconfined aquifer. The area of least saturated thickness
40 generally lies above a groundwater mound identified in the unconfined aquifer south and east

1 of the Z Plant building complex (Figure 3-42). As discussed in Section 3.5.2.4, the mound
2 apparently originated from historical discharges to the U Pond, southwest of the Z Plant.
3

4 Published vadose zone hydraulic data specific to soil samples or subsurface
5 explorations advanced in the Z Plant Aggregate Area were not found. However, ongoing
6 work by the Westinghouse Hanford Company Environmental Technology, Risk and
7 Performance Assessment group to evaluate potential contaminant transport from a proposed
8 facility in the Low-Level Solid Waste Burial Grounds utilizes soil samples from Well 299-
9 W7-9 on the north side of the 218-W-5 Burial Ground in the Z Plant Aggregate Area. In
10 this study, laboratory-measured soil moisture retention curves were used to estimate vadose
11 zone soil hydraulic conductivity values for use in a numerical modeling analysis. The soil
12 samples used to prepare the moisture retention curves were collected from the referenced
13 well. A summary of the moisture content and hydraulic conductivity values is presented
14 below.
15

16	Soil Horizon	Sample Depth In Meters	Moisture Content Weight %	Calculated Saturated Hydraulic Conductivity in cm/s
17	Hanford Formation	3.05	0.20	1.2×10^{-2}
18	Early "Palouse" Soil	19.8	0.38	7.0×10^{-6}
		21.1	0.38	1.4×10^{-4}
19	Plio-Pleistocene Unit	26.9	0.23	1.3×10^{-6}
		30.0	0.26	1.6×10^{-4}
		31.8	0.20	2.1×10^{-5}
20	Upper Ringold	34.2	0.21	1.1×10^{-3}
21	Middle Ringold	40.4	0.23	3.0×10^{-4}
		43.2	0.24	1.9×10^{-4}

22
23 **3.5.3.1.2 Perched Water Zones.** Downward-moving moisture in the vadose zone,
24 whether from precipitation recharge or artificial recharge, may accumulate on or within the
25 Plio-Pleistocene and early "Palouse" soil units beneath the Z Plant Aggregate Area. The top
26 of the Plio-Pleistocene Unit occurs at elevations ranging from 152 m to 203 m (500 to 665
27 feet) (18 m to 61 m [60 to 200 ft below ground surface]), or about 20 m (64 ft) above the
28 unconfined aquifer at locations south and west of the main Z Plant building complex, and
29 about 64 m (203 ft) above the unconfined aquifer near the northern corner of the Z Plant
30 Aggregate Area. The early "Palouse" soil horizon is typically encountered at depths of

1 between 35 to 45 m (120 to 140 ft) below ground surface, 15 to 20 m (50 to 70 ft) above the
2 water table in the unconfined aquifer.

3
4 As an additional means of evaluating potential perched groundwater zones, soil
5 moisture content data obtained during completion of recent Z Plant Aggregate Area
6 groundwater monitoring wells in the burial ground areas (Goodwin and Bjornstad 1990) were
7 reviewed. These wells include 299-W7-7, 299-W7-8, 299-W7-9, 299-W7-10, 299-W15-19,
8 299-W15-20, 299-W15-21, 299-W15-23, 299-W15-24, and 299-W15-26, and are identified
9 on Figure 3-14. Soil moisture contents from the wells are presented in Table A-1. Table
10 A-1 presents the soil sample moisture contents (weight percent H₂O) by depth.
11 Corresponding soil horizons and formation contacts have also been identified in the table to
12 assist in assessing the distribution of soil moisture. Depths of sediment unit contacts for
13 wells 299-W7-9, 299-W7-10, 299-W15-20, 299-W15-23, and 299-W18-26 in Table A-1 were
14 taken from lithologic interpretations by Lindsey et al. (1991) for these wells (Figure 3-13).
15 Depths of sediment unit contacts for wells 299-W7-7, 299-W7-8, 299-W15-19, 299-W15-21,
16 and 299-W15-24 were inferred using well log information in Goodwin and Bjornstad (1990).

17
18 Soil moisture contents in Table A-1 range from 1 to 23 percent water by weight.
19 Where the Plio-Pleistocene or Early "Palouse" units were encountered, increased soil
20 moisture contents were associated with these units, compared to moisture contents for units
21 above and below (wells 299-W7-8, 299-W7-9, 299-W15-21, and 299-W15-26). Also, for
22 many of these wells, the moisture content in soil samples collected within or just above these
23 units was 10 percent or greater. Elevated moisture contents (11 to 22 percent) were also
24 noted locally in Hanford formation soils in wells 299-W7-8, 299-W15-20 and 299-W15-21.

25
26 The trend toward increased soil moisture contents in the Plio-Pleistocene and Early
27 "Palouse" soil may be an indication of a tendency for water retention within or above these
28 units. Within the Hanford formation, elevated moisture contents may reflect very localized
29 increased fines content of the soils. Additional evaluation of the soil moisture data (such as
30 conversion from weight percent to volume percent moisture) would be needed to further
31 evaluate the potential for moisture transport and to assess the potential for development of
32 perched zones in the wells listed.

33
34 Perched water was reportedly encountered during drilling of groundwater monitoring
35 well 299-W18-29. The well is located in the Z Plant Aggregate Area near the southern end
36 of the 216-Z-20 Crib (see Figure 3-14 for location). The well is screened between 169 m
37 (555 ft) and 164 m (539 ft) above sea level, intersecting the Plio-Pleistocene unit. Water has
38 been reported in this well, however a current water level is not available. The presence of
39 water in this zone is likely due to waste disposal practices at the 216-Z-20 Crib.
40

1 **3.5.3.2 Natural Groundwater Recharge.** As discussed in Section 3.3.3, no natural surface
2 water bodies exist within the Z Plant Aggregate Area. Therefore, the potential for natural
3 groundwater recharge within the Z Plant Aggregate Area is limited to precipitation
4 infiltration. No precipitation infiltration data were identified with specific reference to the Z
5 Plant Aggregate Area. However, the amount of precipitation infiltration is likely comparable
6 to the range of values identified for various Hanford test sites, i.e., 0 to 10 cm/year.
7

8 As suggested in Section 3.5.2.2, precipitation infiltration rates probably vary with
9 respect to location within the Z Plant Aggregate Area. Higher infiltration rates are expected
10 in unvegetated areas or areas with shallow rooting plants. Higher infiltration rates are also
11 expected in areas with gravelly soils exposed at the surface.
12

13 **3.5.3.3 Groundwater Flow Beneath the Z Plant Aggregate Area.** Within the Z Plant
14 Aggregate Area, groundwater flow is generally toward the east, based on December 1990
15 Hanford wells groundwater elevation data similar to the June 1990 flow data from Kasza et
16 al. (Figure 3-42). Flow is generally away from the groundwater mound located below the
17 former U Pond in the southern part of the aggregate area. A review of groundwater maps of
18 the unconfined aquifer (Kasza et al. 1990) indicates relatively steep decreases in groundwater
19 elevations directly east of the mound and more gradual elevation decreases to the west.
20 Groundwater elevations across the central and northern portions of the Z Plant Aggregate
21 Area are more or less steady.
22

23 **3.5.3.4 Historical Effects of Operations.** Data identified for this study were not sufficient
24 to quantitatively evaluate the effect of wastewater discharges to the soil column from Z Plant
25 Aggregate Area waste management units on groundwater flow in the unconfined aquifer.
26 Calculations discussed in Section 4.1.8 suggest that wastewater discharged to the 216-Z-1,
27 216-Z-2, 216-Z-3, 216-Z-5, 216-Z-6, 216-Z-7, 216-Z-12, 216-Z-16, and 216-Z-18 Cribs;
28 216-Z-4, 216-Z-9, and 216-Z-17 Trenches; 216-Z-1A Tile Field; and 216-Z-10 Reverse Well
29 may have infiltrated to the underlying unconfined aquifer. Although estimates of the total
30 volume of fluid discharged to each of these facilities were found (Table 2-2), discharge rates
31 were not identified. Therefore, estimating the potential water level rise associated with
32 individual waste management units by means of a point source algorithm (e.g., the Theis
33 equation) could not be done.
34

35 Comparison of total waste water discharges to the soil column from Z Plant
36 Aggregate Area waste management units (exclusive of the 216-Z-20 Crib and the 216-Z-21
37 Seepage Basin) to that of U Plant Aggregate Area waste management units over the same
38 period of record (1949 to present) indicates that at least until 1985, discharges to the U
39 Ponds were several orders of magnitude greater than discharges to Z Plant Aggregate Area

1 waste management units. Correspondingly greater historical groundwater impacts would be
2 expected beneath the U Ponds.

3
4 Currently, an estimated 1.5×10^7 L/yr of liquid are discharged to sanitary tile fields
5 clustered around the Z Plant complex and approximately 5×10^8 L/yr are discharged to the
6 216-Z-20 Crib and the 216-Z-21 Seepage Basin east of the Z Plant Building complex. These
7 values may be as much as 15 percent of the annualized discharge rate (approximately 4×10^9
8 L/yr) to the 216-U-10 Ponds System for the period 1944 to 1985. Therefore, continuing Z
9 Plant complex wastewater discharges may contribute to the maintenance of the groundwater
10 mound identified in the southern part of the Z Plant Aggregate Area.

11 12 13 3.6 ENVIRONMENTAL RESOURCES

14
15 The following subsections provide information regarding Hanford Site environmental
16 resources including flora fauna (Section 3.6.1), land use (Section 3.6.2), and water use
17 (Section 3.6.3).

18
19 The Hanford Site is characterized as a cool desert or a shrub-steppe and supports a
20 biological community typical of this environment.

21 22 23 3.6.1 Flora and Fauna

24
25 The 200 Areas Plateau is represented by a number of plant, mammal, bird, reptile,
26 amphibian, and insect species as discussed below.

27
28 **3.6.1.1 Vegetation of the 200 Areas Plateau.** The vegetation of the 200 Areas Plateau is
29 characterized by native shrub steppe interspersed with large areas of disturbed ground with a
30 dominant annual grass component. The native stands are classified as an *Artemisia*
31 *tridentata*/*Poa sandbergii* - *Bromus tectorum* community (Rogers and Rickard 1977) meaning
32 that the dominant shrub is Big Sagebrush (*Artemisia tridentata*) and the understory is
33 dominated by the native Sandberg's Bluegrass (*Poa sandbergii*) and the introduced annual
34 Cheatgrass (*Bromus tectorum*). Other shrubs that are typically present include Gray
35 Rabbitbrush (*Chrysothamnus nauseosus*), Green Rabbitbrush (*C. viscidiflorus*), Spiny
36 Hopsage (*Grayia spinosa*), and occasionally Antelope Bitterbrush (*Pursia tridentata*). Other
37 native bunchgrasses that are typically present include Bottlebrush Squireltail (*Sitanion*
38 *hystrix*), Indian Ricegrass (*Oryzopsis hymenoides*), Needle-and-Thread (*Stipa comata*), and
39 Prairie Junegrass (*Koeleria cristata*). Common and important herbaceous species include
40 Turpentine cymopteris (*Cymopteris terebinthinus*), Globemallow (*Spheracea munroana*),

1 balsamroot (*Basamorhiza careyana*), several Milkvetch species (*Astragalus caricinus*, *A.*
2 *sclerocarpus*, *A. succumbens*), Long-leaf Phlox (*Phlox longifolia*), the common Yarrow
3 (*Achillea millifolium*), Pale Evening-primrose (*Oenothera pallida*), Thread-leaf phacelia
4 (*Phacelia linearis*), and several Daisy/Fleabane Species (*Erigeron poliospermus*, *E. Filifolius*,
5 and *E. pumilus*). In all, well over 100 plant species have been documented to occur in native
6 stands on the 200 Areas Plateau.

7
8 Disturbed communities on the 200 Areas Plateau are primarily the result of either
9 mechanical disturbance or range fires. Mechanical disturbance, including construction
10 activities, soil borrow areas, road clearings, and fire breaks, results in drastic changes to the
11 plant community. This type of disturbance usually entails a complete loss of soil structure
12 and total disruption of nutrient cycling. The principle colonizers of mechanically disturbed
13 areas are the annual weeds Russian Thistle (*Salsola kali*), Jim Hill Mustard (*Sisymbrium*
14 *altissimum*), and Bur-ragweed (*Ambrosia acanthicarpa*). If no further disturbance occurs, the
15 areas will eventually become dominated by cheatgrass. All of these annual weeds are
16 occasionally found in native stands, but only at relatively low frequencies.

17
18 Range fires also have dramatic effects on the overall ecosystem, the most obvious
19 being the complete removal of Sagebrush from the community, and the rapid increase in
20 cheatgrass coverage. Unlike the native grasses, the other important shrubs, and many of the
21 perennial herbaceous species, Sagebrush is unable to resprout from rootstocks after being
22 burned. Therefore, there is no dominant shrub component in burned areas until Sagebrush is
23 able to become re-established from seed. Burning also opens the community to the invasion
24 by cheatgrass which is capable of quickly utilizing the nutrients that are released through
25 burning. The extensive cover of cheatgrass may then prevent the re-establishment of many
26 of the native species, including Sagebrush. The species richness in formerly burned areas is
27 usually much lower than in native stands, often consisting of only Cheatgrass, Sandberg's
28 Bluegrass, Russian thistle, and Jim Hill Mustard, with very few other species.

29
30 The vegetation in and around the ponds and ditches on the 200 Areas Plateau is
31 significantly different from that of the surrounding dryland areas. Several tree species are
32 present, especially Cottonwood (*Populus trichocarpa*) and Willows (*Salix* spp.). A number
33 of wetland species area also present including several sedges (*Carex* spp.), bulrushes (*Scirpus*
34 spp.), Cattails (*Typha latifolia* and *T. angustifolia*), and pond-weeds (*Potamogeton* spp.).
35

36 **3.6.1.2 Plant Species of Concern.** The Washington State Department of Natural
37 Resources, Natural Heritage Program classifies rare plants in the State of Washington in
38 three different categories, depending on the overall distribution of the taxon and the state of
39 its natural habitat. These categories are: *Endangered*, which is a "vascular plant taxon in
40 danger of becoming extinct or extirpated in Washington within the near future if factors

1 contributing to its decline continue. Populations of these taxa are at critically low levels or
2 their habitats have been degraded or depleted to a significant degree"; *Threatened*, which is a
3 "vascular plant taxon likely to become endangered within the near future in Washington if
4 factors contributing to its population decline or habitat degradation or loss continue"; and
5 *Sensitive*, which is a taxon that is "vulnerable or declining, and could become endangered or
6 threatened in the state without active management or removal of threats" (definitions taken
7 from Washington Department of Natural Resources 1990). Of concern to the Hanford Site,
8 there are two Endangered taxa, two Threatened taxa, and at least eleven Sensitive taxa; these
9 are listed in Table 3-3. All four of the Threatened and Endangered taxa are presently
10 candidates for the Federal Endangered Species List.

11
12 Of the two Endangered taxa, Persistentsepal Yellowcress is well documented along
13 the banks of the Columbia River throughout the 100 Areas, it is unlikely to occur in the 200
14 Areas. The Northern Wormwood is known in the State of Washington by only two
15 populations, one across from The Dalles, Oregon, and the other near Beverly, Washington,
16 just north of the Hanford Site. This taxon has not been found on the Hanford Site, but
17 would probably occur only on rocky areas immediately adjacent to the Columbia River if it
18 were present. Neither of the Threatened taxa listed in Table 3-3 have been observed on the
19 Hanford Site. The Columbia Milkvetch is known to be relatively common on the Yakima
20 Firing Range, and has been documented to occur within 1.6 to 3.2 km (1 to 2 mi) to the
21 west of the Hanford site on both sides of Umptanum Ridge. This species could occur on the
22 200 Areas Plateau. Hoover's Desert Parsley inhabits the steep talus slopes near Priest
23 Rapids Dam. Potentially, it could be found on similar slopes on Gable Mountain and Gable
24 Butte, but has yet to be documented in these areas.

25
26 Of the Sensitive species, five are inhabitants of aquatic or moist habitats and the other
27 six are inhabitants of dry upland habitats. Dense Sedge, Shining Flatsedge, Southern
28 Mudwort, and False Pimpernel are all known to occur in the 100 Areas, especially near the
29 B-C Area, in or near the Columbia River. Some of these species could be present in or near
30 ponds and ditches in the 200 Areas. The few-flowered collinsia may also occur in these
31 habitats. The Gray Cryptantha occurs on open dunes throughout the Hanford Site. Piper's
32 Daisy is fairly common on Umptanum Ridge and Rattlesnake Ridge, but has also been
33 documented in the vicinity of B-pond, the A-24 Crib, and 100-H Area. Bristly Cryptantha,
34 Dwarf Evening-primrose have been found at the south end of the White Bluffs,
35 approximately 3.2 km (2 mi) upstream from the 300 Area. The Palouse Milk-vetch and
36 Coyote tobacco are not as well documented but are known to inhabit dry sandy areas such as
37 the 200 Areas Plateau.

38
39 In addition to the three classifications for species of concern listed above, the Natural
40 Heritage Program also maintains a "Monitor" list, which is divided into three groups. Group

1 consists of taxa in need of further field work before a formal status can be assigned. The Tooth-sepal Dodder (*Cuscuta denticulata*), which has been found in the State of Washington only on the Hanford Site is the only taxon in this group that is of concern to Hanford operations. This parasitic species has been found in the area west of McGee Ranch. Group 2 of the Monitor list includes species with unresolved taxonomic questions. Thompson's sandwort (*Arenaria franklinii* var. *thompsonii*) is of concern to Hanford operations. However, the representatives of this species in the State of Washington are now believed to all be variety *franklinii* which is not considered particularly rare. Group 3 of the Monitor list includes taxa that are either more abundant or less threatened than previously believed. There are approximately 15 taxa on the Hanford site that are included on this list

3.6.1.3 Fauna of the 200 Areas Plateau. The mammals, birds, reptiles, amphibians inhabiting the 200 Areas Plateau are discussed below.

3.6.1.3.1 Mammals. The largest mammal occurring on the 200 Areas Plateau is the mule deer (*Odocoileus hemionus*). Although mule deer are much more common to riparian sites along the Columbia River they are frequently observed foraging throughout the 200 Areas. Elk (*Cervus elaphus*) also occur at Hanford but they have only been observed at the Arid Lands Ecology Reserve. Other mammal species common to the 200 Areas include badgers (*Taxidea taxus*), coyotes (*Canis latrans*), blacktail jackrabbits (*Lepus californicus*), Townsend ground squirrels (*Spermophilus townsendii*), Great Basin pocket mice (*Perognathus parvus*), pocket gophers (*Thomomys talpoides*), and deer mice (*Peromyscus maniculatus*). Badgers are known for their digging capability and have been implicated several times for encroaching into inactive burial grounds throughout the 200 Areas. The majority of the badger excavations in the 200 Areas are a result of badgers searching for prey (mice and ground squirrels). Coyotes are the principal predators, consuming such prey as rodents, insects, rabbits, birds, snakes and lizards. The Great Basin pocket mouse is the most abundant small mammal, which thrives in sandy soils and lives entirely on seeds from native and revegetated plant species. Townsend ground squirrels are not abundant in the 200 Areas but they have been seen at several different sites. Other small mammals that occur in low numbers include the Western harvest mouse (*Reithrodontomys megalotis*) and the Grasshopper mouse (*Onychomys leucogaster*). Mammals associated more closely with buildings and facilities include Nuttall's cottontails (*Sylvilagus nuttallii*), house mice (*Mus musculus*), Norway rats (*Rattus norvegicus*), and some bat species. Bats probably play a minor role in the 200 Areas' ecosystem but no documentation is available on bat populations at Hanford. Mammals such as skunks (*Mephitis mephitis*), raccoons (*Procyon lotor*), weasels (*Mustela* spp.), porcupines (*Erethizon dorsatum*), and bobcats (*Lynx rufus*) have only been observed on very few occasions.

9 3 1 2 8 6 5 0 7 8 7

1 **3.6.1.3.2 Birds.** Over 235 species of birds have been documented to occur at the
2 Hanford Site (Landeem et al. 1990). At least 100 of these species have been observed in the
3 200 Areas. The most common passerine birds include starlings (*Sturnus vulgaris*), horned
4 larks (*Ermophila alpestris*), meadowlarks (*Sturnella neglecta*), Western kingbirds (*Tyrannus*
5 *verticalis*), rock doves (*Columba livia*), barn swallows (*Hirundo rustica*), cliff swallows
6 (*Hirundo pyrrhonota*), black-billed magpies (*Pica pica*) and ravens (*Corvus corax*). Common
7 raptors include the Northern harrier (*Circus cyaneus*), American kestrel (*Falco sparverius*),
8 and Red tailed hawk (*Buteo jamaicensis*). Swainson's hawks (*Buteo swainsoni*) sometimes
9 nest in the trees located at some of the army bunker sites that were used in the 1940's.
10 Golden eagles (*Aquila chrysaetos*) are observed infrequently. Burrowing owls (*Athene*
11 *cunicularia*) nest at several locations throughout the 200 Areas. The most common upland
12 game birds found in the 200 Areas are California Quail (*Callipepla californica*) and Chukar
13 partridge (*Alectoris chukar*), however, Ring-necked pheasants (*Phasianus colchicus*) and
14 Gray partridge (*Pertx perdix*) may be found in limited numbers. The only native game bird
15 common to the 200 Areas Plateau is the Mourning dove (*Zenaida macrora*) which migrates
16 south each fall. Other species of note which nest in undisturbed sagebrush habitats in the
17 200 Areas include Sage sparrows (*Amphispiza belli*), and Loggerhead shrikes (*Lanius*
18 *ludovicianus*). Long-billed Curlews (*Numenius americanus*) also use the sagebrush areas and
19 revegetated burial grounds for nesting and foraging.

20
21 Waterfowl and aquatic birds inhabit B-Pond and other areas where there is running or
22 standing water. However many of these areas such as A-29 Ditch are becoming more scarce
23 due to stabilization and remedial action cleanup activities. Aquatic birds and waterfowl
24 common to B-Pond on a seasonal basis include Canada Geese (*Branta canadensis*), American
25 coot (*Fulica americana*), Mallard (*Anas platyrhynchos*), Ruddy duck (*Oxyura jamaicensis*),
26 Redhead (*Aythya americana*), Bufflehead (*Bucephala albeola*) and Great blue heron (*Ardea*
27 *herodias*).

28
29 **3.6.1.3.3 Reptiles and Amphibians.** Common reptiles include gopher snakes
30 (*Pituophis melanoleucus*) and sideblotched lizards (*Uta stansburiana*). Other reptiles and
31 amphibians which are infrequently observed include sagebrush lizards (*Sceloporus graciosus*),
32 horned toads (*Phrynosoma douglassi*), western spadefoot toads (*Scaphiopus intermontana*),
33 yellow-bellied racer (*Coluber constrictor*), Pacific rattlesnake (*Crotalus viridis*), and striped
34 whipsnake (*Masticophis taeniatus*). Both lizards and snakes are prey items of mammalian and
35 avian predators.

36
37 **3.6.1.3.4 Insects.** There are hundreds of insect species which inhabit the 200 Areas.
38 Two of the most common groups of insects include several species of darkling beetles and
39 grasshoppers. Harvester ants are also common and have been implicated in the uptake of
40 radionuclides from some of the burial grounds in 200 East. Harvester ants have the ability

1 to excavate and bring up material from as far down as 4.6 to 6.1 m (15 to 20 ft). Other
2 major groups of insects include bees, butterflies, and scarab beetles. Insects impact the
3 surrounding plant community as well as serving as the prey base for many species of birds,
4 reptiles, and mammals.
5

6 **3.6.1.4 Wildlife Species of Concern.** Some animals which inhabit the Hanford Site have
7 been given special status designations by the state and federal government. Some of these
8 designations include state and federal threatened and endangered species, federal candidate,
9 state monitor, state sensitive, and state candidate species. Species listed in Table 3-4 as state
10 and/or federal threatened and endangered such as the bald eagle (*Haliaeetus leucocephalus*),
11 peregrine falcon (*Falco peregrinus*), American white pelican (*Pelecanus erythrorhynchos*),
12 ferruginous hawk (*Buteo regalis*), and sandhill crane (*Grus canadensis*) do not inhabit the
13 200 Areas. The bald eagle and American white pelican utilize the Columbia River and
14 associated habitats for roosting and feeding. Peregrine falcons and sandhill cranes fly over
15 the Hanford Site during migration. Ferruginous hawks nest on the Hanford Site but nesting
16 has not been documented for this species on the 200 Areas Plateau. Other species listed in
17 Table 3-4 as state and/or federal candidates and state monitor species such as burrowing
18 owls, Great Blue Herons, Prairie falcons (*Falco mexicanus*), Sage sparrows, and Loggerhead
19 shrikes are not uncommon to the 200 Areas Plateau.
20
21

22 **3.6.2 Land Use**

23
24 The Z Plant Aggregate Area is the location of the Z Plant building complex and its
25 attendant facilities (e.g., 234-5Z Building, 231-Z Building, 242-Z Building and other
26 structures) and the 218-W Solid Waste Burial Grounds.
27

28 Past activities at the Z Plant included plutonium separation from waste streams
29 generated in other 200 Areas facilities and plutonium and americium recovery from in-plant
30 waste streams. Historically, liquid waste generated in Z Plant was disposed of to various
31 land disposal units. Low-level and mixed waste from Z Plant, other Hanford facilities, and
32 off-site facilities was deposited in the 218-W Burial Grounds. Various storage facilities,
33 offices, and laboratories are also located in Z Plant. Waste management units that remain
34 active are noted in Table 2-1.
35
36

37 **3.6.3 Water Use**

38
39 There are no consumptive use of groundwater within the 200 West Area. Water for
40 drinking and emergency use, and facilities process water is drawn from the Columbia River,

1 treated, and imported to the 200 West Area. The nearest wells used to supply drinking water
2 are located at the Yakima barricade, about 5 km west of the 200 West Area, and near the
3 Fast Flux Test Facility in the 400 Area, about 32 km to the southeast. The nearest water
4 supply wells are located off site about 15 km to the northwest. These wells obtain their
5 water from the basalt and the basalt interbeds (The Berk well and Ste. Michelle No. 1 and
6 No. 2). The latter wells are reportedly used for irrigation although they may also be used to
7 supply drinking water.

8 9 10 **3.7 HUMAN RESOURCES**

11
12 The environmental conditions at the Z Plant Aggregate Area must be evaluated in
13 relationship to the surrounding population centers and other human resources. The following
14 subsections provide an overview of the demography (Section 3.7.1), archaeology (Section
15 3.7.2), historical resources (Section 3.7.3), and community involvement (Section 3.7.4)
16 relating to the Hanford Site and the Z Plant Aggregate Area.

17 18 19 **3.7.1 Demography**

20
21 There are no residences on the Hanford Site. The nearest inhabited residences are
22 farm homes on land located 21 km (13 mi) north of the Z Plant Aggregate Area. There are
23 approximately 258,000 people living within a 80 km (50 mi) radius of the 200 Areas plateau.
24 The primary population centers are the cities of Richland, Kennewick, and Pasco, located
25 southeast of the Hanford Site, Prosser to the south, Sunnyside to the southwest, and Benton
26 City to the southeast.

27 28 29 **3.7.2 Archaeology**

30
31 An archaeological survey has been conducted of undeveloped portions of the 200 West
32 Area by the Hanford Cultural Resources Laboratory. Isolated artifacts and sites of interest
33 were identified in the 200 West Area but not within the Z Plant Aggregate Area. The closest
34 site of interest is the remains of the White Bluffs Road, located approximately 1.6 km (1 mi)
35 northwest of the aggregate area, which was previously an Indian trail.

1 **3.7.3 Historical Resources**
2

3 The only historic site in 200 West Area is the old White Bluffs freight road which
4 crosses diagonally through the vicinity. This site is not considered to be eligible for the
5 National Register.
6

7
8 **3.7.4 Community Involvement**
9

10 A Community Relations Plan (CRP) (Ecology et al. 1989) has been developed for the
11 Hanford Site Environmental Restoration Program which includes any potentially affected
12 community with respect to the Z Plant AAMS. The CRP includes a discussion on analysis
13 of key community concerns and perceptions regarding the project, along with a list of all
14 interested parties.
15

16
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18

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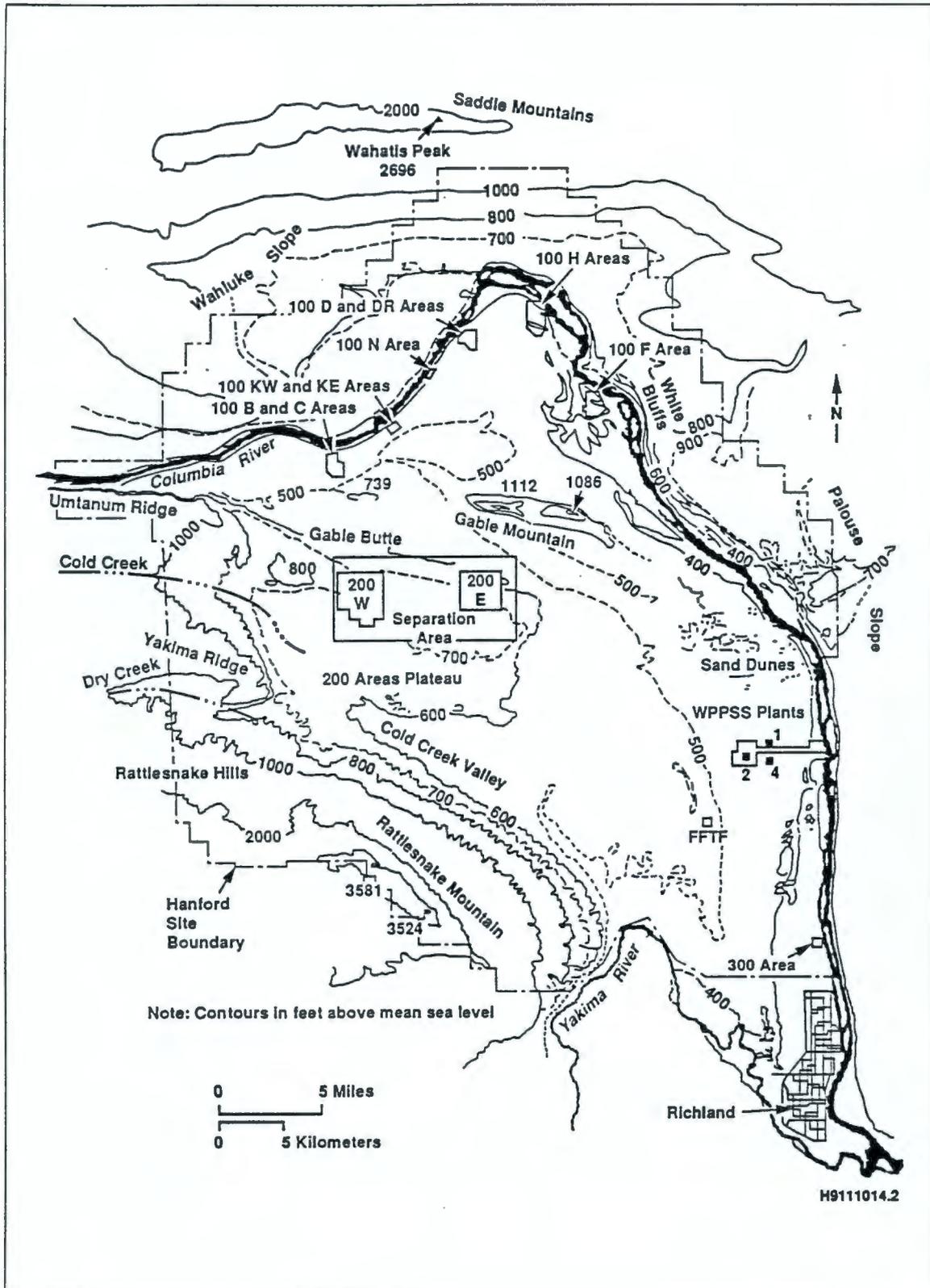


Figure 3-1. Topography and Location Map for the Hanford Site.

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3F-2

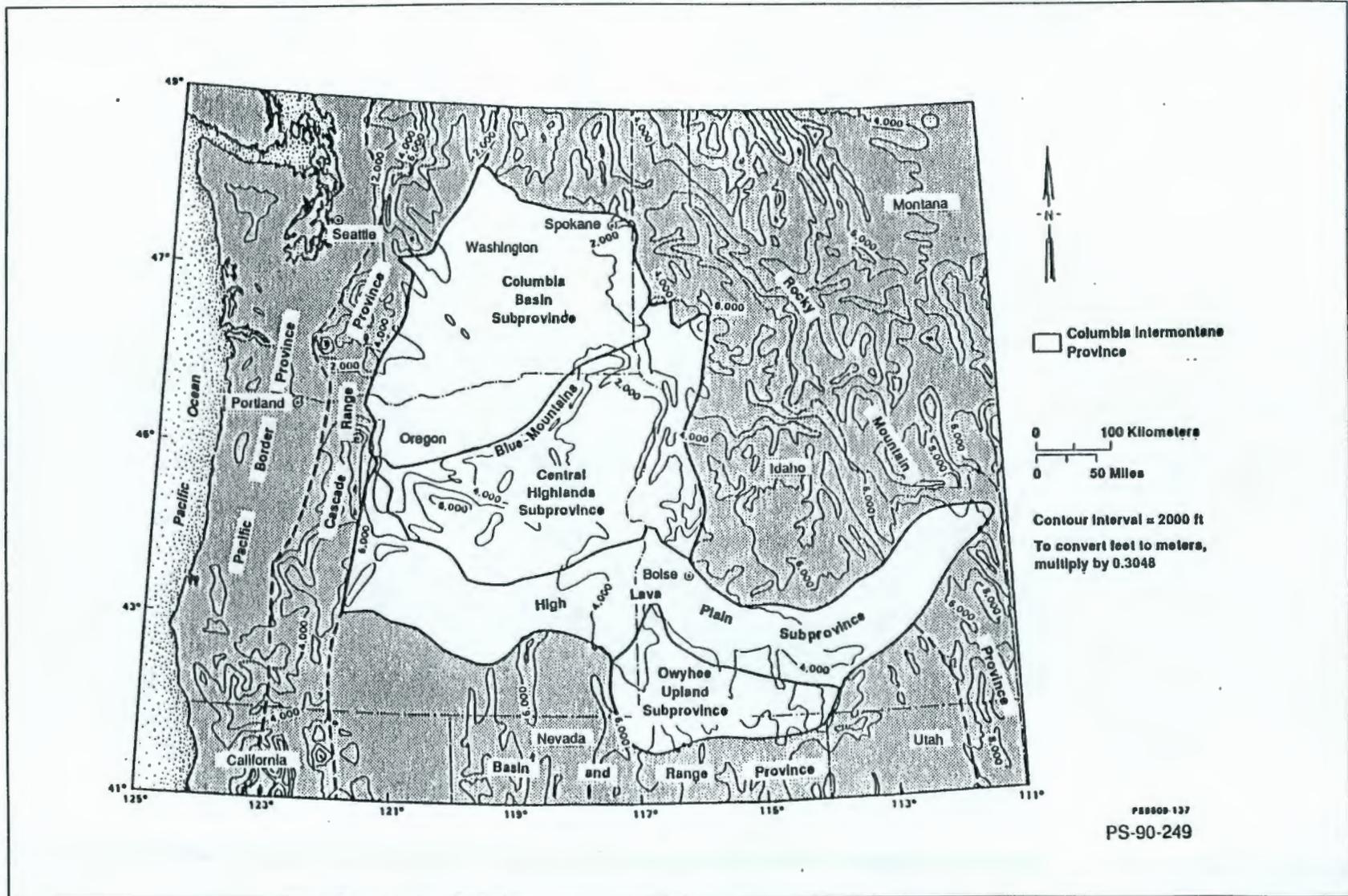


Figure 3-2. Divisions of the Columbia Intermontane Province and Adjacent Snake River Plains Province

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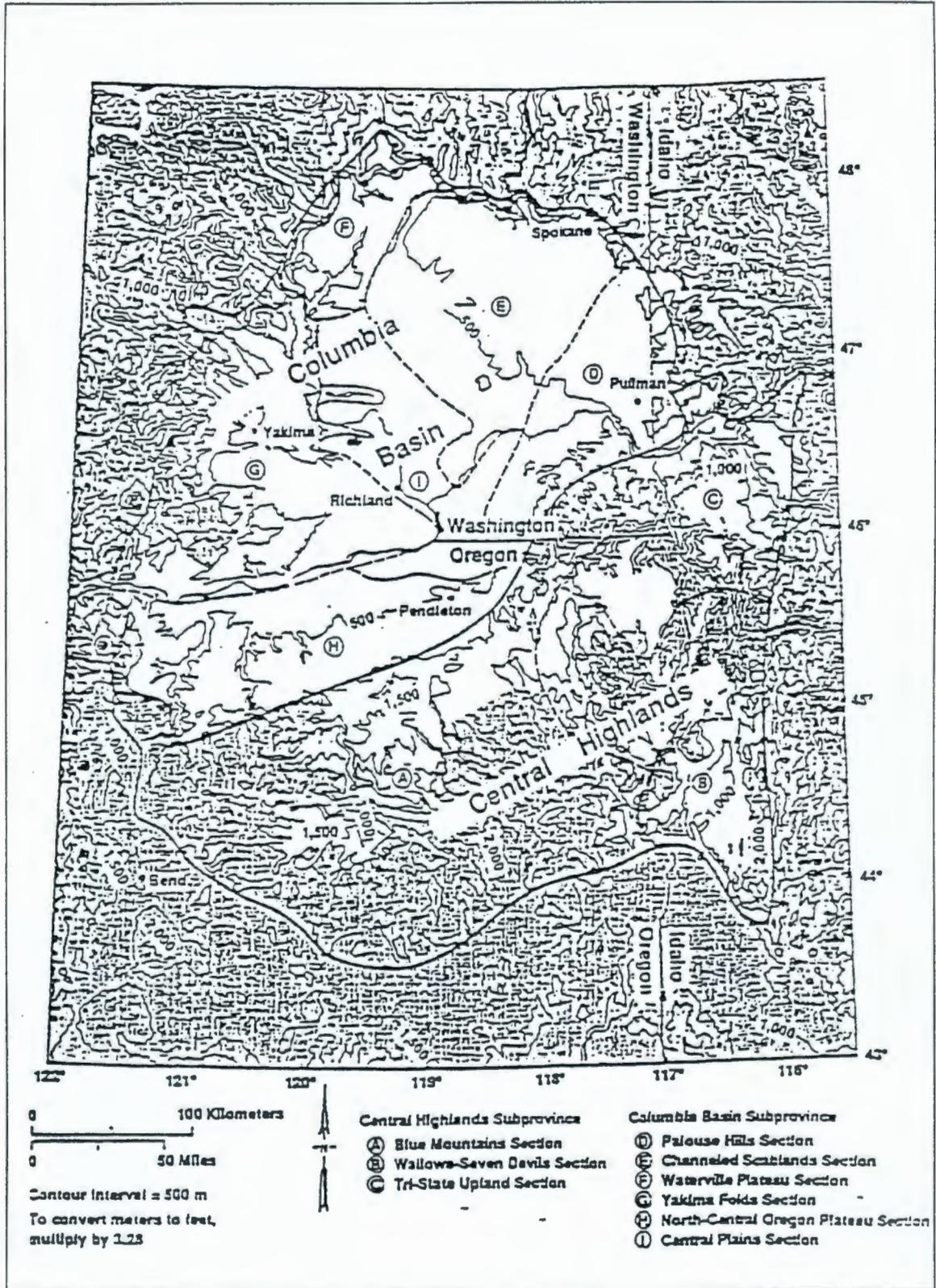


Figure 3-3. Geomorphic Units Within the Central Highlands and Columbia Basin Subprovinces that Contain the Columbia River Basalt Group (after Thornbury 1965) (Last et al. 1989).

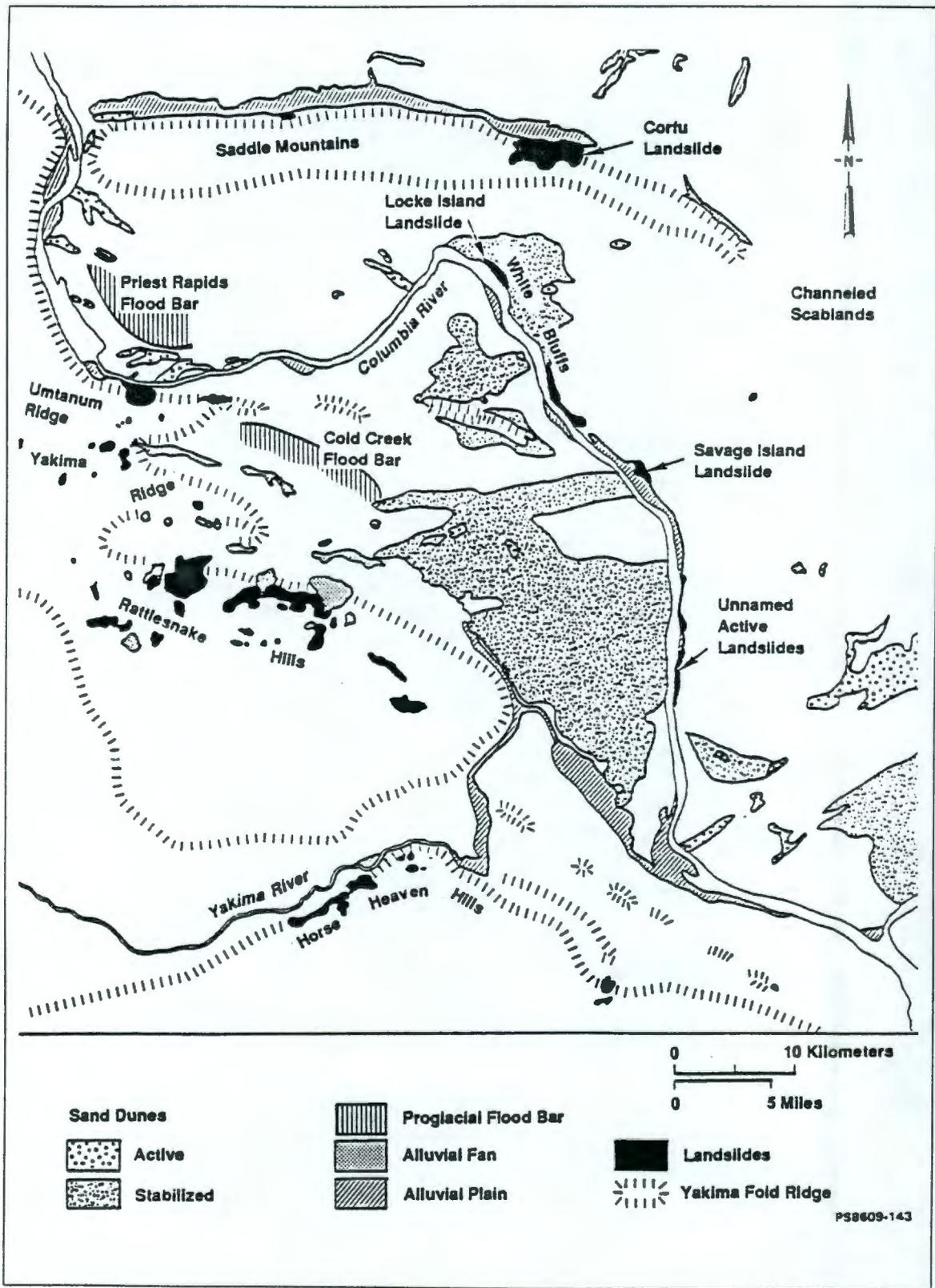


Figure 3-4. Landforms of the Pasco Basin and the Hanford Site.

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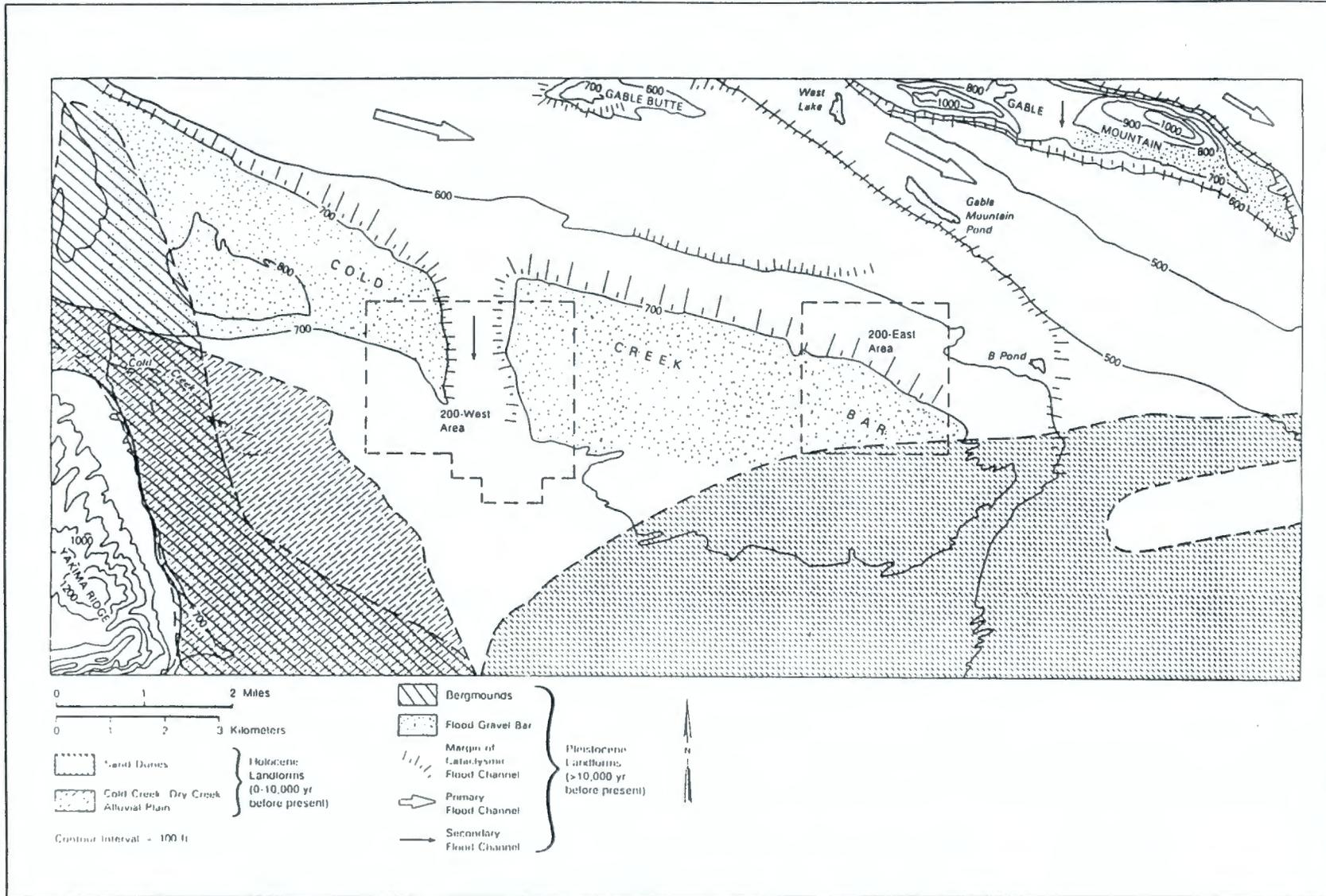


Figure 3-5. Geomorphic Features Surrounding the 200 Areas (Last et al. 1989).

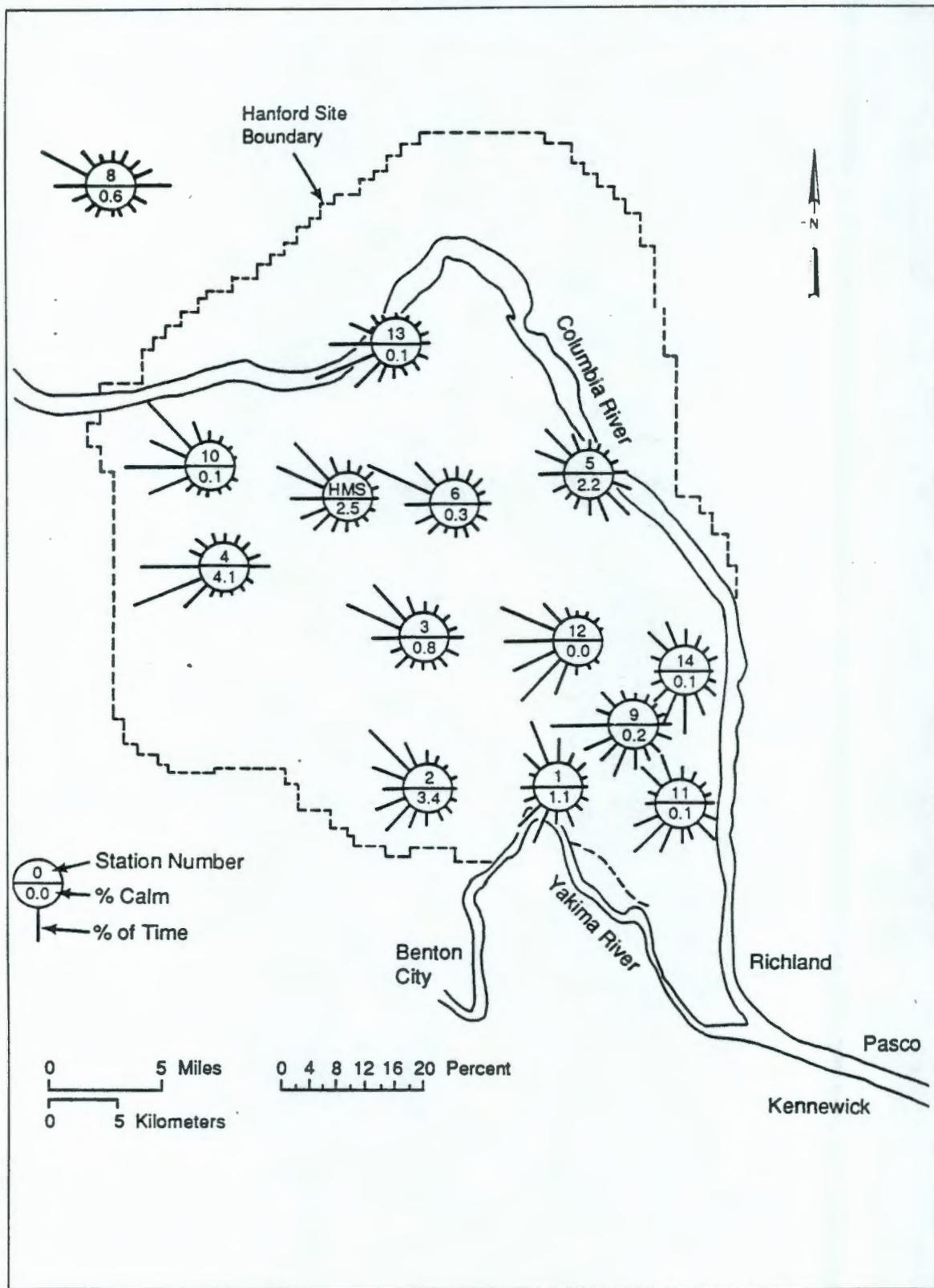


Figure 3-6. Hanford Site Wind Roses, 1979 through 1982 (Stone et al. 1983).

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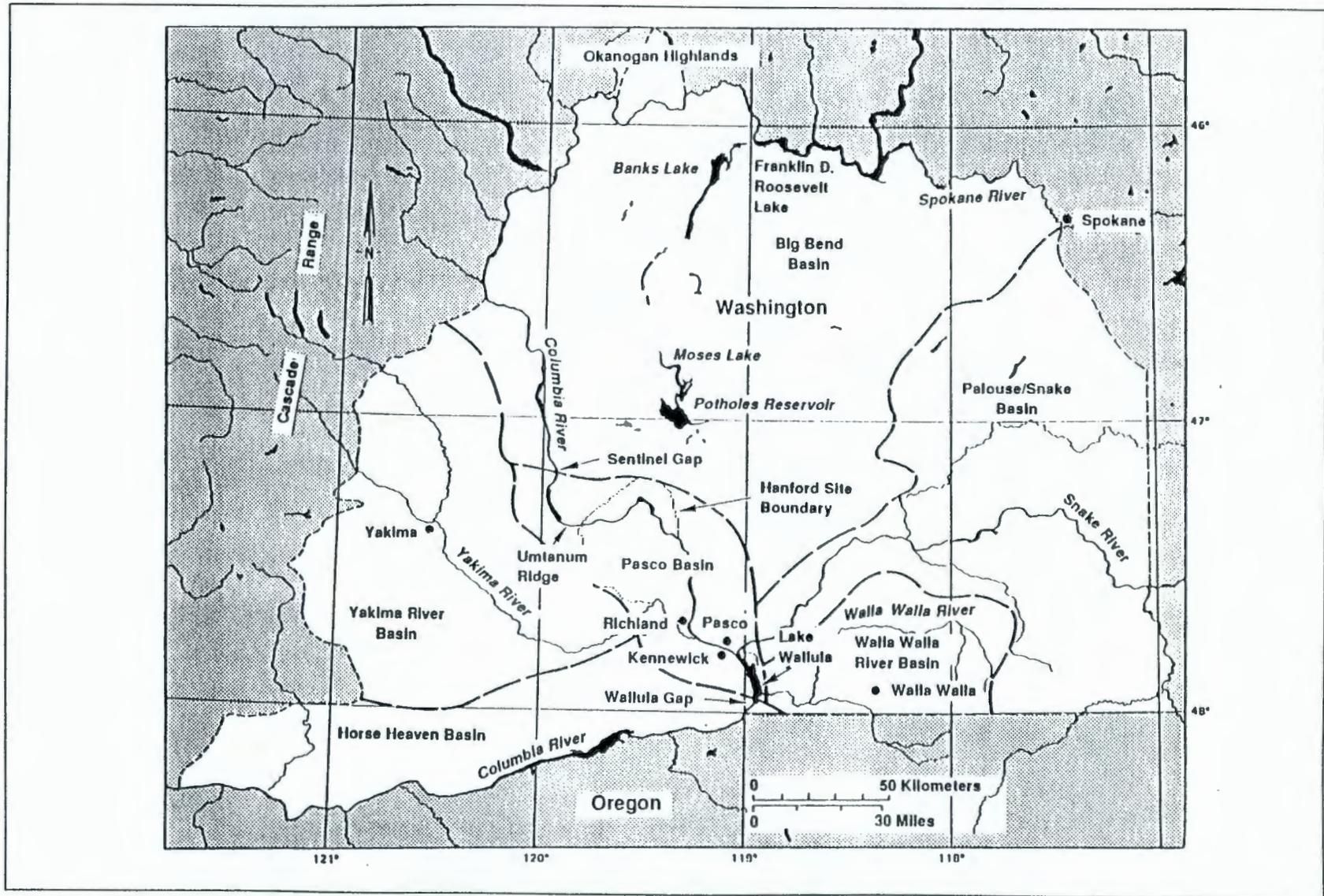
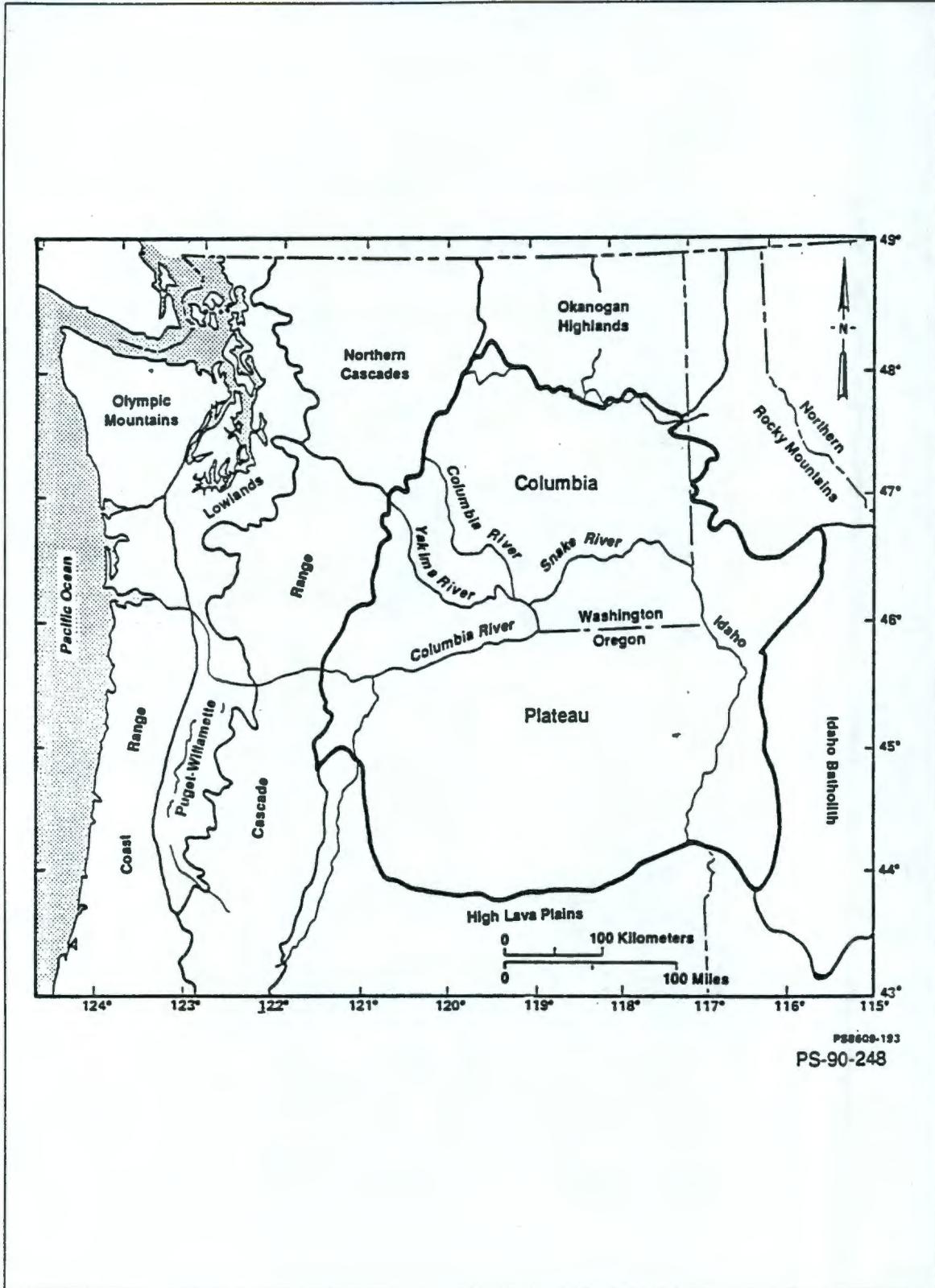


Figure 3-7. Hydrologic Basins Designated for the Washington State Portion of the Columbia Plateau (DOE 1988).

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PS-90-248

Figure 3-8. Structural Provinces of the Columbia Plateau.

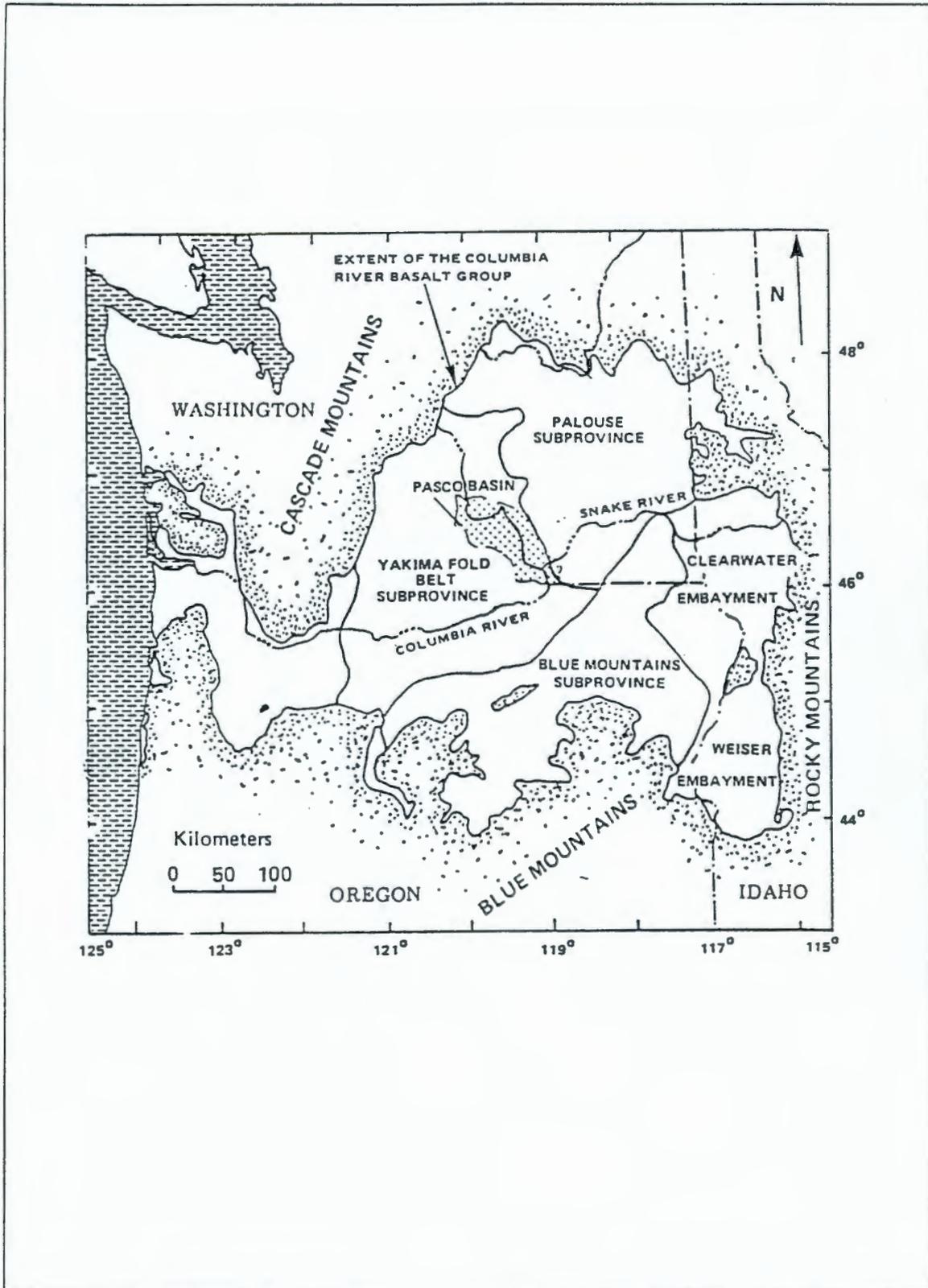
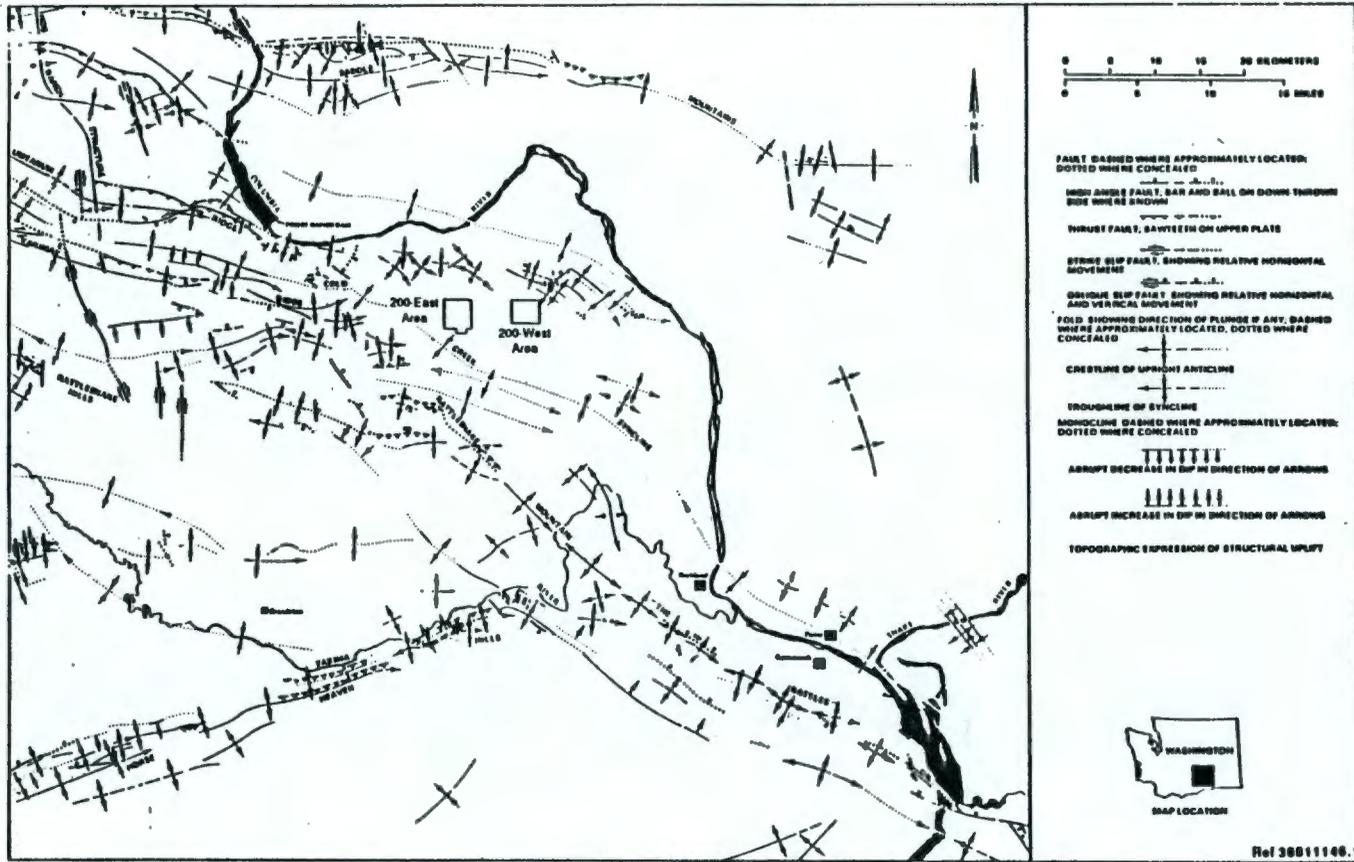


Figure 3-9. Structural Subprovinces of the Columbia Plateau.
(Source: Last et al. 1989)

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Figure 3-10. Structural Elements of the Yakima Fold Belt Subprovince (Last et al. 1989).

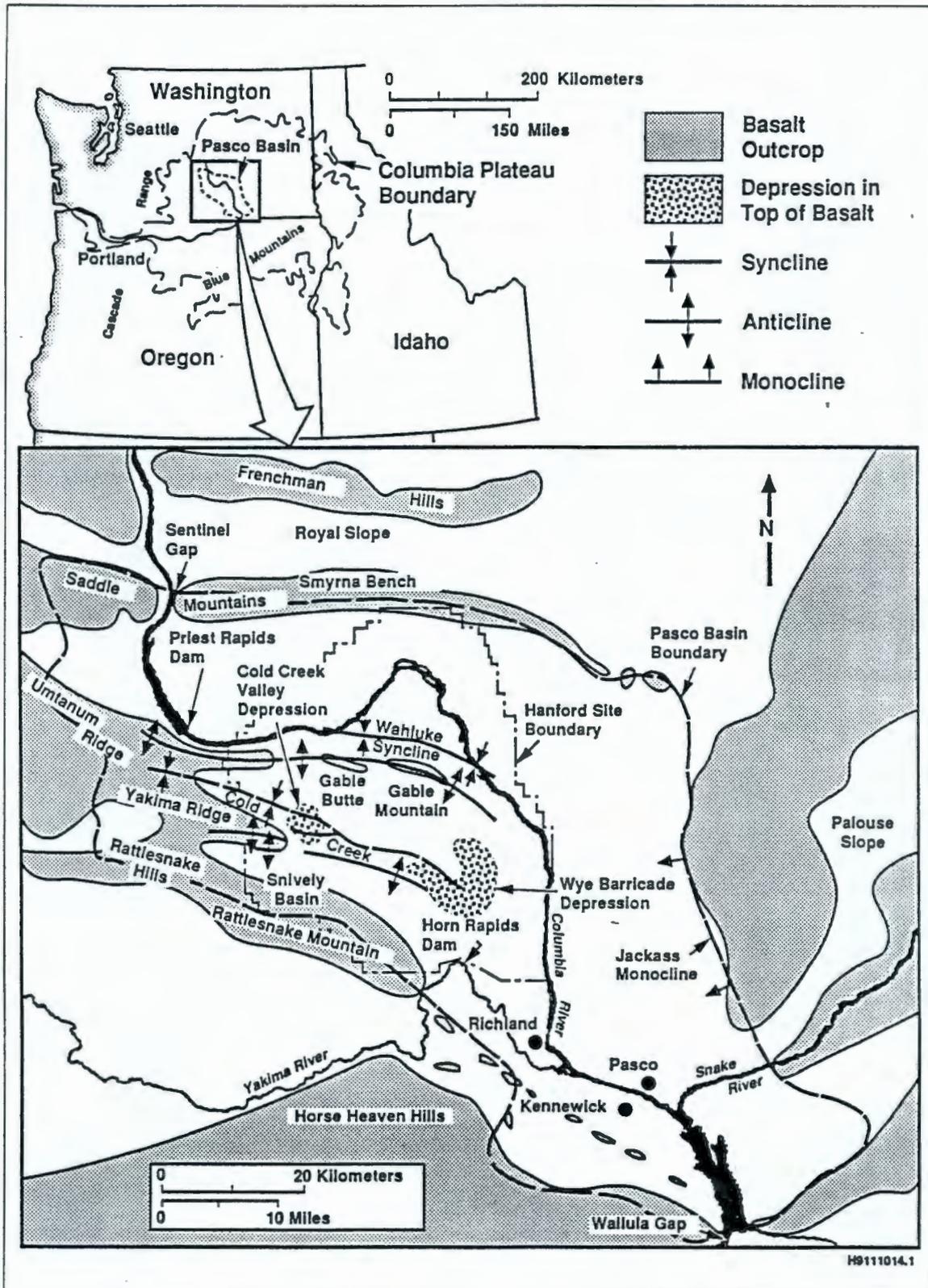


Figure 3-11. Geologic Structures of the Pasco Basin and the Hanford Site.

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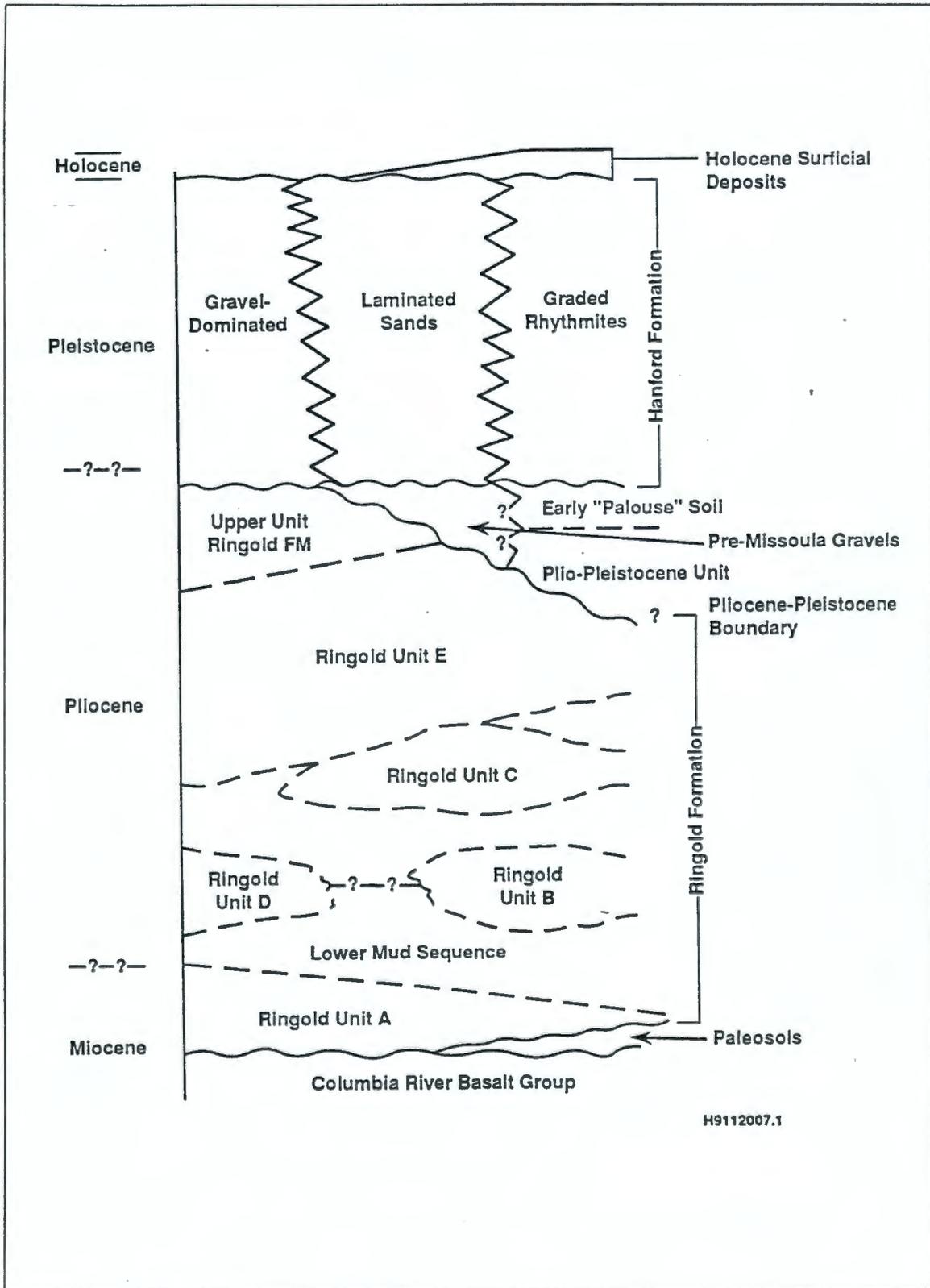


Figure 3-13. Generalized Stratigraphy of the Suprabasalt Sediments Beneath the Hanford Site.

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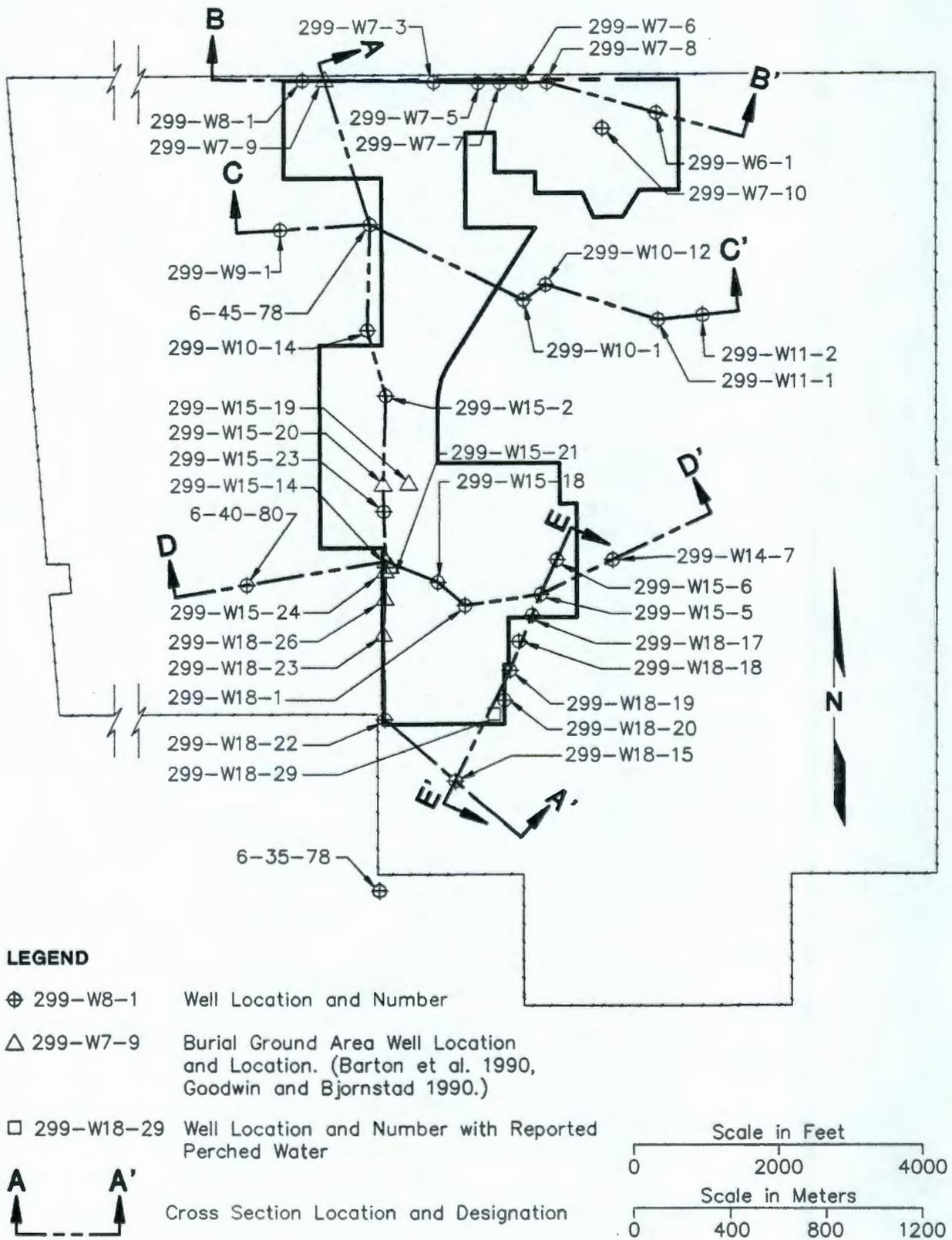


Figure 3-14. Location of Geologic Cross-sections.

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GRAIN SIZE SCALE**UNIT ABBREVIATIONS**

Hc	Upper Coarse Unit, Hanford formation
Hf	Lower Fine Unit, Hanford formation
EP	Early "Palouse" Soil
PP	Plio-Pleistocene Unit
UR	Upper Unit, Ringold Formation
E	Gravel Unit E, Ringold Formation
LM	Lower Mud Sequence, Ringold Formation
A	Gravel Unit A, Ringold Formation

SYMBOLS

—?— Formational Contact, ? Where Inferred

- -? - - Unit Contact, ? Where Inferred

Major Facies Contact

Pedogenic Calcium Carbonate

Paleosols

Ringold Clast Supported Gravels

Open Framework Hanford Gravels

Laminated Muds

Basalt

Blank portions of cross section well logs represent sediments (dominantly sand) which do not fit into sediment categories depicted by symbols listed above.

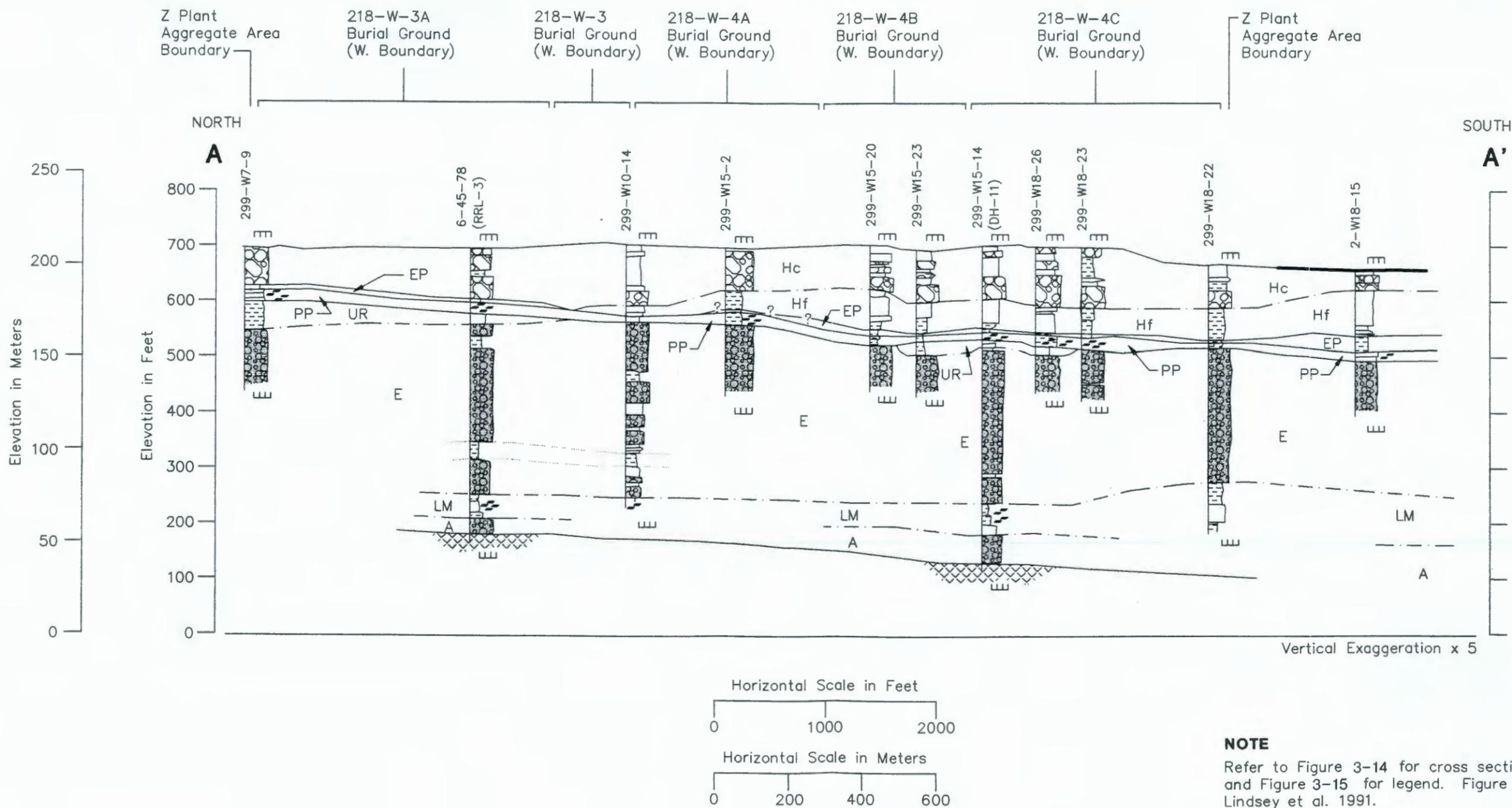
NOTES

1. Refer to Figure 3-14 for cross section locations and designation. Cross sections presented on Figures 3-16 through 3-20.
2. Figures based on Lindsey et al. 1991.

Figure 3-15. Legend for Cross-sections.

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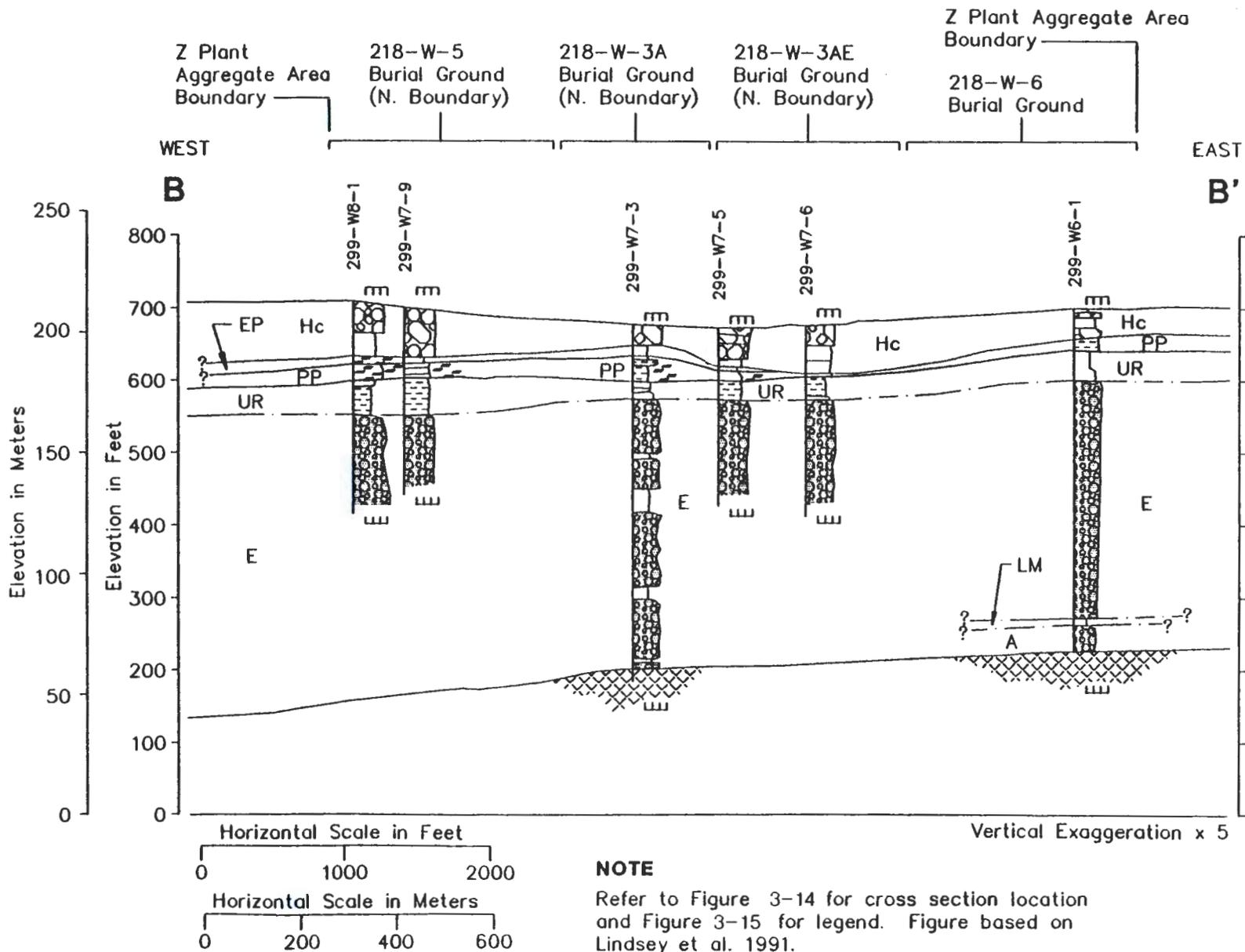
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NOTE
 Refer to Figure 3-14 for cross section location and Figure 3-15 for legend. Figure based on Lindsey et al. 1991.

Figure 3-16. Z Plant Aggregate Area Geologic Cross Section A-A'.
 3F-16

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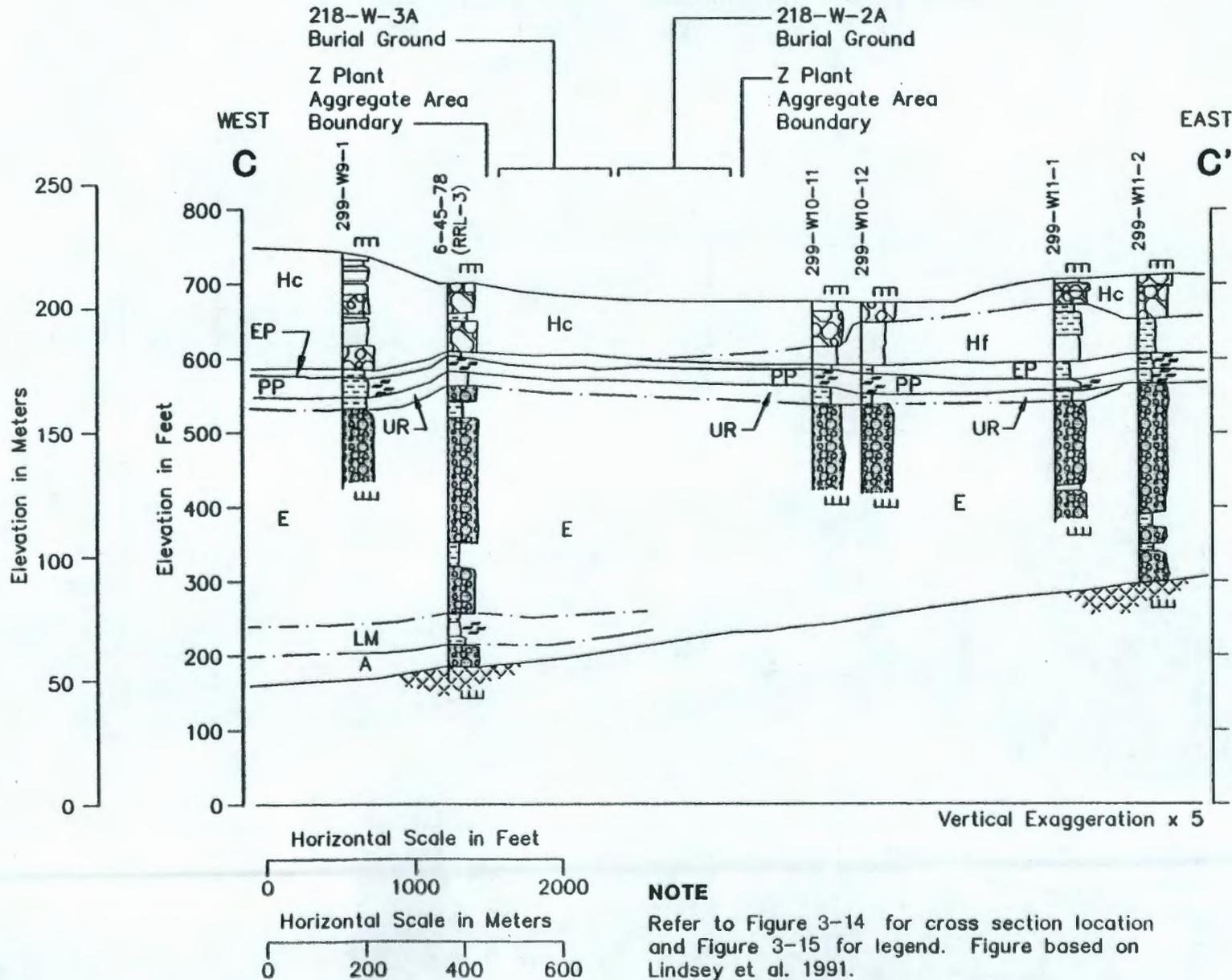


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Figure 3-17. Z Plant Aggregate Area Geologic Cross Section B-B'.

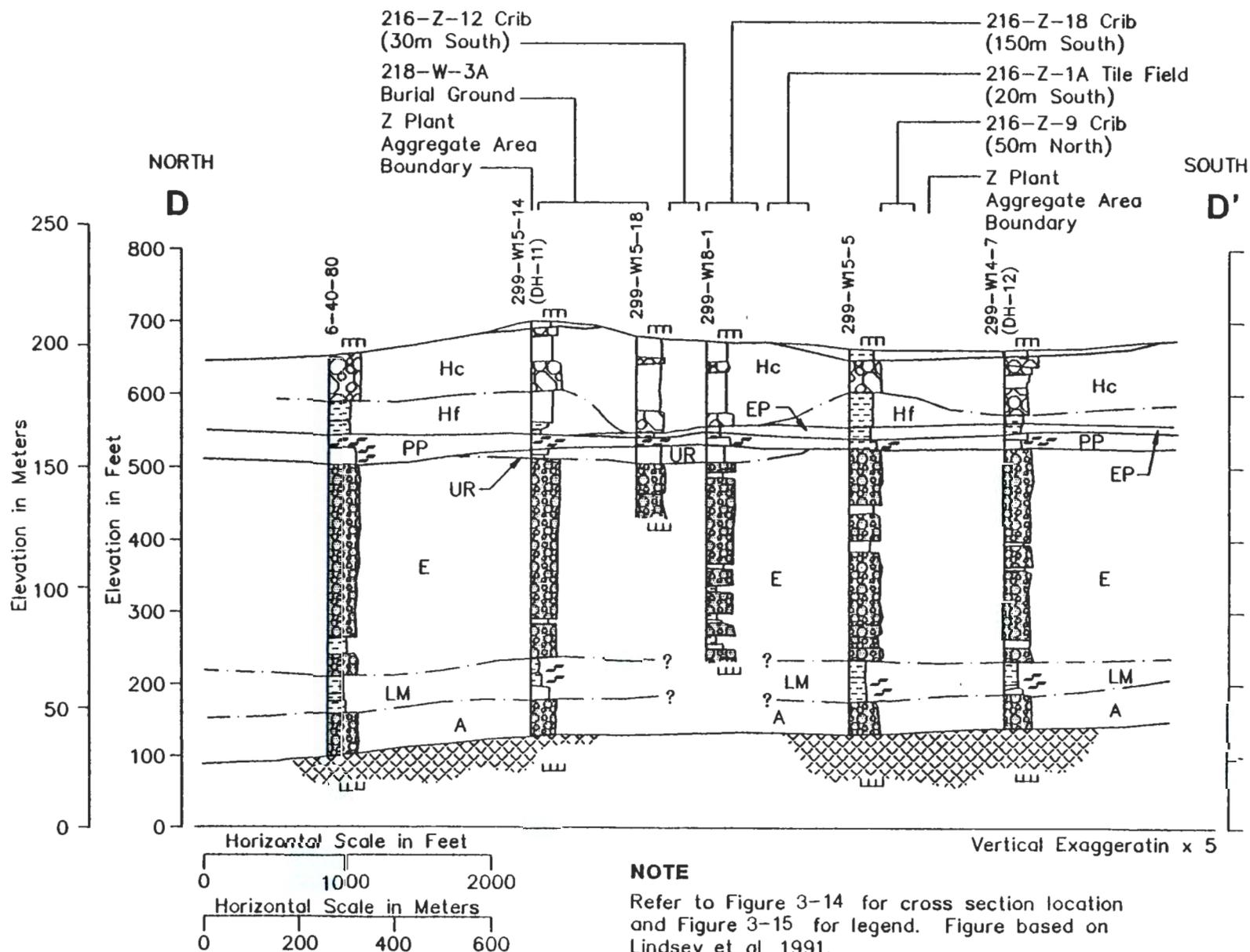
3F-18



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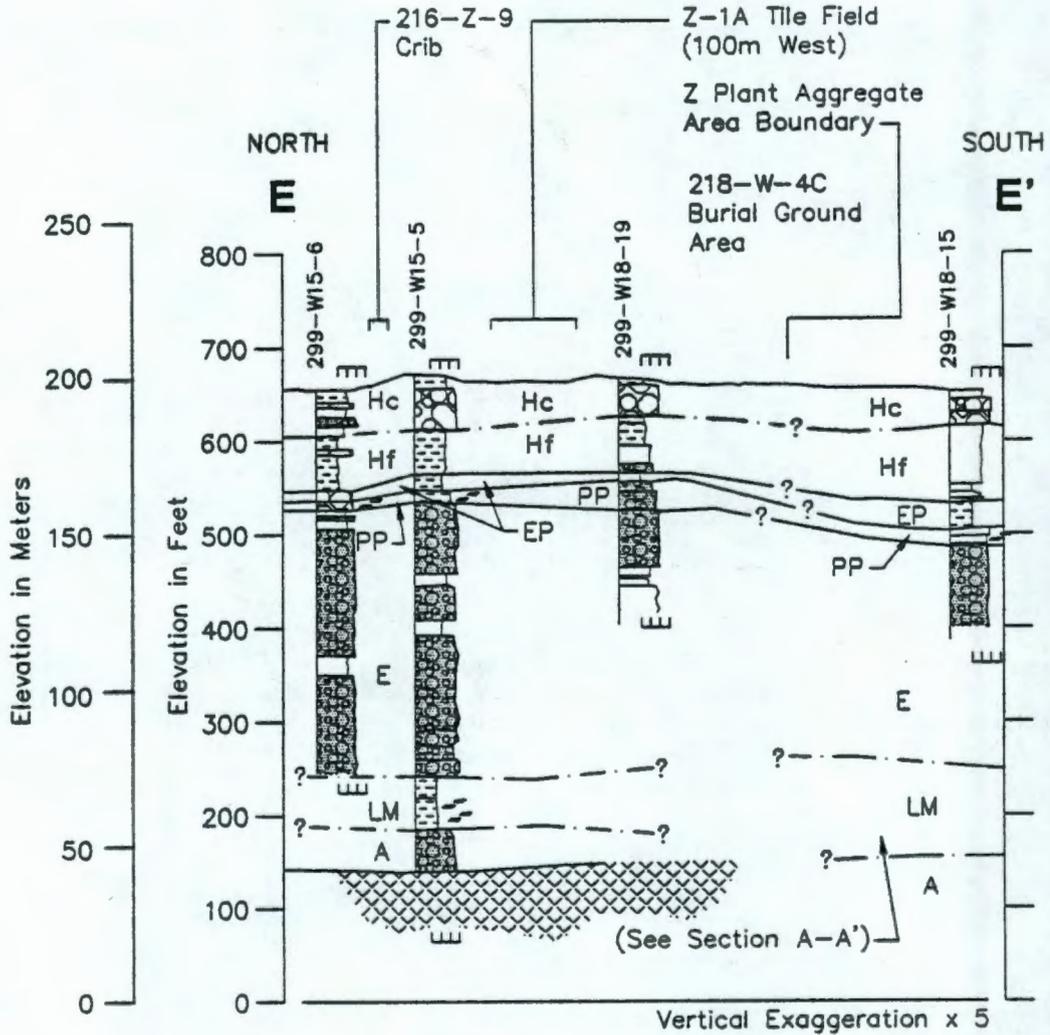
Figure 3-18. Z Plant Aggregate Area Geologic Cross Section C-C'.

3F-19



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Figure 3-19. Z Plant Aggregate Area Geologic Cross Section D-D'.



NOTE

Refer to Figure 3-14 for Cross Section location and Figure 3-15 for legend. Figure based on Lindsey et al. 1991.

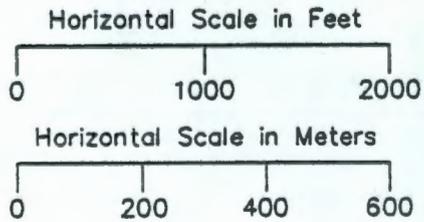


Figure 3-20. Z Plant Aggregate Area Geologic Cross Section E-E'.

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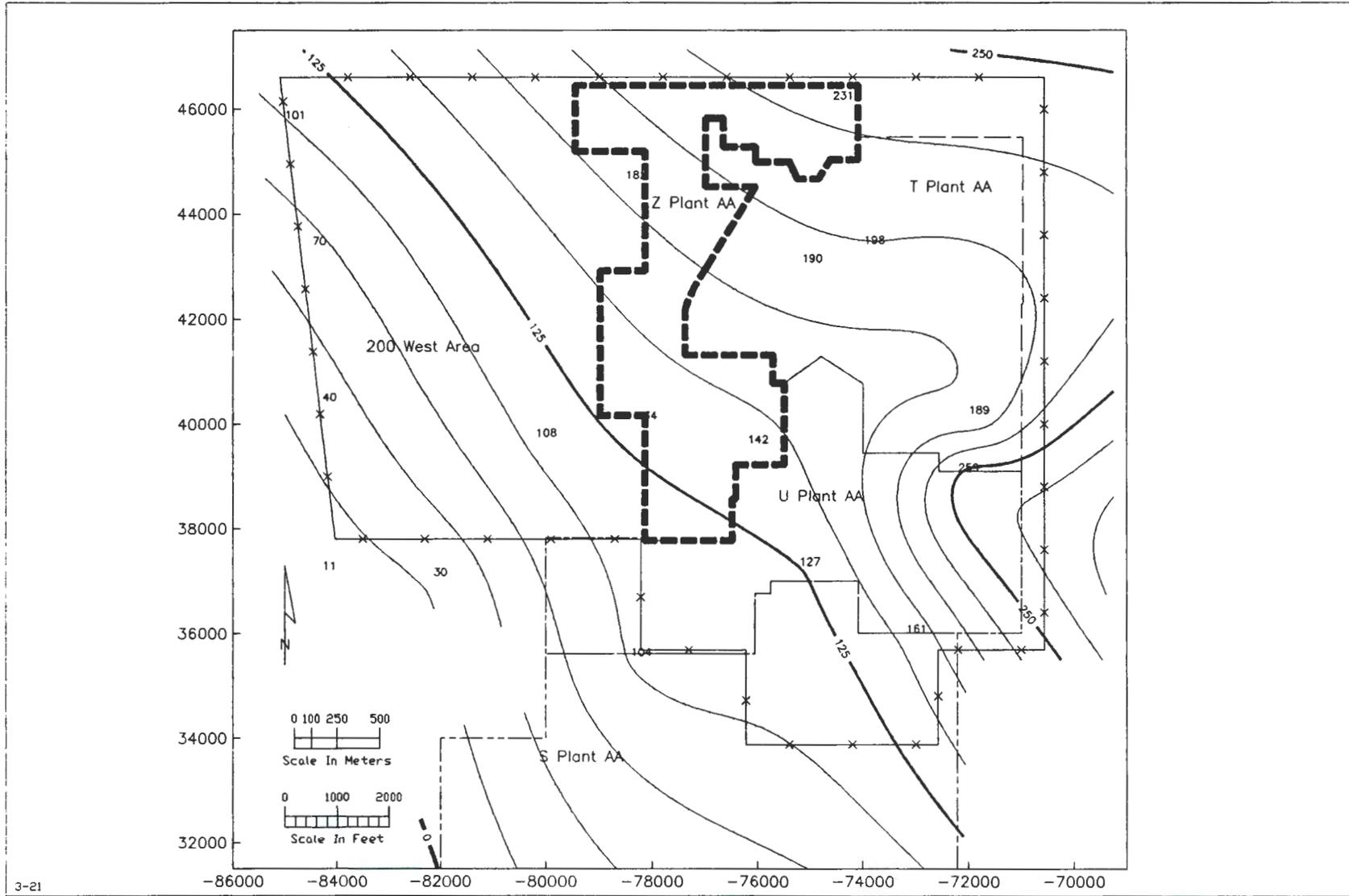


Figure 3-21. Top of the Elephant Mountain Basalt.

3F-22

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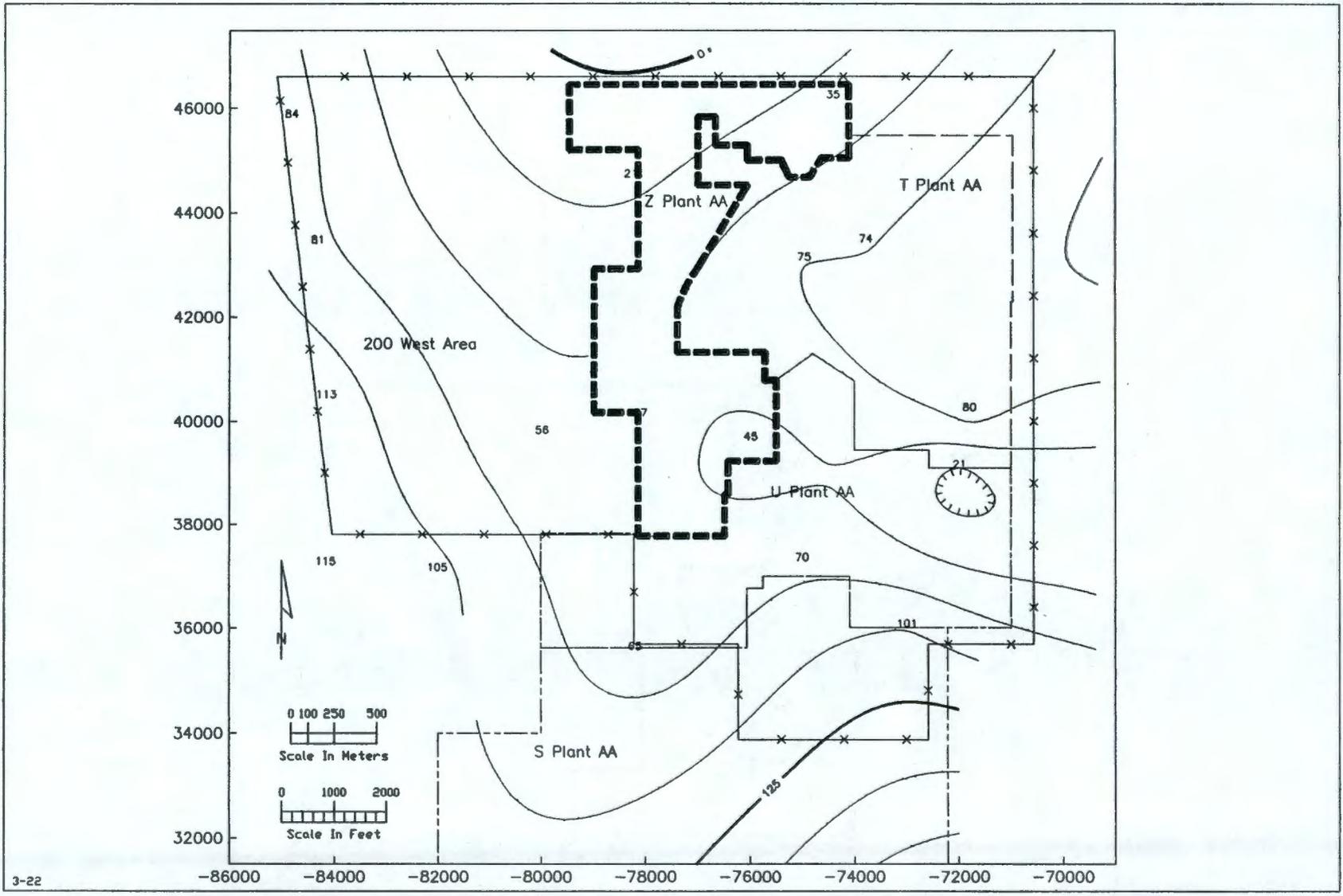


Figure 3-22. Isopach Map of the Ringold Gravel Unit A.

3-22

3F-23

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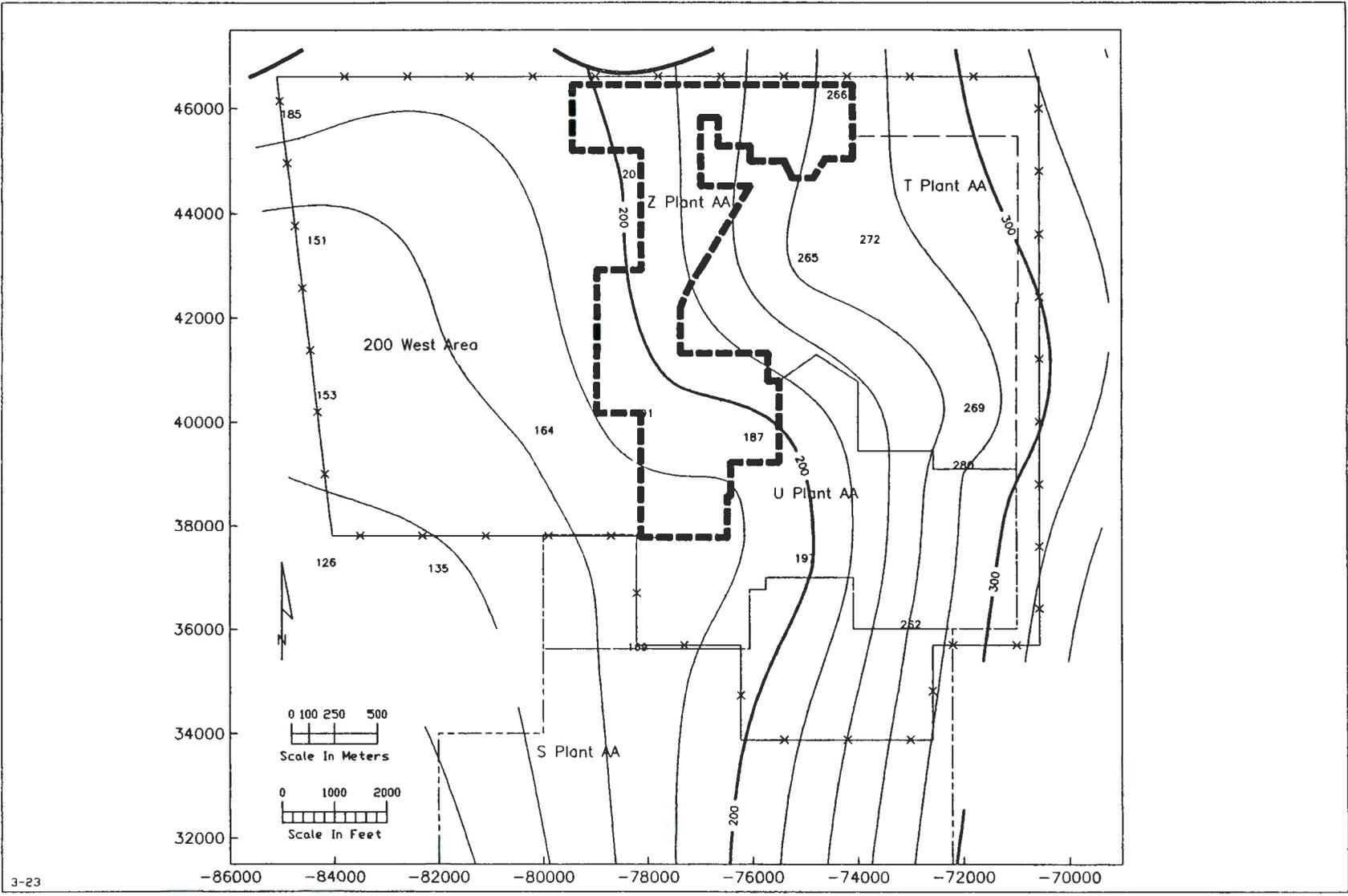


Figure 3-23. Structure Map of the Ringold Gravel Unit A.

3F-25

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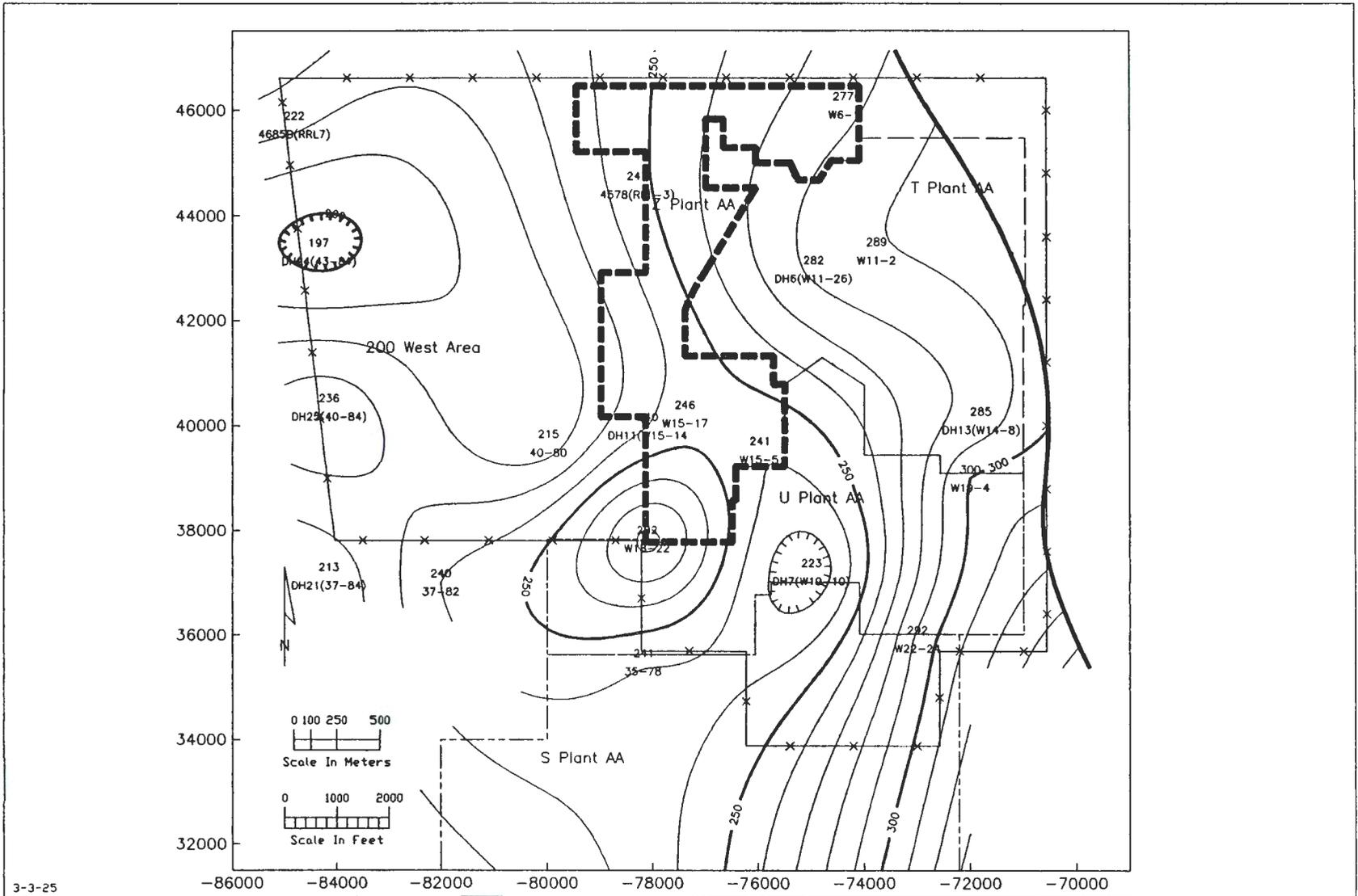


Figure 3-25. Structure Map of the Ringold Lower Mud Unit.

3-3-25

3F-27

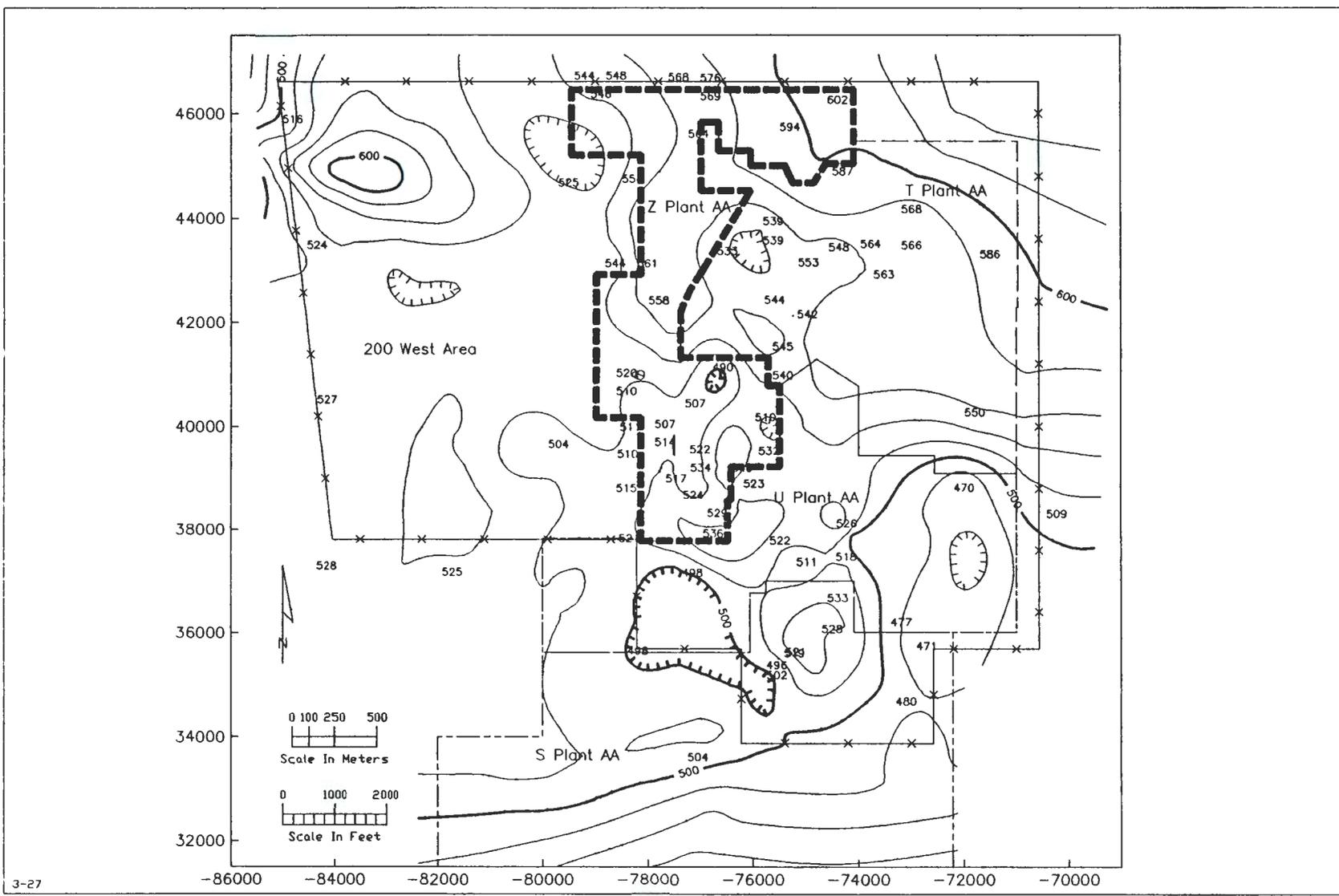


Figure 3-27. Structure Map of the Ringold Gravel Unit E.

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3F-28

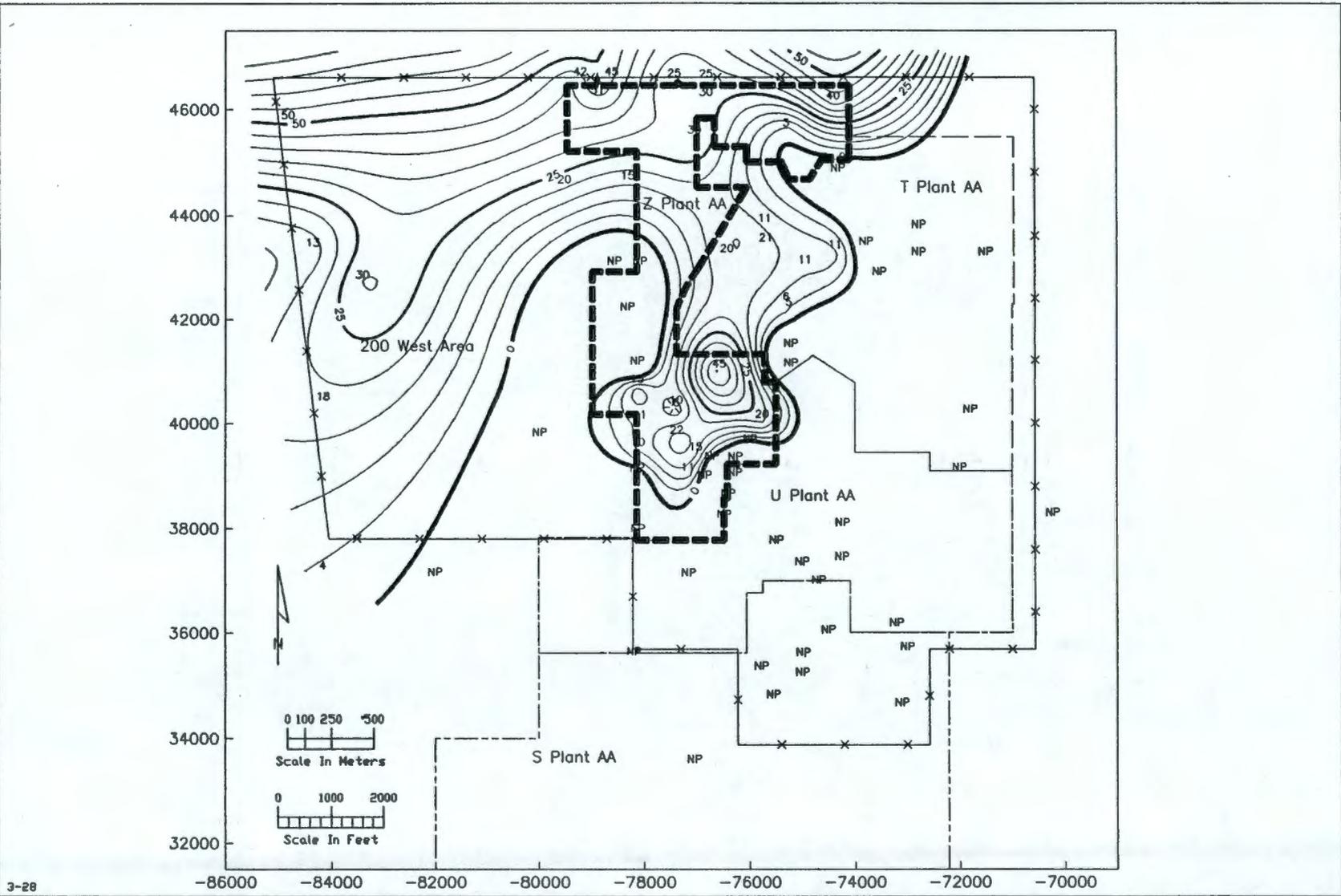


Figure 3-28. Isopach Map of the Upper Ringold.

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3F-30

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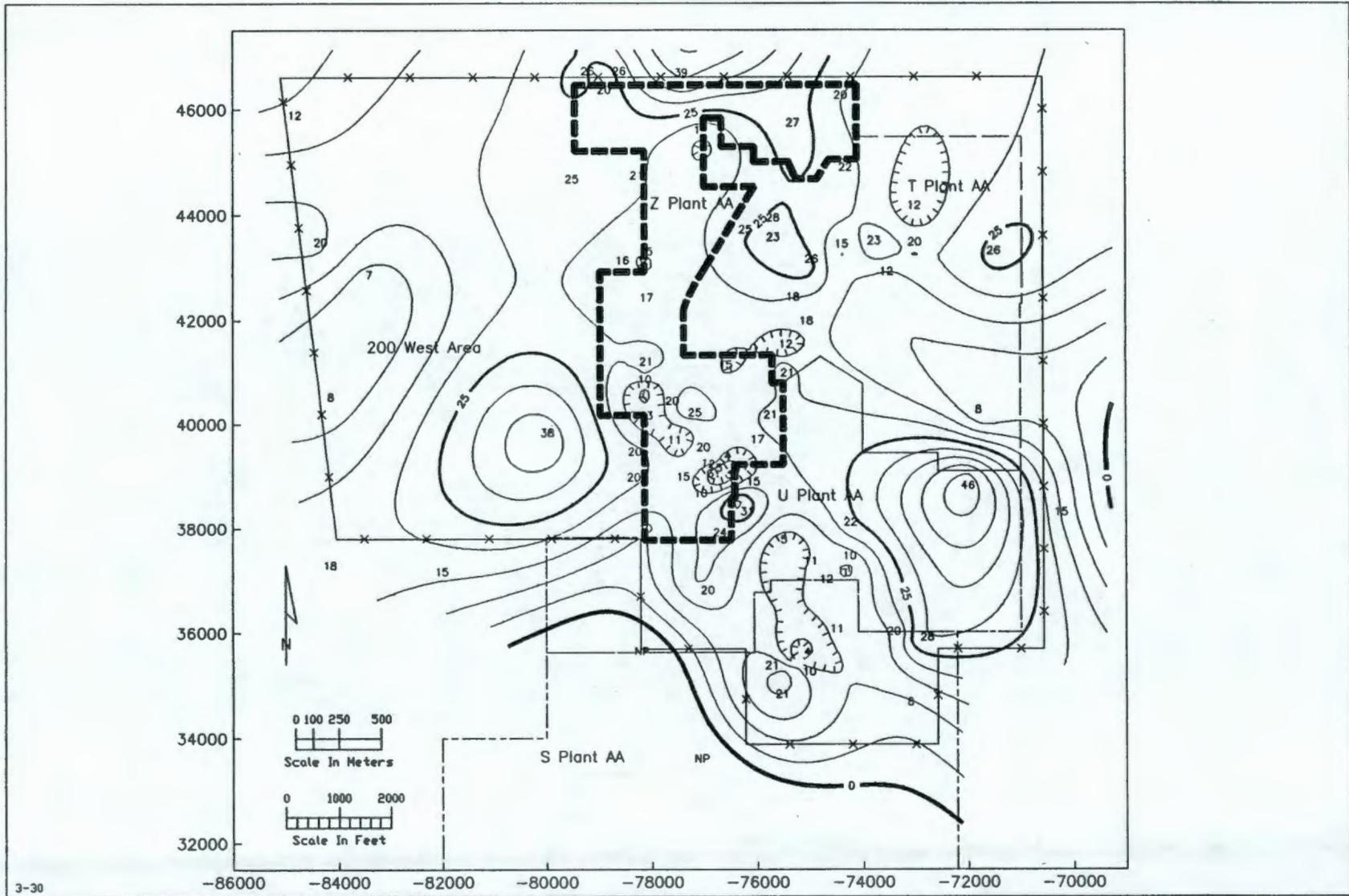


Figure 3-30. Isopach Map of the Plio-Pleistocene Unit.

3F-31

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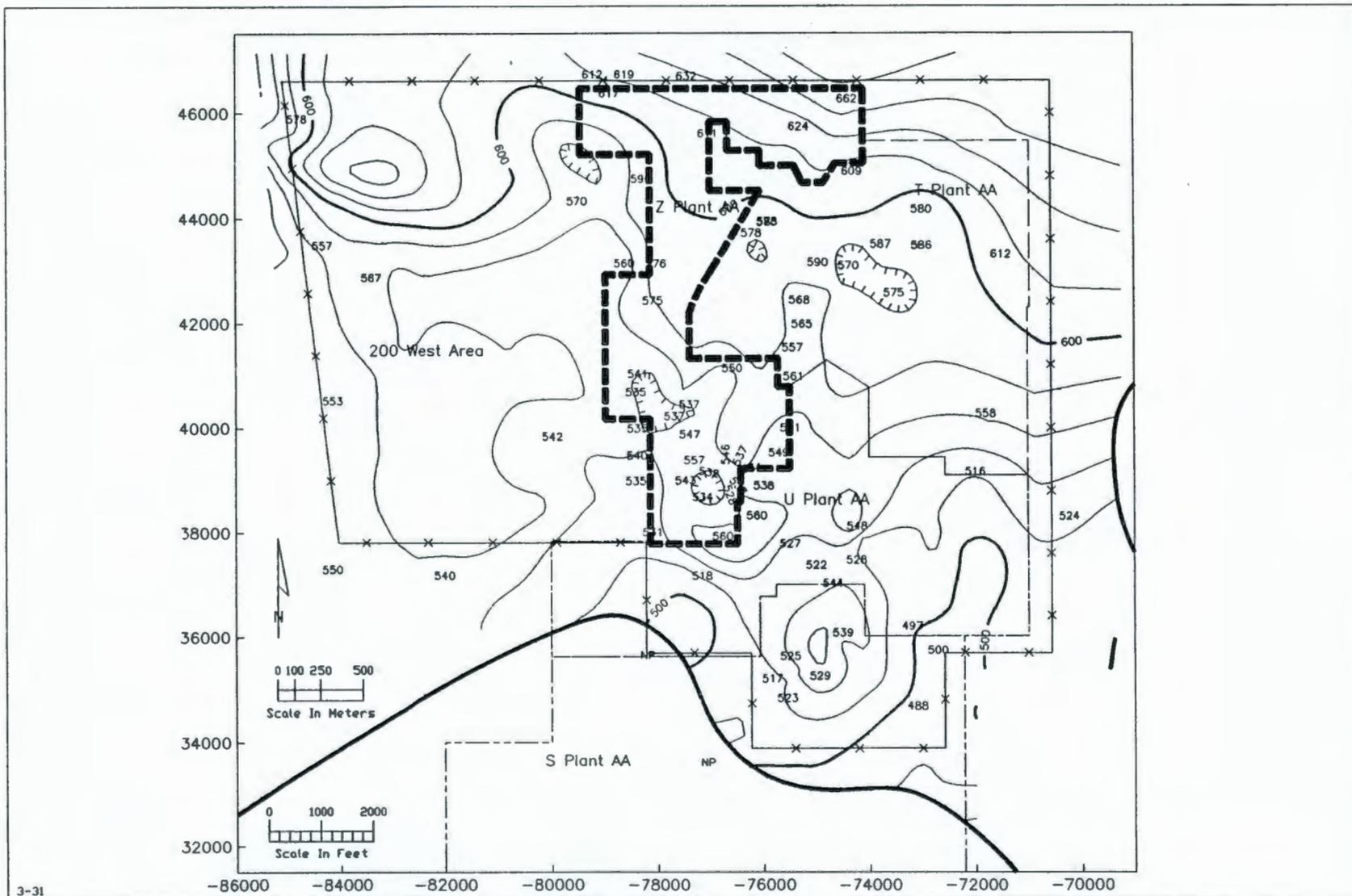


Figure 3-31. Structure Map of the Plio-Pleistocene Unit.

3F-32

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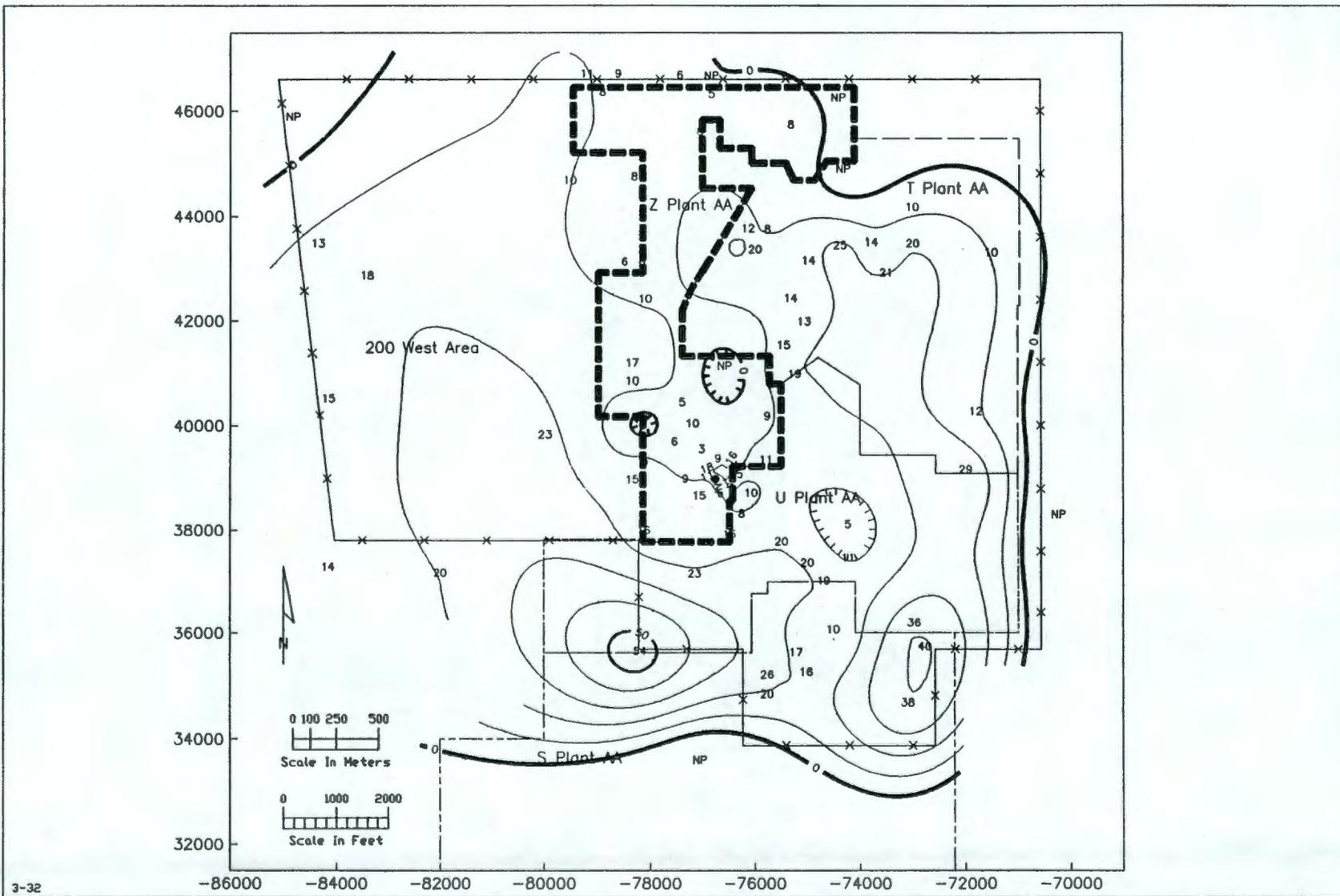


Figure 3-32. Isopach Map of the Early "Palouse" Soil.

3F-33

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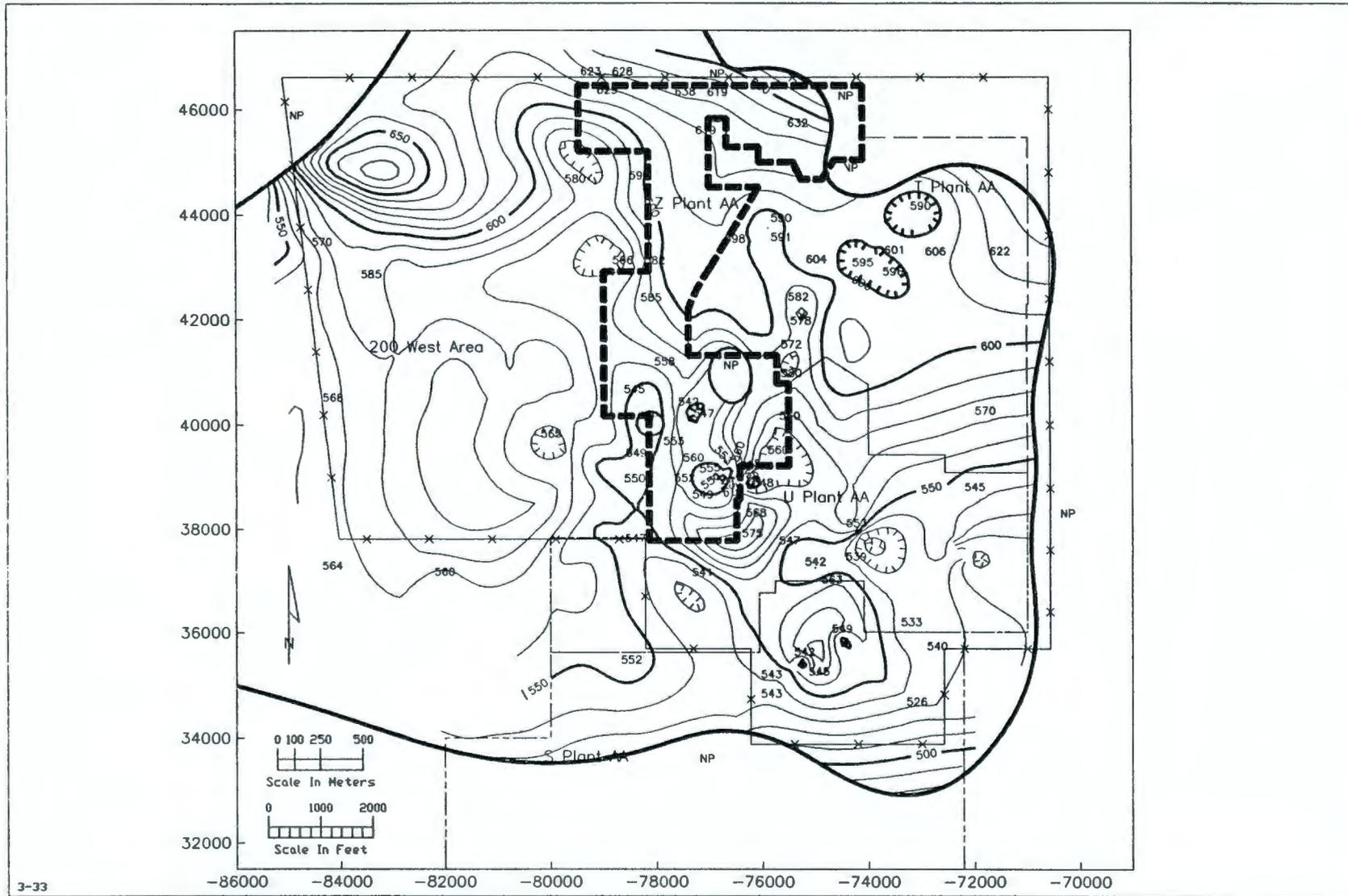
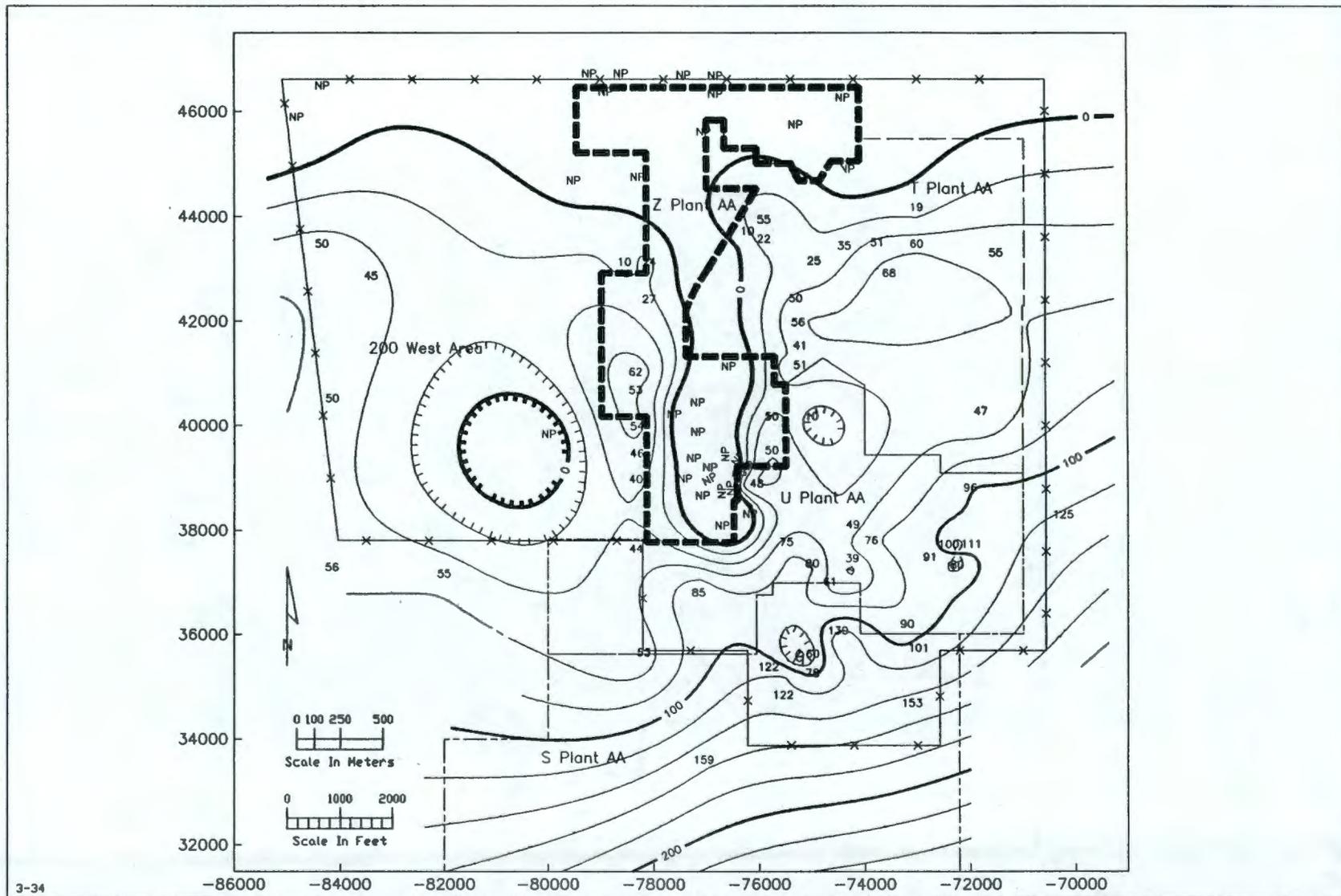


Figure 3-33. Structure Map of the Early "Palouse" Soil.

3F-34

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3-34

Figure 3-34. Isopach Map of the Lower Fine-Grained Unit of the Hanford Formation.

3F-35

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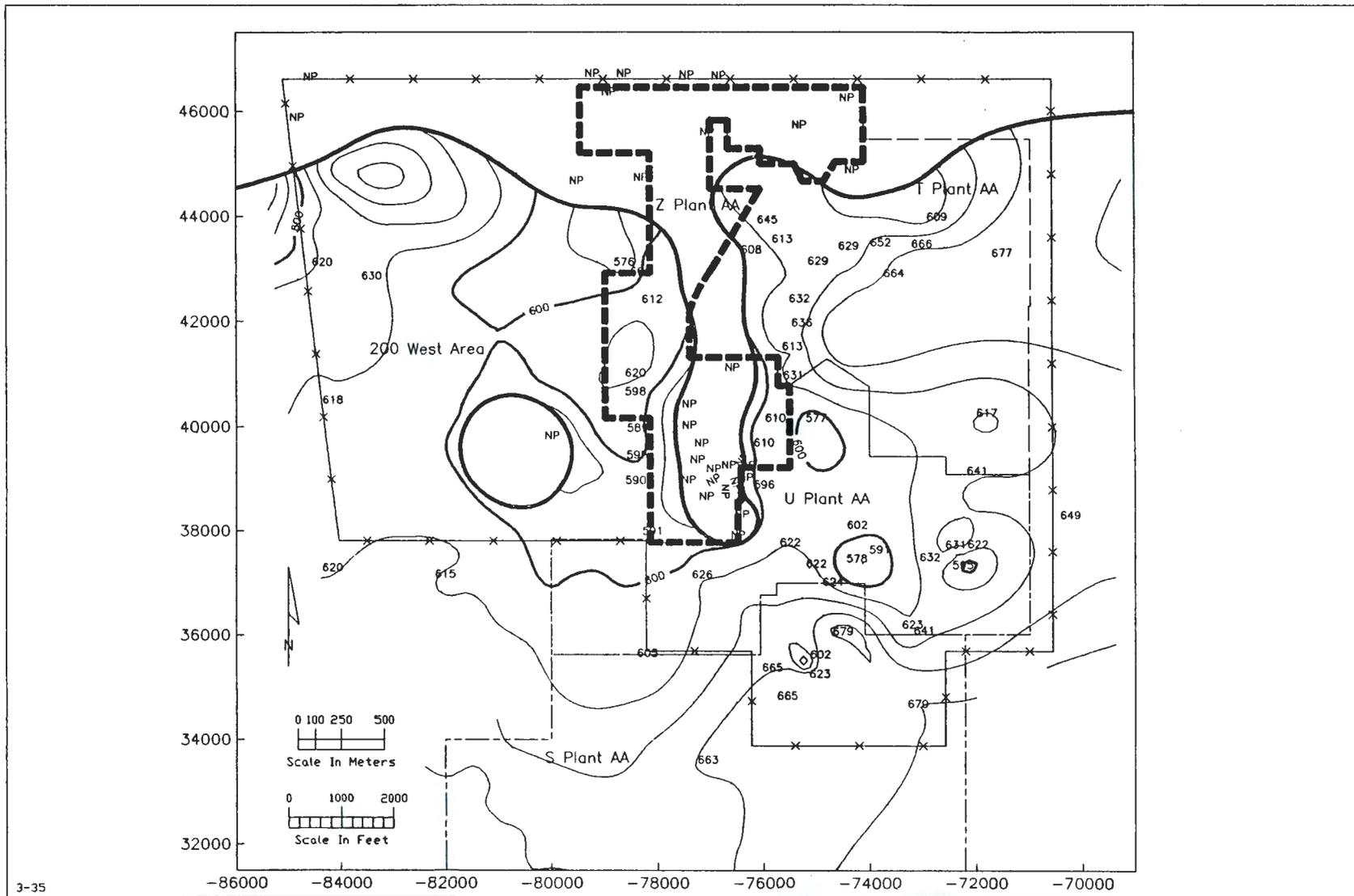


Figure 3-35. Structure Map of the Lower Fine-Grained Unit of the Hanford Formation.

3F-36

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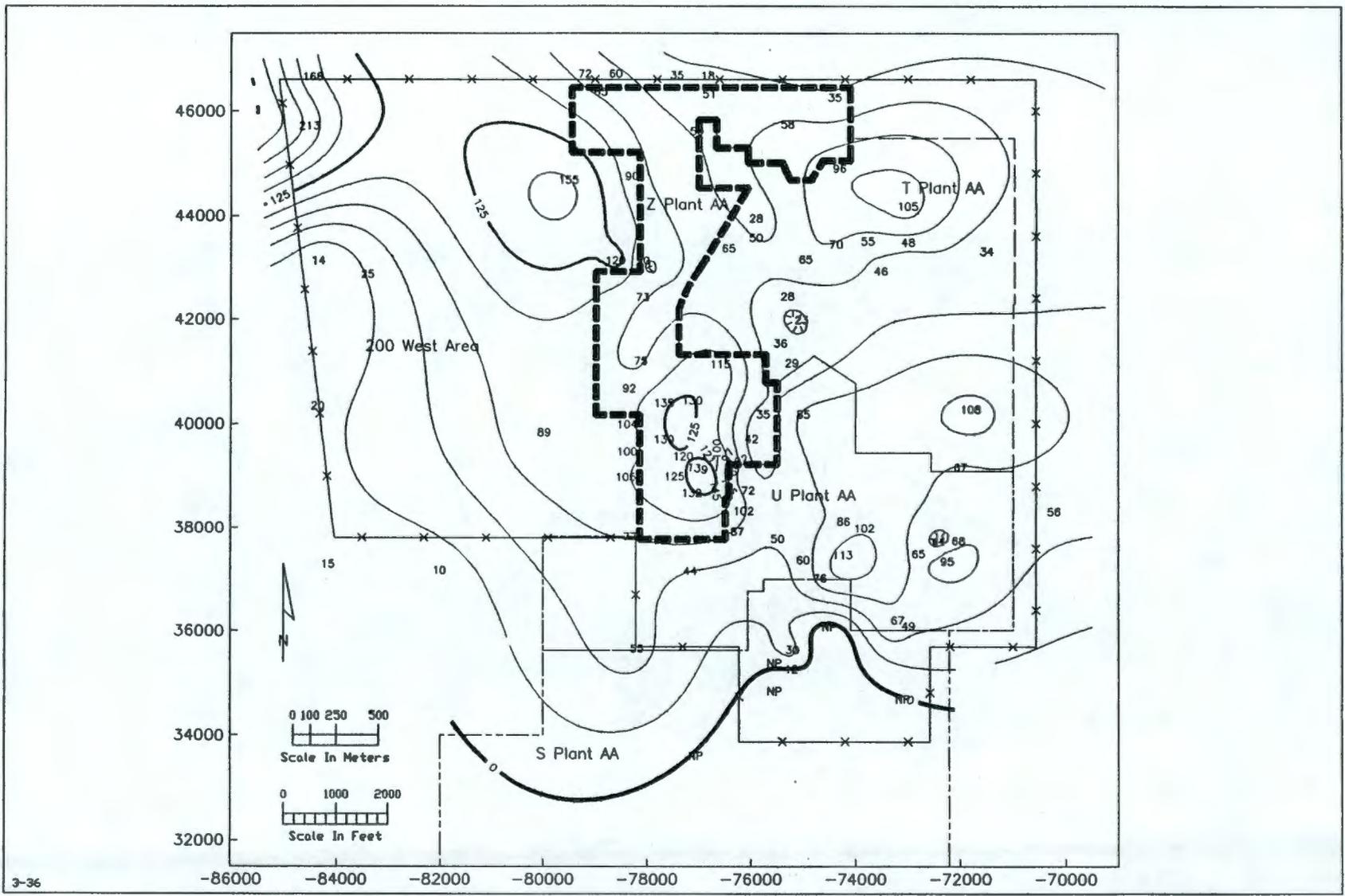
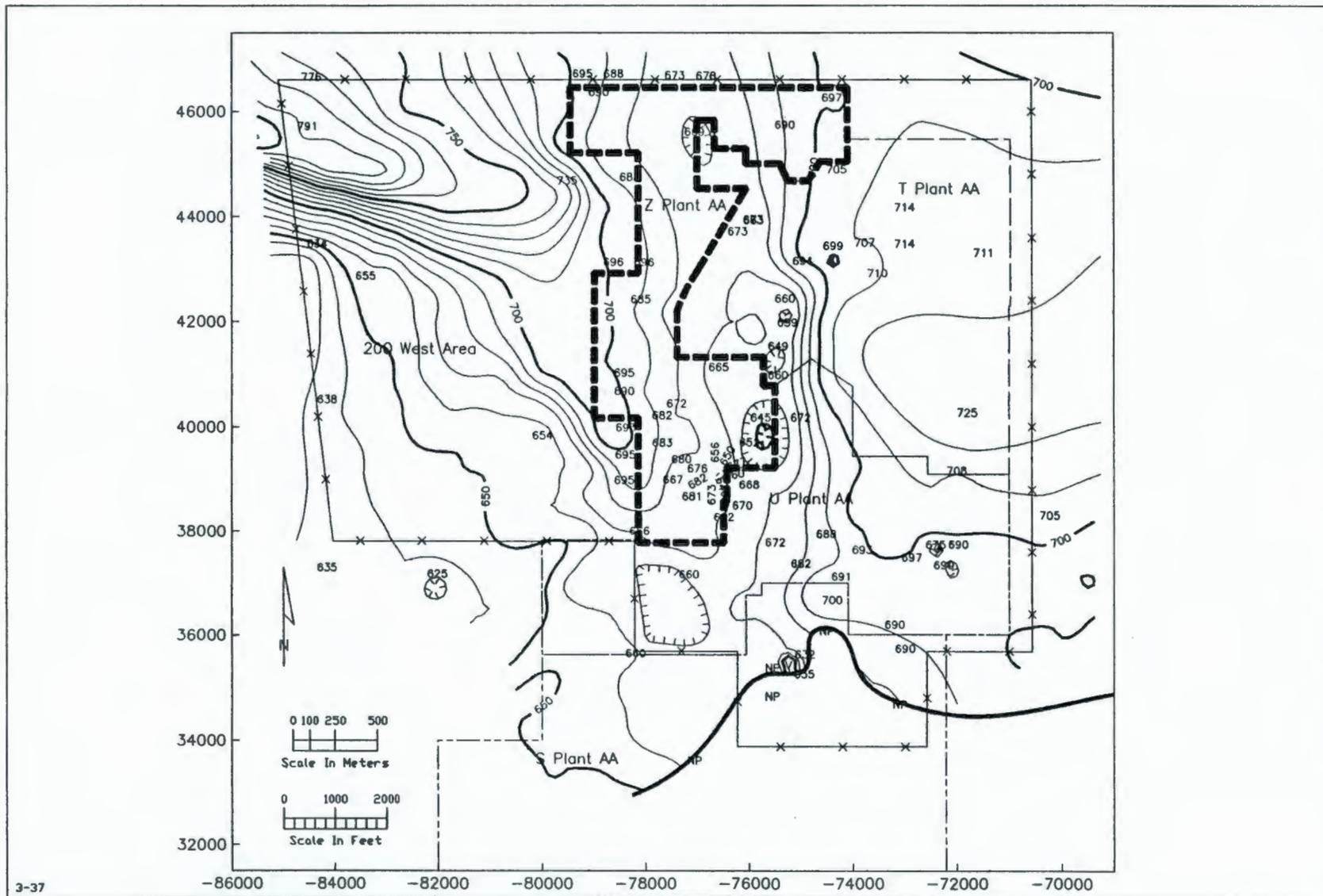


Figure 3-36. Isopach Map of the Upper Coarse-Grained Unit of the Hanford Formation.

3-36

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3-37

Figure 3-37. Structure Map of the Upper Coarse-Grained Unit of the Hanford Formation.

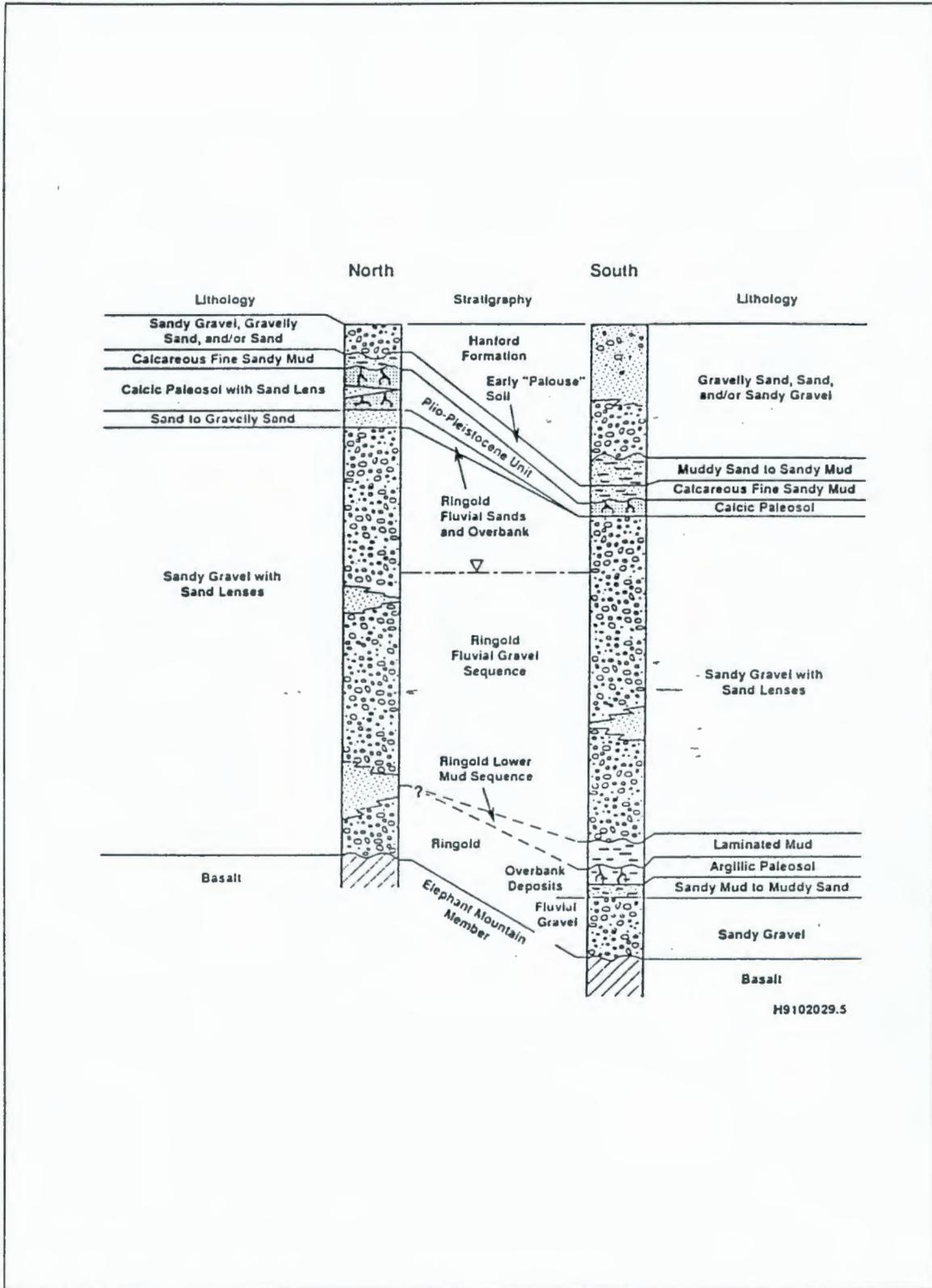
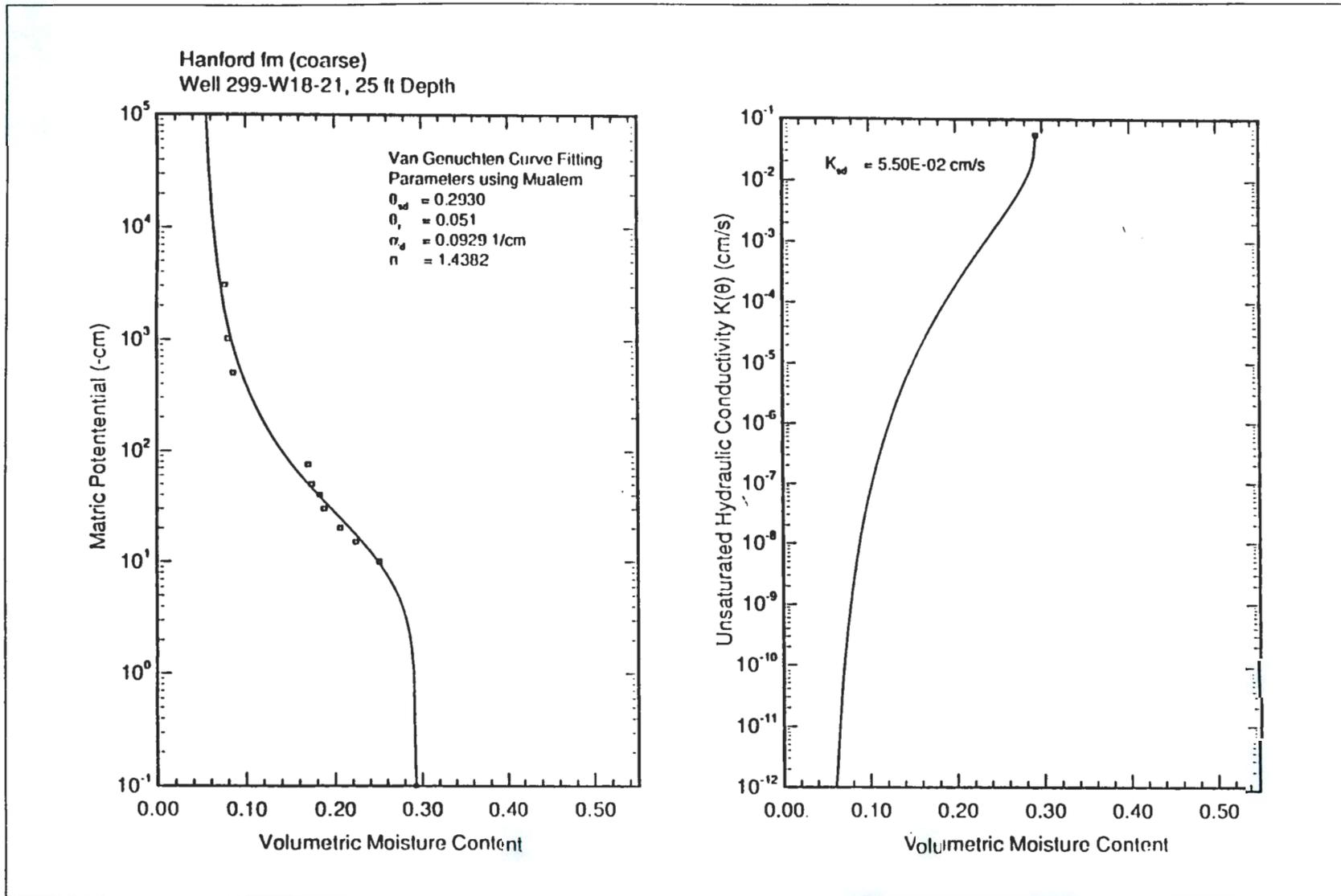


Figure 3-39. Conceptual Geologic and Hydrogeologic Column for the 200 West Area. (Last et al. 1989).

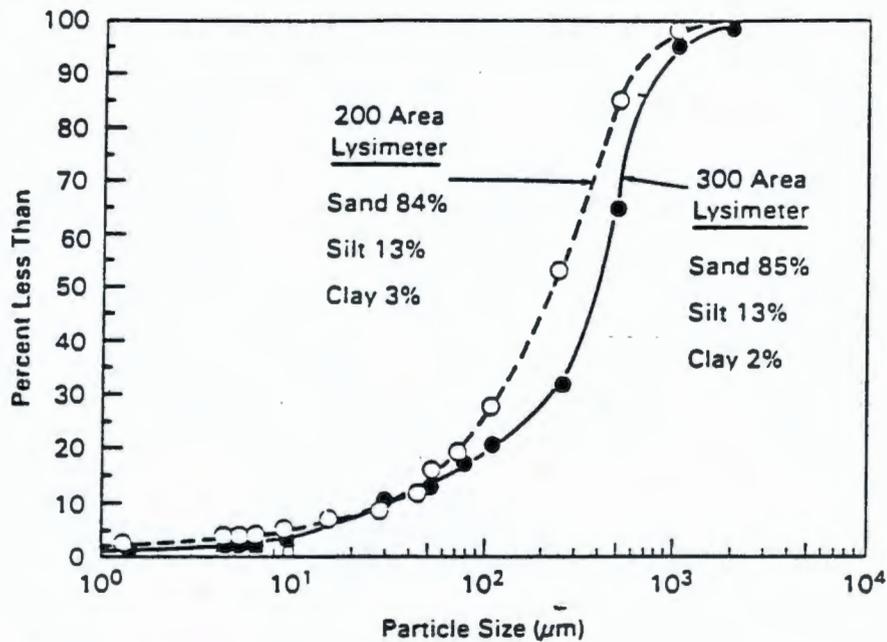
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3F-40

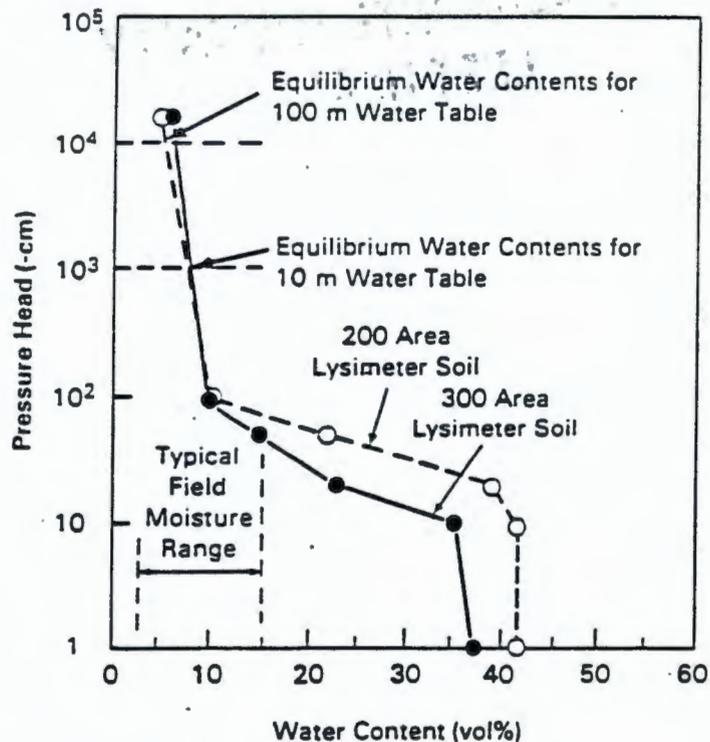


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Figure 3-40. Wetting and Drying Curves for Well 299-W18-21.



a. Particle-Size Distribution



b. Water Retention Characteristics

Figure 3-41. Particle-Size Distribution and Water Retention Characteristics of Soils from Hanford Site Lysimeters (Gee and Heller 1985).

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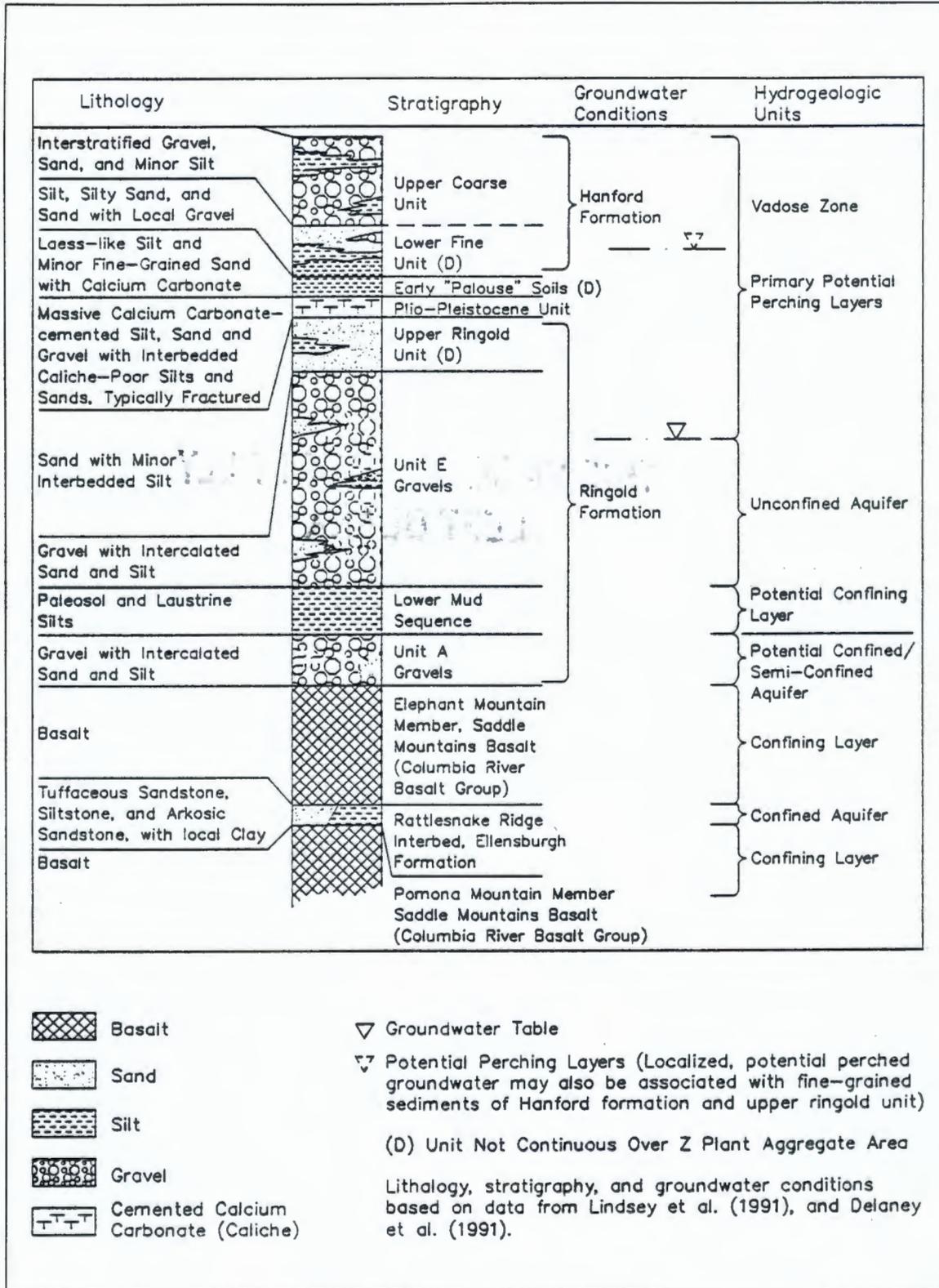


Figure 3-43. Conceptual Hydrogeologic Column for the Z Plant Aggregate Area.

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4.0 PRELIMINARY CONCEPTUAL SITE MODEL

Section 4.1 presents the chemical and radiological data obtained from the documents reviewed for each waste management unit. These data, along with physical descriptions of the waste management units (Section 2.0) and descriptions of the surrounding environment (Section 3.0) are evaluated in Sections 4.2 and 5.0 in order to qualitatively assess the potential impacts of the contamination to human health and to the environment. This information is also used to identify applicable or relevant and appropriate requirements (ARARs) (Section 6.0). Contaminant information is assessed in Section 7.0 to provide a basis for selecting remediation technologies which can be implemented at the sites.

Contaminants released into the environment at a waste management unit may migrate from the point of release into other types of media. The potentially affected media in the Z Plant Aggregate Area include surface soil, surface water, vadose zone soil and perched groundwater, air, and biota. The media that are affected at a specific waste management unit will depend upon the quantities, chemical and physical properties of the material that was released, and the subsequent site history.

4.1 KNOWN AND SUSPECTED CONTAMINATION

There are two major categories of radiological and chemical data for the Z Plant Aggregate Area: data applicable to individual waste management units and Unplanned Releases, and area-wide environmental data that are useful in characterizing regional contamination trends. Some waste management units and Unplanned Releases have been the subject of chemical and radiological studies in the past. However, many of these studies were limited in scope and did not provide a comprehensive analysis of the character and distribution of the contamination at the waste management unit locations. Types of organic/inorganic chemical and radiological data reviewed for Z Plant Aggregate Area waste management units are summarized in Table 4-1. The data presented in Table 4-1 were obtained from surface radiological surveys, external radiation dose rate monitoring, soil and sediment sampling, groundwater sampling, biota sampling, and borehole geophysics. To supplement the radiological and chemical data, waste inventory information indicative of contamination at waste management units is also included in the evaluation of known and suspected contaminants. Historical waste inventory data are detailed in Section 2.0 of this report (Tables 2-1 through 2-3). As discussed in Section 2.0, historical information was obtained from the WIDS (WHC 1991a) and other sources

1 of waste inventory data. It should be emphasized that Table 4.1 only summarizes what
2 types of data were found during review of documents for this report. The table does not
3 indicate the sufficiency of the data, either in terms of quality or quantity. These concerns
4 are addressed in Section 8.0.

5
6 In addition to these unit-specific data, there are area-wide data that may not be
7 directly applicable to specific waste management units within the Z Plant Aggregate
8 Area. The primary sources of this general environmental information are the
9 Environmental Surveillance Annual Monitoring Reports for the 200/600 Areas by
10 Rockwell Hanford Operations (RHO) (Elder et al. 1986 and 1987), and Westinghouse
11 Hanford Company (WHC) (Elder et al. 1988 and 1989, Schmidt et al. 1990 and 1991).
12 The annual reports describe several different sampling and survey programs including
13 surface soil sampling, external radiation measurements, biota sampling, air sampling,
14 surface water sampling, and radiological surveys. The annual monitoring is generally
15 directed toward assessing the effect of Hanford Site-wide operations (including the 200
16 Areas production and processing facilities) on the local environment. Until 1990, few of
17 the sample locations were directly associated with specific waste management units
18 identified for the Z Plant Aggregate Area, except for the Solid Waste Burial Grounds.
19 Much of this information is therefore useful only in characterizing area-wide trends.
20 Beginning in 1990, however, several new sampling locations (shown on Plate 2) were
21 established near specific areas of suspected surface contamination, such as near the main
22 Z Plant building complex.

23
24 An additional source of Hanford Site-wide environmental data are Hanford Site
25 Environmental Reports by Pacific Northwest Laboratories (PNL) (e.g., Jaquish and Bryce
26 1989). As part of the Hanford Site-wide monitoring program, the PNL environmental
27 reports establish regional background concentration data for many radionuclide and
28 chemical parameters. These background data were in turn used as comparative values,
29 or used to derive comparative background values in the RHO/WHC annual monitoring
30 reports.

31
32 Area-wide geophysical data also exist, and include gravity, magnetic,
33 magnetotelluric, seismic refraction, and seismic reflection surveys (DOE 1988). These
34 studies are not useful however, for characterizing the extent of chemical and radionuclide
35 contamination. These data are therefore not presented in Section 4.0 of the this report,
36 but a general discussion of this information is provided in Section 8.0.

37
38 The types of data listed on Table 4-1 were reviewed to evaluate whether air,
39 surface soil, vadose zone soil, or groundwater was potentially impacted by waste handling
40 activities at Z Plant Aggregate Area waste management units. The applicability of the
41 information to specific Z Plant Aggregate Area waste management units was qualitatively

1 reviewed, along with the age and nature of the data. As a result of the this evaluation,
2 potentially affected media (air, surface soil, surface water, vadose zone soil, and biota are
3 listed on Table 4-2 for radionuclide contaminants and on Table 4-3 for organic/inorganic
4 chemical contaminants.
5

6 Two categories of site contamination were established in Tables 4-2 and 4-3 for
7 the purposes of this report: known and suspected. Known contamination was
8 determined to exist at a location if at least one soil, air, or surface water sample chemical
9 testing result above detection limits or background levels was identified in a published
10 document. Contamination was considered to be suspected to exist at a location rather
11 than known if one or more of the following conditions was observed:
12

- 13 ● A release to the environment was reported at an engineered site for which
14 no media-specific laboratory testing data were identified, i.e, radionuclide
15 contamination in the vadose zone beneath the 216-Z-4 Trench was
16 suspected because liquid waste containing radionuclides was reported to be
17 discharged to the trench.
18
- 19 ● External (ambient) radiation or dosimeter readings above background
20 levels were reported at or near a waste site, e.g., surface soil contamination
21 is suspected near the 216-Z-1 and 216-Z-2 Cribs as a result of elevated
22 external radiation readings.
23
- 24 ● Gamma logging results in boreholes completed within or adjacent to a
25 waste management unit indicated gamma radiation readings above defined
26 background levels, e.g., contamination is suspected in the vadose zone
27 below the 216-Z-7 Crib because gamma radiation readings in well
28 299-W15-7 exceed background levels.
29
- 30 ● Data available in published data (referenced in text as applicable) indicate
31 that a facility not intended to receive radionuclides or other hazardous
32 materials may nonetheless have historically received such compounds. This
33 category includes the 216-Z-13, 216-Z-14, and 216-Z-15 French Drains.
34
- 35 ● As discussed in Section 4.1.8, historical migration of waste liquids from a
36 number of Z Plant waste management units is suspected. Criteria
37 considered in assessing whether impacts to the unconfined aquifer may
38 have occurred are as follows:
39
 - 40 ● Groundwater impacts are suspected resulting from discharges to the
41 216-Z-10 Reverse Well due to the depth of injection (46 m [150 ft]).

1 As noted in Section 3.5.3, the unconfined aquifer is typically
2 encountered at a depth of 58 to 67 m (190 to 220 ft) beneath Z
3 Plant Aggregate Area.
4

- 5 • Groundwater impacts were suspected if the estimated total volume
6 of liquid waste disposed of to a waste management unit (as listed in
7 Table 2-1, where available) exceeded the total soil pore volume
8 directly below the unit by a factor of one or more. This analysis
9 does not consider the potential for liquid to spread laterally atop
10 perching layers above the water table. This analysis also does not
11 consider the relative mobility of various waste constituents (e.g., low
12 for most radionuclides and trace metal constituents and high for
13 nitrate and inorganic salts).
14
- 15 • Groundwater impacts were suspected if a gamma log presented in a
16 Hanford document indicated elevated gamma radiation values from
17 the bottom of a waste management unit all the way to the water
18 table. The only unit falling into this category is the 216-Z-7 Crib.
19

20 Additionally, little or no environmental monitoring data were found in the
21 documents reviewed for some engineered facilities where liquid or solid wastes were
22 transferred, treated, stored, or disposed. Although not listed as actual known or
23 suspected locations of contamination in Tables 4-1 and 4-3, some degree contamination
24 (as yet undefined) is possibly associated with these facilities. This category includes the
25 tanks that received Z Plant process waste (e.g., the 216-Z-8 Settling Tank, the 241-Z-361
26 Settling Tank, and 241-Z Diversion Boxes No. 1 and No. 2) and many of the burial
27 grounds. These types of facilities are the subject of discussion for "data gaps" addressed
28 in Section 8.0 of this report.
29

30 The following subsections of Section 4.1 present results of the evaluation of known
31 and suspected contamination for the Z Plant Aggregate Area. Section 4.1.1 describes
32 analysis results on a media-specific basis. Section 4.1.1.1 presents air quality sampling
33 data. Surface soil data are described in Section 4.1.1.2. Results of surface water
34 sampling are presented in Section 4.1.1.3. Results of vegetation and other biota sample
35 analyses Section 4.1.1.4. Vadose Zone sampling data are discussed in Section 4.1.1.5.
36 Although groundwater issues are considered beyond the scope of this study, Section
37 4.1.1.5 also discusses evidence for contamination migration within the vadose zone to the
38 unconfined aquifer underlying the Z Plant Aggregate Area. Additional assessment of the
39 nature and extent of groundwater contamination is presented in the 200 West
40 Groundwater AAMS report. Evaluation of known and suspected contaminants for each
41 of the Z Plant Aggregate Area waste management units is discussed in Section 4.1.2.

1 **4.1.1 Affected Media**
2

3 **4.1.1.1 Air.** This section discusses results of ambient air monitoring applicable to the Z
4 Plant Aggregate Area as reported in RHO/WHC annual environmental surveillance
5 monitoring reports (Elder et al. 1986 through 1989, Schmidt et al. 1990 and 1991).
6 Ambient air monitoring stations are located within the Z Plant Aggregate Area or near
7 its boundary include sites N165, N962, N964, and N994 (Plate 2). As discussed in each
8 of the RHO/WHC annual environmental monitoring reports for 1985 through 1990, the
9 sampling locations are part of a larger network within the 200 Areas to assess the effect
10 of operations on the local environment, and to assess 200 Areas facilities performance.
11 According to the annual reports, sample station locations throughout the 200 Areas were
12 sited based on prevailing wind directions and potential sources of airborne contaminants.
13 Within the Z Plant Aggregate Area, sample stations N962 and N964 are located near the
14 218-W-4B Burial Ground to the west (general up-wind direction) of the main Z Plant
15 building complex (Plate 2). Station N165 is east-southeast of the building complex
16 (general down-wind direction), and station N994 is a fenceline point along the north
17 boundary of the Z Plant.
18

19 The air samplers at each of the monitoring stations contain filters which collect
20 particles entrained air. The air samples are collected by drawing samples through a 47-
21 mm, open-face filter at about 1 m (3 ft) above the ground (2 cubic ft/min [cfm] flowrate).
22 Throughout the 200 Areas, air samplers are operated on a continuous basis. Sample
23 filters are exchanged weekly, held one week to allow for decay of short-lived natural
24 radioactivity, and sent for initial laboratory analyses of gross alpha and beta activity.
25 After the initial analysis, the filters are stored until the end of the calendar quarter, at
26 which time they are composited by sample location (or as deemed appropriate according
27 to the annual reports) and sent for laboratory analyses of specific radionuclides.
28 Compositing of the filters by sample location provides a larger sample size, and thus a
29 more accurate measurement of the concentration of airborne radionuclides resulting from
30 operations in the 200 Areas.
31

32 Air monitoring results from the 1985 through 1989 annual environmental
33 surveillance reports are presented in Table 4-4. Entries in the table are average results
34 over this period for cesium-137, strontium-90, plutonium-239, and total uranium. The
35 complete data set from the annual monitoring reports since 1985 is provided in Table
36 A-3 of Appendix A. The results in Table A-3 are listed as maximum, minimum, and
37 average quarterly values for the radionuclides reported: strontium-90, cesium-137,
38 plutonium-239, and uranium. The data in Table A-3 includes the counting error
39 associated with each value, and results less than the counting error are shaded. The
40 counting error reflects several factors, including the efficiency and configuration of the
41 detector instrument, and the precision of the chemical analysis method. The error also

1 reflects the fact that some of the radioactivity detected is result of the statistical
2 distribution of radionuclides. The remaining values (unshaded) in Table A-3 represent
3 positive detections. The positive detections verify that radionuclides are actually present
4 and not artifacts of the detection and laboratory analysis methods.
5

6 Positive detections for each radionuclide analyzed are common from 1985 to 1989
7 (Elder et al. 1986, Schmidt et al. 1990). Each of the RHO/WHC annual monitoring
8 reports conclude that the activities in the 200 Areas contributed to average air
9 radionuclide concentrations that were "slightly above" background. As discussed in the
10 annual reports, the background concentrations were derived from three background
11 monitoring stations located outside the 200 Areas (Yakima and Wye Barricades, and
12 former Hanford Townsite). The 1989 report concludes that radionuclide concentration
13 trends in air since 1979 have been "generally downward" for the 200 West Area because
14 of overall improvement in operational environmental controls and curtailed operations.
15

16 One of the Z Plant Aggregate Area, N962 (southeast corner of 218-W-4B Burial
17 Ground), has shown the highest annual average strontium-90 concentrations of the 200
18 Areas samples for several years — most recently 1989 (Schmidt et al. 1990). Strontium-
19 90 concentrations up to 58 times greater than background for the Hanford Site have
20 been reported for N962 (1987 annual report, Elder et al. 1988). Annual average
21 concentrations of strontium-90 for the sample location have decreased since 1987. In
22 addition, location N165 near the head of the 216-Z-19 Ditch southeast of the Z Plant
23 building complex had the highest plutonium-239 concentration reported for the 200
24 Areas air samples in 1986, 1987, and 1988. Plutonium-239 concentrations in sample
25 N165 were up to 100 times greater than background levels for the 200 Areas sites (Elder
26 et al. 1986). The elevated plutonium concentrations are likely attributable to airborne
27 particulate matter from historical plutonium finishing/recovery operations at the Z Plant
28 building complex to the west-northwest, in the general up-wind direction from N165. The
29 1985 through 1988 annual reports (Elder et al. 1986 through 1989) indicate that the only
30 other gamma-emitting radionuclides found at levels "significantly greater than
31 background" were detected in samples from the 200 East Area. A similar conclusion for
32 these other radionuclides is not included in the 1988 and 1989 annual reports (Elder et
33 al. 1989, Schmidt et al. 1990).
34

35 Residue from particulate air contaminants derived from 200 Areas production
36 processing facilities, and possibly Unplanned Release locations and wind-eroded burial
37 ground soils would be expected in Z Plant surface soils due to wind-borne dispersion. As
38 discussed in Section 4.1.1.2, radiological soil contamination has been documented at
39 surface soil grid point sampling locations across the Z Plant Aggregate Area. Results of
40 radiation surveys also indicate the presence of surface contamination at many locations.
41 Surface soil contamination is also commonly associated with localized areas within the

1 burial grounds and at Unplanned Release locations. Wind-borne radionuclides likely
2 contributed to the surface contamination detected at these locations.

3
4 **4.1.1.2 Surface Soil.** Several types of data exist for characterizing surface soil
5 contamination or assessing areas of possible contamination. These data include results of
6 aerial and ground radiological surveys, external radiation measurements, and surface soil
7 sampling. These data are presented in the following subsections for the Z Plant
8 Aggregate Area as a whole. In addition, waste management unit-specific radiological and
9 soil sampling are presented in Section 4.1.2.

10
11 **4.1.1.2.1 Airborne Radiological Survey Data.** Radiological survey results may be
12 influenced by buried or airborne radionuclide contamination but are generally indicative
13 of surface and relatively shallow soil contamination. An aerial gamma-ray radiation
14 survey (gross gamma) was performed over the 200 West Area in July and August 1988
15 (Reiman and Dahlstrom 1988). The survey lines were flown with a 122 m (400 ft)
16 spacing at an altitude of 61 m (200 ft). The data were normalized to a height of 1 m
17 (3.28 ft) above the ground surface. Figure 4-1 presents the gross count data (counts per
18 second) on an isoradiation contour map that covers the entire 200 West Area. Much of
19 the Z Plant Aggregate Area, particularly the southern portion has gross gamma counts
20 above background. Several of the Z Plant burial ground areas have counts exceeding
21 22,000 to 70,000 counts per second (ct/sec) (Sites 9 through 12 on Figure 4-1). The
22 results are likely indicative of (shallow) buried radioactive waste sources at these
23 locations, or above-ground storage such as at the 2702-W RMW Storage Facility at Site
24 11.

25
26 General areas of known or suspected surface and subsurface contamination in the
27 burial ground areas have been identified by Huckfeldt (1991b) and are shown on Figure
28 4-2. It is nearly impossible to convert the gross gamma results from the airborne survey
29 to a meaningful exposure rate because of the complex distribution of radionuclides on
30 the site (Reiman and Dahlstrom 1988).

31
32 **4.1.1.2.2 Surface Radiological Survey Data.** Radiological surveys documenting
33 radiation levels dose rates are completed on a regular basis for specific waste
34 management unit areas within the Z Plant Aggregate Area using portable
35 instrumentation. The surveys are performed as part of the Radiation Area Remedial
36 Action program. The primary requirements of the Radiation Area Remedial Action
37 program are to conduct the surveillance, maintenance, decontamination, and/or interim
38 stabilization of inactive burial grounds, cribs, ponds, trenches, and Unplanned Release
39 sites at the Hanford Site. The major concern associated with these requirements is the
40 management and control of surface soil contamination. At confirmed surface soil
41 contamination sites, interim stabilization is routinely conducted to provide a measure of

9 3 1 2 8 6 5 0 8 4 1

1 control that will mitigate migration of radioactive contamination from beyond the posted
2 control boundaries.

3
4 The surveillance of ground surface sites for the Radiation Area Remedial Action
5 program is performed in accordance with surveillance frequencies established in Winship
6 and Hughes (1991) to identify those waste management units that require
7 decontamination and/or stabilization: surveillance is also conducted to verify that
8 radioactive contamination is not migrating beyond the posted control boundaries for
9 those sites ranked under Winship and Hughes (1991). This assessment determines if any
10 changes in the radiological status, resulting from an inadequacy of containment of
11 radioactive materials, has occurred in each area. Each radiological survey is intended to
12 determine whether the contamination is essentially confined to the soil surface or if the
13 contaminant source is present at depth. Further, the surveys provide data for confirming
14 that radioactive-contaminated ground sites are posted in accordance with the
15 requirements in WHC 1989.

16
17 Survey results were compiled from the WIDS (WHC 1991a) and from a
18 compilation of Z Plant radiological survey data. Results of the radiological surveys are
19 presented in Table 4-5, and are broken down by contamination levels and dose rate
20 measurements. Survey results for specific waste management units are discussed in
21 Section 4.1.2. The radiological surveys are either performed by walking the site or
22 utilizing vehicles equipped with β -gamma detectors (scintillation- N_aI (sodium iodide)
23 detectors). Surveys performed on foot report maximum general area dose rates (P-11
24 Probe with Geiger-Mueller detector or equivalent) and "direct frisk" readings within
25 several cm of the soil surface. Few "smears" are taken in environmental sampling.
26 Vehicle surveys (<10 mph) use detectors positioned approximately 0.5m above the
27 ground. The presence of alpha contamination, when measured, is detected with a
28 portable alpha meter. Beta-gamma contamination is measured in ct/min and converted
29 to dis/min (10 percent counting efficiency). High levels of β contamination are
30 sometimes associated with a dose reading (mrad/hr). Alpha contamination is reported as
31 dis/min (7 to 8 percent counting efficiency).

32
33 **4.1.1.2.3 External Radiation Dose Rate Measurements.** External (ambient)
34 radiation monitoring via thermoluminescence dosimetry (TLD) are conducted during the
35 RHO/WHC annual surveillance monitoring (Elder et al. 1986 through 1989, Schmidt et
36 al. 1990 and 1991). The TLD surveys are completed quarterly at soil grid sampling
37 locations (see Section 4.1.1.2.4 for description of grid locations) to measure dose rates
38 from penetrating radiation. The TLDs measure exposure rates resulting from all types of
39 external radiation, including cosmic radiation, naturally occurring radioactivity in soil and
40 air, fallout from nuclear weapons testing, and contributions from Hanford Site activities.
41 Within the 200 Areas, the TLDs are intended to monitor potential exposure rates near

1 possible radiation sources near active and inactive waste management units, and along
2 fence-line boundaries. The TLD survey data is used to determine baseline exposure
3 potential for the 200 Areas, and measure dose-equivalent rates reported in millirems per
4 year (mrem/yr).

5
6 Each TLD consists of three chips of calcium-fluoride/manganese (Harshaw TLD-
7 400) encased in an opaque capsule lined with 0.025 cm of tantalum and 0.005 cm of lead.
8 Each capsule is placed in a translucent, waterproof, plastic vial and is mounted about 1
9 m (3 ft) above the ground. The TLD capsules are exchanged each calendar year. Each
10 quarterly measurement is an average of the exposure received by the three chips in the
11 same container. The response of the chips is calibrated in the PNL Radiation
12 Laboratory.

13
14 TLD results from the RHO/WHC annual monitoring reports for five soil grid
15 points within the Z Plant Aggregate Area are presented in Table 4-6 of this report.
16 Results are also reported for sample locations 218-W-2A (immediately east of 218-W-2A
17 Burial Ground), and 216-Z-20 [location identified at 216-Z-18 Crib in 1990 annual report
18 (Schmidt et al. 1991) (Plate 2)]. Where listed in the RHO/WHC reports, Table 4-4
19 includes quarterly minimum and maximum values, and the normalized annual equivalent
20 total for each sample location. The table results are reported in terms of an air dose.

21
22 For each TLD grid sample locations (except sample 2W2), average annual results
23 ranged from 78 to 85 mrem/yr for each of the years 1985 through 1989 (Elder et al. 1986
24 through 1989, Schmidt et al. 1990). Each of the annual monitoring reports compared
25 these results against regional background levels obtained annually by PNL during
26 Hanford Site-wide monitoring. The background levels are derived by PNL from TLD
27 survey results obtained at sample locations distant from the Hanford Site (Walla Walla,
28 McNary, Sunnyside, Moses Lake, Washtucna, and Yakima). Annual regional background
29 levels ranged between 52 to 93 mrem/yr between 1985 and 1989. For each of these years
30 the RHO/WHC annual monitoring reports concluded that the 200 Areas TLD results
31 (including Z Plant Aggregate Area locations listed) were "within or slightly above" the
32 PNL background values. Grid sample 2W2 had an averaged annual value of 132
33 mrem/yr, between 1985 and 1988 (analysis not completed in 1989 and 1990) above the
34 background levels cited. The elevated TLD results from these sites could be indicative of
35 sources of radiological contamination in surface soil or shallow-subsurface materials near
36 these locations. The presence of other external radiation sources in the vicinity, such as
37 waste burial containers could also potentially contribute to the elevated TLD reading for
38 grid sample 2W2. In 1990 TLD sample analysis results were reported for location in the
39 218-W-2A burial ground and near the head of the 216-Z-20 Crib (Schmidt et al. 1991).
40 Annual totals of 108 and 102 mrem/yr were detected at these locations, respectively.

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1 These values were below the maximum readings detected at PNL McNary site (108
2 mrem/yr) and at the Hanford Site Yakima barricade (112 mrem/yr) in 1989.

3
4 **4.1.1.2.4 Surface Soil Sampling.** Radionuclide data from surface soil samples was
5 reviewed from the RHO/WHC annual environmental surveillance monitoring reports for
6 1985 through 1989 (Elder et al. 1986 through 1989, Schmidt et al. 1990). During the
7 annual monitoring, surface soil samples are collected from points on a rectangular grid in
8 the 200 Areas. The grid points are generally located close to the intersection of Hanford
9 Site coordinate lines, with four of the grid points (2W2, 2W3, 2W7, 2W17) located within
10 the Z Plant Aggregate Area (Plate 2). Grid sample locations 2W2 and 2W3 are located
11 in the 218-W-3AE and 218-W-6 Burial Grounds, respectively, in the northern part of the
12 Z Plant Aggregate Area. Sample 2W7 is located along the eastern boundary of the 218-
13 W-2A Burial Ground. Grid points 2W17 and 2W22 are located in the 218-W-4C Burial
14 Ground in the southwest part of the site. A fenceline soil sample (2WN) was been
15 established along the northern fenceline of the 218-W-3AE Burial Ground.

16
17 Sample 2W7 and fenceline sample location 2WN have analytical results for each
18 of the years 1985 through 1989. Other Z Plant Aggregate Area samples were not
19 analyzed for some of the years within this period. Discussion of rationale for which
20 sample sites are selected for analysis each year, and which radiological parameters are
21 analyzed is not provided in the annual reports. Each grid point sampling site is 10 m by
22 10 m in area, and each fence line sampling point is 1 m by 5 m. Soil samples from each
23 sampling site represent soil composited from five individual plugs 2.5 cm in depth by 10
24 cm in diameter collected over the sampling site.

25
26 The annual reports indicate that the soil sampling grid was established to evaluate
27 general, long-term accumulation trends for a variety of radionuclides in site soils.
28 Fenceline sample points are intended to monitor areas upwind and downwind of specific
29 sources of potential contamination, however the 2WN fenceline location is relatively
30 distant from production and processing facilities. Soil (and biota) grid point and
31 fenceline sampling was discontinued in 1990, and sampling now focuses on buildings and
32 facilities other than waste management units. In 1990, soil samples were collected
33 around the main Z Plant Aggregate Area building complex.

34
35 Soil monitoring results from the 1985 through 1989 annual environmental
36 surveillance reports are presented in Table 4-7. Entries in the table are average results
37 over this period for radionuclides analyzed. The complete data set from the annual
38 monitoring reports since 1985 is provided in Table A-4 of Appendix A. Results for six of
39 the radionuclides in Table A-4 show positive detections greater than the counting error
40 for the Z Plant soil samples in Table A-4. These radionuclides include cesium-137, lead-
41 214, plutonium-238, plutonium-239, strontium-90, and uranium. In general, the highest

1 average Z Plant radionuclide concentrations for cesium-137, plutonium-238, plutonium-
2 239, and strontium-90 in soil were detected at the 2W2 sample location in the 218-W-
3 3AE Burial Ground. Average lead-214 and uranium concentrations were highest at
4 sample locations 2W22 (218-W-4C Burial Ground) and 2W3 (218-W-6 Burial Ground).
5 The concentrations of these parameters likely reflect wind-dispersion patterns of airborne
6 radionuclides from 200 Areas production and processing facilities. Airborne
7 radionuclides transported from Unplanned Release locations and wind-eroded burial
8 ground areas may also contribute to the elevated radionuclide levels in the surface soil
9 samples.

10
11 In the 1989 environmental surveillance report, Schmidt et al. (1990) reported that
12 trend analysis of radionuclide concentrations revealed no overall increase since 1978 for
13 the 200 Areas grid point soil samples. Each of the annual reports also concluded that
14 concentrations of radionuclides other than cesium-137, strontium-90, and plutonium-239
15 in the grid point samples were determined to be "insignificant compared with background
16 or with the latter radionuclides." Background concentrations cited in the annual reports
17 were derived by RHO/WHC from off-site soil monitoring data obtained annually by PNL
18 (Jaquish and Bryce 1989) as part of Hanford Site-wide environmental monitoring
19 activities.

20
21 Some degree of surface soil contamination is suspected in several areas around
22 the periphery of the Z Plant building complex, as indicated by elevated plutonium
23 concentrations in soil samples collected in 1990 (see Section 4.1.2.1.3 for discussion).

24
25 **4.1.1.3 Surface Water.** No natural surface water bodies exist within the Z Plant
26 Aggregate Area. During the 1988, 1989, and 1990 annual monitoring, however, water
27 quality data were collected for the 216-Z-21 Seepage Basin. No detectable
28 concentrations of radionuclides, nitrates, and other constituents were identified (Elder et
29 al. 1989, Schmidt et al. 1990 and 1991). However, several ionic lides were detected in
30 vegetation and sediment samples collected in the Seepage Basin which are discussed
31 below.

32
33 **4.1.1.4 Biota.** Radionuclide analyses were completed for vegetation samples collected
34 from 200 Area grid points during annual monitoring for 1985 through 1989. Average
35 concentrations of radionuclides over this period are presented in Table 4-8. Analytical
36 data from the annual reports for each of these years is provided in Table A-5 of
37 Appendix A. The rationale for selection of sample sites and radiological parameters
38 analyzed each year is not provided in the annual reports.

39
40 Since 1985, each of the Z Plant Aggregate Area grid sites sampled had cesium-137
41 concentrations exceeding background levels as reported in the annual monitoring reports.

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1 Also sample 2W17 contained plutonium-238 concentrations above the reported
2 background level in 1985 (Elder et al. 1986), and sample 2W22 had strontium-90
3 concentrations above the background level in 1988 (Elder et al. 1989). Elevated cesium-
4 137 concentrations detected during 1986 were attributed to the affect of the Chernobyl
5 nuclear accident (Jaquish and Bryce 1989). Background concentrations cited in the
6 annual monitoring reports were derived from off-site regional background data in annual
7 PNL Hanford Site monitoring surveys. Other radionuclides were detected at
8 concentrations above the counting error for several of the samples (notably 2W7 and
9 2W17 in 1989, Schmidt et al. 1990), but background comparative data were not available
10 from the annual reports. Concentrations of these radionuclides (plutonium-238, and
11 strontium-90) in grid point vegetation samples may be attributable to several sources.
12 Although a radionuclides in site soils may be derived from windborne dispersion of
13 material released to air from site production/processing facilities, radioactive fallout from
14 nuclear weapons testing and the Chernobyl accident is also expected to contribute.
15

16 During the 1989 annual environmental surveillance monitoring (Schmidt et al.
17 1990) an aquatic vegetation sample was collected from the 216-Z-21 Seepage Basin
18 (formerly 207-Z Basin) (Table 4-9). The sample contained plutonium-239 concentrations
19 above background levels reported in Schmidt et al. (1990) for 1989. The seepage basin is
20 an area where tumble weeds blow in from other Hanford areas and may be transported
21 from areas with potential radioactivity. The tumble weeds are periodically cleared out
22 for disposal. Sediment from the seepage basin was also found to contain elevated
23 concentrations of several radionuclides (Schmidt et al. 1990 and 1991) during the 1989
24 and 1990 annual monitoring programs (Table 4-9).
25

26 A 1990 surface sample from the 216-Z-9 Crib vegetation contained detectable
27 total uranium (Table 4-9). Comparative background concentrations for total uranium in
28 vegetation were not reported for 1990.
29

30 **4.1.1.4.1 Other Biotic Samples.** Additional biotic samples within the Z Plant
31 Aggregate Area have been collected for radiological evaluation during annual
32 surveillance monitoring for some years. Samples have included rabbit feces at soil grid
33 point 2W22 in the 218-W-4C Burial Ground (Elder et al. 1986), rabbit feces at the 231-Z
34 fenceline (Elder et al. 1988), and mouse feces west of Z Plant (Schmidt et al. 1991), with
35 radiologic biotic contamination reported in each instance. Radionuclide contaminants
36 include cesium-137, europium-152, strontium-90, and plutonium.
37

38 The source of the contaminated material identified in the rabbit feces at 2W22 is
39 indeterminent, because of the mobility of the animal. The contaminated rabbit and
40 mouse feces may be associated with sources within or near the main Z Plant complex,
41 but are not specifically identified in the annual environmental reports.

1 **4.1.1.5 Vadose Zone Contamination.** This section presents sampling and analytical data
2 applicable to vadose zone soils across the Z Plant Aggregate Area as a whole.
3 Information specifically related to individual waste management units, or which applies to
4 a group of units is subsequently discussed under the appropriate subheadings in the Site-
5 Specific Data (Section 4.1.2). The Vadose Zone Contamination section includes three
6 subsections that describe sampling and analysis results from the Expedited Response
7 Action (ERA) Proposal for the 200 West Area Carbon Tetrachloride Plume (DOE/RL
8 1991b). The report describes the extent and concentrations of carbon tetrachloride in
9 vadose zone soils resulting from disposal of an estimated 363,000 to 580,000 liters of
10 organic and aqueous waste processing liquids from Z Plant facilities between 1955 and
11 1973. The discussion in Subsection 4.1.1.5.1 summarizes information from ERA Proposal
12 as it pertains to the "far field" distribution of carbon tetrachloride across the Z Plant
13 Aggregate Area. Subsection 4.1.1.5.2 summarizes the approach for screening and
14 interpreting geophysical gamma-ray logs used to evaluate subsurface radionuclide
15 contamination. The results of the log interpretations are in turn discussed in Section
16 4.1.2 for individual waste management units. Subsection 4.1.1.5.3 describes the potential
17 for historical migration of wastewater from waste disposal sites to the unconfined aquifer.
18

19 **4.1.1.5.1 Carbon Tetrachloride Distribution.** The Carbon Tetrachloride ERA
20 Proposal (DOE/RL 1991b) presents information regarding carbon tetrachloride and other
21 organic and inorganic chemicals, and radionuclides discharged to Z Plant cribs. Carbon
22 tetrachloride waste liquids were discharged primarily to the 216-Z-1A Tile Field, 216-Z-9
23 Trench, and 216-Z-18 Crib. The data from the ERA Proposal include results of soil and
24 soil vapor analyses from samples collected as part of the carbon tetrachloride evaluation.
25

26 As part of the ERA Proposal, a discussion is provided for "far field" soil vapor
27 detections of carbon tetrachloride and other volatile organic compounds in boreholes
28 more distant from the 216-Z-1A Tile Field, 216-Z-9 Trench, and 216-Z-18 Crib areas
29 (Figure 4-3). The compounds were detected using field screening instruments in wells
30 throughout the Z Plant Aggregate Area and 200 West Area drilled since 1987. Field
31 screening was completed via use of photoionization detectors for wells 299-W7-7, 299-
32 W7-8, 299-W7-9, 299-W7-10, 299-W15-19, 299-W15-20, 299-W15-21, 299-W15-23, 299-
33 W15-24, and 299-W15-26 located in the Z Plant Aggregate Area northern and
34 southeastern burial ground areas, as seen on geologist's borehole logs in Goodwin and
35 Bjornstad (1990). Follow-up verification of the presence of carbon tetrachloride or other
36 organic compounds in the vapor samples may not have been completed since results are
37 not reported in the sources cited. The wells are differentiated on Figure 4-3 with respect
38 to whether the organic compounds were detected above or below the Plio-Pleistocene
39 calcic paleosol layer. The Plio-Pleistocene layer is described in Section 3.1.2. Most of
40 the reported field screening detections were below the calcic paleosol layer, although

1 wells west of the 216-Z-18 Crib had detections both above and below the calcic paleosol
2 layer.

3
4 The Carbon Tetrachloride ERA Proposal concludes that the vapors below the
5 caliche layer are generally found in an area roughly coincident with the area underlain by
6 carbon tetrachloride-affected groundwater, suggesting that these vapors may have
7 volatilized from the groundwater plume. The affected groundwater extends over much of
8 the Z Plant Aggregate Area. No reports of liquid phase carbon tetrachloride
9 encountered in the subsurface are known. The ERA Proposal states that the carbon
10 tetrachloride groundwater data are consistent with a "point source" from the 216-Z-9
11 Trench. The report concludes that this source is possibly the result of relatively large
12 volumes of liquid discharged to the crib, or liquid phase carbon tetrachloride moving
13 downward along preferential pathways (e.g., older well casings with no annular seal).

14
15 **4.1.1.5.2 Geophysical Logging.** The extent of radionuclide contamination in
16 vadose zone soils in the Z Plant Aggregate Area has been evaluated using borehole
17 geophysical techniques. Geophysical well logging has been conducted in the Z Plant
18 Aggregate Area since the late 1950s. Gross gamma-ray logs have been used since that
19 time to evaluate radionuclide migration in the vadose zone beneath selected waste
20 management units. However, very little gross gamma data have been published. As part
21 of the current report gamma logs were reviewed from Fecht et al. (1977) and Chamners
22 et al. (1991). Table 4-10 summarizes results of the gross gamma logging by waste
23 management unit. Interpretation of the logs generally consisted of identifying zones with
24 anomalously high gamma-ray counts that could be indicative of radionuclide
25 contamination. The depths, thicknesses, and intensities of these zones were then
26 compared with other historical logs from the same bore holes. Interpretations are
27 complicated by the fact that logging equipment and procedures evolved with time.
28 Attempts made to normalize data collected at different times have met with limited
29 success (e.g., Fecht et al. 1977), and quantitative interpretations were not possible. The
30 log interpretations are discussed in detail in Appendix A.1, and results of log
31 interpretations for individual waste management units are also summarized in Section
32 4.1.2.

33
34 **4.1.1.5.3 Monitoring Well Soil Sampling Results.** Soil samples were collected
35 during installation of nine monitoring wells in the Z Plant Aggregate Area Solid Waste
36 Burial Grounds between 1987 and 1991 (Goodwin and Bjornstad 1990; and Barton et al.
37 1990). The soil samples were analyzed for one or more of the following parameters:

- 38
39 • Organic compounds
40
41 • Inorganic anions

- 1 • Gross alpha and beta
2
3 • Total organic carbon (TOC).
4

5 Soil samples were collected from four well locations near the northern boundary
6 of the Z Plant Aggregate Area (Figure 4-4):
7

- 8 • 218-W-3AE Burial Ground wells 299-W7-7, 299-W7-8, and 299-W7-10
9
10 • 218-W-5 Burial Ground well 299-W7-9.
11

12 Soil samples were also collected from five well locations on the southwestern
13 boundary of the Aggregate Area:
14

- 15 • 299-W-4B Burial Ground wells 299-W-15-19, 299-W-15-20, and 299-W-15-23
16
17 • 218-W-4C Burial Ground wells 299-W-15-21 and 299-W-18-26.
18

19 Soil samples from the wells were collected at depths ranging from 1.5 m (5 ft) to
20 73 m (240 ft) below ground surface. The results of these analyses are presented in
21 Tables A-7 and A-8 in Appendix A. Only chemicals detected in one or more samples
22 are included in these tables. The following discussion summarizes the general
23 distribution of detected chemicals in the burial ground areas.
24

25 **4.1.1.5.3.1 Organic and Inorganic Parameters.** Levels of most inorganic anions
26 were low or nondetectable in the eight samples in which they were measured.
27 Concentrations of nitrate and sulfate ranged from below detection to 38.5 and 130 mg/kg,
28 respectively. Concentrations of nitrate and sulfate did not shown an obvious distribution
29 pattern with depth and did not appear to be greatly elevated in any particular well.
30

31 Organic chemicals were analyzed for in selected samples from each well. Many of
32 the samples were analyzed only for chloroform, carbon tetrachloride, methylene chloride,
33 trichloroethylene, tetrachloroethylene, 1,1,1-trichloroethane, benzene, toluene, and
34 xylenes. One sample (the 38 m [125 ft] sample from well 299-W-15-21) was analyzed for
35 an extensive list of volatile organics; however, most of these were not detected and
36 therefore have not been listed in Table A-8.
37

38 Concentrations of volatile organics in samples from the northern Z Plant
39 Aggregate Area burial grounds were generally less than 10 $\mu\text{g}/\text{kg}$ or below detection
40 limits. The highest levels of these compounds were observed in the 68 m (220 ft) sample
41 of Well 299-W7-9 and in the 64 m (210 ft) sample of Well 299-W7-8, which were taken

1 approximately at the water table. Concentrations in shallower samples from these wells
2 were below detection limits; thus, these results appear to indicate interception of a plume
3 related to the underlying groundwater rather than a vadose zone source in the burial
4 ground areas.

5
6 Halogenated organics were detected in many of the samples obtained from wells
7 in the western Z Plant Aggregate Area burial grounds. Concentrations were generally
8 much higher than in the wells north of the site, with several compounds exceeding 100
9 $\mu\text{g}/\text{kg}$. Chemicals detected at the highest concentrations were methylene chloride,
10 chloroform, benzene, 1,1-dichloroethylene, and trans-1,2-dichloroethylene (wells
11 299-W15-23 and 299-W18-26). Carbon tetrachloride was also detected in eight of the
12 burial ground wells (Table 4-12), at concentrations up to 12 $\mu\text{g}/\text{kg}$ (well 299-W7-9).
13 Chemicals were detected from 6.1 m (20 ft) below the surface to 93 m (240 ft), the
14 greatest depth sampled. This range of depths corresponds to detections both above and
15 below the Plio-Pleistocene calcic paleosol layer. The depth zone of greatest
16 contamination ranged from 55 to 73 m (180 to 240 ft) below ground surface.
17 Concentrations were generally highest at 55 m (180 ft) and decreased with depth;
18 however, this pattern did not hold for individual chemicals in some wells. Due to the low
19 concentrations of these organics in soils above 55 m (180 ft), it appears that these
20 detections do not indicate a source in the immediate area of the well, but rather may
21 indicate interception of an underlying plume of contamination or migration of vapor
22 along the caliche layer.

23
24 **4.1.1.5.3.2 Radionuclide Parameters.** Results of radiological analyses of beta and
25 lo-alpha activity are presented in Tables A-7 and A-8 in Appendix A. Results ($\text{pCi}/\text{G} \pm \sigma$)
26 were reported for all samples submitted from each well (Goodwin and Bjornstad 1990
27 and Barton et al. 1990).

28
29 Each sample result is reported in pCi/g . The standard deviation (σ) associated
30 with each count is also included. Beta radiation ranged from 12.2 pCi/g (well 299-W7-7)
31 to 29.1 pCi/g (well 299-W7-8), and generally showed little variation with sample depth or
32 well location. Two wells, 299-W7-7 and 299-W7-8 had lo-alpha results of 0.171 and -1.52
33 pCi/g , respectively; otherwise lo-alpha radiation in the burial ground wells ranged from
34 1.18 pCi/g (well 299-W15-23) to 15.4 pCi/g (well 299-W15-20). In general, obvious
35 localized sources of radiation are not indicated from the analysis results of the burial
36 ground well soil samples.

37
38 **4.1.1.5.4 Potential for Migration to the Unconfined Aquifer.** As discussed in
39 Subsection 4.1.1.5.1, the Carbon Tetrachloride ERA Proposal (DOE/RL 1991b)
40 concluded that liquid disposal volumes discharged to the 216-Z-9 Trench were probably
41 sufficient to have migrated to the water table. The ERA Proposal also concluded that it
42 is uncertain whether liquids containing carbon tetrachloride reached the water table at

1 the 216-Z-1A Tile Field or 216-Z-18 Crib. These conclusions are based on a comparison
2 of the waste volumes discharged at each crib, with the specific retention volumes of the
3 cribs, and with the estimated pore volume in the vadose zone soil column below the crib.
4

5 Soil column pore volume calculations analogous to those in the Carbon
6 Tetrachloride ERA Proposal were completed for this report to assess the likelihood that
7 contaminated liquid wastes from the Z Plant Aggregate Area cribs and 216-Z-1A Tile
8 Field migrated to the unconfined aquifer (Table 4-11). The volume of liquid required for
9 a wetting front to reach the water table was estimated roughly from the waste
10 management unit dimensions, soil porosity, and soil moisture content. Calculated soil
11 pore volumes for each of the waste management units that received large volumes of
12 liquids and the total volume of liquid waste disposed of to these units are presented in
13 Table 4-11. Waste management units that received a volume of liquid waste substantially
14 less than the pore volume are unlikely to have had the liquid reach the water table. For
15 the 216-Z-1A Tile Field, where infiltration took place primarily beneath the distribution
16 piping, the effective infiltration area may be smaller than the area of the waste
17 management unit, and the use of the total area may overestimate the available pore
18 volume. Since the pore volume calculation is based on historical discharges to liquid
19 waste sites, additional potential driving forces such as recharge from precipitation are not
20 considered. A discussion of natural recharge rates, including results of Hanford Site
21 lysimeter studies is presented in Section 3.5.
22

23 Results of the calculations for the 216-Z-1A Tile Field, 216-Z-9 Trench, and
24 216-Z-18 Crib waste management units are similar to results for these units discussed in
25 the Carbon Tetrachloride ERA Proposal (DOE/RL 1991b). The results indicate that
26 potential for liquids to have reached the water table beneath the 216-Z-9 Trench is high,
27 but low for the 216-Z-1A Tile Field. The results from Table 4-11 also indicate that
28 migration of liquid wastes from the 216-Z-3, 216-Z-5, 216-Z-7, 216-Z-12, 216-Z-16 Cribs,
29 216-Z-17 Trench, and the 216-Z-10 Reverse Well to the water table is suspected. The
30 latter conclusion is primarily due to the waste volumes disposed of at these locations.
31
32

33 4.1.2 Site-Specific Data

34

35 This section presents sampling and analysis data, and waste inventory information
36 regarding possible releases for individual Z Plant Aggregate Area waste management
37 units. The information presented was obtained from reference documents reviewed for
38 the current report. For many of the waste management units the information is limited,
39 and the lack of more comprehensive information may constitute significant "data gaps."
40 Issues related to data gaps are discussed in more detail in Section 8.0 of this report.
41

1 The waste management units discussed in this section are presented in the same
2 general groupings as described in Section 2.0. These groupings are useful because
3 structurally similar units tend to have similar types of available data. Since each of the
4 Unplanned Releases in the Z Plant Aggregate Area is associated with a specific waste
5 management unit, Unplanned Release data are included in the waste management unit
6 discussions as applicable. Locations of the waste management units and Unplanned
7 Releases are identified on Figures 2-2 through 2-4 and 2-7 through 2-13 in Section 2.0.
8

9 **4.1.2.1 Plants, Buildings, and Storage Areas.** Plant, building, and storage area waste
10 management units at the Z Plant Aggregate Area include the 232-Z Incinerator, the 234-
11 5Z Hazardous Waste Staging Area (HWSA), the RMW Storage Facility, and the
12 (proposed) Waste Receiving and Processing Plant (WRAP). Also, the main Z Plant
13 Building complex (consisting of the 234-5Z, 236-Z, 242-Z, 291-Z, 2736-Z, and 2736-ZB
14 Buildings) is included because of several Unplanned Releases in the vicinity, and 1990
15 soil sampling data from this area.
16

17 **4.1.2.1.1 232-Z Incinerator.** The 232-Z Incinerator was used to incinerate
18 plutonium-contaminated wastes, and fallout from stack releases may have contributed to
19 elevated plutonium concentrations in Z Plant Aggregate Area surficial soils. Low levels
20 of alpha radiation have been reported in surface radiological surveys, but the area is
21 listed as stabilized.
22

23 **4.1.2.1.2 234-5Z HWSA, RMW Storage Facility, and WRAP Facility.** No releases
24 were reported at the 234-5Z HWSA or at the RMW Storage Facility in the documents
25 reviewed. The WRAP facility is currently a proposed RCRA TSD facility, and therefore
26 there are no associated releases. Information regarding soil and other potentially
27 affected media associated with the 234-5Z HWSA and the RMW Storage Facility were
28 not found in the documents reviewed.
29

30 **4.1.2.1.3 Main Z Plant Building Complex.** Several Unplanned Releases
31 (UPR-200-W-23, UN-200-W-89, UN-200-W-90, UN-200-W-9, and UPR-200-W-103; Table
32 2-5) are associated with the Main Z Plant Building Complex. In 1990, 22 soil samples
33 were collected at locations adjacent to the main Z Plant building complex for cesium-137
34 and plutonium analysis (Plate 2). The soil samples were collected as part of annual
35 monitoring activities at the Hanford Site (Schmidt et al. 1991). Detectable cesium-137
36 concentrations were noted in 10 of the samples along the building complex perimeter
37 fence and adjacent to the plant buildings (Table A-6). Plutonium was detected in 15 of
38 the samples, primarily at locations north of the 234-5Z Building. Additional information
39 regarding soil sampling rationale, methods, and comparisons to regional background
40 levels was not provided in the 1990 WHC monitoring report (Schmidt et al. 1991).
41

1 **4.1.2.2 Tanks and Vaults.** Z Plant Aggregate Area tanks include the 216-Z-8 Settling
2 Tank, the 241-Z-361 Settling Tank, and the 241-Z-Treatment Tank. No vault structures
3 were identified in the Z Plant Aggregate Area. No specific sampling and analysis
4 information regarding soil and other potentially affected media associated with the
5 216-Z-8 Settling Tank, the 241-Z-361 Settling Tank, and the 241-Z-Treatment Tank were
6 found in the documents reviewed.

7
8 **4.1.2.2.1 216-Z-8 and 241-Z-361 Settling Tanks.** The 216-Z-8 Settling Tank
9 received liquid waste from the RECUPLEX facility from 1955 to 1962. The process
10 waste stream overflowed from the 216-Z-8 Settling Tank into the 216-Z-8 French Drain,
11 where the waste was disposed of to the soil column. The 241-Z-361 Settling Tank
12 received plutonium and other wastes routed to crib disposal sites and the 216-Z-1A Tile
13 Field. No documented releases from either tank were identified in the references
14 reviewed. No monitoring wells were identified near the tanks. Therefore, no geophysical
15 logging data were located for these facilities.

16
17 **4.1.2.2.2 241-Z Treatment Tank.** The 241-Z Treatment Tank is a RCRA TSD
18 facility located inside the 241-Z Building. The D-6 tank, adjacent to the 241-Z
19 Treatment Tank failed and was taken out of service. Three Unplanned Releases, UPR-
20 200-W-74, UN-200-W-79, and UPR-200-W-75 (described in Table 2-5) are associated
21 with this area. These Unplanned Releases are known to have released radionuclides to
22 the environment. However, no specific sampling data were identified.

23
24 **4.1.2.3 Cribs and Drains.** Z Plant Aggregate Area waste management units in this
25 category include the 216-Z-1, 216-Z-2, 216-Z-3, 216-Z-5, 216-Z-6, 216-Z-7, 216-Z-12, 216-
26 Z-16, and 216-Z-18 Cribs; the 216-Z-8, 216-Z-13, 216-Z-14, and 216-Z-15 French Drains;
27 and the 216-Z-1A Tile Field.

28
29 Information available for Z Plant Aggregate Area Cribs, the 216-Z-8 French
30 Drain, and the 216-Z-1A Tile Field includes radionuclide sampling and analyses for waste
31 materials contained in the crib structures and subsurface soils, soil and soil vapor analyses
32 for vadose zone soils, and surface radiological surveys. Due to their historical use for
33 disposal of carbon tetrachloride, the potential for emission of volatile organic compounds
34 to air exists for some of the facilities, notably the 216-Z-1A Tile Field and the 216-Z-18
35 Crib. Waste inventory information also indicates the presence of known or suspected
36 vadose zone contamination at virtually all of the crib and tile field locations. The
37 potential for migration of waste liquids from the crib structures to the underlying
38 unconfined aquifer is discussed in Section 4.1.1.5.3.

39
40 **4.1.2.3.1 216-Z-1, 216-Z-2, and 216-Z-3 Cribs.** The 216-Z-1, 216-Z-2, and 216-Z-3
41 Cribs are located within the overall structure of the 216-Z-1A Tile Field, near its north

1 end. Several monitoring wells are located around the 216-Z-1 and 216-Z-2 Cribs. A
2 review of available gamma scintillation logs revealed elevated gamma response,
3 potentially indicating the presence of radionuclides, between depths of 7 and 21 m
4 beneath both cribs (Table 4-10). Two monitoring wells (299-W18-67 and 299-W18-68)
5 located inside the 216-Z-3 Crib have not been logged using gamma scintillation
6 equipment. Only natural gamma response has been observed in monitoring well 299-
7 W18-88 which is located southeast of the 216-Z-3 Crib (Table 4-10).

8
9 Elevated alpha radiation (15,000 dis/min) and smearable alpha radiation (1,500
10 dis/min) were detected in a 1989 surface radiation survey at the 216-Z-1 and 216-Z-2
11 Cribs.

12
13 Based on this information, near-surface and deeper vadose zone soil radionuclide
14 contamination is suspected for the 216-Z-1, 216-Z-2, and 216-Z-3 Cribs.

15
16 **4.1.2.3.2 216-Z-5, 216-Z-6, and 216-Z-7 Cribs.** The 216-Z-5, 216-Z-6, and 216-Z-7
17 Cribs received radionuclide and chemical wastes (mainly inorganic) received from the
18 231-Z Building. A high cave-in potential was reported for the 216-Z-5 and 216-Z-6 Cribs
19 in the WIDs (WHC 1990a). No specific chemical sampling data was identified for these
20 cribs. A review of available gamma scintillation logs (summarized in Table 4-10)
21 revealed elevated gamma response, possibly indicative of radionuclide contamination,
22 between depths of 30 and 40 m below ground surface (above the water table), and from
23 50 to 63 m (below the water table) in well 299-W15-1 which is located on the east side of
24 the 216-Z-5 Crib. Elevated gamma response was also observed between depths of 8 and
25 23 m in well 299-W15-212 which is located approximately 100 m north of the 216-Z-5
26 Crib. The source of this gamma activity is unknown.

27
28 Elevated gamma response was also observed in several wells completed in and
29 around the 216-Z-7 Crib between depths of 7 and 46 m and below the water table
30 (between depths of 45 and 100 m). No wells monitor conditions in the 216-Z-6 Crib.
31 Based on this information, near-surface and deeper vadose zone soil contamination is
32 suspected for the 216-Z-5 and 216-Z-7 Cribs.

33
34 No detectable surface radiation was measured at these cribs during 1991
35 radiological surveys.

36
37 **4.1.2.3.3 216-Z-12 Crib.** The 216-Z-12 Crib received PFP liquid process waste and
38 analytical development laboratory waste from the 234-5Z Building (via the 241-Z-361
39 Settling Tank and the 241-Z Diversion Box No. 2). Crib wastes included high-salt liquids
40 containing plutonium which were adjusted to a pH of 8 to 10 prior to disposal. No
41 specific chemical sampling data was identified for this crib. A review of available gamma

1 scintillation logs (summarized in Table 4-10) revealed elevated gamma response, possibly
2 indicative of radionuclide contamination, between depths of 5 and 10 m below ground
3 surface in several wells inside the crib. Radionuclide and inorganics contamination in
4 near-surface and possibly deeper vadose zone soils from these materials is therefore
5 suspected.

6
7 No detectable surface radiation was measured at the 216-Z-12 Crib during a 1991
8 radiological survey.

9
10 **4.1.2.3.4 216-Z-16 Crib.** The 216-Z-16 Crib received neutral/basic wastes
11 containing plutonium from the 231-Z Building laboratory. Gamma scintillation logging
12 indicated only natural gamma response (Table 4-10) in two monitoring wells located on
13 the south and north margins of the crib (wells 299-W15-10 and 299-W15-11, respectively).
14 While vadose zone contamination is suspected at the site due to historic liquid waste
15 disposal practices, the areal extent of contamination appears to be limited to the crib
16 boundaries.

17
18 No detectable surface radiation was measured at the 216-Z-16 Crib during a 1991
19 radiological survey.

20
21 **4.1.2.3.5 216-Z-18 Crib.** Along with the 216-Z-9 Trench and the 216-Z-1A Tile
22 Field, the 216-Z-18 Crib received quantities of carbon tetrachloride and other organic
23 radioactive wastes from plutonium processing activities. As discussed in Subsection
24 4.1.1.5.1, the distribution of carbon tetrachloride in vadose zone soils (and groundwater)
25 in the vicinity of these disposal units, and area-wide ("far field") extent was the subject of
26 the ERA Proposal for the 200 West Area Carbon Tetrachloride Plume (DOE/RL
27 1991b).

28
29 With specific reference to the 216-Z-18 Crib, the ERA Proposal reported carbon
30 tetrachloride detections in down-hole soil vapor samples from vadose zone boreholes and
31 groundwater monitoring wells within and adjacent to the crib structure. The locations of
32 these borehole/well explorations, and similar explorations for monitoring carbon
33 tetrachloride vapor concentrations near the 216-Z-1A Tile Field and 216-Z-9 Trench are
34 shown on Figure 4-4. The figure refers generically to all the explorations as "wells." The
35 maximum carbon tetrachloride concentrations in the down-hole vapor samples from the
36 216-Z-18 Crib wells was 140 parts per million (ppm - volume). The ERA Proposal
37 concluded that carbon tetrachloride is present in the vicinity of these structures at depths
38 ranging from 24 to 63 m below ground surface.

39
40 A review of available gamma scintillation logs (summarized in Table 4-10)
41 revealed elevated gamma response, possibly indicative of radionuclide contamination,

1 between depths of 6 and 18 m below ground surface in several wells inside and up to 10
2 m south of the crib. Radionuclide and inorganics contamination in near-surface and
3 possibly deeper vadose zone soils from waste materials disposed to this unit is therefore
4 suspected.

5
6 No detectable surface radiation was measured at the 216-Z-18 Crib during a 1991
7 radiological survey.

8
9 **4.1.2.3.6 216-Z-8 French Drain.** Contamination from radionuclides and organic
10 compounds is suspected in vadose zone soils at the 216-Z-8 French Drain, due to
11 overflow of liquid wastes from the 216-Z-8 Settling Tank. A characterization study was
12 previously conducted to evaluate the distribution of radionuclides in soil beneath the 216-
13 Z-8 French Drain and to investigate a suspected leak in the 216-Z-8 Settling Tank. One
14 well was drilled 1m (3 ft) south of the drain, and radiological and geological analyses
15 were performed. The highest plutonium-239 concentration observed in the well was 4.62
16 nCi/g and occurred at a depth of 7.6 m (25 ft). The study estimated that approximately 4
17 to 5 cubic meters of sediments with concentrations greater than 10. mCi/g lay beneath the
18 216-Z-8 French Drain. Four monitoring wells (299-W15-202, 299-W15-213, 299-W15-214,
19 and 299-W15-215) were identified around the perimeter of the French Drain but have
20 not been logged using gamma scintillation equipment. This may be because the grout
21 seals installed in these (relatively new) wells inhibits gamma scintillation counting.

22
23 No detectable radiation was measured at the 216-Z-8 French Drain during a 1991
24 surface radiological survey.

25
26 **4.1.2.3.7 216-Z-13, 216-Z-14, and 216-Z-15 French Drains.** The 216-Z-13, 216-Z-
27 14, and 216-Z-15 French Drains are active non-contact wastewater management units
28 next to the 291-Z Building. Although no releases were reported for these units in the
29 documents reviewed, trace beta activity has been reported for the 216-Z-14 French
30 Drain. Also, previous reports indicate that low level contamination can be assumed due
31 to accidents or unusual events in the process areas. The contamination would be
32 expected to affect vadose zone soils. No gamma scintillation logging wells were identified
33 near these facilities (Table 4-10).

34
35 No detectable surface radiation was measured near the French Drains during a
36 1991 radiological survey.

37
38 **4.1.2.3.8 216-Z-1A Tile Field.** Like the 216-Z-18 Crib (Section 4.1.2.3.5), the 216-
39 Z-1A Tile Field received quantities of carbon tetrachloride and other liquid wastes. The
40 tile field was a key waste management unit considered in the Carbon Tetrachloride ERA
41 Proposal (DOE/RL 1991b) as discussed in Subsections 4.1.1.5.2. and 4.1.2.3.5. During

9 3 1 2 8 6 5 0 8 5 6

1 down-hole vapor sampling conducted at the tile field for the ERA Proposal, the
2 maximum carbon tetrachloride concentration detected was 16.2 ppmv. As part of the
3 ERA Proposal work, the tile field was also the subject of a soil vapor extraction system
4 characterization test. Down-hole soil samples were collected during the test, and
5 indicated that carbon tetrachloride at concentrations of up to 89 ppm has migrated to
6 depths of at least 40 m beneath the 216-Z-1A Tile Field. During the test, chloroform
7 was also detected in vapor samples, but at concentrations below the 5 to 10 ppm range
8 of analytical quantitation limits cited in the ERA Proposal. According to the ERA
9 Proposal, analyses also indicated the presence of 2-butanone at concentrations up to 148
10 ppm, but may be attributable to alcohol used in the analytical method, since 2-butanone
11 was found in the analysis blank sample. Vapor samples from wells near the 216-Z-18
12 Crib and the 216-Z-9 Trench were not analyzed for volatile compounds other than
13 carbon tetrachloride. Interpretation of the data from the ERA Proposal, and discussion
14 of the extent of carbon tetrachloride in Z Plant Aggregate Area soils is provided in the
15 Vadose Zone Contamination section (4.1.1.5), and in the 216-Z-18 Crib section
16 (4.1.2.3.5).

17
18 Price et al. (1979) investigated the distribution of plutonium and americium in soil
19 in the vicinity of the 216-Z-1A Tile Field. During the investigation, 16 wells or vadose
20 zone soil borings were installed to evaluate the lateral and vertical extent of
21 contamination (Figure 4-5). The authors drew the following conclusions:

- 22
23 ● The distribution of plutonium and americium beneath the tile field are
24 similar. The highest measured concentration of plutonium (about 4×10^4
25 nCi/g) and americium (about 2.5×10^3 nCi/g) occurs in sediments located
26 immediately beneath the central distributor pipe.
- 27
28 ● The concentration of plutonium and americium in sediments generally
29 decreases with depth below the bottom of the tile field. An increase in
30 concentration with depth was generally associated with an increase in the
31 silt content of the sediments or with contacts between sedimentary units.
- 32
33 ● The bulk of the actinide contamination appears to be contained within the
34 first 15 m (48 ft) of sediments beneath the bottom of the 216-Z-1A Tile
35 Field. The maximum vertical penetration of the plutonium and americium
36 contamination (defined by the 10^{-2} nCi/g isopleth) is approximately 30 m
37 (98 ft) below the bottom of the facility, or about 30 m (98 ft) above the
38 water table.
- 39
40 ● The distribution of activity in vadose zone wells around the perimeter of
41 the 216-Z-1A Tile Field is discontinuous with depth. The waste appears to

1 have been released to the ground within a few meters of the central
2 distributor pipe and then spread laterally along contacts between dissimilar
3 soil horizons. The lateral spread was limited to within a 10 m (30 ft) wide
4 zone around the perimeter of the tile field.
5

6 A review of available gamma scintillation logs revealed elevated gamma response,
7 possibly indicative of radionuclide contamination, from near ground surface to a
8 maximum depth of 30 m below ground surface in several wells inside the crib (Table
9 4-10). However, elevated gamma scintillation readings were not observed outside the tile
10 field. In conclusion, radionuclide and inorganics contamination in near-surface and
11 deeper vadose zone soils due to historic waste disposal practices is known to have
12 occurred at this site.
13

14 In a 1989 radiological surface survey, detectable radiation (10,000 dis/min), and
15 smearable alpha radiation (500 dis/min) were detected near the tile field.
16

17 **4.1.2.4 Reverse Wells.** Reverse wells at the Z Plant Aggregate Area include only the
18 216-Z-10 Reverse Well, an inactive underground injection well for waste liquids. The
19 well was completed to a depth of 46 m (150 ft), providing a deeper migration conduit for
20 both chemical and radiological contaminants into the vadose zone. At this location the
21 groundwater table is present at about 63 m (205 ft) below ground surface. As discussed
22 in Subsection 4.1.1.5.3 migration of these waste liquids (and possibly entrained
23 contaminants) is likely at this location due to the volume of liquid injected.
24

25 No specific chemical sampling data was identified for the 216-Z-10 Reverse Well.
26 Several monitoring wells are located near the reverse well but have not been logged
27 using gamma scintillation equipment (Table 4-10).
28

29 **4.1.2.5 Ponds, Ditches, and Trenches.** This category of waste management units includes
30 the 216-Z-4 Trench, the 216-Z-9 Trench, and the 216-Z-17 Trench at the Z Plant
31 Aggregate Area. As discussed in Section 2.0, wastewater conveyance ditches associated
32 with the former 216-Z-1/216-Z-19 Ditch system are discussed in the U Plant AAMSR
33 (DOE/RL 1992). There are no ponds located within the Z Plant Aggregate Area.
34

35 **4.1.2.5.1 216-Z-4 Trench.** The 216-Z-4 Trench received liquid laboratory waste
36 from the 231-Z Building during one month in 1945. The wastes were neutral/basic and
37 contained plutonium. No specific chemical sampling data was identified for the 216-Z-4
38 Trench. No monitoring wells were identified near the 216-Z-4 Trench. Due to
39 information found regarding historic waste disposal practices, radionuclide and chemical
40 contamination is suspected in vadose zone soils at this location.
41

1 **4.1.2.5.2 216-Z-9 Trench.** The 216-Z-9 Trench received liquid waste containing
2 carbon tetrachloride and transuranic wastes from the RECUPLEX facility in the 234-5Z
3 Building. As for the 216-Z-18 Crib and the 216-Z-1A Tile Field, carbon tetrachloride
4 was reportedly detected in down-hole soil vapor samples collected from wells within and
5 adjacent to the 216-Z-9 Trench (DOE/RL 1991b). The maximum carbon tetrachloride
6 concentration detected during the field program was 106 ppmv. Interpretation of the
7 data from the ERA Proposal, and discussion of the extent of carbon tetrachloride in Z
8 Plant Aggregate Area soils are provided in the Vadose Zone Contamination section
9 (4.1.1.5), and in the 216-Z-18 Crib section (4.1.2.3.5).

10
11 Within the 216-Z-9 Trench, soil samples were collected in 1959, 1961, and 1963, to
12 evaluate concentrations and distribution of plutonium within the waste unit so that the
13 service life of the trench could be safely extended. Plutonium concentrations of up to
14 34.5 grams plutonium per liter (gPu/L) of soil were measured in the 1963 samples from
15 the upper 0 to 0.15 m (½ ft) of soil beneath the trench floor. Additional samples
16 collected in 1973 (Smith 1973) confirmed the presence of elevated concentrations of
17 plutonium in the trench. Samples collected in 1973 from a depth of 2.4 m (7.9 ft)
18 contained plutonium concentrations of 0.30 gPu/L of soil, and americium concentrations
19 of 200 to 500 pCi/L of soil. The trench bottom soil was subsequently sprayed with a
20 cadmium nitrate solution to reduce the potential for a criticality event. The upper 30 cm
21 (0.98 ft) of soil were then excavated in 1978 to reduce the risk of environmental
22 contamination (Ludowise 1978) and the soil was placed in drum containers for disposal.

23
24 A number of monitoring wells have been completed near the 216-Z-9 Trench. A
25 review of available gamma scintillation logs indicated elevated gamma response,
26 potentially indicative of radionuclide contamination at several locations 10 to 20 m from
27 the Trench, but generally natural gamma response in wells near the Trench (Table 4-10).
28 For example, elevated gamma response has been observed in well 299-W15-6, 20 m
29 northeast of the Trench, between depths of 1 and 9 m. Elevated gamma response has
30 also been observed between depths of 15 and 38 m in wells 299-W15-8 and 299-W15-86
31 which are located approximately 10 m south and southwest of the Trench, respectively.

32
33 No detectable radiation was measured at the 216-Z-9 Trench during a 1991
34 surface radiological survey.

35
36 **4.1.2.5.3 216-Z-17 Trench.** The 216-Z-17 Trench received laboratory wastes from
37 the 231-Z Building during 1967 and 1968. Like the 216-Z-4 Trench, waste liquids
38 disposed of in the 216-Z-17 Trench were neutral/basic and contained plutonium. A field
39 radiation survey in the 216-Z-17 Trench before backfilling in 1975 indicated 2,000 dis/min
40 of alpha radioactivity. No specific chemical sampling data was identified for the 216-Z-17
41 Trench. One monitoring well, 299-W15-204, was identified on the west side of the

1 trench. However, the well has not been logged using gamma scintillation equipment
2 (Table 4-10).

3
4 Due to available information regarding historic waste disposal practices,
5 radionuclide and chemical contamination is suspected in vadose zone soils at this
6 location.

7
8 A surface radiological survey completed in 1991 did not measure detectable
9 radiation.

10
11 **4.1.2.6 Septic Tanks and Associated Drainfields.** This category of waste management
12 units includes the 2607-Z, 2607-Z-1, 2607-WA, 2607-WB, and 2607-W-8 Septic Tank and
13 Drainfields. No specific chemical sampling data was identified for the septic tanks.
14 These units are reported as having received sanitary wastes only. Radiological and
15 chemical contaminants from Z Plant processing facilities are therefore not suspected at
16 these locations.

17
18 **4.1.2.7 Transfer Facilities, Diversion Boxes, and Pipelines.** As shown on Figure 2-10, a
19 number of pipelines and three includes three transfer facilities were identified in the Z
20 Plant Aggregate Area:

- 21
22 • 241-Z Diversion Box No. 1
23 • 241-Z Diversion Box No. 2
24 • 231-Z-151 Sump.

25
26 **4.1.2.7.1 241-Z Diversion Boxes No. 1 and No. 2.** Diversion Box No. 1 controlled
27 the flow of liquid wastes at the piping junction to the 216-Z-1A Tile Field, 216-Z-1 Crib,
28 216-Z-2 Crib, 216-Z-3 Crib, and the 216-Z12 Crib. Similarly, Diversion Box No. 2 was
29 located north of the 216-Z-12 Crib and controlled flow of wastes to that crib. No specific
30 chemical sampling data was identified for the diversion boxes. One monitoring well, 299-
31 W18-156 is located near Diversion Box No. 2, but has not been logged using gamma
32 scintillation detection equipment. No releases were reported at the locations of these
33 structures in the documents reviewed.

34
35 Available information regarding historic use of these facilities suggests that
36 radionuclide and chemical contamination are possible in vadose zone soils at this
37 location.

38
39 **4.1.2.7.2 231-Z-151 Sump.** The 231-Z-151 Sump controlled flow of waste liquids
40 from the 231-Z Building to the 216-Z-5 Crib, 216-Z-6 Crib, 216-Z-7 Crib, 216-Z-16 Crib,
41 216-Z-16 Crib, 216-Z10 Reverse Well, and 216-Z-4 Trench, and 216-Z-17 Trench.

1 Unplanned Release UN-200-W-130 was identified near the diversion box and involved a
2 leaking waste line from the 231-Z Building.

3
4 No specific chemical sampling data were identified for the 231-Z-151 Sump. No
5 monitoring wells were identified near the sump.

6
7 Based on available information regarding historic use of this facility and the
8 information regarding a nearby Unplanned Release, radionuclide and chemical
9 contamination is suspected in vadose zone soils at this location.

10
11 **4.1.2.8 Basins.** Two basins, the 207-Z Retention Basin and the 216-Z-21 Seepage Basin,
12 are located in the Z Plant Aggregate Area.

13
14 **4.1.2.8.1 207-Z Retention Basin.** The 207-Z Retention Basin is a concrete
15 structure which received potentially contaminated liquid waste from the 234-5Z Building
16 prior to discharge to the 216-Z-1(D)/Z-11 Ditch system. No releases were reported at
17 this locations in the documents reviewed.

18
19 No specific chemical sampling data were identified for the 207-Z Retention Basin.
20 No monitoring wells were identified near the Basin.

21
22 **4.1.2.8.2 216-Z-21 Seepage Basin.** The 216-Z-21 Seepage Basin currently receives
23 non-contact discharge water from the 234-5Z HVAC system and storm water runoff. As
24 discussed in Section 4.1.1.4, aquatic vegetation and sediment samples collected from the
25 seepage basin as part of annual Hanford Site environmental surveillance monitoring
26 contained elevated concentrations of plutonium-239 and other radionuclides (Table 4-9)
27 (Schmidt et al. 1990 and 1991). Also beta radioactivity (5,000 ct/min) was detected in a
28 tumbleweed during a 1989 surface radiological survey. Tumbleweeds blow into the
29 seepage basin from outside sources and are periodically removed for disposal. No
30 radionuclides, nitrates, or other constituents were detected in water samples collected
31 from the seepage basin during annual monitoring for 1988, 1989, and 1990.

32
33 One monitoring well, 299-W15-208, has been completed inside the 216-Z-21
34 Seepage Basin. However, the well has not been logged using gamma scintillation
35 equipment, possibly due to expected attenuation in the grout seal in this well.

36
37 **4.1.2.9 Burial Sites.** Solid Waste Burial Grounds 218-W-1, 218-W-1A, 218-W-2, 218-W-
38 2A, 218-W-3, 218-W-3A, 218-W-3AE, 218-W-4A, 218-W-4B, 218-W-4C, 218-W-5, 218-W-
39 6, 218-W-11, and the Z Plant Burn Pit are located in the Z Plant Aggregate Area.
40 Section 2.9 presents information identified regarding waste materials disposed to the
41 burial sites. Figure 2-12 shows the locations of the burial sites. Soil chemical testing data

1 were collected during the LLWMA groundwater monitoring well installation programs
2 between 1987 and 1990 (Goodwin and Bjornstad 1990; and Barton et al. 1990).
3 Additional data is presented in the Z Plant Geologic and Geophysics Data Package for
4 the 200 Aggregate Area Management Study (Chamness et al. 1991).
5

6 Additional analytical data from the Z Plant Aggregate Area burial grounds include
7 results of air, TLD, surface soil, and vegetation sampling during annual environmental
8 monitoring. These data are presented in Section 4.1.1. As discussed in that section, the
9 information is in general, more indicative of area-wide trends in contamination from
10 ongoing production and process operations in the 200 Areas, than it is indicative of
11 localized releases from burial site sources. Results of airborne radiological surveys, and
12 generalized areas of surface/subsurface radiological contamination and posting for the
13 burial grounds were also discussed in Section 4.1.1.
14

15 The solid waste burial grounds are the locations of many of the Unplanned
16 Releases of radioactive materials described in Section 2.3.10. Residual surface
17 contamination may be present at locations of Unplanned Releases, particularly where
18 remedial efforts involved flushing affected areas with water. Potential for deeper vadose
19 zone or groundwater contamination is low, and is dependent upon a consistent driving
20 force such as natural groundwater recharge via precipitation to promote migration.
21 Issues associated with natural recharge are discussed in Section 3.5.
22

23 **4.1.2.9.1 218-W-1 Burial Ground.** The 218-W-1 Burial Ground is an inactive solid
24 waste disposal facility which received transuranic/mixed solid waste from 1944 to 1953.
25 Two Unplanned Releases, UN-200-W-11 and UPR-200-W-134, are associated with the
26 218-W-1 Burial Ground. A fire in the burial ground in 1952 released plutonium and
27 likely resulted in surface soil contamination at the burial ground and adjacent areas via
28 wind dispersion. No monitoring wells are associated with the burial ground.
29

30 During a 1991 surface radiological survey, 15,000 dis/min of beta radiation was
31 measured at a "small topsoil hot spot" in the 218-W-1 burial ground (Table 4-5).
32

33 **4.1.2.9.2 218-W-1A Burial Ground.** The 218-W-1A Burial Ground is an inactive
34 solid waste disposal facility which received miscellaneous industrial dry waste from 1944
35 to 1955. No Unplanned Releases are associated with the 218-W-1A Burial Ground.
36

37 No detectable surface radiation was reported in the 218-W-1A Burial Ground
38 during a 1991 radiological survey.
39

40 **4.1.2.9.3 218-W-2 Burial Ground.** The 218-W-2 Burial Ground is an inactive solid
41 waste disposal facility which received miscellaneous unsegregated dry waste from 1953 to

1 1956. No Unplanned Releases are associated with the 218-W-2 Burial Ground. No
2 monitoring wells are associated with the burial ground.

3
4 During a 1991 surface radiological survey, 15,000 dis/min of beta radiation was
5 measured at a "small hot spot" in the 218-W-2 burial ground (Table 4-5).

6
7 **4.1.2.9.4 218-W-2A Burial Ground.** The 218-W-2A Burial Ground is an inactive
8 solid waste disposal facility which received low level and mixed solid waste from 1954 to
9 1985. One Unplanned Release, UPR-200-W-45, is associated with the 218-W-2A Burial
10 Ground. The collapse of a burial box in 1957 dispersed transuranic radionuclides over
11 1,800 acres near the burial ground. No monitoring wells are associated with the burial
12 ground.

13
14 During a 1991 surface radiological survey, 15,000 dis/min of beta radiation was
15 measured at the 218-W-2A burial ground (Table 4-5).

16
17 **4.1.2.9.5 218-W-3 Burial Ground.** The 218-W-3 Burial Ground is an inactive solid
18 waste disposal facility which received transuranic/mixed solid waste from 1957 to 1960 or
19 1961. No Unplanned Releases are associated with this unit. No monitoring wells were
20 associated this waste management unit.

21
22 No detectable surface radiation was reported in the 218-W-3 Burial Ground
23 during a 1991 radiological survey.

24
25 **4.1.2.9.6 218-W-3A Burial Ground.** The 218-W-3A Burial Ground is active solid
26 waste disposal facility which began receiving transuranic/mixed solid waste in 1971. No
27 Unplanned Releases are associated with this unit. Three wells potentially monitor
28 conditions in this waste management unit. Gamma scintillation logging performed in
29 1987 indicated only natural gamma response.

30
31 During a 1991 surface radiological survey, 40,000 dis/min of beta radiation was
32 measured over a 1 m x 1 m area in the 218-W-3A Burial Ground (Table 4-5).

33
34 **4.1.2.9.7 218-W-3AE Burial Ground.** The 218-W-3AE Burial Ground is an active
35 solid waste disposal facility which began receiving mixed solid waste in 1982. No
36 Unplanned Releases are associated with this unit. Seven wells potentially monitor
37 conditions in this waste management unit. Gamma scintillation logging performed in
38 different monitoring wells in 1987, 1989, and 1990 indicated only natural gamma
39 response.

40
41

1 **4.1.2.9.8 218-W-4A Burial Ground.** The 218-W-4A Burial Ground is an inactive
2 solid waste disposal facility which received transuranic/mixed waste from 1958 to 1968.
3 Four Unplanned Releases, UPR-200-W-16, UPR-200-W-26, UPR-200-W-53, and UPR-
4 200-W-72, are associated with the 218-W-4A Burial Ground. As described in Table 2-5,
5 the Unplanned Releases resulted in plutonium and ruthenium contamination of surface
6 soils within and outside the burial ground. The 218-W-4A Burial Ground contains two
7 steel-drum caissons which might be a source of radionuclides (Section 2.3.9.8). No
8 monitoring wells were identified within the 218-W-4A Burial Ground.

9
10 During a 1991 surface radiological survey, 10,000 dis/min of beta radiation was
11 measured over a 7 m x 1 m hot spot in the burial ground (Table 4-5).

12
13 Due to the Unplanned Releases and the presence of caissons, vadose zone soil
14 contamination is suspected at this site.

15
16 **4.1.2.9.9 218-W-4B Burial Ground.** The 218-W-4B Burial Ground is an active
17 facility which began receiving transuranic and mixed solid waste in 1967. No Unplanned
18 Releases are associated with the 218-W-4B Burial Ground. Elevated surface radiation
19 monitoring readings have been reported at the site.

20
21 Three monitoring wells located around the perimeter of the 218-W-4B Burial
22 Ground were logged using gamma scintillation equipment in 1989 and 1990. The gamma
23 scintillation logs indicated only natural gamma response (Table 4-10).

24
25 **4.1.2.9.10 218-W-4C Burial Ground.** The 218-W-4C Burial Ground is an active
26 facility which began receiving transuranic and mixed solid waste in 1974. An Unplanned
27 Release associated with the 241-UR Diversion Box (a U Plant Aggregate Area transfer
28 facility), UN-200-W-132, contaminated two areas in the eastern part of the burial ground
29 of approximately 11.2 and 41.9 m² in 1956 (Table 2-5). A total of eleven monitoring
30 wells were identified in the 218-W-4C Burial Ground; all but one have been logged using
31 gamma scintillation detection equipment (Table 4-10). Gamma scintillation logging
32 performed in July 1987 indicated possibly elevated gamma response in one well, 299-
33 W15-18, located 30 m west of the northern portion of the burial ground. The elevated
34 gamma response was observed between depths of 55 and 58 m below ground surface.

35
36 Due to the Unplanned Release and elevated gamma response in one monitoring
37 well, vadose zone soil contamination is suspected in the eastern parts of the 218-W-4C
38 Burial Ground.

39
40 **4.1.2.9.11 218-W-5 Burial Ground.** The 218-W-5 Burial Ground is an active waste
41 management unit which receives low level/mixed solid waste. No Unplanned Releases

1 are associated with the 218-W-5 Burial Ground. Wells 299-W7-1, 299-W7-9, 299-W8-1,
2 299-W9-1, 299-W10-13, and 299-W10-14 potentially monitor site conditions.

3
4 No releases are associated with the site. Consequently, no contamination is
5 suspected at the 218-W-5 Burial Ground.

6
7 **4.1.2.9.12 218-W-6 Burial Ground.** The 218-W-6 Burial Ground is a proposed
8 facility located in the northeast corner of the Z Plant Aggregate Area. No releases of
9 hazardous materials are associated with this site. One monitoring well, 299-W6-1, was
10 identified near the center of the 218-W-6 Burial Ground. Gamma scintillation logging
11 performed in April 1963 indicated only natural gamma response.

12
13 No contamination is suspected at the 218-W-6 Burial Ground.

14
15 **4.1.2.9.13 218-W-11 Burial Ground.** The 218-W-11 Burial Ground is an inactive
16 facility that received low-level and mixed waste during 1960. One Unplanned Release,
17 UPR-200-W-84, is associated with the 218-W-11 Burial Ground. Contaminated soil from
18 the Unplanned Release was picked up and placed in a burial trench. One monitoring
19 well, 299-W15-2, is associated with the 218-W-11 Burial Ground. Gamma scintillation
20 logging performed in November 1976 indicated only natural gamma response.

21
22 Only minor vadose zone soil contamination is suspected at the 218-W-11 Burial
23 Ground.

24
25 No surface radiation was detected during a 1991 radiological survey of the 218-W-
26 11 Burial Ground Area.

27
28 **4.1.2.9.14 Z Plant Burn Pit.** Releases may be associated with the estimated 1,000
29 cubic meters of chemical waste disposed at the Z Plant Burn Pit, but were not reported
30 in the documents reviewed. The Z Plant Burn Pit is east of the main Z Plant building
31 complex. No specific chemical sampling data were identified for the Burn Pit. Also, no
32 monitoring wells were identified near the Z Plant Burn Pit.

33
34 Non-hazardous chemical contaminants are suspected in vadose zone soils at this
35 location.

36
37 **4.1.2.10 Unplanned Releases.** No specific chemical sampling data were identified for the
38 Unplanned Releases. Also, no monitoring wells were identified near Unplanned Release
39 sites. Historical information discussed in Section 2.3.10 and Table 2-5 indicates that
40 radionuclide contamination is suspected at most of the Unplanned Release sites but
41 insufficient information was identified to characterize the nature and extent of

1 contamination. Tables 4-2 and 4-3 summarize available information regarding media
2 potentially affected by Unplanned Releases.

1 4.2 POTENTIAL IMPACTS TO HUMAN HEALTH

2
3 This preliminary assessment is intended to provide a qualitative evaluation of
4 potential human health hazards associated with the known and suspected contaminants at
5 the Z Plant Aggregate Area. The assessment includes a discussion of potential transport
6 pathways, develops a conceptual model of human exposure based on these pathways, and
7 presents the physical, radiological, and toxicological characteristics of the known or
8 suspected contaminants.

9
10 In developing the conceptual model, potential exposures to groundwater have not
11 been addressed in detail. Since migration to groundwater is the primary route for
12 potential future exposures to many of the chemicals disposed of at the site, this pathway
13 (i.e., travel time, receptors) will be addressed in the 200 West Groundwater AAMS.

14
15 It is important to note that these evaluations do not attempt to quantify potential
16 human health risks associated with exposure to Z Plant Aggregate Area waste
17 management unit contaminants. Such a risk assessment cannot be performed until
18 additional waste management unit characterization data are acquired. Risk assessments
19 will be performed in accordance with the *Hanford Site Baseline Risk Assessment*
20 *Methodology* document (DOE/RL 1991a) being prepared in response to the M-29
21 milestone.

22 23 24 4.2.1 Release Mechanisms

25
26 Z Plant Aggregate Area waste management units can be divided into two general
27 categories based on the nature of the waste release: 1) units where waste was discharged
28 directly to the environment; and 2) units where waste was disposed of inside a
29 containment structure and must bypass an engineered barrier to reach the environment.

30
31 In the first group are those waste management units where release of wastes to
32 the soil column was an integral part of the waste disposal strategy. Included in this group
33 are tile fields, septic system drain fields, ditches, french drains, seepage basins, cribs
34 without liners, reverse wells, and some disposal trenches. Also in this group are
35 Unplanned Releases that involved waste material contacting bare soil. For these types of
36 waste management units, if discharges to the unit contained chemicals of concern, it can
37 be assumed that soils underlying the waste management unit are contaminated. The first

1 task in developing a conceptual model for these units is to determine whether chemicals
2 of concern are retained in soil near the waste management unit, or are likely to migrate
3 to the underlying aquifer and then to receptor points such as drinking water wells or
4 surface water bodies. Factors affecting migration of chemicals away from the point of
5 release will be discussed in the following section.

6
7 In the second group are waste management units that were intended to act as a
8 barrier to environmental releases. Included in this group are burial grounds containing
9 drums or other containers, cribs with membrane liners, caissons, vaults, tanks, retention
10 basins, waste transfer facilities, and Unplanned Releases that occurred within
11 containment structures. Waste management units that received only dry waste could also
12 be included in this category, since the potential for wastes to migrate to soils outside of
13 the unit is low due to the negligible natural recharge rate at the Hanford Site. For these
14 waste management units, the first consideration to be addressed in developing a
15 conceptual model is the integrity of the containment structure.

16
17 The ability of this report to evaluate the efficacy of engineered barriers is limited
18 by the lack of vadose zone soil sampling data and air sampling data for many waste
19 management units. Available sampling information for the waste management units and
20 Unplanned Releases was summarized in Section 4.1. The data indicate that membrane
21 liner systems used in waste management units with significant liquid inputs (e.g., 216-Z-12
22 Crib) were ineffective in preventing releases to the subsurface.

23
24 The efficacy and integrity of concrete liners (207-Z Retention Basin), concrete and
25 steel pads (high-level transuranic caissons and vaults), and concrete plugs in corrugated
26 piping (low-level radioactive waste caissons) have not been determined. For those waste
27 management units that received only dry wastes such as gloves, pumps, contaminated
28 dirt, and process equipment, the potential for release is expected to be low. However,
29 small amounts of liquid wastes (tritium, lab wastes) are known to have been disposed of
30 in these waste management units, and early disposal records (prior to about 1968) are
31 incomplete. Thus, releases from these structures to the surrounding soil are possible.

32
33 In addition to evaluating releases to the subsurface, the conceptual model must
34 address the potential for releases to air and, for radionuclides, the potential for direct
35 irradiation. All waste management units have some type of barrier to releases to the
36 surface; however, barriers can fail over time or may not be designed to prevent migration
37 by certain transport pathways (e.g., volatilization).

38
39 Many of the cribs in the Z Plant Aggregate Area have experienced cave-ins in
40 recent years due to decomposition of the wooden framework of the cribs. Such collapse
41 can lead to high levels of direct radiation at the surface and the potential for spread of

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1 contaminated materials by wind erosion. The Westinghouse Hanford Radiation Area
2 Remedial Action Program is responsible for detecting and remediating cave-ins by
3 covering the cribs with additional soil. Thus, any exposures from these incidents are
4 generally short-term. Waste management units that were remediated due to cave-ins
5 during 1991 were the 216-Z-5 and 216-Z-7 Cribs.

8 **4.2.2 Transport Pathways**

9
10 Transport pathways expected within the Z Plant Aggregate Area are summarized
11 in this section, including:

- 12
- 13 ● Drainage and leaching from soil to groundwater;
- 14 ● Volatilization from wastes and shallow soils;
- 15 ● Wind erosion of contaminated surface soils;
- 16 ● Deposition of fugitive dust on soils, plants, and surface water;
- 17 ● Uptake from soils by vegetation;
- 18 ● Uptake from soils by animals via direct contact with soils or ingestion of
19 vegetation; and
- 20 ● Direct radiation.
- 21

22 In addition, transport within the saturated zone and subsequent release to
23 groundwater wells or to off-site surface water (i.e., the Columbia River) is of potential
24 concern, but will not be addressed in this document, since this topic will be the focus of
25 the 200 West Groundwater AAMS.

26
27 **4.2.2.1 Transport from Soils to Groundwater.** Soil is the initial receiving medium for
28 waste discharges in the Z Plant Aggregate Area, whether the release is directly to soil or
29 through failure of a containment system. Several factors determine whether chemicals
30 that are introduced into the vadose zone will reach a perched zone or the unconfined
31 aquifer, which lies at a depth of approximately 60 m (200) feet below ground surface.
32 These factors are discussed in the following subsections.

33
34 **4.2.2.1.1 Depth of Release.** Waste management units which released wastes at a
35 greater depth below the surface are more likely to contaminate groundwater than waste
36 management units where the release was shallow. The 216-Z-10 Reverse Well is the
37 primary example of a deep release at the Z Plant Aggregate Area. This unit discharged
38 wastes to the vadose zone approximately 45 m (150 ft) below the surface, or
39 approximately 15 m (50 ft) above the water table in the unconfined aquifer.
40

1 **4.2.2.1.2 Liquid Volume or Recharge Rate.** For waste constituents to migrate to
2 the underlying water table, some source of recharge must be present. In the Z Plant
3 Aggregate Area, the primary sources of moisture for mobilizing contaminants are waste
4 management units which discharge liquid waste to the soil column and precipitation
5 recharge. As discussed in Section 3.5.2, estimates of natural precipitation recharge range
6 from 0 to 10 cm/yr, primarily depending on surface soil type, vegetation, and topography.
7 Gravelly surface soils with no or minor shallow-rooted vegetation appear to facilitate
8 precipitation recharge. One modeling study (Smoot et al. 1989) indicated that some
9 radionuclide (¹³⁷Cs and ¹⁰⁶Ru) transport could occur with as little as 5 cm/yr of natural
10 recharge. However, other researchers (Routson and Johnson 1990) have concluded that
11 no net precipitation recharge occurs in the 200 Areas, particularly at waste management
12 units which are capped with fine-grained soils or impermeable covers.

13
14 With respect to artificial recharge, as discussed in Section 4.1.8, several waste
15 management units (e.g., the 216-Z-12 Crib) were identified in which the known volume of
16 liquid waste discharged substantially exceeded the total estimated soil pore volume
17 present below the footprint of the facility. In this case, the moisture content of soil
18 below the waste management units likely approached saturation during the period of use
19 of these facilities. Because vadose zone hydraulic conductivities are maximized at water
20 contents near saturation, the volume of liquid waste water historically discharged to the
21 waste management units identified in Table 4-11 probably enhanced fluid migration in
22 the vadose zone beneath these units.

23
24 Contaminants that are not initially transported to the water table by drainage may
25 be mobilized at a later date if a large volume of liquid is added to the waste management
26 unit. In addition, liquids discharged to one unit could mobilize wastes discharged to an
27 adjacent unit if lateral migration takes place within the vadose zone. An example of this
28 process occurred at the U Plant 216-U-16 Crib where lateral migration of acidic waste
29 above a caliche layer mobilized radionuclides in the 216-U-1 and 216-U-2 Crib. No
30 examples of interactions between waste management units are known to have occurred
31 within the Z Plant Aggregate Area. However, septic fields and the 216-Z-21 Seepage
32 Basin are located within 50 meters of waste management units that received liquid waste
33 and thus could potentially mobilize wastes from these units.

34
35 **4.2.2.1.3 Soil Moisture Transport Properties.** As discussed in Section 3.5.2, the
36 moisture flux in the vadose zone is dependent on hydraulic conductivity as well as
37 gradients of moisture content or matrix suction. Higher unsaturated hydraulic
38 conductivities are associated with higher moisture contents. However, higher unsaturated
39 hydraulic conductivities may be associated with fine-grained soils compared to coarse-
40 grained soils at low moisture contents. Due to the highly stratified nature of Hanford
41 Site vadose zone soils and the moisture content dependence of unsaturated hydraulic

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1 conductivity, substantial vertical anisotropy is expected, i.e., vadose zone soils are likely
2 more permeable in the horizontal direction than in the vertical. This vertical anisotropy
3 may substantially reduce the potential for contaminant migration to the unconfined
4 aquifer.

5
6 **4.2.2.1.4 Retardation.** The rate at which contaminants will migrate out of a
7 complex waste mixture and be transported through unsaturated soils depends on a
8 number of characteristics of the chemical, the waste, and the soil matrix. In general,
9 chemicals that have low solubilities in the leaching fluid or are strongly adsorbed to soils
10 will be retarded in their migration velocity compared to the movement of soil pore water.
11 Studies have been conducted of soil parameters affecting waste migration at the Hanford
12 Site to attempt to identify the factors that control migration of radionuclides and other
13 chemicals. Recent studies of soil sorption are summarized by Serne and Wood (1990).
14 Some of the processes that have been shown to control the rate of transport are:

- 15
16 ● **Adsorption to Soils.** Most contaminants are chemically attracted to some
17 degree to the solid components of the soil matrix. For organic compounds,
18 the adsorption is generally to the organic fraction of the soil, although in
19 extremely low-organic soils, adsorption to inorganic components may be of
20 greater importance. Soil components contributing to adsorption of
21 inorganic compounds include clays, organic matter, and iron and aluminum
22 oxyhydroxides. In general, Hanford Site surface soils are characterized as
23 sandy or gravelly with very low organic content (<0.1%) and low clay
24 content (<12%) (Tallman et al. 1981). Thus, site-specific adsorption
25 factors are likely to be lower, and rate of transport higher, than the average
26 for soils nationwide.
- 27
28 ● **Filtration.** Filtration of suspended particulates by fine-grained sediments
29 was suggested as a mechanism for concentration of plutonium in certain
30 sedimentary layers at the 216-Z-1A Tile Field. This finding suggests that
31 migration of suspended particulates may be an important mechanism of
32 transport for poorly soluble chemicals.
- 33
34 ● **Solubility.** The rate of release of some chemicals is controlled by the rate
35 of dissolution of the chemical from a solid form. The concentration of
36 these chemicals in the pore water will be extremely low, even if they are
37 poorly sorbed. An example cited by Serne and Wood (1990) is the
38 solubility of plutonium oxide, which appears to be the limiting factor
39 controlling the release of plutonium from waste materials at neutral and
40 basic pH.
- 41

- 1 • **Ionic Strength of Waste.** For some inorganics, the dominant mechanism
2 leading to desorption from the soil matrix is ion exchange. Leachant
3 having high ionic strength (high salt content) can bias the sorption
4 equilibrium toward desorption, leading to higher concentrations of the
5 chemical in the soil pore water. Wastes within the Z Plant Aggregate Area
6 that can be considered high ionic strength include the PFP process wastes
7 and the RECUPLEX and PRF aqueous wastes.
8
- 9 • **Waste pH.** The pH of a leachant has a strong effect on inorganic
10 contaminant transport. Acidic leachates tend to increase migration both by
11 increasing the solubility of precipitates and by changing the distribution of
12 charged species in solution. The exact impact of acidic or basic wastes will
13 depend on whether the chemical is normally in cationic, anionic, or neutral
14 form, and the form that it takes at the new pH. Cationic species tend to
15 be more strongly adsorbed to soils than neutral or anionic species. The
16 extent to which addition of acidic leachate will cause a contaminant to
17 migrate will also depend on the buffering or neutralizing capacity of the
18 soil, which is correlated with the calcium carbonate (CaCO_3) content of the
19 soil. Percent CaCO_3 measurements on soil samples from three monitoring
20 wells from the Z Plant Aggregate Area are shown in Table A-2 of
21 Appendix A. The soils in the Hanford formation beneath the Z Plant
22 Aggregate Area generally have carbonate contents in the range of 0.1 to 5
23 percent. Higher carbonate contents (20 to 30 percent) are observed within
24 the Plio-Pleistocene caliche layer.
25

26 Once the leaching solution has been neutralized the dissolved constituents
27 may reprecipitate or become readsorbed to the soil. Observations of pH
28 impacts on waste transport at the Hanford Site include:
29

- 30 • Mobilization of plutonium and americium isotopes beneath the 216-
31 Z-1A Tile Field by acid liquid waste depends on a combination of
32 pH effects and complexation by organic components of the waste.
33 These processes were implicated in migration of the radionuclides to
34 a depth of 30 meters below the bottom of the crib; and
35
- 36 • Leaching of americium from 216-Z-9 Trench sediments was found to
37 be solubility controlled and correlated to solution pH (Rai et al.
38 1981).
39

40 **4.2.2.1.5 Complexation by Organics.** Certain organic materials disposed of at Z
41 Plant Aggregate Area are known to form complexes with inorganic ions, which can

1 enhance their solubility and mobility. Tributyl phosphate is the primary organic
2 complexing agent disposed of at the Z Plant Aggregate Area.

3
4 **4.2.2.1.6 Contaminant Loss Mechanisms.** Processes that can lead to loss of
5 chemicals from soils, and thus decrease the amount of chemical available for leaching to
6 groundwater, include:

- 7
- 8 ● **Radioactive Decay.** Radioactivity of radionuclides decays over time, which
9 generally decreases the quantities and impacts from radioactive isotopes.
10 However, for some radioactive decay chains, ingrowth of daughter products
11 can lead to a net increase in radioactive emissions over time.
 - 12
 - 13 ● **Biotransformation.** Microorganisms in the soil may degrade organic
14 chemicals such as acetone and inorganic chemicals such as nitrate.
 - 15
 - 16 ● **Chemical Transformation.** Hydrolysis, oxidation, reduction, radiolytic
17 degradation, and other chemical reactions are possible degradation
18 mechanisms for contaminants.
 - 19
 - 20 ● **Vegetative Uptake.** Vegetation may remove chemicals from the soil, bring
21 them to the surface, and thereby introduce them to the food web.
 - 22
 - 23 ● **Volatilization.** Organic chemicals and volatile radionuclides can be
24 transported in the vapor phase through open pores in soil either to
25 adjacent soil or to the atmosphere. Some elements (mainly fission products
26 such as iodine, ruthenium, cerium, and antimony) are referred to as
27 "semivolatiles" because they have a lesser tendency to volatilize.
 - 28

29 **4.2.2.2 Transport from Soils to Air.** Transport of contaminants from waste units to the
30 atmosphere can occur by means of vapor transport or by fugitive dust emissions.

31
32 Vapor transport may occur from waste management units where volatile organics
33 (e.g., CCl_4) or volatile radionuclides (^{14}C , $^{14}\text{CO}_2$, ^{129}I , or ^3H) have been released.
34 Transport mechanisms include diffusion down a concentration gradient and gas-driven
35 flow. Situations where the latter process may occur include production of methane gas
36 from degradation of organic compounds in soil, or production of hydrogen and oxygen
37 gases by radiolytic hydrolysis of water.

38
39 In general, the earthen covers on cribs and trenches are not designed to retard
40 volatile emissions. However, waste management units where high-level radioactive mixed
41 wastes were disposed of, such as the burial caissons, generally have air filtration devices

1 on outlet vents, designed to prevent release of contaminants to the atmosphere while the
2 units were being filled. The effectiveness of these devices for preventing ongoing volatile
3 releases is not known.

4
5 In order for fugitive dust emissions to occur, contaminants must be exposed at the
6 surface of the waste management unit. A number of mechanisms could lead to exposure
7 of contaminants in soil-covered waste management units. These mechanisms include
8 uptake by vegetation, transport by animals, disruption of the waste management unit
9 (e.g., cave-ins at cribs), and wind erosion. Wind erosion can strip off surface soil and
10 uncover waste materials. This mechanism has been identified as an ongoing problem in
11 some of the waste management unit areas. The processes by which biota may expose
12 contaminated soils are discussed in Section 4.2.2.4.

13
14 The contribution of Z Plant Aggregate Areas to overall fugitive dust emissions at
15 the Hanford Site is expected to be relatively minor, based on results of air monitoring
16 downwind of Z Plant Aggregate Area waste management units.

17
18 **4.2.2.3 Transport from Soils to Surface Water.** There are no natural surface water
19 bodies within the Z Plant Aggregate Area. The 216-Z-21 Seepage Basin is occasionally
20 flooded with water from the Plutonium Recovery Facility storm drains and cooling water.
21 Although the water entering the seepage basin is non-contact wastewater and thus should
22 not contain contaminants, accidental releases to the Plutonium Recovery facility drains
23 could lead to contaminants entering this unit.

24
25 Transport of contaminants to surface water bodies outside of the Z Plant
26 Aggregate Area via groundwater discharge and deposition of fugitive dust on water
27 bodies are the primary pathways of potential concern for surface water effects.
28 Groundwater discharge will be addressed in the 200 West Groundwater AAMS.

29
30 **4.2.2.4 Transport from Soils to Biota.** Biota, plants and animals, have the potential for
31 taking up (bio-uptake), concentrating (bioaccumulating), transporting, and depositing
32 contamination beyond its original extent. Transfer from one species to another in the
33 food chain is also possible because of predation. The possibility of these processes
34 contributing significantly to the transport of contamination from the Z Plant Aggregate
35 Area waste management units is uncertain.

36
37 **4.2.2.4.1 Uptake by Vegetation.** Release of radioactivity to the surface by growth
38 of vegetation is an ongoing problem at Z Plant waste management units. Roots of
39 sagebrush and other native species can take up radionuclides from soils below the surface
40 and transport these chemicals to the foliage. Wind dispersal of portions of the
41 contaminated vegetation, or entire plants (tumbleweeds), can lead to transport of

1 contaminants outside of the unit. Westinghouse Hanford has an ongoing vegetation
2 control program (herbicide application, reseeding with shallow-rooted vegetation, and
3 mechanical removal) and radiological survey program to prevent radioactivity from being
4 transported by this mechanism. However, the program does not assure complete
5 removal of vegetation, and incidents of detection of contaminated vegetation are
6 reported occasionally in the radiological surveys.

7
8 **4.2.2.4.2 Transport by Animals.** Disturbance of waste management unit barriers
9 by animals occasionally leads to release of contaminants to the surface. Additionally,
10 animals that become contaminated by contact with subsurface waste can spread
11 contamination in their feces on the surface and outside of the waste management unit.
12 Rabbits were noted as causing the greatest spread of contamination in the Separations
13 Area in 1985 (Elder et al. 1986).

14
15
16 **4.2.3 Conceptual Model**

17
18 Figure 4-6 presents a graphical summary of the physical summary of the physical
19 characteristics and mechanisms at the site which could potentially affect the generation,
20 transport, and impact of contamination in the Z Plant Aggregate Area on humans and
21 biota (conceptual model).

22
23 The sources of potentially hazardous chemicals identified at the Z Plant Aggregate
24 Area include process wastes, cooling water, stack releases, sewage, settling tank solids,
25 laboratory wastes, process feed materials, and radioactive mixed wastes from nuclear
26 production facilities on and off the Hanford Site that were disposed of in the Solid Waste
27 Burial Grounds. The sources displayed in this figure were identified from historical and
28 current process information and from waste management unit inventories, as described in
29 Section 2. In addition to the known or suspected releases to waste management units,
30 Unplanned Releases due to spills, leaks in piping, and other accidental sources have led
31 to release of radionuclides and other chemicals to the environment. Some of the
32 Unplanned Releases are associated with the various waste sites, and are shown on Figure
33 2-13.

34
35 The column in the Conceptual Model titled "Treatment or Disposal" is used to
36 indicate waste streams that were routed to waste management units outside of the
37 aggregate area, and waste streams that were routed through treatment tanks or settling
38 tanks before being released to units within the aggregate area. The units are grouped in
39 the model by type, as was done in Section 2.0.

40

9 1 9 3 5 1 2 7 4

1 Chemicals from the sources noted on Figure 4-6 have been disposed of into the
2 waste management units under investigation. Waste site groups include retention basins,
3 seepage basins, settling tanks, trenches, cribs, French drains, reverse wells, tile fields,
4 septic tanks and drain fields, and burial grounds. The vaults and caissons which comprise
5 part of the Solid Waste Burial Grounds were assigned to a different waste site group
6 than the burial trenches, since release mechanisms applicable to these concrete-lined
7 containment structures would be expected to be different than for the earth-lined burial
8 trenches. Each of the waste site groups represents a collection of units with similar
9 construction, waste type (i.e., solid vs. liquid) and potential release mechanisms.

10
11 From the Z Plant Aggregate Area waste management units, various release
12 mechanisms may have transported chemicals to the potentially affected media. Waste
13 management units where liquid wastes were disposed of (cribs, trenches, drain fields,
14 retention basins) impacted the vadose zone and may have impacted groundwater by
15 infiltration of liquids through the soil. Reverse wells and French drains released wastes
16 directly to the vadose zone by injection of liquids.

17
18 Many waste management units discharge their waste effluents directly to the near
19 surface (vadose zone) soils. The trenches are potential release points via leaching or
20 drainage of the liquid portion of the disposed materials. The cribs provide seepage
21 discharge and similarly the French drains, reverse wells, and septic system drain fields
22 directly inject their effluents into the subsurface sediments. The Unplanned Releases
23 have mainly impacted surface soils although some contamination may have also taken
24 place on building surfaces. Fugitive dust from sediment and surface soils has also been
25 released or resuspended due to wind effects or surface disturbances, and some surface
26 soils have been buried or removed to off-site disposal.

27
28 Stack releases may have led to deposition of contaminants on surface soils and
29 vegetation within and outside of the aggregate area. Ambient air quality data for the Z
30 Plant Aggregate Area is presented in Section 4.1. Due to resuspension of dust from soils
31 within and outside of the aggregate area, it is not possible to use these data to distinguish
32 stack releases from other sources of airborne contaminants.

33
34 The primary mechanisms of vertical contaminant migration is the downward
35 movement of water from the surface through the vadose zone to the unconfined aquifer.
36 The contaminants generally move as a dissolved phase in the water and their rate of
37 migration is controlled both by groundwater movement rates and by adsorption and
38 desorption reactions involving the surrounding sediments. Some contaminants are
39 strongly sorbed on sediments and their downward movement through the stratigraphic
40 column is greatly retarded. Significant lateral migration of contaminants is restricted to
41 perched water zones and to the unconfined aquifer, where water is moving laterally.

1 Again adsorption and desorption reactions may greatly retard lateral contaminant
2 migration. Contaminants that were introduced to the soil column outside of the
3 aggregate area may migrate into the area along with perched or aquifer water.

4
5 Transport of chemical vapors in the unsaturated zone has been implicated as an
6 important transport pathway in migration of carbon tetrachloride and other volatile
7 organics away from source areas. These vapors may then become adsorbed to soils
8 solids or dissolved in soil pore water.

9
10 There are four exposure routes by which humans (off site and on site) and other
11 biota (plants and animals) can be exposed to these possible contaminants:

- 12
13 ● Inhalation of airborne volatiles or fugitive dusts with adsorbed
14 contamination;
- 15
16 ● Ingestion of surface water, fugitive dust, surface soils, biota (either directly
17 or through the food chain), or groundwater;
- 18
19 ● Direct contact with the waste materials (such as those exhumed by
20 burrowing animals), contaminated surface soils, buildings, or plants; and
- 21
22 ● Direct radiation from waste materials, surface soils, building surfaces, or
23 fugitive dusts.

24 25 26 **4.2.4 Characteristics of Contaminants**

27
28 Table 4-13 is a list of radioactive and nonradioactive chemical substances that
29 represent candidate contaminants of potential concern for this study based on their
30 known presence in wastes, usage, disposal in waste management units, historical
31 association, or detection in environmental media at the Z Plant Aggregate Area. In
32 addition, Table 4-13 includes chemicals that have not been detected or reported in Z
33 Plant wastes or environmental samples but are expected to be present (e.g., decay
34 products of radionuclide contaminants). Table 4-14 summarizes the types of known or
35 suspected contamination that are thought to exist at the individual waste sites. Known
36 contaminants have been proven to exist from sampling and inventory data (Tables 2-2
37 and 2-3). Suspected contaminants are those which could occur at a site based upon
38 historical practices or chemical associations. Given the large number of chemicals known
39 or suspected to be present, it is appropriate to focus this assessment on those
40 contaminants that pose the greatest risk to human health or the environment. Table 4-15
41 lists the contaminants of concern for the Z Plant Aggregate Area. This list was

1 developed from Table 4-13 and includes only those contaminants which meet the
2 following criteria:

- 3
- 4 ● Radionuclides that have a half-life greater than one year;
- 5
- 6 ● Radionuclides with a half-life of less than one year and are part of long-
7 lived decay chains that result in the building up of the short-lived
8 radionuclide activity to a level of 1 percent or greater of the parent
9 radionuclide's activity within the time period of interest;
- 10
- 11 ● Contaminants that are known or suspected carcinogens or have a EPA
12 non-carcinogenic toxicity factor; and
- 13
- 14 ● Chemical is mobile in the environment via one of the transport pathways
15 identified in the Conceptual Model.
- 16

17 In practice, the last criterion was not used to eliminate chemicals from the list,
18 since chemicals that are not of concern for groundwater migration (high K_d) may be of
19 concern for airborne transport.

20

21 It should be noted that the majority of the listed chemicals and radionuclides were
22 reported disposed of in the Solid Waste Burial Grounds. The potential for these
23 materials to enter the environment will depend on the extent to which free liquids were
24 co-disposed in the burial areas, and the extent to which container leakage and infiltration
25 has occurred, or may occur in the future, and the potential for disruption of the soil
26 cover.

27

28 The following characteristics will be discussed for the contaminants listed in Table
29 4-13:

- 30
- 31 ● Detection of contaminants in environmental media;
- 32
- 33 ● Historical association with plant activities;
- 34
- 35 ● Mobility;
- 36
- 37 ● Persistence;
- 38
- 39 ● Toxicity; and
- 40
- 41 ● Bioaccumulation.

9 3 1 2 8 6 5 0 8 7 7

1 Chemicals for which no toxicity criteria are available were included on the list only
2 if they have known chronic toxic effects and are known to have been released in large
3 quantities to the environment. Chemicals included in this group are:

- 4
- 5 ● Lead;
- 6 ● Dibutyl phosphate; and
- 7 ● Tributyl phosphate.
- 8

9 **4.2.4.1 Detection of Contaminants in Environmental Media.** The nature and extent of
10 surface and subsurface soils, surface water, and biota contamination have not yet been
11 thoroughly characterized for the Z Plant Aggregate Area. All recent environmental
12 monitoring data that could be obtained for this study were reviewed and summarized for
13 each media in Section 4.1.

14

15 The most extensive monitoring data available are for groundwater. Because
16 groundwater will be evaluated in the 200 West Groundwater AAMS, it will not be
17 discussed further here. Surface soil and vegetation samples have been collected from
18 locations on a regular rectangular grid. These sampling locations do not correspond to
19 any of the waste management units, but are intended to characterize the Z Plant
20 Aggregate Area as a whole. Air and external radiation samples have been collected at
21 several locations within or adjacent to the Z Plant Aggregate Area. These sampling
22 locations are also not located directly on any of the waste management units and
23 therefore the sampling results cannot be attributed to any particular unit.

24

25 The only routine sampling data that correspond directly to waste management
26 units are the external radiation surveys, which are performed on a regular basis. In
27 addition, limited soil sampling was performed in 1979 at the 216-Z-1A Crib, in 1981 at
28 the 216-Z-9 Crib (Rai et al. 1981), and in 1983 at the 216-Z-8 French Drain during
29 special studies of radionuclide migration, and at the Solid Waste Burial Grounds during
30 studies of carbon tetrachloride distribution (DOE/RL 1991b). The former samples were
31 analyzed only for plutonium and americium, and the latter only for volatile organic
32 compounds. In addition, soil samples from the Solid Waste Burial Grounds taken in
33 1990 were analyzed for organic and inorganic constituents (Goodwin and Bjornstad
34 1990).

35

36 **4.2.4.2 Historical Association with Z Plant Activities.** Radionuclides that are known
37 components of Z Plant waste streams are listed in Table 2-9. This list includes chemicals
38 known to occur in the process wastes as well as chemicals that were detected at elevated
39 levels in PFP wastewater. Since these waste streams are known to have been disposed of
40 directly to the soil column in some waste management units, it is probable that the
41 chemicals on this list have affected environmental media.

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1 Radionuclides that are known to have been disposed of to Z Plant waste
2 management units in the greatest quantities, based on the WIDS data and records of the
3 Solid Waste Burial Grounds, are as follows:

- 4
- 5
- 6 ● ^{239}Pu
- 7 ● ^{240}Pu
- 8 ● ^{137}Cs
- 9 ● ^{90}Sr
- 10 ● ^3H
- 11 ● ^{60}Co
- 12 ● ^{106}Ru
- 13

14 Note that a complete radionuclide analysis of the Z Plant waste streams is not
15 available, and no information was located on the composition of wastes from the 231-Z
16 Building. Thus, it is possible that additional radionuclides were disposed of to Z Plant
17 Aggregate Area waste management units that are not reported in the waste inventories.

18
19 Nonradioactive chemicals reportedly released into Z Plant Aggregate Area waste
20 management units in large quantities include nitric acid, nitrates, sodium, phosphate,
21 sodium hydroxide, fluorides, tributyl phosphate, carbon tetrachloride, dibutyl phosphate,
22 calcium, magnesium, and iron.

23
24 **4.2.4.3 Mobility.** Since most wastes at the Z Plant Aggregate Area were released
25 directly to subsurface soils via injection, infiltration, or burial, the mobility of the wastes
26 in the subsurface will determine the potential for future exposures. The mobility of the
27 chemicals listed in Table 4-13 varies widely and depends on site-specific factors as well as
28 the intrinsic properties of the chemical. Much of the site-specific information needed to
29 characterize mobility is not available and will need to be obtained during the RI/FS
30 process. However, it is possible to make general statements about the relative mobility
31 of the candidate chemicals of concern.

32
33 **4.2.4.3.1 Transport to the Subsurface.** The mobility of radionuclides and other
34 inorganic elements in groundwater depends on the chemical form and charge of the
35 element or molecule, which in turn depends on site-related factors such as the pH, redox
36 state, and ionic composition of the groundwater. Cationic species (e.g., Cd^{2+} , Pu^{4+})
37 generally are retarded in their migration relative to groundwater to a greater extent than
38 anionic species such as nitrate (NO_3^-). The presence in groundwater of complexing or
39 chelating agents can increase the mobility of metals by forming neutral or negatively
40 charged compounds.

41

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1 The chemical properties of radionuclides are essentially identical to the
2 nonradioactive form of the element; thus, discussions of the chemical properties affecting
3 the transport of contaminants can apply to both radionuclides and nonradioactive
4 chemicals.

5
6 A soil-water distribution coefficient (K_d) can be used to predict mobility of
7 inorganic chemicals in the subsurface. Table 4-16 presents a summary of soil-water
8 distribution coefficients that have been developed for many of the candidate inorganic
9 chemicals of concern at the Z Plant Aggregate Area. As discussed above, the pH and
10 ionic strength of the leaching medium has an impact on the absorption of inorganics to
11 soil; thus, the listed K_d s are valid only for a limited range of pH and waste composition.
12 In addition, soil sorption of inorganics is highly dependent on the mineral composition of
13 the soil, the ionic composition of the soil pore water, and other site-specific factors.
14 Thus, a high degree of uncertainty is involved with use of K_d values that have not been
15 verified by experimentation with site soils.

16
17 Serne and Wood (1990) recommended K_d values for use with Hanford waste
18 assessments for a limited number of important radionuclides (Am, Cs, Co, Cu, I, Pu, Ru,
19 Sr, and tritium) based on soil column or batch desorption studies, and have proposed
20 conservative average values for a more extensive list of elements based on a review of
21 the literature. An assumed retardation of <1 is recommended for Am, Cs, Pu, and Sr
22 under acidic conditions.

23
24 Streng and Peterson (1989) developed default K_d values for a large number of
25 elements for use in the Multimedia Environmental Pollution Assessment System, a
26 computerized waste management unit evaluation system. The K_d values were based on
27 findings in the scientific literature, and include non-site-specific as well as Hanford Site
28 values. Values are provided for nine sets of environmental conditions: three ranges of
29 waste pH and three ranges of soil adsorbent material (sum of percent clay, organic
30 material, and metal hydrous oxides). The values presented in Table 4-17 are for
31 conditions of neutral waste pH and less than 10 percent adsorbent material, which is
32 likely to be most representative of Hanford Site soils.

33
34 The mobility of inorganic species in soil can be divided roughly into three classes,
35 using site-specific values (Serne and Wood 1990) where available and conservative
36 default values otherwise: highly mobile ($K_d < 5$), moderately mobile ($5 < K_d < 100$), and low
37 mobility ($K_d > 100$). The class ranking for each of the inorganic contaminants of concern
38 is listed below:

1	Highly mobile ($K_d < 5$)	
2	Antimony	Neptunium
3	Boron	Nitrate, nitrite
4	Carbon (as $^{14}\text{CO}_2$)	Potassium
5	Chloride	Protactinium
6	Chromium (VI)	Selenium
7	Cyanide	Sodium
8	Fluoride	Technetium
9	Iodine	Thallium
10	Krypton	Tritium
11	Molybdenum	Uranium
12	Moderately mobile ($5 < K_d < 100$)	
13	Barium	Niobium
14	Beryllium	Phosphate
15	Bismuth	Potassium
16	Cadmium	Radium
17	Calcium	Ruthenium
18	Copper	Silver
19	Iron	Strontium
20	Lead	Thorium
21	Nickel	Vanadium
		Zinc
22	Low mobility ($K_d > 100$)	
23	Actinium	Europium
24	Asbestos	Mercury
25	Americium	Plutonium
26	Cesium	Samarium
27	Cobalt	Yttrium
28	Curium	

30 The tendency of organic compounds to adsorb to the organic fraction of soils is
 31 indicated by the soil-organic matter partition coefficient, K_{oc} . Partition coefficients for
 32 the organic chemicals disposed of or detected at Z Plant Aggregate Area waste
 33 management units are listed in Table 4-17. Chemicals with low K_{oc} values are weakly
 34 absorbed by soils and will tend to migrate in the subsurface, although their rate of travel
 35 will be retarded somewhat relative to the pore water or groundwater flow. Soils at the
 36 Hanford Site have very little organic carbon content and thus sorption to the inorganic
 37 fraction of soils may dominate over sorption to soil organic matter.
 38

1 **4.2.4.3.2 Transport to Air.** Transport between soils and air can occur either by
2 fugitive dust emissions or volatilization. Chemicals subject to transport via airborne dust
3 dispersion are those that are non-volatile and persistent on the soil surface, including
4 most radionuclides and inorganics, and some organics such as creosote and coal tar.

5
6 Chemicals subject to volatilization are mostly organic compounds; however, certain
7 of the radionuclides detected at the site are subject to evaporation and could be lost
8 from shallow soils to the ambient air. The most important species in this category are
9 ^{14}C , ^3H , and ^{129}I .

10
11 The tendency of an organic compound to volatilize can be predicted from its
12 Henry's law constant, K_h , a measured or calculated parameter with units of atmospheres
13 per cubic meter per mole of chemical. Henry's law constants of the candidate organic
14 chemicals of concern are presented in Table 4-17. Compounds with a K_h greater than
15 about 10^3 will be lost rapidly to the atmosphere from surface water and shallow soils.
16 Organic compounds that fall into this class include:

17		
18	Benzene	Hexane
19	Carbon tetrachloride	Methylene chloride
20	Chlorobenzene	Tetrachloroethylene
21	Chloroform	Toluene
22	Cyclohexane	Tributyl phosphate
23	1,2-Dichloroethane	1,1,1-Trichloroethane
24	1,2-Dichloroethylene	Trichloroethylene
25	Ethylbenzene	Vinyl chloride
26	Freon II	Xylenes
27		

28 **4.2.4.4 Persistence.** Once released to environmental media, the concentration of a
29 chemical may decrease because of biological or chemical transformation, radioactive
30 decay, or the intermediate transfer processes discussed above that remove the chemical
31 from the medium (e.g., volatilization to air). Radiological, chemical, and biological decay
32 processes affecting the persistence of the Z Plant Aggregate Area contaminants are
33 discussed below.

34
35 The persistence of radionuclides depends primarily on their half-lives. A
36 comparison of the half-lives and specific activities for all radionuclides detected or
37 disposed of at the Z Plant Aggregate Area is presented in Table 4-18. This table also
38 includes daughters of long-lived parent radionuclides, whether or not the daughter
39 species have been detected or reported. The specific activity is the decay rate per unit
40 mass, and is inversely proportional to the half-life of the radionuclide. Half-lives for the
41 radionuclides listed in Table 4-18 range from seconds to over one billion years. Also

1 listed are the decay mechanisms of primary concern for the radionuclide. Note that
2 radionuclides often undergo several decay steps in quick succession, (e.g., an alpha decay
3 followed by release of one or more gamma rays). The daughter products of these decays
4 are often themselves radioactive.

5
6 Decay will occur during transport (e.g., through the vadose zone to the aquifer
7 and through the aquifer) and may lead to significant reductions in levels discharging to
8 the Columbia River. For direct exposures (e.g., to surface soils or air), the half-life of
9 the radionuclide is of less importance, unless the half-life is so short that the radionuclide
10 undergoes substantial decay between the time of disposal and release to the environment.

11
12 Nonradioactive inorganic chemicals detected at the site are generally persistent in
13 the environment, although they may decline in concentration due to transport processes
14 or change their chemical form due to chemical or biological reactions. Nitrate and
15 sulfate undergo chemical and biological transformations that may lead to their loss to the
16 atmosphere (as N_2 and H_2S) or incorporation into living organisms, depending on the
17 redox environment and microbiological communities present in the medium.

18
19 Biotransformation rates for organics vary widely and are highly dependent on site-
20 specific factors such as soil moisture, redox conditions, and the presence of nutrients and
21 of organisms capable of degrading the compound. Ketones, such as acetone and MIBK,
22 are easily degraded by microorganisms in soil and thus would tend not to persist.
23 Chlorinated solvents (e.g., carbon tetrachloride) may undergo slow biotransformation in
24 the subsurface under anoxic conditions. Tetrachloroethylene and trichloroethylene may
25 be converted to the more toxic compound vinyl chloride under some redox conditions.
26 Volatile aromatics such as toluene are generally intermediate in their biodegradability
27 between these two example groups.

28
29 **4.2.4.5 Toxicity.** Contaminants may be of potential concern for impacts to human health
30 if they are known or suspected to have carcinogenic properties, or if they have adverse
31 noncarcinogenic human health effects. The toxicity characteristics of the chemicals
32 detected at the operable unit are summarized below.

33
34 **4.2.4.5.1 Radionuclides.** All radionuclides are classified by EPA as known human
35 carcinogens based on their property of emitting ionizing radiation and on the evidence
36 provided by epidemiological studies of radiation-induced cancers in humans. Non-
37 carcinogenic health effects associated with radiation exposure include genetic and
38 teratogenic effects; however, these effects generally occur at higher exposure levels than
39 those required to induce cancer. Thus, the carcinogenic effect of radionuclides is the
40 primary identified health concern for these chemicals.

41

1 Risks associated with radionuclides differ for various routes of exposure depending
2 on the type of ionizing radiation emitted. Nuclides that emit alpha or beta particles are
3 hazardous primarily if the materials are inhaled or ingested, since these particles expend
4 their energy within a short distance after penetrating body tissues. Gamma-emitting
5 radioisotopes are of concern as both external and internal hazards. A fourth mode of
6 radioactive decay, neutron emission, is generally not of major health concern, since this
7 mode of decay is much less frequent than other decay processes. In addition to the
8 mode of radioactive decay, the degree of hazard from a particular radionuclide depends
9 on the rate at which particles or gamma radiation are released from the material.

10
11 Excess cancer risks for exposure to radionuclides by inhaling air, drinking water,
12 ingesting soil, and by external irradiation are shown in Table 4-19. These values
13 represent the increase in probability of cancer to an individual exposed for a lifetime to a
14 radionuclide at a level of 1 pCi/m³ in air, 1 pCi/L in drinking water, 1 pCi/g in ingested
15 soil, or to external radiation from soil having a radionuclide content of 1 pCi/g (EPA
16 1991a).

17
18 For those radionuclides without EPA (1991a) slope factors, the *Hanford Site*
19 *Baseline Risk Assessment Methodology* (DOE/RL 1991a) proposes to use the dose
20 conversion factors developed by the International Commission on Radiological Protection
21 to calculate a risk value.

22
23 The unit risk factors for different radionuclides are roughly proportional to their
24 specific activities, but also incorporate factors to account for distribution of each
25 radionuclide within various body organs, the type of radiation emitted, and the length of
26 time that the nuclide is retained in the lungs.

27
28 Based on the factors listed in Table 4-19, the highest risk for exposure to 1 pCi/m³
29 in air is from plutonium, americium and uranium isotopes, which are alpha emitters.
30 Among the radionuclides detected in environmental samples at the Z Plant Aggregate
31 Area, the highest risks from ingestion of soil at 1 pCi/g are for ²²⁷Ac, ²⁴¹Am, ²⁴³Am, ²³⁸Pu,
32 ²⁴⁴Cm, and ²⁴³Cm. The primary gamma-emitters are ²¹⁴Bi, ⁶⁰Co, ¹³⁴Cs, ¹³⁷Cs (because of its
33 metastable decay product, ^{137m}Ba), ¹⁵²Eu, and ¹⁵⁴Eu.

34
35 The standard EPA risk assessment methodology assumes that the probability of a
36 carcinogenic effect increases linearly with dose at low dose levels, i.e., there is no
37 threshold for carcinogenic response. The EPA methodology also assumes that the
38 combined effect of exposure to multiple carcinogens is additive without regard to target
39 organ or cancer mechanism.

40

1 **4.2.4.5.2 Hazardous Chemicals.** Carcinogenic and non-carcinogenic health effects
2 associated with chemicals known or suspected to occur within the Z Plant Aggregate
3 Area are summarized in Table 4-20.
4

5 EPA has not derived toxicity criteria for many of the chemicals suspected of being
6 present or detected at the Z Plant Aggregate Area. Many of the chemicals that lack
7 toxicity criteria have negligible toxicity or are necessary nutrients in the human diet.
8

9 Several of the chemicals have known toxic effects but no toxicity criterion is
10 presently available. In some instances the criteria have been withdrawn by EPA pending
11 review of the toxicological data and will be reissued at a future date. Chemicals with
12 known toxicity for which toxicity factors are presently not available include:
13

14 creosote
15 ethanol
16 Freon II (trichlorofluoromethane)
17 isopropanol
18 lead
19 methanol
20 selenium
21 kerosene
22 naphthylamine (untritiated)
23 tributyl phosphate.
24

25 **4.2.4.6 Bioaccumulation potential.** Contaminants may be of concern for exposure if they
26 have a tendency to accumulate in plant or animal tissues at levels higher than those in
27 the surrounding medium (bioaccumulation) or if their levels increase at higher trophic
28 levels in the food chain (biomagnification). Contaminants may be bioaccumulated
29 because of element-specific uptake mechanisms (e.g., incorporation of strontium into
30 bone) or by passive partitioning into body tissue (e.g., concentration of organic chemicals
31 in fatty tissues).
32

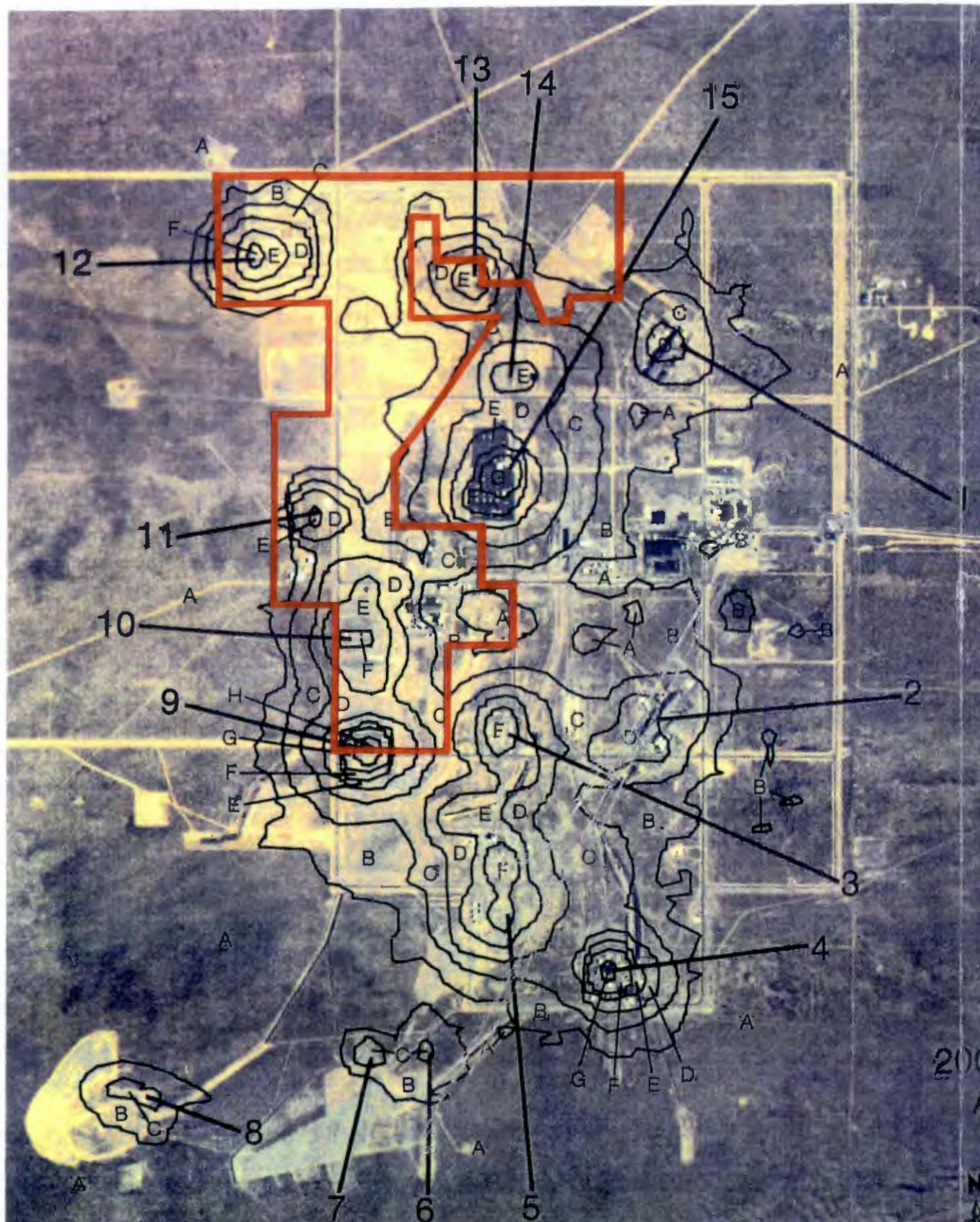
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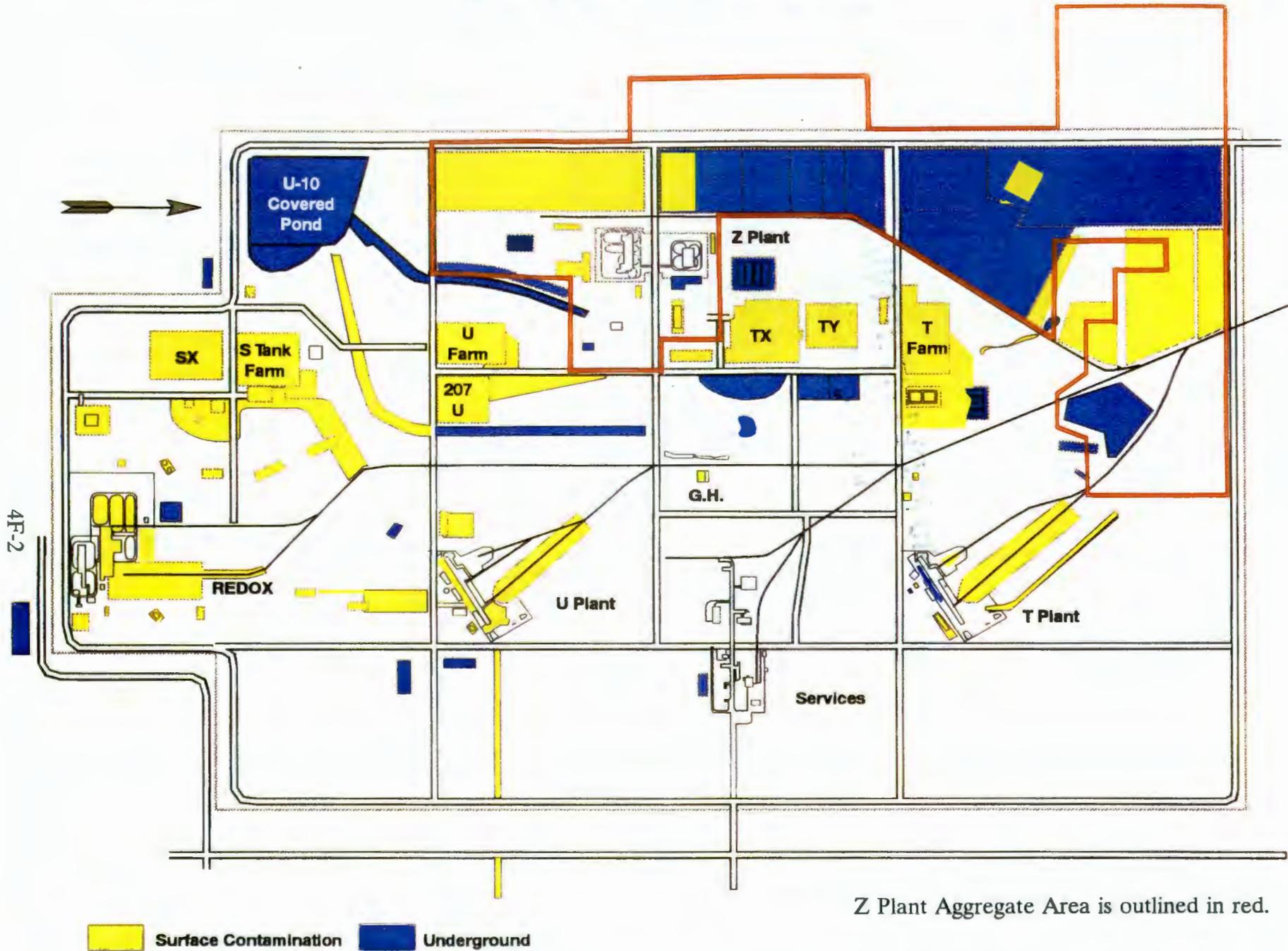


Zone A = <700 ct/s	Zone E = 22,000 to 70,000 ct/s
Zone B = 700 to 2,200 ct/s	Zone F = 70,000 to 220,000 ct/s
Zone C = 2,200 to 7,000 ct/s	Zone G = 220,000 to 700,000 ct/s
Zone D = 7,000 to 22,000 ct/s	Zone H = 700,000 to 2,200,000 ct/s

2 = U Plant Aggregate Area and 216-U-1 and 216-U 2 Cribs
 3 = 244-U Tank Farm
 Other numbers refer to sites outside the U Plant Aggregate Area.
 Z Plant Aggregate Area is outlined in red.
 The results are displayed as relative levels of man-made radionuclide activity

Figure 4-1. Gamma Isoradiation Contour Map of the 200 West Area.
(Reiman and Dahlstrom 1988)

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Draft A

Figure 4-2. Surface, Underground and Migrating Contamination Map of the 200 West Area (Huckfeldt 1991b).

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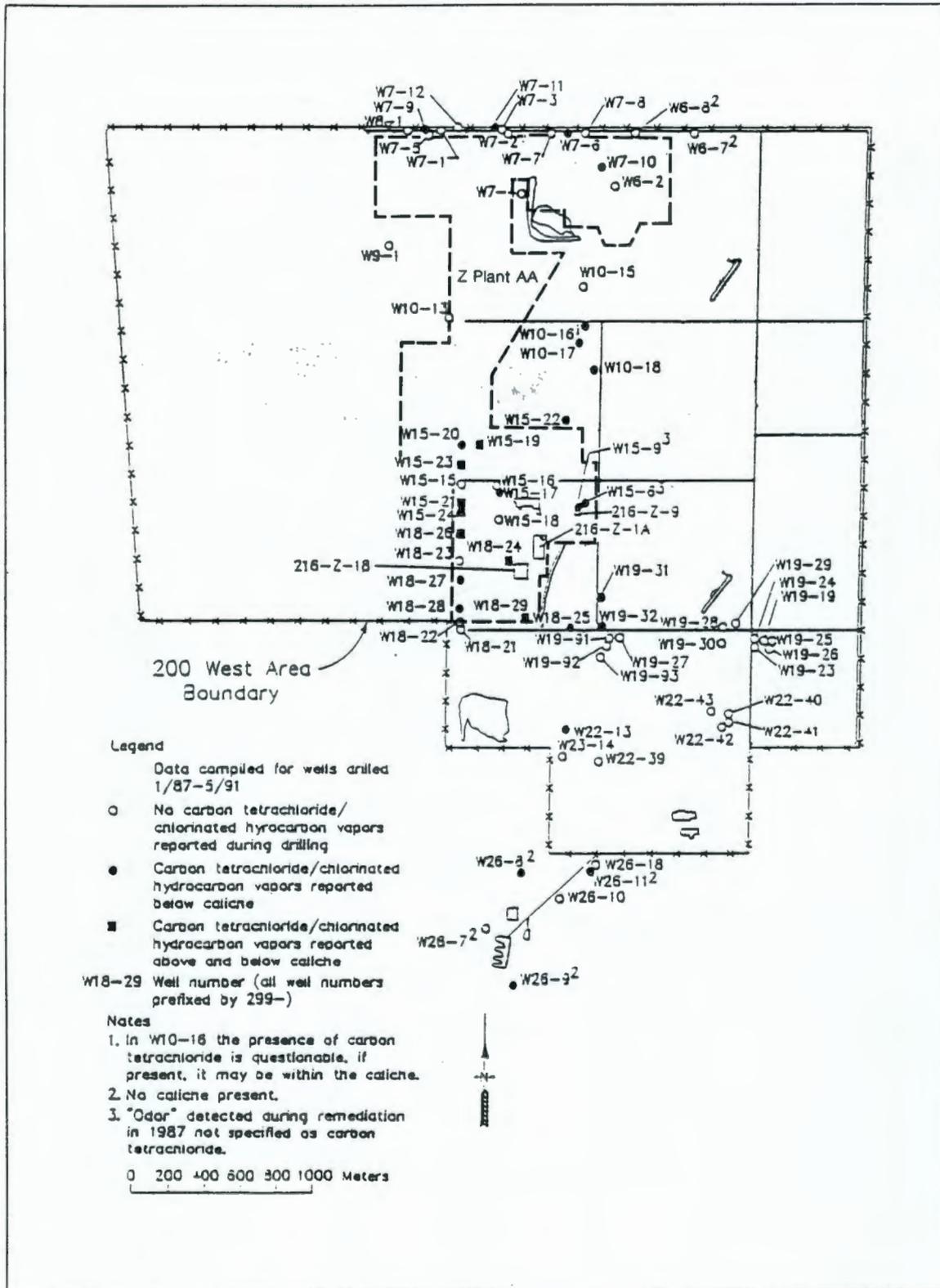


Figure 4-3. Wells in Which Carbon Tetrachloride/Chlorinated Hydrocarbon Vapor was Detected during Drilling in the 200 West Area, 1987-1991. (Source: DOE 1991)

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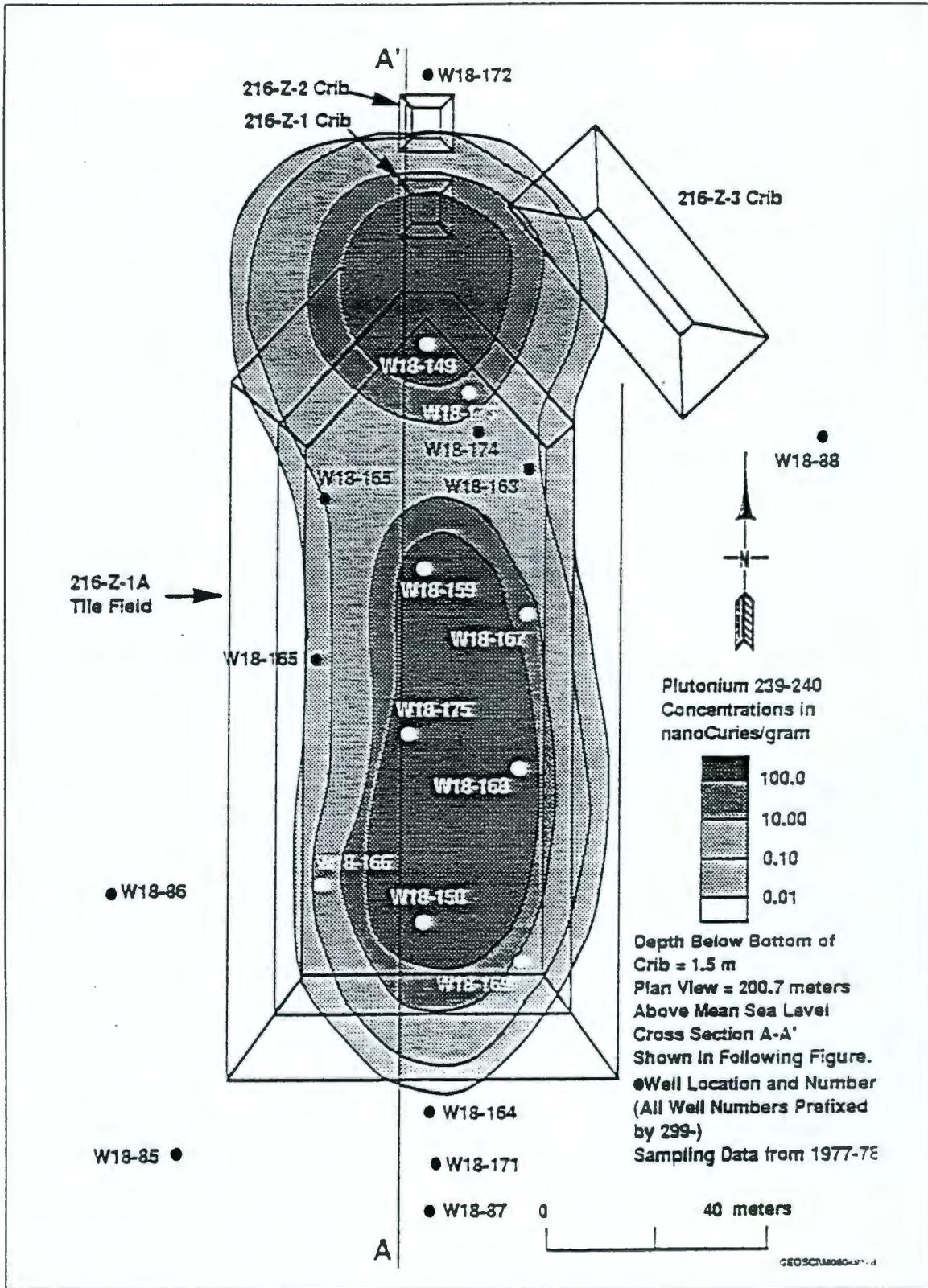


Figure 4-5. Map of 1977 Plutonium Concentrations in Unsaturated Zone 1.5 m below Bottom of the 216-Z-1A Tile Field.

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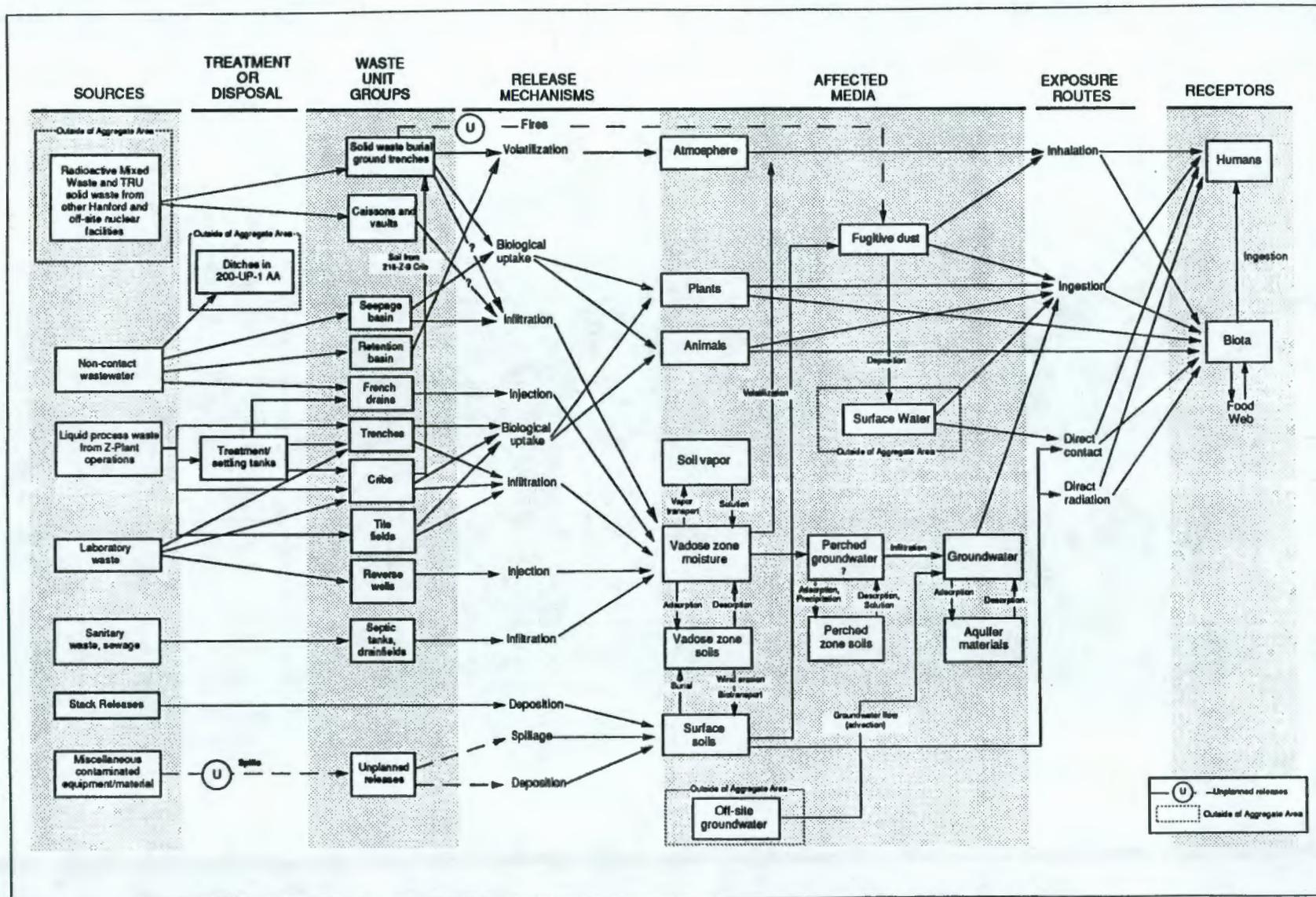


Figure 4-6. Conceptual Model.

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Draft A

Table 4-1. Types of Data for the Z Plant Aggregate Area Waste Management Units. (Sheet 1 of 5)

Waste Management Unit	Waste Inventory Database (WIDS)	Surface Soil/Sediment Data	External Radiation Monitoring Data	Biota Sampling Data	Subsurface Vapor/Soil Sampling Data	Borehole Geophysics Data
Plants, Buildings, and Storage Areas						
232-Z Incinerator			R			
234-5Z HWSA	C					
WRAP						
RMW Storage Facility						
Tanks and Vaults						
216-Z-8 Settling Tank	C, R					
241-Z-361 Settling Tank	C, R					
241-Z Treatment Tank	C, R					
Cribs and Drains						
216-Z-1 & 216-Z-2 Cribs	C, R		R			R
216-Z-3 Crib	C, R		R			R
216-Z-5 Crib	C, R		R			R
216-Z-6 Crib	C, R		R			
216-Z-7 Crib	C, R		R			R
216-Z-12 Crib	C, R		R			R
216-Z-16 Crib	R		R			R
216-Z-18 Crib	C, R		R		C	R

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Draft A

Table 4-1. Types of Data for the Z Plant Aggregate Area Waste Management Units. (Sheet 2 of 5)

Waste Management Unit	Waste Inventory Database (WIDS)	Surface Soil/Sediment Data	External Radiation Monitoring Data	Biota Sampling Data	Subsurface Vapor/Soil Sampling Data	Borehole Geophysics Data
216-Z-8 French Drain	R		R		R	
216-Z-13 French Drain	R		R			
216-Z-14 French Drain	R		R			
216-Z-15 French Drain	R		R			
216-Z-1A Tile Field	C, R		R		C, R	R
Reverse Well						
216-Z-10 Reverse Well	C, R		R			
Ponds, Ditches, and Trenches						
216-Z-4 Trench	R		R			
216-Z-9 Trench	C, R		R	R	C, R	R
216-Z-17 Trench	R		R			
Septic Tanks and Associated Drain Fields						
2607-Z Septic Tank & Field						
2607-Z-1 Septic Tank & Field						
2607-WA Septic Tank & Field						
2607-WB Septic Tank & Field						
2607-W-8 Septic Tank & Field						

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Table 4-1. Types of Data for the Z Plant Aggregate Area Waste Management Units. (Sheet 3 of 5)

Waste Management Unit	Waste Inventory Database (WIDS)	Surface Soil/Sediment Data	External Radiation Monitoring Data	Biota Sampling Data	Subsurface Vapor/Soil Sampling Data	Borehole Geophysics Data
Transfer Facilities, Diversion Boxes, and Pipelines						
241-Z-Diversion Box No. 1						
241-Z-Diversion Box No. 2						
231-Z-151 Sump						
Basins						
207-Z Retention Basin						
216-Z-21 Seepage Basin		R	R	R		
Burial Sites						
218-W-1 Burial Ground	R		R			
218-W-1A Burial Ground	R		R			
218-W-2 Burial Ground	R		R		C	
218-W-2A Burial Ground	R		R	R		
218-W-3 Burial Ground	R		R			
218-W-3A Burial Ground	R		R			R
218-W-3AE Burial Ground	R			R	C, R	R
218-W-4A Burial Ground	R		R			
218-W-4B Burial Ground	R		R		C, R	R
218-W-4C Burial Ground	R			R	C, R	R

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Table 4-1. Types of Data for the Z Plant Aggregate Area Waste Management Units. (Sheet 4 of 5)

Waste Management Unit	Waste Inventory Database (WIDS)	Surface Soil/Sediment Data	External Radiation Monitoring Data	Biota Sampling Data	Subsurface Vapor/Soil Sampling Data	Borehole Geophysics Data
218-W-5 Burial Ground	R				C, R	R
218-W-6 Burial Ground						R
218-W-11 Burial Ground	R		R			R
Z Plant Burn Pit						
Unplanned Releases						
UN-200-W-11						
UPR-200-W-16			R			
UN-200-W-23			R			
UPR-200-W-26			R			
UN-200-W-44	R		R			
UPR-200-W-45	R		R			
UPR-200-W-53	R		R			
UPR-200-W-72	R		R			
UN-200-W-74	R		R			
UN-200-W-75	R		R			
UN-200-W-79	R		R			
UPR-200-W-84	R		R			
UN-200-W-89	R		R			

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Table 4-1. Types of Data for the Z Plant Aggregate Area Waste Management Units. (Sheet 5 of 5)

Waste Management Unit	Waste Inventory Database (WIDS)	Surface Soil/Sediment Data	External Radiation Monitoring Data	Biota Sampling Data	Subsurface Vapor/Soil Sampling Data	Borehole Geophysics Data
UN-200-W-90	R		R			
UN-200-W-91	R		R			
UN-200-W-103	R		R			
UN-200-W-130	R		R			
UN-200-W-132						
UPR-200-W-134						
UPR-200-W-158	R		R			
UN-200-W-159	C					

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Notes:

C Nonradioactive organic or inorganic constituents

R Radiological constituents

Blank entries indicate no applicable data found during document review.

Table 4-2. Summary of Radionuclide Contamination in Various Affected Media for the Z Plant Aggregate Area. (Sheet 1 of 5)

Waste Management Unit	Air	Surface Soil (0 to 1 m)	Surface Water	Biota	Vadose Zone	Remarks
Plants, Buildings, and Storage Areas						
232-Z Incinerator		s				Slightly elevated external radiation.
234-5Z HWSA	nc	nc			nc	
WRAP	nc	nc			nc	
RMW Storage Facility	nc	nc			nc	
Tanks and Vaults						
216-Z-8 Settling Tank					s	Single wall steel tank containing 1.6 kg Pu (1974).
241-Z-361 Settling Tank						
241-Z Treatment Tank		k, r			s	See UPR-200-W-79.
Cribs and Drains						
216-Z-1 & 216-Z-2 Cribs		s			s	Elevated external radiation.
216-Z-3 Crib					s	
216-Z-5 Crib		k			s	High cave-in potential reported.
216-Z-6 Crib					s	High cave-in potential reported.
216-Z-7 Crib		k			s	Elevated gamma to groundwater.
216-Z-12 Crib					s	Elevated gamma to 8 m.
216-Z-16 Crib					s	
216-Z-18 Crib					s	Elevated gamma to 9 m.

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Table 4-2. Summary of Radionuclide Contamination in Various Affected Media for the Z Plant Aggregate Area. (Sheet 2 of 5)

Waste Management Unit	Air	Surface Soil (0 to 1 m)	Surface Water	Biota	Vadose Zone	Remarks
216-Z-8 French Drain					k	²³⁹ Pu to 7.6 m.
216-Z-13 French Drain					s	Floor drainage from 291-Z Building.
216-Z-14 French Drain					s	Trace beta activity reported.
216-Z-15 French Drain					s	Received Evaporative cooler water.
216-Z-1A Tile Field		s			k	Pu and Am to 30 m.
Reverse Well						
216-Z-10 Reverse Well					s	
Ponds, Ditches and Trenches						
216-Z-4 Trench					s	Only used one month.
216-Z-9 Trench		k		k	k	Elevated gamma to more than 30 m.
216-Z-17 Trench					s	Received laboratory waste.
Septic Tanks and Associated Drain Fields						
2607-Z Septic Tank & Field						Sanitary wastes only.
2607-Z-1 Septic Tank & Field						Sanitary wastes only.
2607-WA Septic Tank & Field						Sanitary wastes only.
2607-WB Septic Tank & Field						Sanitary wastes only.
2607-W-8 Septic Tank & Field						Sanitary wastes only.

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Table 4-2. Summary of Radionuclide Contamination in Various Affected Media for the Z Plant Aggregate Area. (Sheet 3 of 5)

Waste Management Unit	Air	Surface Soil (0 to 1 m)	Surface Water	Biota	Vadose Zone	Remarks
Transfer Facilities, Diversion Boxes, and Pipelines						
241-Z-Diversion Box No. 1					s	
241-Z-Diversion Box No. 2					s	
231-Z-151 Sump					s	See UN-200-W-130
Basins						
207-Z Retention Basin						
241-Z-21 Seepage Basin		k	nc	k		Contaminated aquatic vegetation and sediment.
Burial Sites						
218-W-1 Burial Ground		k, r?				Elevated external radiation. See UPR-200-45, UPR-200-W-84, UPR-200-W-134.
218-W-1A Burial Ground						
218-W-2 Burial Ground		s				Elevated external radiation.
218-W-2A Burial Ground		s		k		Elevated external radiation. Contaminated vegetation.
218-W-3 Burial Ground						
218-W-3A Burial Ground		s				Elevated external radiation.
218-W-3AE Burial Ground						
218-W-4A Burial Ground	k	k, r?			s	See UPR-200-W-16, UPR-200-W-26, UPR-200-W-53, and UPR-200-W-72. Elevated external radiation.
218-W-4B Burial Ground		k				Small area of contaminated mulch.

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Table 4-2. Summary of Radionuclide Contamination in Various Affected Media for the Z Plant Aggregate Area. (Sheet 4 of 5)

Waste Management Unit	Air	Surface Soil (0 to 1 m)	Surface Water	Biota	Vadose Zone	Remarks
218-W-4C Burial Ground		s		k		Contaminated vegetation.
218-W-5 Burial Ground						
218-W-6 Burial Ground				k		Proposed site. Contaminated vegetation.
218-W-11 Burial Ground		k		k		Small area of contaminated mulch
Z Plant Burn Pit						
Unplanned Releases						
UN-200-W-11		s				
UPR-200-W-16	s	r?				Elevated external radiation (historical).
UN-200-W-23		s				
UPR-200-W-26	s	r?				Elevated external radiation (historical).
UN-200-W-44	s	s				Elevated external radiation (historical).
UPR-200-W-45	k	r?				Elevated external radiation (historical). Ruthenium spill affected 1,800 acres.
UPR-200-W-53	k	r?				Elevated external radiation (historical). Ruthenium spill affected 250 acres.
UPR-200-W-72	s	r?				Elevated external radiation (historical).
UN-200-W-74		r				Elevated external radiation (historical). 241-Z Treatment Tank Area.
UN-200-W-75		r				Elevated external radiation (historical). 241-Z Treatment Tank Area.

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Table 4-2. Summary of Radionuclide Contamination in Various Affected Media for the Z Plant Aggregate Area. (Sheet 5 of 5)

Waste Management Unit	Air	Surface Soil (0 to 1 m)	Surface Water	Biota	Vadose Zone	Remarks
UN-200-W-79		r				241-Z Treatment Tank Area. Elevated external radiation (historical).
UPR-200-W-84	s	r?				Elevated external radiation (historical).
UN-200-W-89	s	r				Elevated external radiation (1985).
UN-200-W-90	s	r				Elevated external radiation (1985).
UN-200-W-91	s	r?				Elevated external radiation (1985).
UN-200-W-103		r?			s	Elevated external radiation. 216-Z-18 Crib line
UN-200-W-130		r?			s	Elevated external radiation (historical).
UN-200-W-132		s			s	
UPR-200-W-134	nc	nc				
UPR-200-W-158		s				Elevated external radiation (historical).
UN-200-W-159						

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Notes:

- s Suspected contamination, based on WIDS, other waste inventory data, and available sampling and analysis information.
 - k Known contamination based on WIDS, or other source.
 - r Complete remediation reported.
 - r? Remediation attempted, effectiveness not documented.
 - nc No contamination indicated by the available data.
- Blank entires indicate no applicable data found during document review.

Table 4-3. Summary of Chemical Contamination for Various Affected Media for the Z Plant Aggregate Area. (Sheet 1 of 5)

Waste Management Unit	Air	Surface Soil (0 to 1 m)	Surface Water	Biota	Vadose Zone Soil 0 to 5 meters	Remarks
Plants, Buildings, and Storage Areas						
232-Z Incinerator						
234-5Z HWSA						
WRAP						
RWM Storage Facility						
Tanks and Vaults						
216-Z-8 Settling Tank						Single wall steel tank.
241-Z-361 Settling Tank						
241-Z Treatment Tank		k, r				See UPR-200-W-79.
Cribs and Drains						
216-Z-1 & 216-Z-2 Cribs	s				k	Carbon tetrachloride disposal area.
216-Z-3 Crib					s	Mainly inorganics.
216-Z-5 Crib					s	Mainly inorganics.
216-Z-6 Crib					s	Mainly inorganics.
216-Z-7 Crib					s	Mainly inorganics.
216-Z-12 Crib					s	Received laboratory waste.
216-Z-16 Crib					s	
216-Z-18 Crib	s				k	Carbon tetrachloride disposal area.

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Table 4-3. Summary of Chemical Contamination for Various Affected Media for the Z Plant Aggregate Area. (Sheet 2 of 5)

Waste Management Unit	Air	Surface Soil (0 to 1 m)	Surface Water	Biota	Vadose Zone Soil 0 to 5 meters	Remarks
216-Z-8 French Drain					s	
216-Z-13 French Drain					nc	Floor drainage from 291-Z Building.
216-Z-14 French Drain					nc	
216-Z-15 French Drain					nc	Received Evaporative cooler water.
216-Z-1A Tile Field	s				k	Carbon tetrachloride disposal area.
Reverse Well						
216-Z-10 Reverse Well					s	
Ponds, Ditches, and Trenches						
216-Z-4 Trench					s	Only used one month. Received laboratory waste.
216-Z-9 Trench	s				k	Carbon tetrachloride disposal area.
216-Z-17 Trench					s	Received laboratory waste.
Septic Tanks and Associated Drain Fields						
2607-Z Septic Tank & Field					nc	Sanitary wastes only.
2607-Z-1 Septic Tank & Field					nc	Sanitary wastes only.
2607-WA Septic Tank & Field					nc	Sanitary wastes only.
2607-WB Septic Tank & Field					nc	Sanitary wastes only.
2607-W-8 Septic Tank & Field					nc	Sanitary wastes only.

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Table 4-3. Summary of Chemical Contamination for Various Affected Media for the Z Plant Aggregate Area. (Sheet 3 of 5)

Waste Management Unit	Air	Surface Soil (0 to 1 m)	Surface Water	Biota	Vadose Zone Soil 0 to 5 meters	Remarks
Transfer Facilities, Diversion Boxes, and Pipelines						
241-Z-Diversion Box No. 1						
241-Z-Diversion Box No. 2						
231-Z-151 Sump						
Basins						
207-Z Retention Basin						
216-Z-21 Seepage Basin			nc			
Burial Sites						
218-W-1 Burial Ground						See UPR-200-45, UPR-200-W-84, UPR-200-W-134.
218-W-1A Burial Ground						
218-W-2 Burial Ground						
218-W-2A Burial Ground						
218-W-3 Burial Ground						
218-W-3A Burial Ground						
218-W-3AE Burial Ground						Doesn't receive radioactive waste.
218-W-4A Burial Ground						See UPR-200-W-16, UPR-200-W-26, UPR- 200-W-53, and UPR-200-W-72.
218-W-4B Burial Ground						Small area of contaminated mulch.
218-W-4C Burial Ground						

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Table 4-3. Summary of Chemical Contamination for Various Affected Media for the Z Plant Aggregate Area. (Sheet 4 of 5)

Waste Management Unit	Air	Surface Soil (0 to 1 m)	Surface Water	Biota	Vadose Zone Soil 0 to 5 meters	Remarks
218-W-5 Burial Ground						
218-W-6 Burial Ground						Proposed site.
218-W-11 Burial Ground						Small area of contaminated mulch.
Z Plant Burn Pit						
Unplanned Releases						
UN-200-W-11						
UPR-200-W-16						
UN-200-W-23						
UPR-200-W-26						
UN-200-W-44						
UPR-200-W-45						
UPR-200-W-53						
UPR-200-W-72						
UN-200-W-74						241-Z Treatment Tank Area.
UN-200-W-75						241-Z Treatment Tank Area.
UN-200-W-79						241-Z Treatment Tank Area.
UPR-200-W-84						
UN-200-W-89						

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Table 4-3. Summary of Chemical Contamination for Various Affected Media for the Z Plant Aggregate Area. (Sheet 5 of 5)

Waste Management Unit	Air	Surface Soil (0 to 1 m)	Surface Water	Biota	Vadose Zone Soil 0 to 5 meters	Remarks
UN-200-W-90						
UN-200-W-91						
UN-200-W-103						216-Z-18 Crib line.
UN-200-W-130						
UN-200-W-132						
UPR-200-W-134						
UPR-200-W-158						
UN-200-W-159		r?				

Notes:

s Suspected contamination, primarily based on WIDS, and other waste inventory data.

k Known contamination based on chemical analysis data, WIDS, or other source.

r Complete remediation reported.

r? Remediation attempted, effectiveness not documented.

nc No contamination indicated by the available data.

Blank entries indicate no applicable data found during document review.

Table 4-4. Summary of Air Sampling Results (1985 through 1989).

Radionuclide in pCi/m ³	Sites			
	N165	N962	N964	N994
Strontium -90	6.55E-04	2.25E-03	7.45E-04	6.26E-05
Cesium -137	1.37E-04	5.95E-04	7.80E-05	1.70E-04
Plutonium - 239	2.37E-04	3.28E-05	2.04E-05	2.10E-06
Uranium (Total)	5.43E-05	4.73E-05	3.66E-05	2.31E-05

Notes:

Table values are averages for radionuclide concentrations in air from 1985 through 1989 in pCi/m³.

See Table A-3 for complete data set.

See Plate 2 for sampling locations.

9 1 2 3 4 5 1 9 0 8

Table 4-5. Radiation and Dose Rate Surveys at the Z Plant Aggregate Area Waste Management Units. (Sheet 1 of 6)

			Radiation Survey				Radiation Type, Notes
Waste Management Unit	Ref.	Inspection Date	ct/min	dis/min	mrem/hr	Smearable Alpha in dis/min	
Plants, Buildings, and Storage Areas							
232-Z Incinerator	2						Low levels of α , stabilized
234-5Z HWSA							
WRAP							
RMW Storage Facility							
Tanks and Vaults							
216-Z-8 Settling Tank							
241-Z-361 Settling Tank							
241-Z Treatment Tank							
Cribs and Drains							
216-Z-1 & 216-Z-2 Cribs	1	Jan. 4, 1989	ND	15,000	ND	1,500	α
216-Z-3 Crib	2	March, 1986	NA	NA	ND	ND	
216-Z-5 Crib	1	Sept. 5, 1991	NA	ND	NA	NA	Stabilized (backfilled) 9/5/91
216-Z-6 Crib	1	Aug. 13, 1991	NA	ND	NA	ND	
216-Z-7 Crib	1	Sept. 9, 1991	NA	ND	NA	ND	Stabilized (backfilled) 9/11/91

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Table 4-5. Radiation and Dose Rate Surveys at the Z Plant Aggregate Area Waste Management Units. (Sheet 2 of 6)

			Radiation Survey				Radiation Type, Notes
Waste Management Unit	Ref.	Inspection Date	ct/min	dis/min	mrem/hr	Smearable Alpha in dis/min	
216-Z-12 Crib	1	July 18, 1991	NA	ND	ND	ND	
216-Z-16 Crib	1	Feb. 28, 1991	NA	ND	ND	NA	
216-Z-18 Crib	1	July 9, 1991	ND	ND	ND	NA	
216-Z-8 French Drain	1	July 2, 1991	NA	ND	ND	ND	
216-Z-13 French Drain	1	Feb. 28, 1991	ND	ND	ND	NA	
216-Z-14 French Drain	1	Feb. 28, 1991	NA	ND	ND	NA	
216-Z-15 French Drain	1	Feb. 28, 1991	NA	ND	ND	NA	
216-Z-1A Tile Field	1	Jan. 3, 1989	NA	10,000	ND	500	
Reverse Well							
216-Z-10 Reverse Well	1	Aug. 13, 1991			ND	NA	
Ponds, Ditches, and Trenches							
216-Z-4 Trench	1	Aug. 13, 1991	NA	ND	NA	ND	
216-Z-9 Trench	1	July 10, 1991	NA	ND	ND	ND	
216-Z-17 Trench	1	Aug. 13, 1991	NA	ND	ND	ND	

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Table 4-5. Radiation and Dose Rate Surveys at the Z Plant Aggregate Area Waste Management Units. (Sheet 3 of 6)

			Radiation Survey				Radiation Type, Notes
Waste Management Unit	Ref.	Inspection Date	ct/min	dis/min	mrem/hr	Smearable Alpha in dis/min	
Septic Tanks and Associated Drain Fields							
2607-Z Septic Tank & Field							
2607-Z-1 Septic Tank & Field							
2607-WA Septic Tank & Field							
2607-WB Septic Tank & Field							
2607-W-8 Septic Tank & Field							
Transfer Facilities, Diversion Boxes, and Pipelines							
241-Z-Diversion Box No. 1							
241-Z-Diversion Box No. 2							
231-Z-151 Sump							
Basins							
207-Z Retention Basin							
216-Z-21 Seepage Basin	1	Jan. 25, 1989	NA	5,000	ND	NA	β , Contaminated tumbleweed

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Table 4-5. Radiation and Dose Rate Surveys at the Z Plant Aggregate Area Waste Management Units. (Sheet 4 of 6)

			Radiation Survey				Radiation Type, Notes
Waste Management Unit	Ref.	Inspection Date	ct/min	dis/min	mrem/hr	Smearable Alpha in dis/min	
Burial Sites							
218-W-1 Burial Ground	1	Aug. 8, 1991	NA	15,000	NA	NA	β , Small hot spot - topsoil
218-W-1A Burial Ground	1	June 19, 1991	ND	ND	NA	NA	
218-W-2 Burial Ground	1	Aug. 8, 1991	NA	15,000	NA	NA	β , Small hot spot - topsoil
218-W-2A Burial Ground	1	June 6, 1991	NA	10,000	ND	NA	β
218-W-3 Burial Ground	1	June 6, 1991	ND	ND	ND	ND	
218-W-3A Burial Ground	1	Mar. 15, 1991	4,000	40,000	18	NA	β , Hot spot 1 x 1 m (3 x 3 ft)
218-W-3AE Burial Ground							
218-W-4A Burial Ground	1	Aug. 8, 1991	NA	10,000	NA	NA	β , Hot spot 7 x 1 m (20 x 3 ft)
218-W-4B Burial Ground	1	Aug. 8, 1991	NA	ND	ND	NA	
218-W-4C Burial Ground							
218-W-5 Burial Ground							
218-W-6 Burial Ground							
218-W-11 Burial Ground	1	Aug. 8, 1991	NA	ND	NA	NA	
Z Plant Burn Pit							

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Table 4-5. Radiation and Dose Rate Surveys at the Z Plant Aggregate Area Waste Management Units. (Sheet 5 of 6)

			Radiation Survey				Radiation Type, Notes
Waste Management Unit	Ref.	Inspection Date	ct/min	dis/min	mrem/hr	Smearable Alpha in dis/min	
Unplanned Releases							
UN-200-W-11	2	1952					Plutonium - levels unknown
UPR-200-W-16	2	1952		200,000			Unknown, disposed of into 218-W-4A
UN-200-W-23	2	1953		10,000			Paved, posted
UPR-200-W-26	2	1953			2,000		Spotty contamination with ¹⁰⁶ Ru
UN-200-W-44	2	1957			2,000		Unknown
UPR-200-W-45	2	1957			1,100		Unknown, occurred within 218-W-1
UPR-200-W-53	2	1959			50		Unknown, 250 acres, ¹⁰⁶ Ru
UPR-200-W-72	2	1975	100,000	70,000			α , β , γ , waste removed, covered with clean soil
UN-200-W-74	2	1976		8,000			α , remediated soil
UN-200-W-75	2	1975		40,000			Unknown, remediated
UN-200-W-79	2	1978		2,000			α
UPR-200-W-84	2	1980			2,000		Unknown, placed in 218-W-1
UN-200-W-89	2	Dec. 1985		50,000			α , remediated to background

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Table 4-5. Radiation and Dose Rate Surveys at the Z Plant Aggregate Area Waste Management Units. (Sheet 6 of 6)

Waste Management Unit	Ref.	Inspection Date	Radiation Survey				Radiation Type, Notes
			ct/min	dis/min	mrem/hr	Smearable Alpha in dis/min	
UN-200-W-90	2	May, 1985		10,000			α , remediated to background
UN-200-W-91	2	Dec., 1985		20,000			α , remediated to background
UN-200-W-103	2	1971				76,000,000	α , soil excavated, covered with 2 m (6 ft) of clean soil
UN-200-W-130	2	1967		40,000	100 β 500 γ		β , γ
UN-200-W-132	2	1956					Level not reported, remediated
UPR-200-W-134	2	1975					Improper drum disposal - no release
UPR-200-W-158	2	1960	1,000		60		Unknown
UN-200-W-159	2	1959					Non-radioactive spill

Notes:

Refs: 1. WHC (1990a); 2. Z Plant Aggregate Area Radiological Surveys - Compilation

ND Measured but not detected

NA Parameter was not available (not measured) in most recent survey

ct/min Counts per minute

dis/min Disintegrations per minute

mrem/hr Millirem per hour

Table 4-6. Results of External Radiation Monitoring: TLD Readings

Location	Readings in mrem/yr						Annual Average
	1985	1986	1987	1988	1989	1990	
218-W-2A	max	—	—	—	—	124	108
	min	—	—	—	—	100	
	total	—	—	—	—	108	
216-Z-20	max	—	—	—	—	116	102
	min	—	—	—	—	88	
	total	—	—	—	—	102	
2W2	max	160	178	131	156	—	132
	min	96	134	106	123	—	
	total	126	152	118	133	—	
2W3	max	80	93	105	118	—	85
	min	64	65	79	90	—	
	total	74	76	89	101	—	
2W7	max	98	118	115	136	120	78
	min	69	74	91	94	60	
	total	85	93	102	110	99	
2W17	max	78	96	117	117	—	88
	min	68	68	79	95	—	
	total	73	76	95	106	—	
2W22	max	82	96	110	124	—	84
	min	66	62	68	93	—	
	total	73	75	83	105	—	

Notes:

— indicates results not reported.

Monthly/quarterly dose rates normalized to annual dose rate equivalent.

max - maximum quarterly value reported.

min - minimum quarterly value reported.

total - Annual average value reported.

Data Sources: Elder et al. 1986 through 1989, Schmidt et al. 1990 and 1991.

See Plate 2 for sample locations.

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Table 4-7. Summary of Soil Sampling Results (1985 through 1989).

Radionuclide in pCi/g	Sites					
	2W2	2W3	2W7	2W17	2W22	2WN
Cerium - 141	—	—	-5.64E-02	9.60E-03	—	3.63E-03
Cerium - 144	—	—	-2.48E-02	3.00E-02	—	-3.37E-02
Cobalt - 58	—	1.30E-01	-6.82E-03	-6.65E-03	—	-1.03E-02
Cobalt - 60	-4.60E-03	-1.50E-03	7.59E-03	-8.33E-03	9.50E-03	-3.55E-03
Cesium - 134	—	5.00E-02	4.98E-02	3.53E-02	3.00E-02	1.13E-03
Cesium - 137	6.40E+00	1.74E+00	4.51E+00	5.40E-01	1.90E+00	1.44E-01
Europium - 152	5.90E-02	9.80E-02	7.55E-02	9.44E-02	1.42E-01	6.21E-02
Europium - 154	-2.30E-02	1.80E-02	-2.90E-02	6.57E-03	1.80E-02	4.87E-03
Europium - 155	5.50E-02	2.60E-02	3.31E-02	8.80E-02	4.50E-02	3.45E-02
Iodine - 129	—	—	-1.58E-02	1.96E+01	—	—
Potassium - 40	—	—	1.59E+01	1.36E+01	—	1.44E+01
Manganese - 54	1.30E-02	1.70E-02	2.07E-02	-2.69E-03	-2.40E-03	1.62E-02
Niobium - 95	3.20E-02	3.90E-03	-4.88E-02	-5.95E-02	-1.70E-02	-7.52E-02
Lead - 212	—	—	7.10E-01	8.09E-01	—	7.99E-01
Lead - 214	600E-01	6.20E-01	5.36E-01	5.70E-01	6.50E-01	5.92E-01
Plutonium - 238	1.70E-03	1.07E-03	3.41E-03	4.50E-03	2.60E-03	6.40E-05
Plutonium - 239	7.90E-01	1.80E-01	5.63E-02	1.15E-01	5.73E-02	4.60E-03
Ruthenium - 106	6.10E-02	3.30E-01	1.44E-01	6.47E-02	2.29E-01	-8.83E-02
Strontium - 90	9.10E-01	6.50E-01	4.39E-01	2.09E-01	6.33E-01	6.90E-02
Technetium - 99	—	—	1.27E-01	-7.71E-02	—	—
Uranium	3.00E-01	3.50E-01	3.17E-01	3.27E-01	3.50E-01	3.82E-01
Zinc - 65	—	4.40E-01	-1.04E-01	-1.79E-03	—	-3.62E-02
Zirconium - 95	3.70E-03	2.00E-02	-1.67E-03	1.17E-02	3.40E-02	-7.67E-03

Notes:

Table values are averages for radionuclide concentrations in soil from 1985 through 1989 in pCi/g.

Blank entries indicate radionuclide not analyzed or results not reported.

See Table A-4 for complete data set.

See Plate 2 for sample locations.

TABLE 4-7

Table 4-8. Summary of Vegetation Sampling Results (1985 through 1989).

Radionuclides in pCi/g	Sites				
	2W2	2W3	2W7	2W17	2W22
Beryllium - 7			1.19E+00	2.13E+00	
Cerium - 141			-1.56E-02	-6.42E-03	
Cobalt - 58					
Cobalt - 60	-5.20E-03	5.30E-03	8.02E-03	5.52E-02	6.40E-03
Cesium - 134		9.60E-02	1.12E-01		1.77E-01
Cesium - 137	1.40E-01	1.84E-01	3.85E-01	9.88E-02	1.84E-01
Europium - 152	1.60E-02	2.30E-02	2.72E-02	6.24E-02	-2.70E-02
Europium - 154	3.50E-02	1.20E-01	2.10E-02	-1.04E-02	7.10E-03
Europium - 155	1.90E-02	4.70E-04	1.04E-02	1.47E-02	3.70E-02
Iodine - 129			-1.84E-02	6.07E-02	
Niobium - 95	-5.40E-02	-3.60E-02	1.56E+00	1.30E+01	5.50E-02
Plutonium - 238			-4.90E-03	1.07E-02	
Plutonium - 239			4.10E-01	5.94E-02	
Ruthenium - 103		1.19E-01	3.23E-01	7.17E-02	
Ruthenium - 106			1.04E-03	8.07E-04	1.69E-01
Strontium - 90			4.68E-03	2.39E-02	
Technetium - 99			1.70E-01	8.30E-02	1.90E-01
Zinc - 65			2.88E-01		
Zirconium - 95			1.91E-01	1.66E-01	

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Notes:

Table values are averages for radionuclide concentrations in vegetation from 1985 through 1989 in pCi/g.
 Blank entries indicate radionuclide not analyzed or results not reported.
 See Table A-5 for complete data set.
 See Plate 2 for sample location.

**Table 4-9. Radionuclide Concentrations in Vegetation and Sediment:
216-Z-21 Seepage Basin (Sample RM30) and 216-Z-9 Trench.**

216-Z-21 Seepage Basin (Sample RM30)			216-Z-9 Trench	
Radionuclide	1989		1990	1990
	Aquatic Vegetation	Sediment	Sediment	Vegetation
Concentration in pCi/g				
Bismuth-214	—	—	—	—
Cerium-144	—	—	—	—
Cobalt-60	—	—	—	—
Cesium-144	—	—	—	—
Cesium-137	0.3	0.1	1.2	<0.3
Lead-212	—	—	—	—
Lead-214	—	—	—	—
Plutonium-239	0.3	0.4	1.7	<0.3
Ruthenium-106	—	—	—	—
Tin-125	—	—	—	—
Strontium-90	0.4	0.5	0.87	—
Thallium-208	—	—	—	—
Uranium-total in g/g	7.18E-08	3.88E-07	1.40E-06	5.10E-08

— indicates sample not analyzed, or analysis result not reported.

(1) Data for 1989 and 1990 only.

Source: Schmidt et al. 1990 and 1991.

(2) Data Available for 1990 only.

Source: Schmidt et al. 1991.

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Table 4-10. Summary of Gamma Scintillation Logging Results. (Sheet 1 of 12)

Waste Management Unit	Well Number	Relative Location	Remarks
Plants, Buildings, and Storage Areas			
232-Z Incinerator	No monitoring wells.		
234-5Z HWSA	No monitoring wells.		
WRAP	No monitoring wells.		
RMW Storage Facility	No monitoring wells.		
Tanks and Vaults			
21-Z-8 Settling Tank	No monitoring wells.		
241-Z-361 Settling Tank	No monitoring wells.		
241-Z Treatment Tank	No monitoring wells.		
Cribs and Drains			
216-Z-1A Tile Field	299-W18-6	West of tile field.	Natural gamma response.
	299-W18-7	East of tile field.	Natural gamma response.
	299-W18-56	Northwest portion of tile field.	Elevated gamma response between depths of 10 and 22 m.
	299-W18-57	Northeast portion of tile field.	Elevated gamma response between depths of 5 and 19 m.
	299-W18-58	Southwest portion of tile field.	Elevated gamma response between depths of 12 and 25 m.
	299-W18-59	Southeast portion of tile field.	Natural gamma response.
	299-W18-66	South portion of tile field.	Elevated gamma response between depths of 5 and 29 m.
	299-W18-76	North portion of tile field.	Natural gamma response.

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Table 4-10. Summary of Gamma Scintillation Logging Results. (Sheet 2 of 12)

Waste Management Unit	Well Number	Relative Location	Remarks
	299-W18-77	North portion of tile field.	Not logged.
	299-W18-78	North portion of tile field.	Natural gamma response.
	299-W18-79	North portion of tile field.	Not logged.
	299-W18-80	North portion of tile field.	Not logged.
	299-W18-81	North portion of tile field.	Elevated gamma response.
	299-W18-85	Southwest of tile field.	Natural gamma response.
	299-W18-86	Southwest of tile field.	Natural gamma response.
	299-W18-87	South of tile field.	Natural gamma response.
	299-W18-89	West of tile field.	Natural gamma response.
	299-W18-149	Northern portion of tile field.	Not logged.
	299-W18-150	Southern portion of tile field.	Elevated gamma response between depths of 2 and 24 m.
	299-W18-158	Northwestern portion of tile field.	Elevated gamma response between depths of 15 and 18 m.
	299-W18-159	Central portion of tile field.	Elevated gamma response between depths of 2 and 20 m.
	299-W18-163	Northeast portion of tile field.	Elevated gamma response between depths of 12 and 14 m.
	299-W18-164	South central part of tile field.	Elevated gamma response between depths of 23 and 30 m.
	299-W18-165	Southwest portion of tile field.	Elevated gamma response between depths of 28 and 29 m.

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Table 4-10. Summary of Gamma Scintillation Logging Results. (Sheet 3 of 12)

Waste Management Unit	Well Number	Relative Location	Remarks
	299-W18-166	Southwest portion of tile field.	Elevated gamma response between depths of 25 and 30 m.
	299-W18-167	Eastern portion of tile field.	Elevated gamma response between depths of 15 and 18 m.
	299-W18-168	Southeast edge of tile field.	Elevated gamma response between depths of 13 and 19 m.
	299-W18-169	Southeast portion of tile field.	Natural gamma response.
	299-W18-170	South central portion of tile field.	Elevated gamma response between depths of 0 and 8 m.
	299-W18-171	South of tile field.	Natural gamma response.
	299-W18-173	Northern portion of tile field.	Elevated gamma response between depths of 2 and 5 m, and 8 and 11 m.
	299-W18-174	Northern portion of tile field.	Elevated gamma response between depths of 2 and 7 m, and 9 and 12 m.
	299-W18-175	Southern portion of tile field.	Elevated gamma response between depths of 1 and 20 m, and at depths of 23 and 29 m.
216-Z-1 Crib	299-W18-64	Southwest corner of crib.	Elevated gamma response.
	299-W18-65	Southeast corner of crib.	Elevated gamma response between depths of 7 and 20 m.
216-Z-2 Crib	299-W18-60	Northwest corner of crib.	Natural gamma response? ⁽¹⁾
	299-W18-61	Northeast corner of crib.	Elevated gamma response between depths of 7 and 21 m.
	299-W18-62	Southwest corner of crib.	Natural gamma response.
	299-W18-63	Southeast corner of crib.	Elevated gamma response between depths of 7 and 17 m.
	299-W18-172	North of crib.	Natural gamma response.

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Table 4-10. Summary of Gamma Scintillation Logging Results. (Sheet 4 of 12)

Waste Management Unit	Well Number	Relative Location	Remarks
216-Z-3 Crib	299-W18-67	Northeast part of crib.	Not logged.
	299-W18-68	Central part of crib.	Not logged.
	299-W18-88	Southeast of crib.	Natural gamma response.
216-Z-5 Crib	299-W15-1	East edge of crib.	Elevated gamma response between depths of 30 and 40 m (above the water table), and from 50 to 63 m (below the water table).
	299-W15-52	East of crib.	Not logged.
	299-W15-53	South of crib.	Not logged.
	299-W15-54	West of crib.	Not logged.
	299-W15-55	South side of crib.	Not logged.
	299-W15-56	Southwest side of crib.	Not logged.
	299-W15-57	Southern portion of crib.	Not logged.
	299-W15-58	West of crib.	Not logged.
	299-W15-212	100 m north of crib.	Elevated gamma response between depths of 8 and 23 m.
216-Z-6 Crib	no monitoring wells		
216-Z-7 Crib	299-W15-7	Southwest corner of crib.	Elevated gamma response between depths of 7 and 40 m (above the water table), and from 45 to 100 m (below the water table).
	299-W15-62	North of crib.	Elevated gamma response between depths of 30 and 46 m.
	299-W15-63	North of center of crib.	Elevated gamma response between depths of 26 and 43 m.
	299-W15-76	Southwest of crib.	Elevated gamma response between depths of 13 and 23 m.
	299-W15-77	South of crib.	Elevated gamma response between depths of 12 and 21 m.

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Table 4-10. Summary of Gamma Scintillation Logging Results. (Sheet 5 of 12)

Waste Management Unit	Well Number	Relative Location	Remarks
	299-W15-78	South of center of crib.	Elevated gamma response between depths of 12 and 21 m.
216-Z-8 French Drain	299-W15-202	<5 m southeast of french drain.	Not logged
	299-W15-213	<5 m northeast of french drain.	Not logged
	299-W15-214	<5 m northwest of french drain.	Not logged
	299-W15-215	<5 m southwest of french drain.	Not logged
216-Z-12 Crib	299-W18-2	Southwest of crib.	Natural gamma response.
	299-W18-4	40 m west of crib.	Natural gamma response.
	299-W18-5	North end of west side of crib.	Elevated gamma response between depths of 5 and 10 m.
	299-W18-8	Northwest part of crib.	Elevated gamma response between depths of 5 and 10 m.
	299-W18-13	Northwest side of crib.	Not logged.
	299-W18-14	North central part of crib.	Not logged.
	299-W18-24	8 m south of crib.	Natural gamma response.
	299-W18-69	North central side of crib.	Elevated gamma response between depths of 5 and 10 m.
	299-W18-70	Northwest part of crib.	Not logged.
	299-W18-71	North central part of crib.	Elevated gamma response between depths of 5 and 10 m.
	299-W18-72	North central part of crib.	Elevated gamma response at depth of 6 m.
299-W18-73	South central part of crib.	Natural gamma response.	

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Table 4-10. Summary of Gamma Scintillation Logging Results. (Sheet 6 of 12)

Waste Management Unit	Well Number	Relative Location	Remarks
	299-W18-74	South central part of crib.	Natural gamma response.
	299-W18-75	Northern part of crib.	Elevated gamma response between depths of 5 and 9 m.
	299-W18-151	North of crib.	Natural gamma response.
	299-W18-152	Northern end of west side of crib.	Elevated gamma response between depths of 6 and 9 m.
	299-W18-153	Northern end of east side of crib.	Elevated gamma response between depths of 6 and 8 m.
	299-W18-154	North of crib.	Elevated gamma response between depths of 4 and 6 m.
	299-W18-155	North of crib.	Natural gamma response.
	299-W18-156	North of crib.	Not logged.
	299-W18-157	South of crib.	Natural gamma response.
	299-W18-162	North central part of crib.	Not logged.
	299-W18-179	North side of of crib.	Not logged.
	299-W18-180	Northeast part of crib.	Not logged.
	299-W18-181	North central part of crib.	Not logged.
	299-W18-182	Central part of crib.	Not logged.
	299-W18-183	Southern part of crib.	Not logged.
	299-W18-184	Northern part of crib.	Not logged.
	299-W18-182	Northern part of crib.	Not logged.
	299-W18-185	Northern part of crib.	Not logged.
	299-W18-242	Central part of crib.	Not logged.

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Table 4-10. Summary of Gamma Scintillation Logging Results. (Sheet 7 of 12)

Waste Management Unit	Well Number	Relative Location	Remarks
	299-W18-243	West central part of crib.	Not logged.
	299-W18-244	East central part of crib.	Not logged.
	299-W18-245	West central part of crib.	Not logged.
216-Z-13 French Drain	No monitoring wells.		
216-Z-14 French Drain	No monitoring wells		
216-Z-15 French Drain	No monitoring wells		
216-Z-16 Crib	299-W15-10	South of crib.	Natural gamma response.
	299-W15-11	North of crib.	Natural gamma response.
216-Z-18 Crib	299-W18-9	Northern part of crib.	Elevated gamma response between depths of 6 and 18 m.
	299-W18-10	Northeast side of crib.	Elevated gamma response between depths of 8 and 17 m.
	299-W18-11	Southwest part of crib.	Natural gamma response.
	299-W18-12	Northwest part of crib.	Natural gamma response.
	299-W18-82	South of crib.	Natural gamma response.
	299-W18-83		Natural gamma response.
	299-W18-93	Southeast part of crib.	Elevated gamma response between depths of 7 and 17 m.
	299-W18-94	South of crib.	Elevated gamma response between depths of 9 and 12 m.
	299-W18-95	South of crib.	Natural gamma response.
	299-W18-96	Western part of crib.	Elevated gamma response between depths of 8 and 11 m.
	299-W18-97	East of crib.	Natural gamma response.
	299-W18-98	North of crib.	Natural gamma response.

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Table 4-10. Summary of Gamma Scintillation Logging Results. (Sheet 8 of 12)

Waste Management Unit	Well Number	Relative Location	Remarks
	299-W18-99	Northeast of crib.	Natural gamma response.
Reverse Wells			
216-Z-10 Reverse Well	299-W15-51	5 m southeast of reverse well.	Not logged.
	299-W15-59	7 m east of reverse well.	Not logged.
	299-W15-60	10 m southeast of reverse well.	Not logged.
	299-W15-61	<5 m southwest of reverse well.	Not logged.
Ponds, Ditches, and Trenches			
216-Z-4 Trench	no monitoring wells		
216-Z-9 Trench	299-W15-6	20 m northeast of trench.	Elevated gamma response between depths of 1 and 9 m.
	299-W15-8	Approximately 15 m south of trench.	Elevated gamma response between depths of 15 and 38 m.
	299-W15-9	North of trench.	Natural gamma response.
	299-W15-82	East of trench.	Natural gamma response.
	299-W15-84	West of trench.	Natural gamma response.
	299-W15-85	North of trench.	Natural gamma response.
	299-W15-86	Southwest of trench.	Elevated gamma response between depths of 15 and 38 m.
	299-W15-94	North of trench.	Natural gamma response.
	299-W15-95	North of trench.	Natural gamma response.

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Table 4-10. Summary of Gamma Scintillation Logging Results. (Sheet 9 of 12)

Waste Management Unit	Well Number	Relative Location	Remarks
	299-W15-101	Northeast of trench.	Natural gamma response.
216-Z-17 Trench	299-W15-204	West of trench.	Not logged.
Septic Tanks			
2607-Z Septic Tank	no monitoring wells		
2607-Z-1 Septic Tank	no monitoring wells		
2607-WA Septic Tank	no monitoring wells		
2607-WB Septic Tank	no monitoring wells		
2607-W-8 Septic Tank	no monitoring wells		
Transfer Facilities, Diversion Boxes, and Pipelines			
241-Z Diversion Box No. 1	no monitoring wells		
241-Z Diversion Box No. 2	299-W-18-156	Southwest of diversion box.	Not logged
231-Z-151 Sump	no monitoring wells		
Basins			
207-Z Retention Basin	No monitoring wells.		
216-Z-21 Seepage Basin	299-W-15-208	Center of basin.	Not logged.
Burial Sites			
218-W-1 Burial Ground	No monitoring wells.		
218-W-2 Burial Ground	No monitoring wells.		
218-W-2A Burial Ground	No monitoring wells.		

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Table 4-10. Summary of Gamma Scintillation Logging Results. (Sheet 10 of 12)

Waste Management Unit	Well Number	Relative Location	Remarks
218-W-3 Burial Ground	No monitoring wells		
218-W-3A Burial Ground	299-W7-2	Northern border of burial ground.	Natural gamma response.
	299-W7-3	Northern border of burial ground.	Natural gamma response.
	299-W10-179		Not logged
218-W-3AE Burial Ground	299-W6-2	Southeast of burial ground.	Natural gamma response.
	299-W7-4	Southwest of burial ground.	Natural gamma response.
	299-W7-5	Northern border of burial ground.	Natural gamma response.
	299-W7-6	Northern border of burial ground.	Natural gamma response.
	299-W7-7	Northern border of burial ground.	Natural gamma response.
	299-W7-8	Northern border of burial ground.	Natural gamma response.
	299-W7-10	Southeast corner of burial ground.	Natural gamma response.
218-W-4A Burial Ground	No monitoring wells.		
218-W-4B Burial Ground	299-W15-19	North side of burial ground.	Natural gamma response.
	299-W15-20	Northwest corner of burial ground.	Natural gamma response.

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Table 4-10. Summary of Gamma Scintillation Logging Results. (Sheet 11 of 12)

Waste Management Unit	Well Number	Relative Location	Remarks
	299-W15-23	West side of burial ground.	Natural gamma response.
218-W-4C Burial Ground	299-W15-14	Northwest portion of burial ground.	Not logged
	299-W15-15	Northwest corner of burial ground.	Natural gamma response.
	299-W15-16	East side of northern portion of burial ground.	Natural gamma response.
	299-W15-17	East side of northern portion of burial ground.	Natural gamma response.
	299-W15-18	West of northern portion of burial ground.	Possibly elevated gamma response between depths of 55 and 58 m.
	299-W15-21	West side of burial ground.	Natural gamma response.
	299-W15-24	Northwest portion of burial ground.	Natural gamma response.
	299-W18-3	North central portion of burial ground.	Natural gamma response.
	299-W18-21	Southwest corner of burial ground.	Natural gamma response.
	299-W18-22	Southwest corner of burial ground.	Natural gamma response.
	299-W18-23	West side of burial ground.	Natural gamma response.
	299-W18-26	West side of burial ground.	Natural gamma response.
	299-W18-84		Natural gamma response.

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Table 4-10. Summary of Gamma Scintillation Logging Results. (Sheet 12 of 12)

Waste Management Unit	Well Number	Relative Location	Remarks
218-W-5 Burial Ground	299-W7-1	North side of burial ground.	Natural gamma response.
	299-W7-9	North side of burial ground.	Natural gamma response.
	299-W8-1	North side of burial ground.	Natural gamma response.
	299-W9-1	West side of burial ground.	Natural gamma response.
	299-W10-13	South side of burial ground.	Natural gamma response.
	299-W10-14	South side of burial ground.	Natural gamma response.
218-W-6 Burial Ground	299-W6-1	Central portion of burial ground.	Probably natural
218-W-11 Burial Ground	299-W15-2	Northwest side of burial ground.	Probably natural gamma response.
Z Plant Burn Pit	No monitoring wells.		

Source: Fecht et al. 1977, Chamness et al. 1991.

(1) Well reportedly contaminated with alpha-emitting particles.

TABLE 4.9

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Table 4-11. Potential for Migration of Liquid Discharges to the Unconfined Aquifer.

Liquid Discharge Source	Range of Soil Column Pore Volumes in m ³⁽³⁾	Liquid Effluent Volume Received in m ³	Potential Migration to Unconfined Aquifer
Cribs and Drains			
216-Z-1 and 216-Z-2 Cribs	220 to 660	33,700	Yes
216-Z-3 Crib	145 to 435	178,000	Yes
216-Z-5 Crib	160 to 480	31,000	Yes
216-Z-6 Crib	180 to 540	98	No
216-Z-7 Crib	10,270 to 30,800	79,000	Yes
216-Z-12 Crib	500 to 1,500	281,000	Yes
216-Z-16 Crib	750 to 2,250	100,000	Yes
216-Z-18 Crib	3,700 to 11,340	3,860	Yes ⁽¹⁾
216-Z-1A Tile Field	14,700 to 44,100	5,310	No ⁽²⁾
Ponds, Ditches, and Trenches			
216-Z-4 Trench	55 to 165	11	No
216-Z-9 Trench	835 to 2,505	4,090	Yes ⁽¹⁾
216-Z-17 Trench	1,110 to 3,330	37,000	Yes
Reverse Well			
216-Z-10 Reverse Well	<1	1,000	Yes

Assumptions:

- ▶ Area for infiltration equal to the dimension of the base of crib/trench/tile field
- ▶ No evapotranspiration
- ▶ No lateral flow assumed

- (1) The pore volume of the soil column is roughly the same order of magnitude as the total known volume of the waste received. Given the high permeability of the soil column, it is likely that the discharge waste volume reached the groundwater.
- (2) The liquid waste discharged to the 216-Z-1A Tile Field is 12 percent of the pore volume available underlying the base of the tile field. However, this calculation assumes that the liquid waste was discharged over the entire base of the tile field which may not be accurate given that the waste was distributed through an array of perforated pipes.
- (3) Pore volume calculation: (waste unit section area) x (nominal depth to groundwater) x (porosity). Pore volume based on nominal depth to groundwater of 50m (164 ft) for all waste unit structures, except 216-Z-10 Reverse Well (15 m used for depth to groundwater from bottom of reverse well). Lower pore volume value reflects 0.10 porosity, higher pore volume reflects 0.30 porosity. Pore volume calculation does not account for the ability of the soil to retain the liquid discharged.

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Table 4-12. Carbon Tetrachloride Concentrations in Z Plant Aggregate Area Well Soil Samples. (Sheet 1 of 2)

	Depth in Meters (Feet)	Concentration in nanograms/gram
Well 299-W7-7	7.6 (5)	6.5
	30.5 (100)	<0.01
	36.6 (120)	<0.02
	48.8 (160)	0.53
	54.9 (180)	<0.13
	67.1 (220)	0.75
Well 299-W7-8	6.3 (20.5)	<0.05
	9.3 (30.5)	<0.08
	12.5 (41)	<0.05
	14.6 (48)	<0.07
	15.3 (50)	0.09
	16.8 (55)	0.09
	18.9 (62)	0.07
	23.8 (78)	<0.07
	27.5 (90)	<0.06
	33.6 (110)	<0.06
	39.7 (130)	<0.06
	45.8 (150)	<0.05
	51.9 (170)	<0.07
58.0 (190)	<0.11	
64.1 (210)	0.30	
70.2 (230)	0.36	
Well 299-W7-9	12.2 (40)	<0.2
	31.1 (102)	<0.2
	56.1 (184)	0.2
	67.1 (220)	12
	73.2 (240)	<0.08
Well 299-W7-10	24.4 (80)	<0.1
	48.8 (160)	<0.2
	61.0 (200)	<0.3
	67.1 (220)	<0.3
	73.2 (240)	<0.3
Well 299-W15-19	12.2 (40)	0.55
	24.4 (80)	1.4
	36.6 (120)	0.56
	67.1 (220)	5.8
	73.2 (240)	8.1

Table 4-12. Carbon Tetrachloride Concentrations in Z Plant Aggregate Area Well Soil Samples. (Sheet 2 of 2)

	Depth in Meters (Feet)	Concentration in nanograms/gram
Well 299-W15-20	6.1 (20)	<0.4
	24.4 (80)	3.2
	54.9 (180)	9.5
	67.1 (220)	0.3
	73.2 (240)	<0.5
Well 299-W15-21	36.6 (120)	0.31
	38.4 (126)	0.14
	42.7 (140)	0.12
	48.5 (159)	2.8
	67.1 (220)	6.2
	70.2 (230)	<0.1
Well 299-W15-23	18.3 (60)	0.2
	47.3 (155)	0.5
	61.0 (200)	<0.1
	67.1 (220)	3.8
	73.2 (240)	<0.1
Well 299-W18-26	39.7 (130)	0.12
	54.9 (180)	2.3
	67.1 (220)	2.6
	73.2 (240)	4.3

Sources: Wells 299-W7-7, 299-W7-8, 299-W15-19, 299-W15-20, 299-W15-21, and 299-W18-26 from Goodwin and Bjornstad (1990).

Well locations shown on Figure 4-3.

Note: Nanograms/gram equivalent to parts per billion.

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Table 4-13. Candidate Chemicals of Potential Concern for the Z Plant Aggregate Area^a.
(Sheet 1 of 2)

TRANSURANICS	Cobalt-60	Tellurium-127*
Americium-241	Europium-152	Tellurium-129m*
Americium-242*	Europium-154	Thallium-204
Americium-242m	Europium-155	Thorium-227
Americium-243	Gadolinium-153*	Thorium-229
Curium-242*	Germanium-68*	Thorium-230
Curium-243	Gold-195*	Thorium-231
Curium-244	Iodine-123*	Thorium-232
Curium-245	Iodine-125*	Thorium-234
Einsteinium-254*	Iodine-129	Thulium-170*
Neptunium-237	Iodine-131*	Tin-113*
Neptunium-239	Iron-55	Tin-123m*
Plutonium-238	Iron-59*	Tritium
Plutonium-239	Krypton-85	Vanadium-49*
Plutonium-240	Lead-209	Yttrium-88*
Plutonium-241	Lead-210	Yttrium-90
	Lead-211	Zinc-65*
	Lead-212*	Zirconium-95*
	Lead-214	
URANIUM	Manganese-54*	METALS
Uranium-233	Molybdenum-93	Aluminum
Uranium-234	Nickel-59	Barium
Uranium-235	Nickel-63	Beryllium
Uranium-236	Niobium-91	Cadmium
Uranium-238	Niobium-93m	Chromium
	Niobium-94	Copper
FISSION PRODUCTS	Niobium-95*	Iron
Actinium-225	Phosphorus-32*	Lead
Actinium-227	Polonium-210	Magnesium
Aluminum-28*	Polonium-214	Mercury
Antimony-122*	Polonium-215*	Nickel
Antimony-124*	Polonium-218	Silver
Antimony-125	Potassium-40	Zinc
Antimony-126*	Promethium-147	
Barium-133	Protactinium-231	OTHER
Barium-137m	Radium-225	INORGANICS
Beryllium-7*	Radium-226	Ammonia
Beryllium-10	Radium-228	Asbestos
Bismuth-210	Rhenium-187	Boron
Bismuth-211	Ruthenium-106	Calcium
Bismuth-213	Samarium-151	Chloride
Bismuth-214	Scandium-46*	Cyanide
Cadmium-109	Selenium-75*	Fluoride
Carbon-14	Selenium-79	Nitrate/Nitrite
Cerium-141*	Silver-108*	Phosphate
Cerium-144*	Silver-110m*	Potassium
Cesium-134	Sodium-22	Silica
Cesium-137	Strontium-85*	Sodium
Chlorine-36	Strontium-90	Sulfate
Chromium-51*	Sulfur-35*	
Cobalt-57*	Tantalum-182*	
Cobalt-58*	Technetium-99	
	Tellurium-125m	

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Table 4-13. Candidate Chemicals of Potential Concern for the Z Plant Aggregate Area^a.
(Sheet 2 of 2)

VOLATILE ORGANICS	SEMIVOLATILE ORGANICS
Benzene	Acetone
Butyl Acetate	Acetonitrile
Carbon tetrachloride	Coal Tars
Chlorobenzene	Creosote
Chloroform	Cyclohexanone
Cyclohexane	Decane
1,2-Dichloroethane	Dibutyl phosphate
cis/trans-1,2-Dichloroethene	Dibutyl butyl phosphonate
Ethylbenzene	Ethanol
Fluoromethane	Ethanolamine
Freon II	Ethylene glycol
Hexane	Hexanol
Methylene chloride	Isopropanol
Methyl isobutyl ketone (MIBK)	Kerosene
Tetrachloroethene	Methanol
Tetrahydrofuran	Naphthylamine tritium
Toluene	Naphthylamine
Tributyl phosphate	Normal paraffins
1,1,1-Trichloroethane	Polychlorinated biphenyls
Trichloroethene	Polyurethane
Vinyl Chloride	Pseudocumene (1,2,5-trimethylbenzene)
Xylenes	Trioctyl phosphine

- Candidate chemicals of concern are those that were reported in waste management unit inventories, detected at elevated levels in environmental media within the aggregate area, or are expected to occur based on historical association with waste processes.
- The radionuclide has a half-life of <1 year and, if it is a daughter product, the parent has a half-life of <1 year, or the buildup of the short-lived daughter would result in an activity of <1% of the parent radionuclide's initial activity.

TABLE.413

Table 4-14. Summary of Known and Suspected Contamination in Each Waste Management Unit and Unplanned Release at Z Plant Aggregate Area. (Sheet 1 of 5)

Waste Management Unit or Unplanned Release	TRU	Fission Products	Uranium	Metals	Other Inorganics	Volatiles	Semi-volatiles
Plants, Buildings, and Storage Areas							
232-Z Incinerator	K	S					
234-5Z HWSA					S	S	S
WRAP							
RMW Storage Facility	K	K	S				
Tanks and Vaults							
216-Z-8 Settling Tank	K	S		S	S	S	S
241-Z-361 Settling Tank	K	S		S	S	S	S
241-Z Treatment Tank	S	S		S			
Cribs and Drains							
216-Z-1 & 216-Z-2 Cribs	K	K	K	S	K	K	S
216-Z-3 Crib	K	K	K	S	K		
216-Z-5 Crib	K	K	K		K		
216-Z-6 Crib	K	K	K		K		
216-Z-7 Crib	K	K	K		K		
216-Z-12 Crib	K	K	K	S	K		
216-Z-16 Crib	K	S			S		
216-Z-18 Crib	K	S		S	K	K	K
216-Z-8 French Drain	K	S		S	S	S	S

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Table 4-14. Summary of Known and Suspected Contamination in Each Waste Management Unit and Unplanned Release at Z Plant Aggregate Area. (Sheet 2 of 5)

Waste Management Unit or Unplanned Release	TRU	Fission Products	Uranium	Metals	Other Inorganics	Volatiles	Semi-volatiles
216-Z-13 French Drain	S	S			S		
216-Z-14 French Drain	S	S			S		
216-Z-15 French Drain	S	S			S		
216-Z-1A Tile Field	K	K		S	K	K	K
Reverse Well							
216-Z-10 Reverse Well	K	S		S	K		
Ponds, Ditches, and Trenches							
216-Z-4 Trench	K	K	K		S		
216-Z-9 Trench	K	K	K	S	K	K	K
216-Z-17 Trench	K	S	K		S		
Septic Tanks and Associated Drain Fields							
2607-Z Septic Tank & Field							
2607-Z-1 Septic Tank & Field							
2607-WA Septic Tank & Field							
2607-WB Septic Tank & Field							
2607-W-8 Septic Tank & Field							
Transfer Facilities, Diversion Boxes, and Pipelines							
241-Z-Diversion Box No. 1	K	K	K	S	K	K	S
241-Z-Diversion Box No. 2	K	K	K	S	K		

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Table 4-14. Summary of Known and Suspected Contamination in Each Waste Management Unit and Unplanned Release at Z Plant Aggregate Area. (Sheet 3 of 5)

Waste Management Unit or Unplanned Release	TRU	Fission Products	Uranium	Metals	Other Inorganics	Volatiles	Semi-volatiles
231-Z-151 Sump	K	K	K	S	S		
Basins							
207-Z Retention Basin	S	S			S		
216-Z-21 Seepage Basin	S	S	S	S	S	S	S
Burial Sites							
218-W-1 Burial Ground	K	K	K	S	S	S	S
218-W-1A Burial Ground	K	K	K	S	S	S	S
218-W-2 Burial Ground	K	K	K	S	S	S	S
218-W-2A Burial Ground	S	K		S	S	S	S
218-W-3 Burial Ground	K	K	K	S	S	S	S
218-W-3A Burial Ground	K	K		S	S	S	S
218-W-3AE Burial Ground	K	K		S	S	S	S
218-W-4A Burial Ground	K	K		S	S	S	S
218-W-4B Burial Ground	K	K		K	S	S	S
218-W-4C Burial Ground	K	K		S	S	S	S
218-W-5 Burial Ground	K	K		K	S	S	S
218-W-6 Burial Ground							
218-W-11 Burial Ground	S	K	K	S	S	S	S
Z Plant Burn Pit					S		

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Table 4-14. Summary of Known and Suspected Contamination in Each Waste Management Unit and Unplanned Release at Z Plant Aggregate Area. (Sheet 4 of 5)

Waste Management Unit or Unplanned Release	TRU	Fission Products	Uranium	Metals	Other Inorganics	Volatiles	Semi-volatiles
Unplanned Releases							
UN-200-W-11	S	S					
UPR-200-W-16	S	S					
UN-200-W-23	S	S					
UPR-200-W-26	S	S					
UN-200-W-44		S					
UPR-200-W-45		S					
UPR-200-W-53		S					
UPR-200-W-72		S					
UN-200-W-74	S	S					
UN-200-W-75	S	S					
UN-200-W-79	S	S					
UPR-200-W-84	S	S					
UN-200-W-89	S	S					
UN-200-W-90	S	S					
UN-200-W-91	S	S					
UN-200-W-103	S	S					
UN-200-W-130	S	S					
UN-200-W-132			S				

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Table 4-14. Summary of Known and Suspected Contamination in Each Waste Management Unit and Unplanned Release at Z Plant Aggregate Area. (Sheet 5 of 5)

Waste Management Unit or Unplanned Release	TRU	Fission Products	Uranium	Metals	Other Inorganics	Volatiles	Semi-volatiles
UPR-200-W-134	S						
UPR-200-W-158	S	S					
UN-200-W-159					K		

Notes:

- K Contamination of environmental media is known to have occurred based on waste inventory or sampling data and knowledge of waste release mechanism.
- S Contamination of environmental media is suspected to have occurred based on historical process information or indications from nonspecific sampling data (e.g., gamma logs).

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Table 4-15. Chemicals of Potential Concern for the Z Plant Aggregate Area

TRANSURANICS	Niobium-94	1,2-Dichloroethane
Americium-241	Polonium-210	cis/trans-1,2-Dichloroethene
Americium-242m	Polonium-214	Ethylbenzene
Americium-243	Polonium-218	Hexane
Curium-243	Potassium-40	Methylene chloride
Curium-244	Promethium-147	Methyl isobutyl ketone (MIBK)
Curium-245	Protactinium-231	Tetrachloroethene
Neptunium-237	Radium-225	Toluene
Neptunium-239	Radium-226	Tributyl phosphate
Plutonium-238	Radium-228	1,1,1-Trichloroethane
Plutonium-239	Rhenium-187	Trichloroethene
Plutonium-240	Ruthenium-106	Vinyl Chloride
Plutonium-241	Samarium-151	Xylenes
	Selenium-79	
	Sodium-22	
URANIUM	Strontium-90	SEMIVOLATILE ORGANICS
Uranium-233	Technetium-99	Acetone
Uranium-234	Tellurium-125m	Acetonitrile
Uranium-235	Thallium-204	Creosote
Uranium-236	Thorium-227	Cyclohexanone
Uranium-238	Thorium-229	Dibutyl phosphate
	Thorium-230	Naphthylamine
	Thorium-231	Polychlorinated biphenyls
	Thorium-232	
FISSION PRODUCTS	Thorium-234	
Actinium-225	Tritium	
Actinium-227	Yttrium-90	
Antimony-125		
Barium-133	METALS	
Barium-137m	Barium	
Beryllium-10	Beryllium	
Bismuth-210	Cadmium	
Bismuth-211	Chromium	
Bismuth-213	Copper	
Bismuth-214	Lead	
Cadmium-109	Mercury	
Carbon-14	Nickel	
Cesium-134	Silver	
Cesium-137	Zinc	
Chlorine-36		
Cobalt-60	OTHER	
Europium-152	INORGANICS	
Europium-154	Asbestos	
Europium-155	Boron	
Iodine-129	Cyanide	
Iron-55	Fluoride	
Krypton-85	Nitrate/Nitrite	
Lead-209		
Lead-210	VOLATILE ORGANICS	
Lead-211	Benzene	
Lead-214	Carbon tetrachloride	
Molybdenum-93	Chlorobenzene	
Nickel-59	Chloroform	
Nickel-63		
Niobium-91		
Niobium-93m		

TABLE 415

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Table 4-16. Soil-Water Distribution Coefficients (K_d) for Candidate Radionuclides^a and Inorganics of Potential Concern at Z Plant Waste Management Units. (Sheet 1 of 3)

Element or Chemical	Recommended K_d for Hanford Site (Serne and Wood 1990) in ml/g	Conservative Default K_d^b (Serne and Wood 1990) in ml/g	MEPAS Default K_d pH 6-9 ^c (Streng and Peterson 1989) in ml/g	Mobility Class
Actinium	—	—	228	Low
Aluminum	—	—	35,300	Low
Americium	100 - 1,000 (<1 at pH 1-3)	100	82	Low
Antimony	—	—	2	High
Asbestos	—	—	100,000	Low
Barium	—	50	530	Moderate
Beryllium	—	—	70	Moderate
Bismuth	—	20	—	Moderate
Boron	—	—	0.19	High
Cadmium	—	15	14.9	Moderate
Calcium	—	10	70	Moderate
Carbon (¹⁴ C)	—	—	0	High
Cesium	200 - 1,000 1 - 200 (acidic waste)	50	51	Low
Chloride	<1	0	—	High
Chromium (VI)	—	0	16.8	Moderate-High
Cobalt	500 - 2,000	10	1.9	Low
Copper	—	15	41.9	Moderate
Cyanide	—	—	—	Moderate-High ^d
Curium	100 - >2,000	100	82	Low
Europium	—	—	228	Low
Fluoride	—	—	0	High
Iodine	<1	0	0	High
Iron	—	20	15	Moderate
Krypton	—	—	0	High
Lead	—	30	234	Moderate

Table 4-16. Soil-Water Distribution Coefficients (K_d) for Candidate Radionuclides^a and Inorganics of Potential Concern at Z Plant Waste Management Units. (Sheet 2 of 3)

Element or Chemical	Recommended K_d for Hanford Site (Serne and Wood 1990) in ml/g	Conservative Default K_d^b (Serne and Wood 1990) in ml/g	MEPAS Default K_d pH 6-9 ^c (Streng and Peterson 1989) in ml/g	Mobility Class
Magnesium	—	—	70	Moderate
Manganese	—	20	16.5	Moderate
Mercury	—	—	322	Low
Molybdenum	—	0	40	High
Neptunium	<1 to 5	3	3	High
Nickel	—	15	12.2	Moderate
Niobium	—	—	50	Moderate
Nitrate/nitric acid	—	—	0	High
Phosphate	—	—	50	Moderate
Plutonium	100 - 1,000 < 1 at pH 1 - 3	100	10	Low
Polonium	—	—	5.9	Moderate
Potassium	—	—	0	High
Promethium	—	—	—	Unknown
Protactinium	—	—	0	High
Radium	—	20	24.3	Moderate
Rhenium	—	—	—	Unknown
Ruthenium	20 - 700 (<2 at >1 M nitrate)	—	274	Low-Moderate
Samarium	—	—	228	Low
Selenium	—	0	5.91	High
Silica	—	—	5.0	High
Silver	—	20	0.4	Moderate
Sodium	—	3	0	High
Strontium	5 - 100 3 - 5 (acidic conditions) 200 - 500 (w/phosphate or oxalate)	10	24.3	Moderate

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Table 4-16. Soil-Water Distribution Coefficients (K_d) for Candidate Radionuclides^a and Inorganics of Potential Concern at Z Plant Waste Management Units. (Sheet 3 of 3)

Element or Chemical	Recommended K_d for Hanford Site (Serne and Wood 1990) in ml/g	Conservative Default K_d ^b (Serne and Wood 1990) in ml/g	MEPAS Default K_d pH 6-9 ^c (Streng and Peterson 1989) in ml/g	Mobility Class
Technetium	0 - 1	0	3	High
Thallium	—	—	0	High
Thorium	—	50	100	Moderate
Tritium	0	0	0	High
Uranium	—	0	0	High
Vanadium	—	—	50	Moderate
Yttrium	—	—	278	Low
Zinc	—	15	12.7	Moderate

^a Radionuclides with half-lives of greater than one year or short-lived products of long-lived precursors.

^b Average K_{ds} for low salt and organic solutions with neutral pH.

^c Default values for pH 6-9 and soil content of [clay + organic matter + metal oxyhydroxides] < 10% (Streng and Peterson 1989).

^d Cyanide mobility is highly dependent on identity of complexing agent. Simple cyanides (e.g., NaCN) are more mobile than complex cyanides.

— Value was not provided for this element in above references.

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Table 4-17. Physical/Chemical Properties of Candidate Organic Compounds of Potential Concern at Z Plant Waste Management Units. (Sheet 1 of 3)

Compound	Molecular Weight in g/mole	Water Solubility in mg/liter	Vapor Pressure in mm Hg	Henry's Law Constant in atm-m ³ /mo	Soil/Organic Matter Partition Coef. K _{ow} in ml/g
Acetone	58.0	miscible	270	2.1 x 10 ⁻⁵	2.2
Acetonitrile	41.0	miscible	7.4	4.0 x 10 ⁻⁶	2.2
Benzene	78	1,800	95	5.6 x 10 ⁻³	83
Butyl acetate ^a	116.16	14,000	15	3.2 x 10 ⁻⁴	233
Caffeine ^a	194.19	"slightly soluble"	na	na	na
Carbon tetrachloride	154.0	758	90	2.4 x 10 ⁻²	110
Chlorobenzene	112.56	470	12	3.7 x 10 ⁻³	330
Chloroform (trichloromethane)	119	8,200	150	2.9 x 10 ⁻³	31
Coal tars ^b	276	5.3 x 10 ⁻⁴	1 x 10 ⁻¹⁰	7 x 10 ⁻⁸	1,600,000
Creosote	130.0	5000	3.2 x 10 ⁻³	1.1 x 10 ⁻⁷	40
Cyclohexane	84.18	49	100	2.5 x 10 ⁻¹	1,700
Cyclohexanone	98.16	50,000	4.5	1.3 x 10 ⁻⁵	4
Decane ^a	142.28	0.052	1.43	na	22,200
Dibutyl butyl phosphonate ^a	250.36	"insoluble"	na	na	na
Dibutyl phosphate ^a	210.21	"v. low"	1	na	na
1,2-dichloroethane	98.96	8,500	64	9.8 x 10 ⁻⁴	14
1,2-dichloroethene (cis/trans)	96.94	6,300	320	6.6 x 10 ⁻³	59
Ethanol	46.1	miscible	59	1.2 x 10 ⁻⁵	0.3
Ethanolamine ^a	61.08	miscible	0.4	4 x 10 ⁻⁸	5

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Table 4-17. Physical/Chemical Properties of Candidate Organic Compounds of Potential Concern at Z Plant Waste Management Units. (Sheet 2 of 3)

Compound	Molecular Weight in g/mole	Water Solubility in mg/liter	Vapor Pressure in mm Hg	Henry's Law Constant in atm-m ³ /mo	Soil/Organic Matter Partition Coef. K _{oc} in ml/g
Ethylbenzene	106.17	150	7	6.4 x 10 ⁻³	1,100
Ethylene glycol	62.1	miscible	0.065	1 x 10 ⁻⁴	0.027
Fluoromethane	na	na	na	na	na
Freon II (trichlorofluoromethane)	137.4	1,100	670	1.1 x 10 ⁻¹	160
Hexane	86.2	19	180	1.6	4,600
Hexanol ^a	102.17	na	1	na	na
Isopropanol	60.1	miscible	48	3.8 x 10 ⁻⁵	0.69
Kerosene ^f	142.2	32	0.045	2.9 x 10 ⁻⁴	4,500
Methanol	32.0	miscible	130	2.8 x 10 ⁻⁵	0.1
Methylene chloride	84.9	20,000	360	2 x 10 ⁻³	8.8
Methyl isobutyl ketone (MIBK)	100.16	19,000	6	4.2 x 10 ⁻⁵	19
1-Naphthylamine	143.2	2,400	6.5 x 10 ⁻⁵	5.2 x 10 ⁻⁹	61
2-Naphthylamine	143.2	590	2.6 x 10 ⁻⁴	8.2 x 10 ⁻⁸	130
Normal paraffins ^g	na	"insoluble"	na	na	na
Oil	na	na	na	na	na
PCBs (average) ^e	328.0	0.031	7.7 x 10 ⁻⁵	1.1 x 10 ⁻³	53,000
Polyurethane	na	na	na	na	na
Pseudocumene (1,2,5-trimethylbenzene)	120.2	64	1.4	na	1,600
Tetrachloroethene	165.9	150	18	2.6 x 10 ⁻²	360

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Table 4-17. Physical/Chemical Properties of Candidate Organic Compounds of Potential Concern at Z Plant Waste Management Units. (Sheet 3 of 3)

Compound	Molecular Weight in g/mole	Water Solubility in mg/liter	Vapor Pressure in mm Hg	Henry's Law Constant in atm-m ³ /mo	Soil/Organic Matter Partition Coef. K _{oc} in ml/g
Tetrahydrofuran	72.1	69,000	370	5.1 x 10 ⁻⁴	1.8
Toluene	92.2	1,550 ^d	28.4	6.4 x 10 ⁻³	300
Tributyl phosphate	266.3	280	15	1.9 x 10 ⁻²	6,000
1,1,1-Trichloroethane	133.41	1,500	120	1.4 x 10 ⁻²	150
Trichloroethene	131.3	1,100	58	9.1 x 10 ⁻³	130
Trioctyl phosphine	na	na	na	na	na
Vinyl Chloride	62.5	2,700	2,700	6.9 x 10 ⁻¹⁶	8.2 ^e
Xylenes (total)	106.2	200	10	7.0 x 10 ⁻³	240

Sources: Strenge and Peterson 1989, except as noted in footnotes below.

- ^a Values listed in Hazardous Substance Data Base (HSDB), National Library of Medicine database (HSDB 1991).
- ^b Properties of coal tar are represented by data for indeno(1,2,3-c,d)pyrene.
- ^c Average value for all aroclor mixtures.
- ^d Value from Banerjee et al. 1980.
- ^e Value from Mackay and Shiu 1981.
- ^f Kerosene properties are represented by 2-methyl naphthalene.

na Value not available from above sources.

Table 4-18. Radiological Properties of Candidate Radionuclides of Potential Concern for Z Plant Waste Management Units. (Sheet 1 of 4)

Radionuclide	Half-Life	Specific Activity ^a in Ci/g	Radiation of Concern ^b
²²⁵ Ac	10 d	5.8×10^4	α
²²⁷ Ac	21.8 yr	7.2×10^1	β, α
¹⁰⁸ Ag	2.4 min	2.7×10^{13}	β
¹¹⁰ Ag	24.6 sec	4.2×10^9	β
²⁸ Al	2.24 min	3.0×10^9	β, γ
²⁴¹ Am	432 yr	3.4×10^0	α
²⁴² Am	16 hr	8.1×10^5	β
^{242m} Am	152 yr	9.7×10^0	α
²⁴³ Am	7,380 yr	2.0×10^{-1}	α
¹⁹⁵ Au	30.5 sec	1.9×10^9	γ^c
¹³³ Ba	10.5 yr	2.5×10^2	γ^c
^{137m} Ba	2.6 min	5.3×10^8	γ
⁷ Be	53.4 d	3.5×10^{-5}	γ
¹⁰ Be	1.6×10^6 yr	2.2×10^{-2}	β
²¹⁰ Bi	5.01 d	1.2×10^5	β
²¹¹ Bi	2.13 min	4.2×10^8	α, β
²¹³ Bi	45.6 min	1.9×10^7	β, α
²¹⁴ Bi	19.9 min	4.4×10^7	β, γ
¹⁴ C	5,730 yr	4.5×10^0	β
⁴⁵ Ca	163.8 d	1.8×10^4	β
¹⁰⁹ Cd	453 d	2.6×10^3	γ^c
¹⁴¹ Ce	32.5 d	2.8×10^4	β, γ^c
¹⁴⁴ Ce	284.9 d	3.2×10^3	β, γ^c
³⁶ Cl	3.0×10^5 yr	3.3×10^{-2}	β
²⁴² Cm	163.2 d	3.3×10^3	α
²⁴³ Cm	28.5 yr	5.2×10^1	α
²⁴⁴ Cm	18.1 yr	8.1×10^1	α
²⁴⁵ Cm	8,500 yr	1.7×10^{-1}	α, γ
⁵⁷ Co	271.8 d	8.5×10^3	γ^c
⁵⁸ Co	70.92 d	3.2×10^4	γ^c
⁶⁰ Co	5.3 yr	1.1×10^3	γ
⁵¹ Cr	27.7 d	9.2×10^4	γ^c
¹³⁴ Cs	2.06 yr	1.3×10^3	γ
¹³⁷ Cs	30 yr	8.7×10^1	γ^c

Table 4-18. Radiological Properties of Candidate Radionuclides of Potential Concern for Z Plant Waste Management Units. (Sheet 2 of 4)

Radionuclide	Half-Life	Specific Activity ^a in Ci/g	Radiation of Concern ^b
²⁵⁴ Es	275 d	1.9×10^3	α, γ
¹⁵² Eu	13.3 yr	7.7×10^2	β, γ^c
¹⁵⁴ Eu	8.8 yr	2.7×10^2	β, γ^c
¹⁵⁵ Eu	4.96 yr	4.6×10^2	β
⁵⁵ Fe	2.73 yr	2.5×10^3	γ^c
⁵⁹ Fe	44.5 d	4.9×10^4	β
¹⁵³ Gd	241.6 d	3.5×10^3	γ^c
⁶⁸ Ge	287 d	6.7×10^3	γ^c
³ H	12.3 yr	9.7×10^3	β
¹²⁹ I	13.2 hr	1.9×10^6	γ^c
¹²⁵ I	60.14 d	1.7×10^4	γ^c
¹²⁹ I	1.6×10^7 yr	1.7×10^4	β
¹³¹ I	8.0 d	1.2×10^5	β, γ^c
⁴⁰ K	1.3×10^9 yr	6.7×10^6	β, γ^c
⁸⁵ Kr	10.7 yr	3.9×10^2	β
⁵⁴ Mn	312.2 d	7.7×10^3	γ^c, e^-
⁹⁹ Mo	5,300 yr	1.1×10^0	γ^c
²² Na	2.6 yr	6.3×10^3	β, γ^c
⁹¹ Nb	10,000 yr	3.9×10^{-1}	γ^c
^{95m} Nb	14.6 yr	2.8×10^2	γ^c
⁹⁴ Nb	20,300 yr	1.87×10^{-1}	β, γ^c
⁹⁵ Nb	34.97 d	3.9×10^4	β, γ
⁵⁹ Ni	75,000 yr	7.6×10^4	γ^c
⁶³ Ni	100.1 yr	6.2×10^1	β
²³⁷ Np	2.14×10^6 yr	7.0×10^{-4}	α, γ
²³⁹ Np	2.35 d	2.3×10^5	β
³² P	14.3 d	2.9×10^5	β
²³¹ Pa	32,800 yr	4.7×10^{-2}	α
²⁰⁹ Pb	3.25 hr	4.5×10^6	β
²¹⁰ Pb	22.3 yr	7.6×10^1	β
²¹¹ Pb	36.1 min	2.5×10^7	β
²¹² Pb	10.6 hr	1.4×10^6	β, γ^c

Table 4-18. Radiological Properties of Candidate Radionuclides of Potential Concern for Z Plant Waste Management Units. (Sheet 3 of 4)

Radionuclide	Half-Life	Specific Activity ^a in Ci/g	Radiation of Concern ^b
²¹⁴ Pb	26.8 min	3.3×10^7	β, γ°
¹⁴⁷ Pm	2.62 yr	9.3×10^2	β
²¹⁰ Po	128 d	4.9×10^3	α
²¹⁴ Po	6×10^{-5} sec	8.8×10^{14}	α
²¹⁵ Po	7.8×10^{-4} sec	2.9×10^{13}	α
²¹⁸ Po	3.05 min	2.8×10^8	α
²³⁸ Pu	87.7 yr	1.7×10^1	α
²³⁹ Pu	24,400 yr	6.2×10^{-2}	α
²⁴⁰ Pu	6,560 yr	2.3×10^{-1}	α
²⁴¹ Pu	14.4 yr	1.0×10^2	β
²²⁵ Ra	14.8 d	3.9×10^4	β
²²⁶ Ra	1,600 yr	9.9×10^{-1}	α
²²⁸ Ra	5.75 yr	2.3×10^2	β
⁸⁶ Rb	18.7 d	8.1×10^4	β
¹⁸⁷ Re	5×10^{10} yr	3.8×10^8	β
¹⁰⁰ Ru	39.2 d	3.2×10^4	β, γ°
¹⁰⁶ Ru	1.0 yr	3.4×10^3	β, γ°
³⁵ S	87.5 d	4.3×10^4	β
¹²² Sb	2.7 d	4.0×10^5	β, γ°
¹²⁴ Sb	60.2 d	1.8×10^4	β, γ°
¹²⁵ Sb	2.73 yr	1.0×10^3	β, γ°
¹²⁶ Sb	12.4 d	8.4×10^4	β, γ°
⁴⁶ Sc	83.8 d	3.4×10^4	β, γ°
⁷⁵ Se	119.8 d	1.5×10^4	γ°
⁷⁹ Se	<65,000 yr	7.0×10^{-2}	β
¹⁵¹ Sm	90 yr	2.6×10^1	β
¹¹³ Sn	115.1 d	1.0×10^4	γ°
^{125m} Sn	129 d	8.2×10^3	β, γ°
⁸² Sr	25 d	6.4×10^4	γ°
⁹⁰ Sr	28.5 yr	1.4×10^2	β
¹⁸² Ta	115 d	6.3×10^3	β, γ°
⁹⁹ Tc	213,000 yr	1.7×10^{-2}	β
¹²¹ Te	16.8 d	6.4×10^4	γ°
^{125m} Te	58 d	1.8×10^4	e^-, γ°

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Table 4-18. Radiological Properties of Candidate Radionuclides of Potential Concern for Z Plant Waste Management Units. (Sheet 4 of 4)

Radionuclide	Half-Life	Specific Activity ^a in Ci/g	Radiation of Concern ^b
¹²⁷ Te	9.35 hr	2.6 x 10 ⁶	β
^{129m} Te	33.6 d	3.0 x 10 ⁴	β, γ ^c
²²⁷ Th	18.7 d	3.1 x 10 ⁴	α
²²⁹ Th	7,340 yr	2.1 x 10 ⁻¹	α
²³⁰ Th	77,000 yr	2.1 x 10 ⁻²	α
²³¹ Th	25.5 hr	5.3 x 10 ⁵	β
²³² Th	1.4 x 10 ¹⁰ yr	1.1 x 10 ⁻⁷	α
²³⁴ Th	24.1 d	2.3 x 10 ⁻⁴	β
²⁰⁴ Tl	3.78 yr	4.6 x 10 ⁴	β
¹⁷⁰ Tm	128.6 d	4.3 x 10 ³	β
²³³ U	159,000 yr	9.7 x 10 ⁻³	α
²³⁴ U	244,500 yr	6.2 x 10 ⁻³	α
²³⁵ U	7.0 x 10 ⁸ yr	2.2 x 10 ⁻⁶	α, γ
²³⁶ U	2.3 x 10 ⁷ yr	6.5 x 10 ⁻⁵	α
²³⁸ U	4.5 x 10 ⁹ yr	3.4 x 10 ⁻⁷	α
⁴⁹ V	330 d	8.1 x 10 ³	γ ^c
⁸⁷ Y	80.3 hr	4.5 x 10 ⁵	γ ^c
⁸⁸ Y	106.6 d	5.6 x 10 ⁵	γ ^c
⁹⁰ Y	6.41 hr	5.4 x 10 ⁵	β
⁶⁵ Zn	244 d	8.2 x 10 ³	γ ^c
⁹⁵ Zr	64 d	2.1 x 10 ⁴	β

^a Source: DOE 1990 or calculated from half-life and atomic weight.

^b α - alpha decay; β - negative beta decay; γ - release of gamma rays.

^c Gamma radiation due to daughter product.

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Table 4-19. Comparison of Radionuclide Relative Risks for Radionuclides of Potential Concern at the Z Plant Aggregate Area. (Sheet 1 of 3)

Radionuclide	Half-Life ^a	Air Unit Risk ^b in (pCi/m ³) ⁻¹	Drinking Water Unit Risk ^c in (pCi/L) ⁻¹	Soil Ingestion Unit Risk ^d in (pCi/g) ⁻¹	External Exposure Unit Risk ^e in (pCi/g) ⁻¹
²²⁵ Ac	10 d	1.2 x 10 ⁻³	8.7 x 10 ⁻⁷	4.6 x 10 ⁻⁸	9.4 x 10 ⁻⁶
²²⁷ Ac	21.8 yr	4.2 x 10 ⁻²	1.8 x 10 ⁻⁵	9.5 x 10 ⁻⁷	1.3 x 10 ⁻⁷
²⁴¹ Am	433 yr	2.1 x 10 ⁻²	1.6 x 10 ⁻⁵	8.4 x 10 ⁻⁷	1.6 x 10 ⁻⁵
^{242m} Am	152 yr	na	na	na	na
²⁴³ Am	7,380 yr	2.1 x 10 ⁻²	1.5 x 10 ⁻⁵	8.1 x 10 ⁻⁷	3.6 x 10 ⁻⁵
¹³³ Ba	10.5 yr	na	na	na	na
^{137m} Ba	2.6 min	3 x 10 ⁻¹⁰	1.2 x 10 ⁻¹⁰	6.5 x 10 ⁻¹²	3.4 x 10 ⁻⁴
¹⁰ Be	1.6 x 10 ⁶ yr	na	na	na	na
²¹⁰ Bi	5.01 d	4.1 x 10 ⁻⁵	9.7 x 10 ⁻⁸	5.1 x 10 ⁻⁹	0
²¹¹ Bi	2.13 min	9.7 x 10 ⁻⁸	6.1 x 10 ⁻¹⁰	3.2 x 10 ⁻¹¹	2.8 x 10 ⁻⁵
²¹³ Bi	45.6 min	1.6 x 10 ⁻⁷	1.2 x 10 ⁻⁸	6.2 x 10 ⁻¹⁰	8.1 x 10 ⁻⁵
²¹⁴ Bi	19.9 min	1.1 x 10 ⁻⁶	7.2 x 10 ⁻⁹	3.8 x 10 ⁻¹⁰	8.0 x 10 ⁻⁴
¹⁴ C	5,730 yr	3.2 x 10 ⁻⁹	4.7 x 10 ⁻⁸	2.5 x 10 ⁻⁹	0
¹⁰⁹ Cd	453 d	na	na	na	na
³⁶ Cl	3.0 x 10 ⁵ yr	na	na	na	na
²⁴³ Cm	28.5 yr	1.6 x 10 ⁻²	1.2 x 10 ⁻⁵	6.2 x 10 ⁻⁷	8.2 x 10 ⁻⁵
²⁴⁴ Cm	18.1 yr	1.4 x 10 ⁻²	1.0 x 10 ⁻⁵	5.4 x 10 ⁻⁷	5.9 x 10 ⁻⁷
²⁴⁵ Cm	8,500 yr	na	na	na	na
⁶⁰ Co	5.3 yr	8.1 x 10 ⁻⁵	7.8 x 10 ⁻⁷	4.1 x 10 ⁻⁸	1.3 x 10 ⁻³
¹³⁴ Cs	2.06 yr	1.4 x 10 ⁻⁵	2.1 x 10 ⁻⁶	1.1 x 10 ⁻⁷	8.9 x 10 ⁻⁴
¹³⁷ Cs	30 yr	9.6 x 10 ⁻⁶	1.4 x 10 ⁻⁶	7.6 x 10 ⁻⁸	0
¹⁵² Eu	13.3 yr	6.1 x 10 ⁻³	1.1 x 10 ⁻⁷	5.7 x 10 ⁻⁹	6.3 x 10 ⁻⁴
¹⁵⁴ Eu	8.8 yr	7.2 x 10 ⁻⁵	1.5 x 10 ⁻⁷	8.1 x 10 ⁻⁹	6.8 x 10 ⁻⁴
¹⁵⁵ Eu	4.96 yr	na	na	na	na
⁵⁵ Fe	2.73 yr	na	na	na	na
³ H	12.3 yr	4.0 x 10 ⁻⁸	2.8 x 10 ⁻⁹	1.5 x 10 ⁻¹⁰	0

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Table 4-19. Comparison of Radionuclide Relative Risks for Radionuclides of Potential Concern at the Z Plant Aggregate Area. (Sheet 2 of 3)

Radionuclide	Half-Life ^a	Air Unit Risk ^b in (pCi/m ³) ⁻¹	Drinking Water Unit Risk ^c in (pCi/L) ⁻¹	Soil Ingestion Unit Risk ^d in (pCi/g) ⁻¹	External Exposure Unit Risk ^e in (pCi/g) ⁻¹
¹²⁹ I	1.6 x 10 ⁷ yr	6.1 x 10 ⁻⁵	9.6 x 10 ⁻⁶	5.1 x 10 ⁻⁷	1.5 x 10 ⁻⁵
⁴⁰ K	1.3 x 10 ⁹ yr	4.0 x 10 ⁻⁶	5.7 x 10 ⁻⁷	3.0 x 10 ⁻⁸	7.8 x 10 ⁻⁵
⁸⁵ Kr	10.7 yr	na	na	na	na
⁹⁹ Mo	5,300 yr	na	na	na	na
²² Na	2.6 yr	na	na	na	na
⁹¹ Nb	10,000 yr	na	na	na	na
^{95m} Nb	14.6 yr	na	na	na	na
⁹⁴ Nb	20,300 yr	1.1 x 10 ⁻⁴	1.1 x 10 ⁻⁷	5.7 x 10 ⁻⁹	8.9 x 10 ⁻⁴
⁵⁹ Ni	75,000 yr	3.5 x 10 ⁻⁷	4.4 x 10 ⁻⁹	2.3 x 10 ⁻¹⁰	3.4 x 10 ⁻⁷
⁶³ Ni	100.1 yr	8.7 x 10 ⁻⁷	1.2 x 10 ⁻⁸	6.2 x 10 ⁻¹⁰	0
²³⁷ Np	2.14 x 10 ⁶ yr	1.8 x 10 ⁻²	1.4 x 10 ⁻⁵	7.3 x 10 ⁻⁷	1.8 x 10 ⁻⁵
²³⁹ Np	235 d	7.7 x 10 ⁻⁷	4.8 x 10 ⁻⁸	2.5 x 10 ⁻⁹	1.1 x 10 ⁻⁴
²³¹ Pa	32,800 yr	2.0 x 10 ⁻²	9.7 x 10 ⁻⁶	5.1 x 10 ⁻⁷	2.0 x 10 ⁻⁵
²⁰⁹ Pb	3.25 hr	3.6 x 10 ⁻⁸	4.3 x 10 ⁻⁹	2.3 x 10 ⁻¹⁰	0
²¹⁰ Pb	22.3 yr	8.7 x 10 ⁻⁴	3.4 x 10 ⁻⁵	1.8 x 10 ⁻⁶	1.8 x 10 ⁻⁶
²¹¹ Pb	36.1 min	1.5 x 10 ⁻⁶	9.2 x 10 ⁻⁹	4.9 x 10 ⁻¹⁰	2.9 x 10 ⁻⁵
²¹⁴ Pb	26.8 min	1.5 x 10 ⁻⁶	9.2 x 10 ⁻⁹	4.9 x 10 ⁻¹⁰	1.5 x 10 ⁻⁴
¹⁴⁷ Pm	2.62 yr	na	na	na	na
²¹⁰ Po	128 d	8.7 x 10 ⁻⁴	3.4 x 10 ⁻⁵	1.8 x 10 ⁻⁶	1.8 x 10 ⁻⁶
²¹⁴ Po	6 x 10 ⁻⁵ sec	1.4 x 10 ⁻¹³	5.1 x 10 ⁻¹⁶	2.7 x 10 ⁻¹⁷	4.7 x 10 ⁻⁸
²¹⁵ Po	7.8 x 10 ⁻⁴ sec	2.9 x 10 ⁻¹²	1.4 x 10 ⁻¹⁴	7.6 x 10 ⁻¹⁶	8.7 x 10 ⁻⁸
²¹⁸ Po	3.05 min	3.0 x 10 ⁻⁷	1.4 x 10 ⁻⁹	7.6 x 10 ⁻¹¹	0
²³⁸ Pu	87.7 yr	2.1 x 10 ⁻²	1.4 x 10 ⁻⁵	7.6 x 10 ⁻⁷	5.9 x 10 ⁻⁷
²³⁹ Pu	24,400 yr	2.6 x 10 ⁻²	1.6 x 10 ⁻⁵	8.4 x 10 ⁻⁸	2.6 x 10 ⁻⁷
²³⁹ Pu oxide	24,400 yr	2.6 x 10 ⁻²	1.6 x 10 ⁻⁶	8.4 x 10 ⁻⁸	2.6 x 10 ⁻⁷
²⁴⁰ Pu	6,560 yr	2.1 x 10 ⁻²	1.6 x 10 ⁻⁵	8.4 x 10 ⁻⁸	5.9 x 10 ⁻⁷
²⁴⁰ Pu oxide	6,560 yr	2.1 x 10 ⁻²	1.6 x 10 ⁻⁶	8.4 x 10 ⁻⁸	5.9 x 10 ⁻⁷
²⁴¹ Pu	14.4 yr	1.5 x 10 ⁻⁴	2.5 x 10 ⁻⁷	1.3 x 10 ⁻⁸	0

Table 4-20. Potential Chronic Health Effects of Candidate Chemicals of Potential Concern at the Z Plant Aggregate Area. (Sheet 1 of 3)

Chemical	Tumor Site Inhalation Route; Oral Route [Weight of Evidence Group ^a]	Non-carcinogenic Chronic Health Effects Inhalation Route; Oral Route
INORGANIC CHEMICALS		
Aluminum		
Ammonium ion		decreased pulmonary function; degrades odor; taste of water
Asbestos	lung and mesothelioma [A]; large intestine [A]	
Barium		fetotoxicity; increased blood pressure
Beryllium	lung [B2]; total tumors [B2]	none observed
Boron		NA; testicular lesions
Cadmium	respiratory tract [B1]; NA	cancer; renal damage
Calcium		
Chloride		
Chromium	lung [A] - Cr(VI) only; NA	nasal mucosa atrophy; hepatotoxicity
Copper		NA; gastrointestinal irritation
Fluoride		NA; dental fluorosis at high levels
Iron		
Lead	[B2] ^b ; [B2]	central nervous system (CNS) effects ^c ; CNS effects
Magnesium		
Mercury		neurotoxicity; kidney effects
Nickel	respiratory tract [A]; NA	cancer; reduced weight gain
Nitrate/Nitrite		NA; methemoglobinemia in infants ^d
Phosphate		
Potassium		
Silica		
Silver		
Sodium		
Sulfate		
Uranium (soluble salts)		NA; body weight loss, nephrotoxicity
Zinc		NA; anemia

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Table 4-20. Potential Chronic Health Effects of Candidate Chemicals of Potential Concern at the Z Plant Aggregate Area. (Sheet 2 of 3)

Chemical	Tumor Site Inhalation Route; Oral Route [Weight of Evidence Group ^a]	Non-carcinogenic Chronic Health Effects Inhalation Route; Oral Route
ORGANIC CHEMICALS		
Acetone		NA; kidney and liver effects
Acetonitrile		blood effects, hepatotoxicity; blood effects, hepatotoxicity
Benzene	blood (leukemia) [A]; blood [A]	
Butyl Acetate		
Caffeine		
Carbon tetrachloride	liver [B2]	NA; liver lesions
Chlorobenzene		liver, kidney effects; liver, kidney
Chloroform	liver; kidney [B2]	NA; liver lesions
Coal tars	lung [NA]; NA	
Creosote	NA [B1]; NA [B1]	
Cyclohexane		
Cyclohexanone		NA; body weight loss
Decane		
Dibutyl butyl phosphonate		
Dibutyl phosphate		NA; respiratory irritation ^b
1,2-Dichloroethane	circulatory system [B2]; circulatory system [B2]	
cis-1,2-Dichloroethene		NA; blood chemistry effects
trans-1,2-Dichloroethene		NA; increased serum phosphatase
Ethanol		NA; CNS, reproductive effects ^b
Ethanalamine		NA; fetotoxicity ^b
Ethylbenzene		developmental toxicity; liver and kidney
Ethylene glycol		NA; mortality, liver and kidney
Fluoromethane		
Freon II (trichlorofluoromethane)		NA; survival, histopathology ^b
Hexane		neurotoxicity; neuropathy or testicular atrophy
Hexanol		

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Table 4-20. Potential Chronic Health Effects of Candidate Chemicals of Potential Concern at the Z Plant Aggregate Area. (Sheet 3 of 3)

Chemical	Tumor Site Inhalation Route; Oral Route [Weight of Evidence Group ^a]	Non-carcinogenic Chronic Health Effects Inhalation Route; Oral Route
Isopropanol		NA; liver, kidney damage ^b
Methanol		NA; blood system effects, decreased brain weight
Methylene chloride	lung, liver [B2]; liver [B2]	NA; liver toxicity
Methyl isobutyl ketone		liver and kidney effects; liver and kidney effects
Naphthylamine tritium ^c	NA; multiple sites ^b	
Normal paraffins		
Polychlorinated biphenyls	NA [B2]; liver [B2]	
Polyurethane		
Pseudocumene (1,2,5-trimethylbenzene)		
Tetrachloroethene	leukemia, liver [B2]; liver [B2]	NA; hepatotoxicity
Tetrahydrofuran		
Toluene		CNS effects, eye irritation; change in liver and kidney weights
Tributyl phosphate		respiratory irritant; kidney damage ^b
1,1,1-Trichloroethane		liver toxicity; liver toxicity
Trichloroethene	lung [B2]; liver [B2]	
Trioctyl phosphine		
Vinyl chloride	liver [A]; lung [A]	
Xylenes		CNS effects, nose and throat irritation; hyperactivity, decreased body weight

^a Weight of Evidence Groups for carcinogens: A - Human carcinogen (sufficient evidence of carcinogenicity in humans); B - Probable Human Carcinogen (B1 - limited evidence of carcinogenicity in humans; B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack of data in humans); C - Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data); D - Not Classifiable as to Human Carcinogenicity (inadequate or no evidence).

^b Verified toxicity information was not available from EPA 1991a or 1991b. Toxicity information was obtained from EPA Registry of Toxic Effects of Chemical Systems (RTECS). A blank space means that no information was available from the above sources.

^c Lead is considered by EPA to have both neurotoxic and carcinogenic effects; however, no toxicity criteria are available for lead at the present time.

^d Toxic effect is considered to occur from exposure to nitrite; nitrate can be converted to nitrite in the body by intestinal bacteria.

^e Toxic effect of untritiated naphthylamine.

NA Information not available.

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4 **5.0 WASTE MANAGEMENT UNIT SCREENING**
5 **POTENTIAL FOR HUMAN HEALTH IMPACT**
6
7

8 This preliminary qualitative evaluation of potential human health concerns is
9 intended to provide input to the Z Plant Aggregate Area waste management unit
10 recommendation process (Section 9.0). This process requires consideration of actual or
11 potential impacts to human health and the environment. The approach that has been
12 taken to identify potential health concerns related to individual waste management units
13 and unplanned releases is as follows:
14

- 15 ● Contaminants of potential concern are identified for each exposure
16 pathway that is likely to occur within the Z Plant Aggregate Area.
17 Selection of contaminants was discussed in Section 4.2. Contaminants of
18 potential concern were selected from the list of candidate contaminants of
19 potential concern presented in Table 4-13. This table includes
20 contaminants that are likely to be present in the environment based on
21 occurrence in the liquid process wastes that were discharged to soils,
22 contaminants that have been detected in environmental samples within the
23 aggregate area but have not been identified as components of Z Plant
24 Aggregate Area waste streams, and contaminants that are expected to be
25 present based on historical association with waste streams.
26
- 27 ● Exposure pathways potentially applicable to individual waste management
28 units are identified based on the presence of the above contaminants of
29 potential concern in wastes in the waste management units, consideration
30 of known or suspected releases from those waste management units, and
31 the physical and institutional controls affecting site access and use over the
32 period of interest. The relationships between waste management units and
33 exposure pathways are summarized in the conceptual model (Section 4.2).
34
- 35 ● Estimates of relative hazard derived for the Z Plant Aggregate Area waste
36 management units are identified using the Comprehensive Environmental
37 Response, Compensation, and Liability Act (CERCLA) Hazard Ranking
38 System (HRS), modified Hazard Ranking System (mHRS), surface
39 radiation survey data, and by Westinghouse Hanford Company
40 (Westinghouse Hanford) Environmental Protection Group scoring.
41

1 The human health concerns and various hazard ranking scores listed above are
2 used to establish whether or not a site is considered a "high" priority. In the data
3 evaluation process presented in Section 9.0, "high" priority sites are evaluated for the
4 potential implementation of an interim remedial measure (IRM). "Low" priority sites are
5 evaluated to determine what type of additional investigation is necessary to establish a
6 final remedy. Further detail is presented in Section 9.0.

7
8 The data used for this human health evaluation are presented in the earlier
9 sections of this report. The types of data that have been assessed include site histories
10 and physical descriptions (Section 2.0), descriptions of the physical environment of the
11 study area (Section 3.0) and a summary of the available chemical and radiological data
12 for each waste management unit (Section 4.0).

13
14 The quality and sufficiency of these data are assessed in Section 8.0. This
15 information is also used to identify applicable or relevant and appropriate requirements
16 (ARARs) (Section 6.0).

17 18 19 **5.1 CONCEPTUAL FRAMEWORK FOR RISK-BASED SCREENING**

20
21 The range of potential human health exposure pathways at the Z Plant Aggregate
22 Area were summarized in Section 4.2. The EPA (1989) considers a human exposure
23 pathway to consist of four elements: 1) a source and mechanism for contaminant
24 release, 2) a retention or transport medium (or media), 3) a point of potential human
25 contact, and 4) an exposure route (e.g., ingestion) at the contact point. The probability
26 of occurrence of these four elements, and, therefore, the existence of a pathway, is
27 dependent, in part, upon the physical and institutional controls affecting site access and
28 use. In the absence of site access controls and other land use restrictions, the identified
29 potential exposure pathways could all be completed. For example, it could be
30 hypothesized that an individual could establish a residence within the boundaries of the Z
31 Plant Aggregate Area, disrupt the soil surface and contact buried contamination, and drill
32 a well and withdraw contaminated groundwater for drinking water and crop irrigation.
33 However, within the 5- to 10-year period of interest associated with identification and
34 prioritization of remedial actions within the Z Plant Aggregate Area, unrestricted access
35 and uncontrolled disruption of buried contaminants have a negligible probability of
36 occurrence.

37
38 For the purpose of identifying immediate and long-term health hazards associated
39 with Z Plant Aggregate Area waste management units, and prioritizing remediation
40 actions for those units, an occupational exposure scenario was determined to be the most
41 appropriate. While work activities are assumed to include occasional contact with

1 surface soils, it is assumed that no contact with buried contaminants will take place
2 without proper protective measures.

3
4 The following exposure routes are available to a worker at the Z Plant Aggregate
5 Area:

- 6
- 7 ● Ingestion of surface soils;
- 8
- 9 ● Inhalation of volatilized contaminants and resuspended particulates;
- 10
- 11 ● Direct dermal contact with surface soils; and
- 12
- 13 ● Direct exposure to radiation from surface soils and airborne resuspended
14 particles.
- 15

16 Since evaluation of migration in the saturated zone is not within the scope of a
17 source area AAMS, ingestion or contact with groundwater was not evaluated as an
18 exposure pathway. However, since migration of waste constituents within the saturated
19 zone will be addressed in the 200 West Groundwater AAMS, chemicals likely to migrate
20 to the water table and waste management units that have a high potential to impact
21 groundwater will be identified.

22

23

24 **5.2 POTENTIAL EXPOSURE SCENARIOS AND HUMAN HEALTH CONCERNS**

25

26 The routes by which a Hanford Site worker could potentially be exposed to
27 contamination at the waste management units include ingestion, inhalation, direct contact
28 with soils, and direct exposure to radiation. To evaluate the potential for exposure at
29 individual waste management units, it is necessary to have data available for surface soils,
30 air, and radiation. Although samples have been collected from each of these media, only
31 the radiation survey data, and a limited number of soil samples analyzed for
32 radionuclides and volatiles, are specific to individual waste management units. Therefore,
33 only external radiation can be evaluated with confidence at this time. Exposures by other
34 pathways were evaluated based on available knowledge about chemicals disposed of to
35 the waste management unit and the engineered barriers to releases.

36

37 **5.2.1 External Exposure**

38

39 External dose rate surveys, which are performed on a waste management unit
40 basis, were used as the measure of a unit's potential for impacting human health through
41 direct external radiation exposure. The contaminants of potential concern for this
42 pathway are the radionuclides that emit moderate to high energy penetrating gamma

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1 radiation. The radiation doses from direct external exposure are presented in Table 5-1
2 from the available survey data. Recent survey data were available for only 27 of the 66
3 Z Plant Aggregate Area waste management units and unplanned release sites. For those
4 units that have recent radiation survey data, only 8 were reported as having radiation
5 detected. Radiation surveys were not available for settling tanks, septic tanks or tile
6 fields, reverse wells, French drains, transfer facilities, and retention or seepage basins.

7
8 Westinghouse Hanford manual WHC-CM-4-10, Section 7 (WHC 1989) was used
9 to help identify waste management units that can be considered a high priority for
10 remediation. The manual indicates that posting ("Radiation Area") and access controls
11 are to be implemented at a level of 2 mrem/hr for the purpose of personnel protection.
12 With the same objective in mind, the level of 2 mrem/hr is recommended as one of the
13 criteria for distinguishing high priority from lower priority waste management units. Only
14 one of the regularly surveyed units exceeded this criterion. Dose rates up to 18 mrem/hr
15 were measured at the 218-W-3A Solid Waste Burial Ground in March 1991. The area of
16 high readings was reported as approximately 1 square meter (3 feet by 3 feet).
17 Additional readings exceeding 2 mrem/hr were reported at scattered locations at this
18 waste management unit.

19
20 High levels of radiation (up to 2,000 mrem/hr) were reportedly associated with
21 some of the unplanned releases, as noted in Table 5-1. However, many of these releases
22 occurred in the early years of the Hanford Site and recent survey data were not located.
23 Some of the releases were reportedly remediated by removing contaminated soil for
24 disposal in burial grounds, paving or covering the area with soil, or flushing the soil with
25 water. The effectiveness of the various remediation measures is not known, and
26 confirmatory survey measurements were not located. Other releases consisted of ^{106}Ru ,
27 which has a decay half-life of about 1 year, and would be largely decayed 40 years after
28 release. Thus, with the exception of those unplanned releases located within engineered
29 waste units, which are routinely surveyed, information on the current radiological status
30 of these remediated unplanned releases is lacking and is identified as a data gap in
31 Section 8.

32 33 34 **5.2.2 Ingestion of Soil or Inhalation of Fugitive Dust**

35
36 Radionuclides and nonradioactive chemicals of concern for these pathways are
37 those that are non-volatile, persistent in surface soils, and have appreciable carcinogenic
38 or toxic effects by ingestion or inhalation. However, little information is available to
39 evaluate the presence of specific radionuclides or nonradioactive chemicals in surface
40 soils. Available gross activity survey data for the Z Plant Aggregate Area waste
41 management units are provided in Table 5-1.
42

1 Westinghouse Hanford manual WHC-CM-4-10 (WHC 1989) was used to set
2 criteria for identifying waste management units that can be considered high priority
3 remediation sites. The manual indicates that posting ("Surface Contamination Area")
4 and access controls are to be implemented at a level of 100 counts per minute (ct/min)
5 above background beta/gamma, and/or 20 ct/min alpha, for the purpose of personnel
6 protection. With the same objective in mind, the levels of 100 ct/min above background
7 beta/gamma and 20 ct/min alpha are recommended as two of the criteria for
8 identification of candidate waste management units. For those survey readings that are
9 in units of disintegration per minute (dis/min), a conversion will be made to ct/min
10 assuming a detector efficiency of 10 percent.

11
12 The following waste management units exceed the criterion based on recent
13 radiation survey results:

- 14
- 15 ● 216-Z-1 and 216-Z-2 Cribs
- 16 ● 216-Z-1A Tile Field
- 17 ● 218-W-1 Burial Ground
- 18 ● 218-W-2 Burial Ground
- 19 ● 218-W-2A Burial Ground
- 20 ● 218-W-3A Burial Ground
- 21 ● 218-W-4A Burial Ground
- 22

23 It should be noted that these radiation readings may indicate transient conditions
24 (e.g., presence of contaminated vegetation) and that routine stabilization of surface
25 contamination is carried out under the auspices of the Westinghouse RARA program.

26
27 The Westinghouse Environmental Protection group policies state that the
28 presence of any smearable alpha constitutes a potential threat to human health and
29 qualifies a waste management unit for a high remediation priority (Huckfeldt 1991a).
30 Measurements of smearable alpha were made at 10 of the 30 waste management units
31 surveyed, and smearable alpha was not detected at 8 of the 10 units. Waste management
32 units where smearable alpha was detected are:

- 33
- 34 ● 216-Z-1A Tile Field at 500 dis/min
- 35 ● 216-Z-2 Crib at 1,500 dis/min
- 36

37 Sampling data for contaminants in surface soils were not located for the Z Plant
38 Aggregate Area waste management units. Therefore, the potential for workers to be
39 exposed to nonradioactive chemicals via direct contact or inhalation or airborne
40 particulates cannot be evaluated with certainty at this time.

41

1 Units subject to collapse of containment structures pose a potential threat of
2 exposure by release of chemicals to surface soils. Units with high release potential based
3 on recent occurrence of cave-ins include:

- 4
- 5 ● 216-Z-5 Crib;
- 6 ● 216-Z-6 Crib; and
- 7 ● 216-Z-7.
- 8

9 However, all cribs that were constructed with wood are likely to suffer structural
10 failure, and should be considered to pose a risk of releases to surface soil.

11
12 Units subject to wind erosion because of insufficient soil cover or erodible cover
13 materials pose a potential threat of exposure via surface soil. Wind erosion has been
14 noted as a problem in the Solid Waste Burial Grounds, particularly at the 218-W-3 and
15 218-W-4A Burial Grounds. These units contain radionuclides that would pose a potential
16 health risk if released to the surface.

17
18 Animal burrows have been noted in a number of units, including the 216-Z-1,
19 216-Z-2, and 216-Z-3 Cribs. Burrows and rabbit and mouse feces were also noted
20 around the perimeter of the Solid Waste Burial Grounds, particularly at the 218-W-3A
21 Burial Ground. To date, no contamination associated with these burrows has been
22 detected; however, disturbance of cover materials by animals could be a source of
23 exposure in the future.

24 25 26 **5.2.3 Inhalation of Volatiles**

27
28 As summarized in Section 4.1, the distribution of volatile organics in soils is not
29 well-defined in the Z Plant Aggregate Area. Limited sampling of soils and soil gas was
30 performed at the periphery of the Solid Waste Burial Grounds (see Tables A-7 and A-8).
31 A number of volatile organics were detected in these samples, including carbon
32 tetrachloride and methylene chloride. These data do not indicate an overlying source of
33 these chemicals in the immediate vicinity of the soil borings. It appears from the
34 observed distribution of volatile organics, that the detections are due to the presence of a
35 plume of contaminated groundwater beneath the site. Lateral migration of chemical
36 vapors along the caliche layer may also have contributed to the detected concentrations.
37 Waste inventories of hazardous chemicals disposed of to the Solid Waste Burial Ground
38 indicate that numerous volatile organics were disposed of in these waste management
39 units, including Freons, trichloroethane, vinyl chloride, and xylenes (Last et al. 1989). If
40 these compounds are available for volatilization from shallow buried wastes, or are
41 contained in vapors emitted from vent pipes, they would pose a potential risk of
42 exposure to workers at the Hanford Site.

1 Based on available knowledge about the disposal of carbon tetrachloride in Z
2 Plant Aggregate Area waste management units, it is likely that airborne emissions of this
3 chemical have occurred in the past. Whether emissions continue to occur at levels of
4 concern is unknown.

5
6 The primary volatile radionuclide of concern disposed of in the Solid Waste Burial
7 Grounds was tritium. Approximately 280,000 curies of tritium (decayed through 1990)
8 were disposed of in these units, with the majority going to the 218-W-3 Burial Ground
9 (Anderson et al. 1991). The mode of disposal of this material could not be determined
10 from available information. Exposure to tritium (as tritiated water vapor) is of concern
11 as is the potential for tritium release via radiolytic production of hydrogen from aqueous
12 radioactive wastes.

13
14 Due to the uncertainty as to whether a driving force exists for release of volatiles
15 to the atmosphere, none of the Z Plant Aggregate Area waste management units will be
16 classified as high priority based on this exposure pathway.

17 18 19 **5.2.4 Migration to Groundwater**

20
21 Risks that could potentially occur due to migration of contaminants in
22 groundwater to existing or potential receptors will be addressed in the 200 West
23 Groundwater AAMS and thus, will not be discussed in the Z Plant AAMS. However,
24 the potential for individual waste management units to impact groundwater has been
25 discussed in Section 4.1.

26 27 28 **5.3 ADDITIONAL SCREENING CRITERIA**

29
30 In addition to determining human health concerns for a worker at each of the
31 waste management units, previously developed site ranking criteria were investigated for
32 the purpose of setting priorities for waste management units and unplanned releases.
33 These criteria are the CERCLA HRS scores assigned during preliminary assessment/site
34 inspection (PA/SI) activities performed for the Hanford Site (DOE 1988), and the
35 rankings assigned by the Westinghouse Hanford Environmental Protection Group to
36 prioritize sites needing remedial actions for radiological control (Huckfeldt 1991a).

37
38 Both of these ranking systems take into account some measure of hazard and
39 environmental mobility, and are thus appropriate to consider for waste unit prioritization.
40 The HRS ranking system evaluates sites based on their relative risk, taking into account
41 the population at risk, the hazard potential of the substances at the facility, the potential
42 for contamination of the environment, the potential risk of fire and explosion, and the

1 potential for injury associated with humans or animals that come into contact with the
2 waste management unit inventory. The HRS is thus appropriate to consider for
3 screening waste management units.

4
5 The PA/SI screening was performed using the EPA's HRS and mHRS. The HRS
6 (40 CFR 300) is a site ranking methodology which was designed to determine whether
7 sites should be placed on the CERCLA NPL based on chemical contamination history.
8 The EPA has established the criteria for placement on the NPL to be a score of 28.5 or
9 greater. The mHRS is a ranking system developed by the Pacific Northwest Laboratory
10 (PNL) for DOE that uses the basic methodology of the HRS; however, it more
11 accurately predicts the impacts from radionuclides. The mHRS takes into account
12 concentration, half-life, and other chemical-specific parameters that are not considered by
13 the HRS. The mHRS has not been accepted by EPA as a ranking system.

14
15 Many of the Z Plant Aggregate Area waste management units were ranked in the
16 PA/SI using the HRS and mHRS. For those waste management units which were not
17 ranked in the PA/SI, unit type and discharge history were evaluated in comparison with
18 ranked units for the purpose of this report. If a waste management unit which has been
19 ranked exhibits similar characteristics (e.g., construction, waste type, and volume), the
20 value for the ranked unit was applied to the unit without an HRS or mHRS score. If no
21 ranked waste management units exhibit similar characteristics, then the unit was not
22 ranked; however, a high or low score was determined qualitatively through evaluation of
23 unit configuration and contamination history.

24
25 Table 5-1 lists the HRS and mHRS scores, as well as scores that were assigned for
26 unranked waste management units, based on their similarity to ranked units in terms of
27 type, construction, and quantity of waste. If no similar waste management units were
28 available for comparison, the units were not ranked but were assigned a qualitative
29 indicator of migration potential.

30
31 For the HRS ranking, 30 of the 66 Z Plant Aggregate Area waste management
32 units were assigned rankings. Of the units scored, four were given a score of 28.5 or
33 greater. All other units were assigned rankings less than 2.0. The high-ranking units, and
34 their scores, are as follows:

35		
36	● 216-Z-1 & 216-Z-2 Cribs	52.85
37	● 216-Z-7 Crib	50.33
38	● 216-Z-10 Reverse Well	47.81
39	● 216-Z-17 Trench	45.30
40		

41 For the mHRS ranking, 21 waste management units were ranked and 3 were
42 given a score of 28.5 or greater. Scores from the mHRS were similar to the HRS scores

1 for all waste management units except the 216-Z-17 Trench, which received a mHRS
2 score of 1.18. The difference between the rankings assigned by the two systems is
3 probably due to the fact that HRS does not consider concentrations or radionuclide
4 decay.

5
6 Of the waste management units that were not assigned HRS or mHRS scores, five
7 (burial grounds) were assigned scores based on similarity to scored units. Twenty-three
8 units were assigned a qualitative "low" score. Eight units did not receive a ranking,
9 although investigated in the PA/SI, because of insufficient data. These are denoted as
10 "INS" according to the terminology used in the PA/SI.

11 12 13 **5.4 SUMMARY OF HIGH-PRIORITY WASTE MANAGEMENT UNITS BASED ON** 14 **HUMAN HEALTH CONCERNS**

15
16 The screening process was used to sort sites as either high priority or low priority.
17 Table 5-1 lists the Z Plant Aggregate Area waste management units that exceeded one or
18 more of the screening criteria identified in the preceding sections. In total, 10 waste
19 management units were identified as high priority.

20
21 Recent radiation survey results (dose rate and/or contamination) were available
22 for 30 of the 66 waste management units and unplanned releases. Nineteen were
23 reported as having no detectable results. Of the remaining 11 units, 8 had survey results
24 that exceeded one or more of the criteria (2 mrem/hr, 100 dis/min beta/gamma, or 20
25 ct/min alpha).

26
27 For the HRS scores, 4 waste management units were given scores of 28.5 or
28 greater. For the mHRS, 3 units received a score of 28.5 or greater. Some of the sites
29 were designated as high priority for more than one of the criteria, hence only a total of
30 ten waste management sites are designated high priority.

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9 3 1 2 8 6 5 0 9 6 6

Table 5-1. Hazard Ranking Scores for the Z Plant Aggregate Area Waste Management Units. (Sheet 1 of 5)

Waste Management Unit	HRS Migration Score	mHRS Migration Score	Assigned Score ^a	Remarks
Plants, Buildings, and Storage Area				
232-Z Incinerator			Low	
234-5Z HWSA			Low	
WRAP			0	Proposed facility
RMW Storage Facility			Low	
Tanks and Vaults				
216-Z-8 Settling Tank			Low	
241-Z-361 Settling Tank				Integrity of tank unknown
241-Z Treatment Tank			Low	
Cribs and Drains				
216-Z-1 & 216-Z-2 Cribs	52.85	57.73		
216-Z-3 Crib	1.31	1.31		
216-Z-5 Crib	2.00	1.91		
216-Z-6 Crib	1.03	0.71		
216-Z-7 Crib	50.33	43.70		
216-Z-12 Crib	1.36	1.36		
216-Z-16 Crib	0.98	0.16		
216-Z-18 Crib	1.36	1.36		

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Table 5-1. Hazard Ranking Scores for the Z Plant Aggregate Area Waste Management Units. (Sheet 2 of 5)

Waste Management Unit	HRS Migration Score	mHRS Migration Score	Assigned Score ^a	Remarks
216-Z-8 French Drain	1.03	0.71		
216-Z-13 French Drain			~1	Assumed similar to 216-Z-8
216-Z-14 French Drain			~1	Assumed similar to 216-Z-8
216-Z-15 French Drain			~1	Assumed similar to 216-Z-8
216-Z-1A Tile Field	1.09	1.09		
Reverse Well				
216-Z-10 Reverse Well	47.81	32.72		
Ponds, Ditches, and Trenches				
216-Z-4 Trench	1.03	0.82		
216-Z-9 Trench	2.27	2.27		
216-Z-17 Trench	45.30	1.18		
Septic Tanks				
2607-Z Septic Tank & Field			Low	Sanitary waste only
2607-Z-1 Septic Tank & Field			Low	Sanitary waste only
2607-WA Septic Tank & Field			Low	Sanitary waste only
2607-WB Septic Tank & Field			Low	Sanitary waste only
2607-W-8 Septic Tank & Field			Low	Sanitary waste only

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Table 5-1. Hazard Ranking Scores for the Z Plant Aggregate Area Waste Management Units. (Sheet 3 of 5)

Waste Management Unit	HRS Migration Score	mHRS Migration Score	Assigned Score*	Remarks
Transfer Facilities, Diversion Boxes, and Pipelines				
241-Z Diversion Box No. 1			Low	
241-Z Diversion Box No. 2			Low	
231-Z-151 Sump			Low	
Basins				
241-Z Retention Basin	1.03			
216-Z-21 Seepage Basin				
Burial Sites				
218-W-1 Burial Ground	0.70	0.50		
218-W-1A Burial Ground	0.70	0.90		
218-W-2 Burial Ground	0.70	0.80		
218-W-2A Burial Ground			0.90	Assumed similar to other burial grounds.
218-W-3 Burial Ground	0.70	0.50		
218-W-3A Burial Ground			0.90	Assumed similar to other burial grounds.
218-W-3AE Burial Ground			0.90	Assumed similar to other burial grounds.
218-W-4A Burial Ground	0.70	0.90		
218-W-4B Burial Ground			0.90	Assumed similar to other burial grounds.
218-W-4C Burial Ground			0.90	Assumed similar to other burial grounds.

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Table 5-1. Hazard Ranking Scores for the Z Plant Aggregate Area Waste Management Units. (Sheet 4 of 5)

Waste Management Unit	HRS Migration Score	mHRS Migration Score	Assigned Score ^a	Remarks
218-W-5 Burial Ground			0.90	Assumed similar to other burial grounds.
218-W-6 Burial Ground			0	Proposed - not used.
218-W-11 Burial Ground	0	0		No information available to set priority
Z Plant Burn Pit	0.00	0.00		
Unplanned Releases				
UN-200-W-11				Potentially low-scoring , insufficient info. to score.
UPR-200-W-16				Release disposed of to engineered facility - not scored.
UN-200-W-23	0.90			
UPR-200-W-26			Low	
UN-200-W-44	0.90			
UPR-200-W-45				Not scored because of radionuclide decay
UPR-200-W-53				Not scored because of radionuclide decay
UPR-200-W-72				Release disposed of to engineered facility - not scored
UN-200-W-74	1.00			
UN-200-W-75	0.80			
UN-200-W-79	1.20			

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Table 5-1. Hazard Ranking Scores for the Z Plant Aggregate Area Waste Management Units. (Sheet 5 of 5)

Waste Management Unit	HRS Migration Score	mHRS Migration Score	Assigned Score ^a	Remarks
UPR-200-W-84				Release disposed to engineered facility - not scored
UN-200-W-89			Low	
UN-200-W-90			Low	Remediated to background
UN-200-W-91				Insufficient info to score
UN-200-W-103	1.04			
UN-200-W-130				Potentially low-scoring; insufficient info to score.
UN-200-W-132	1.04			
UPR-200-W-134				Release disposed to engineered facility - not scored.
UPR-200-W-158	0.82			
UN-200-W-159			Low	

Source: Stenner et al. 1988.

Notes:

- ^a If no mHRS or HRS score was available, a ranking or qualitative ranking was developed for this report. An assigned score of "high" is equivalent to ≥ 28.5 , "low" is < 28.5 .

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**Table 5-2. Candidate High Priority Waste Management Units
for the Z Plant Aggregate Area**

Waste Management Unit	Unit Type	Basis for Selection
216-Z-1 and 216-Z-2	Crib	HRS, Surface Radiation
216-Z-1A	Tile Field	Surface Radiation
216-Z-7	Crib	HRS
216-Z-17	Trench	HRS
216-Z-10	Reverse Well	HRS
218-W-2	Burial Ground	Surface Radiation
218-W-2A	Burial Ground	Surface Radiation
218-W-3A	Burial Ground	Surface Radiation
218-W-4A	Burial Ground	Surface Radiation

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6.0 IDENTIFICATION OF POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR THE Z PLANT AGGREGATE AREA

6.1 INTRODUCTION

The Superfund Amendments and Reauthorization Act (SARA) of 1986 amended CERCLA to require that all ARARs be employed during implementation of a hazardous waste site cleanup. "Applicable" requirements are defined by the EPA in "CERCLA Compliance with Other Laws Manual" (OSWER Directive 9234.1-01, August 8, 1988) as:

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.

A separate set of "relevant and appropriate" requirements that must be evaluated include:

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.

"To-be-Considered Materials" (TBCs) are nonpromulgated advisories or guidance issued by federal or state governments that are not legally binding and do not have the status of potential ARARs. However, in many circumstances, TBCs will be considered along with ARARs and may be used in determining the necessary level of cleanup for protection of health or the environment.

The following sections identify ARARs to be used in developing and assessing various remedial action alternatives at the Z Plant Aggregate Area. Specific requirements pertaining to hazardous and radiological waste management, remediation of contaminated soils, surface water protection, and air quality will be discussed.

1 The ARARs focus on federal or state statutes, regulations, criteria, and guidelines.
2 ARARs also include DOE Orders that carry out authority granted to the EPA by the
3 Atomic Energy Act. All DOE Orders are potentially applicable to operations at the Z
4 Plant Aggregate Area and are legally enforceable against contractors and subcontractors.
5 The DOE Orders specifically related to remedial actions are discussed in the following
6 sections. A complete list of all DOE Orders is included as Appendix A.

7
8 The specific types of ARARs evaluated include:

- 9
- 10 • Contaminant-specific;
 - 11 • Location-specific; and
 - 12 • Action-specific.
- 13
14
15

16 Contaminant-specific ARARs are usually health or risk-based numerical values or
17 methodologies that, when applied to site-specific conditions, result in the establishment of
18 numerical contaminant values that are generally recognized by the regulatory agencies as
19 allowable to protect human health and the environment. In the case of the Z Plant
20 Aggregate Area, contaminant-specific ARARs address chemical constituents and/or
21 radionuclides. The potential contaminant-specific ARARs that were evaluated for the Z
22 Plant Aggregate Area are discussed in Section 6.2.

23
24 Location-specific ARARs are restrictions placed on the concentration of
25 hazardous substances, or the conduct of activities, solely because they occur in specific
26 locations. The location-specific ARARs that were evaluated for the Z Plant Aggregate
27 Area are discussed in Section 6.3.

28
29 Action-specific ARARs apply to particular remediation methods and technologies,
30 and are evaluated during the detailed screening and evaluation of remediation
31 alternatives. The potential action-specific ARARs that were evaluated for the Z Plant
32 Aggregate Area are discussed in Section 6.4.

33
34 The TBC requirements are other criteria, advisories, and regulatory guidance that
35 are not legally enforceable, but are to be considered in evaluating alternatives. Specific
36 TBC requirements are discussed in Section 6.5.

37
38 Potential contaminant- and location-specific ARARs will be refined during the
39 AAMS process. Potential action-specific ARARs are briefly discussed in this section, and
40 will be further evaluated upon final selection of remedial alternatives. The points at
41 which these ARARs must be achieved and the timing of the ARARs evaluations are
42 discussed in Sections 6.6 and 6.7, respectively.

1
2 **6.2 CONTAMINANT-SPECIFIC REQUIREMENTS**
3

4 A contaminant-specific requirement sets concentration limits in various
5 environmental media for specific hazardous substances, pollutants, or contaminants.
6 Based on available information, some of the currently known or suspected contaminants
7 that may be present in the Z Plant Aggregate Area are outlined in Table 4-15. The
8 currently identified potential federal and state contaminant-specific ARARs are
9 summarized below.
10

11
12 **6.2.1 Federal Requirements**
13

14 Federal contaminant-specific requirements are specified in several statutes,
15 codified in the U.S. Code (USC), and promulgated in the Code of Federal Regulations
16 (CFR), as follows:
17

18 **6.2.1.1 Clean Water Act.** Federal Water Quality Criteria (FWQC) are developed under
19 the authority of the Clean Water Act to serve as guidelines to the states for determining
20 receiving water quality standards. Different FWQC are derived for protection of human
21 health and protection of aquatic life. The human health FWQC are further subdivided
22 according to how people are expected to use the water (e.g., drinking the water versus
23 consuming fish caught from the water). SARA 121(d)(2) states that remedial actions
24 shall attain FWQC where they are relevant and appropriate, taking into account the
25 designated or potential use of the water, the media affected, the purpose of the criteria,
26 and current information. Many more substances have FWQC than maximum
27 contaminant levels (MCLs) issued under the Safe Drinking Water Act (see discussion
28 below); consequently, EPA and other state agencies rely on these criteria more than
29 MCLs, even though these criteria can only be considered relevant and appropriate and
30 not applicable.
31

32 FWQC would not be considered at Z Plant Aggregate Area, as no natural surface
33 water bodies exist in the Z Plant Aggregate Area. The only existing man-made surface
34 water bodies at Z Plant Aggregate Area are waste management units.
35

36 **6.2.1.2 Safe Drinking Water Act.** Under the authority of the Safe Drinking Water Act,
37 MCLs apply when the water may be used for drinking. At present, EPA and the State of
38 Washington apply MCLs as the standards for groundwater contaminants at CERCLA
39 sites that could be used as drinking water sources. Groundwater contamination and
40 application of MCLs as ARARs are addressed under a separate AAMS specific to
41 groundwater.
42

1 **6.2.1.3 Resource Conservation and Recovery Act.** RCRA addresses the generation and
2 transportation of hazardous waste, and waste management activities at facilities that
3 treat, store, or dispose of hazardous wastes. Subtitle C (Hazardous Waste Management)
4 mandates the creation of a cradle-to-grave management and permitting system for
5 hazardous wastes. RCRA defines hazardous wastes as "solid wastes" (even though the
6 waste is often liquid in physical form) that may cause or significantly contribute to an
7 increase in mortality or serious illness, or that poses a substantial hazard to human health
8 or the environment when improperly managed. In Washington State, RCRA is
9 implemented by EPA and the authorized state agency, the Washington State Department
10 of Ecology (Ecology).

11
12 RCRA is potentially applicable or relevant and appropriate to the Z Plant
13 Aggregate Area. The extensive permitting requirements under RCRA would only apply
14 to a waste management unit that is an identified hazardous waste TSD facility, and to
15 hazardous waste management activities that occurred outside an area of contamination.
16 If a waste management unit is not a RCRA TSD facility and if remediation occurs on
17 site, then the RCRA permitting requirements would not have to be satisfied. However,
18 other substantive requirements necessary to protect human health and the environment
19 would constitute potential ARARs.

20
21 Two key contaminant-specific ARARs have been adopted under the federal
22 hazardous waste regulations: the Toxicity Characteristic Leaching Procedure (TCLP)
23 designation limits promulgated under 40 CFR Part 261; and the hazardous waste land
24 disposal restrictions for constituent concentrations promulgated under 40 CFR Part 268.

25
26 The TCLP designation limits define when a waste is hazardous, and are used to
27 determine when more stringent management standards apply than would be applied to
28 typical solid wastes. Thus, the TCLP contaminant-specific ARARs can be used to
29 determine when RCRA waste management standards may be required. The TCLP limits
30 are presented in Table 6-1.

31
32 The land disposal restrictions are numerical limits derived by EPA by reviewing
33 available technologies for treating hazardous wastes. Until a prohibited waste can meet
34 the numerical limits, it can be prohibited from land disposal. Two sets of limits have
35 been promulgated: limits for constituent concentrations in waste extract, which uses the
36 TCLP test to obtain a leached sample of the waste; and limits for constituent
37 concentrations in waste, which addresses the total contaminant concentration in the
38 waste. The land disposal restrictions can be used to determine if cleanup wastes can be
39 left in place (i.e., land disposed), redispersed of on site without further treatment, or must
40 be subject to certain treatment practices. The land disposal restrictions limits are
41 presented in Table 6-1 (see Section 6.4.1.2 for a further discussion on applying the land
42 disposal restriction limits).

1 **6.2.1.4 Clean Air Act.** The Clean Air Act establishes National Primary and Secondary
2 Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), National Emission
3 Standards for Hazardous Air Pollutants (NESHAP)(40 CFR Part 61), and New Source
4 Performance Standards (NSPS)(40 CFR Part 60).
5

6 In general, new and modified stationary sources of air emissions must undergo a
7 pre-construction review to determine whether the construction or modification of any
8 source, such as a CERCLA remedial program, will interfere with attainment or
9 maintenance of NAAQS or fail to meet other new source review requirements including
10 NESHAP and NSPS. However, the process applies only to "major" sources of air
11 emissions (defined as emissions of 250 tons per year). The Z Plant Aggregate Area
12 would not constitute a major source.
13

14 Section 112 of the Clean Air Act directs EPA to establish standards at the level
15 that provides an ample margin of safety to protect the public health from hazardous air
16 pollutants. The NESHAP standards for radionuclides are directly applicable to DOE
17 facilities under Subpart H of Section 112 that establishes a 10 mrem/year facility-wide
18 standard during cleanup of the site. Further, if the maximum individual dose added by a
19 new construction or modification during remediation exceeds 1 percent of the NESHAP
20 standard (0.1 mrem/yr), a report meeting the substantive requirements of an application
21 for approval of construction must be prepared.
22

23 **6.2.1.5 DOE Order 5400.5.** The DOE Standards for Radiation Protection of the Public
24 and Environment (DOE Order 5400.5) establishes the requirements for DOE facilities to
25 protect the environment and human health from radiation including soil and air
26 contamination. The purpose of the Order is to establish standards and requirements for
27 operations of the DOE and DOE contractors with respect to protection of members of
28 the public and the environment against undue risk from radiation.
29

30 The Order mandates that the exposure to members of the public from a radiation
31 source as a consequence of routine activities shall not exceed 100 mrem from all
32 exposure sources due to routine DOE activities. In accordance with the Clean Air Act,
33 exposures resulting from airborne emissions shall not exceed 10 mrem to the maximally
34 exposed individual at the facility boundary. DOE Order 5400.5 provides Derived
35 Concentration Guide values for releases of radionuclides into the air or water. Derived
36 Concentration Guide values are calculated so that, under conditions of continuous
37 exposure, an individual would receive an effective dose equivalent of 100 mrem/year.
38 Because dispersion in air or water is not accounted for in the Derived Concentration
39 Guide, actual exposures of maximally exposed individuals in unrestricted areas are
40 considerably below the 100 mrem/year level.
41

1 DOE Order 5400.5 also provides for establishment of soil cleanup levels through a
2 site-specific pathway analysis such as the allowable residual contamination level method.
3 The calculation of allowable residual contamination level values for radionuclides is
4 dependent on the physical characteristics of the site, the radiation dose limit determined
5 to be acceptable, and the scenarios of human exposure judged to be possible and to
6 result in the upper-bound exposure. These values will be developed upon collection of
7 additional information concerning site contamination and exposure parameters.
8
9

10 **6.2.2 State of Washington Requirements**

11
12 State contaminant-specific requirements are specified in several statutes, codified
13 in the Revised Code of Washington (RCW) and promulgated in the Washington
14 Administrative Code (WAC).
15

16 **6.2.2.1 Model Toxics Control Act.** The Model Toxics Control Act (Ecology, 1991)
17 authorized Ecology to adopt cleanup standards for remedial actions at hazardous waste
18 sites. These regulations are considered ARARs for soil, groundwater, and surface water
19 cleanup actions. The processes for identifying, investigating, and cleaning up hazardous
20 waste sites are defined and cleanup standards are set for groundwater, soil, surface water,
21 and air in Chapter 173-340 WAC.
22

23 Under the Model Toxics Control Act regulations, cleanup standards may be
24 established by one of three methods.
25

- 26 ● Method A may be used if a routine cleanup action, as defined in WAC
27 173-340-200, is being conducted at the site or relatively few hazardous
28 substances are involved for which cleanup standards have been specified by
29 Tables 1, 2, or 3 of WAC 173-340-720 through -745.
30
- 31 ● Under Method B, a risk level of 10^{-6} is established and a risk calculation
32 based on contaminants present is determined.
33
- 34 ● Method C cleanup standards represent concentrations that are protective
35 of human health and the environment for specified site uses. Method C
36 cleanup standards may be established where it can be demonstrated that
37 such standards comply with applicable state and federal laws, that all
38 practical methods of treatment are used, that institutional controls are
39 implemented, and that one of the following conditions exist: (1) Method A
40 or B standards are below background concentrations; (2) Method A or
41 Method B results in a significantly greater threat to human health or the
42 environment; (3) Method A or Method B standards are below technically

1 possible concentrations, or (4) the site is defined as an industrial site for
2 purposes of soil remediation.
3

4 Table 1 of Method A addresses groundwater, so it is not considered to be an
5 ARAR for Z Plant Aggregate Area (groundwater will be addressed in the 200 West
6 Groundwater AAMS report). Table 2 of Method A is intended for non-industrial site
7 soil cleanups, and Table 3 of Method A is intended for industrial site cleanups.
8 Method A industrial soil cleanup standards for preliminary contaminants of concern are
9 provided as ARARs in Table 6-1.
10

11 In addition to Method A, Method B and Method C cleanup standards may also be
12 considered ARARs for the Z Plant Aggregate Area. Method B and Method C cleanup
13 standards can be calculated on a case-by-case basis in concert with Ecology. Method B
14 and Method C should be used where Method A standards do not exist or cannot be met,
15 or where routine cleanup actions cannot be implemented at a specific waste management
16 unit.
17

18 **6.2.2.2 State Hazardous Waste Management Act and Dangerous Waste Regulations.**

19 The State of Washington is a RCRA-authorized state for hazardous waste management,
20 and has developed state-specific hazardous waste regulations under the authority of the
21 State Hazardous Waste Management Act. Generally, state hazardous waste regulations
22 parallel the federal regulations. The state definition of a hazardous waste incorporates
23 the EPA designation of hazardous waste that is based on the compound being specifically
24 listed as hazardous, or on the waste exhibiting the properties of reactivity, ignitability,
25 corrosivity, or the TCLP.
26

27 In addition, Washington State identifies other waste as hazardous. Three unique
28 criteria are established: toxic dangerous waste; persistent dangerous waste; and
29 carcinogenic dangerous waste. These additional designation criteria may be imposed by
30 Ecology as ARARs, for purposes of determining acceptable cleanup standards and
31 appropriate waste management standards.
32

33 **6.2.2.3 Ambient Air Quality Standards and Emission Limits for Radionuclides (Chapter**
34 **173-480 WAC).** These Ecology ambient air quality standards specify maximum
35 accumulated dose limits to members of the public.
36

37 **6.2.2.4 Monitoring and Enforcement of Air Quality and Emission Standards for**
38 **Radionuclides (WAC 246-247).** These permitting requirements by the Washington State
39 Department of Health adopt the Ecology standards for maximum accumulated dose
40 limits to members of the public.
41

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1 **6.2.2.5 Controls for New Sources of Toxic Air Pollutants (Chapter 173-460 WAC).** In
2 accordance with regulations recently promulgated by Ecology in Chapter 173-460 WAC,
3 any new emission source will be subject to Toxic Air Pollutant emission standards. The
4 regulations establish allowable ambient source impact levels (ASILs) for hundreds of
5 organic and inorganic compounds. Ecology's ASILs may constitute ARARs for cleanup
6 activities that have a potential to affect air. ASILs for preliminary contaminants of
7 concern are provided in Table 6-1.
8

9 **6.2.2.6 Water Quality Standards.** Washington State has promulgated various numerical
10 standards related to surface water and groundwater contaminants. These are included
11 principally in the following regulations:
12

- 13 ● **Public Water Supplies (Chapter 248-54 WAC).** This regulation establishes
14 drinking water standards for public water supplies. The standards
15 essentially parallel the federal drinking water standards (40 CFR Parts 141
16 and 143).
17
- 18 ● **Water Quality Standards for Ground Waters of the State of Washington**
19 **(Chapter 173-200 WAC).** This regulation establishes contaminant standards
20 for protecting existing and future beneficial uses of groundwater through
21 the reduction or elimination of the discharge of contaminants to the state's
22 groundwater.
23
- 24 ● **Water Quality Standards for Surface Waters of the State of Washington**
25 **(Chapter 173-201 WAC and Proposed Chapter 173-203 WAC).** Ecology has
26 adopted numerical ambient water quality criteria for six conventional
27 pollutant parameters (defined at WAC 173-201-025): (1) fecal coliform
28 bacteria; (2) dissolved oxygen; (3) total dissolved gas; (4) temperature; (5)
29 pH; and (6) turbidity. In addition, toxic, radioactive, or deleterious
30 material concentrations shall be below those of public health significance or
31 which may cause acute or chronic toxic conditions to the aquatic
32 environment or which may adversely affect any water use. Ecology has
33 initiated rulemaking to incorporate numerical criteria for toxic chemicals
34 (i.e., EPA Water Quality Criteria), and reclassify certain waters of the state
35 to Class A or better.
36

37 Under the state Water Quality Standards, the criteria and classifications do
38 not apply inside an authorized dilution zone surrounding a wastewater
39 discharge. In defining dilution zones, Ecology generally follows guidelines
40 contained in "Criteria for Sewage Works Design." Although water quality
41 standards can be exceeded inside the dilution zone, state regulations will

1 not permit discharges that cause mortalities of fish or shellfish within the
2 zone or that diminish aesthetic values.

3
4 These water quality standards do not constitute ARARs for purposes of
5 establishing cleanup standards for the Z Plant Aggregate Area. Groundwater is being
6 addressed under a separate study in which pertinent groundwater-related ARARs will be
7 covered. No surface water bodies exist within the Z Plant Aggregate Area, so there will
8 be no need to achieve ambient water quality standards during remediation activities.
9

10 The numerical water quality standards cited above may become potential ARARs
11 if selected remedial actions could result in discharges to groundwater or surface water
12 (e.g., if treated wastewaters are discharged to the soil column or the Columbia River).
13 Determining appropriate standards for such discharges will depend on the type of
14 remediation performed and will have to be established on a case-by-case basis as
15 remedial actions are defined.
16

17 18 **6.2.3 National Pollutant Discharge Elimination System (WAC 173-220 and 40 CFR 122)** 19 **and Water Quality Standards.**

20
21 National Pollutant Discharge Elimination System (NPDES) regulations govern
22 point source discharges into navigable waters. Limits on the concentrations of
23 contaminants and volumetric flowrates that may be discharged are determined on a case-
24 by-case basis and permitted under this program. No point source discharges have been
25 identified. The EPA implements this program in Washington State for federal facilities;
26 however, assumption of the NPDES program by the state is likely within five years.
27

28 29 **6.3 LOCATION-SPECIFIC REQUIREMENTS**

30
31 Location-specific ARARs are restrictions placed on the concentration of
32 hazardous substances or the conduct of activities solely because they are in specific
33 locations. Some examples of special locations include floodplains, wetlands, historic
34 places, and sensitive ecosystems or habitats.
35

36 Table 6-2 lists various location-specific standards and indicates which of these may
37 be potential ARARs. Potential ARARs have been identified as follows:
38

- 39 ● **Floodplains.** Requirements for protecting floodplains are not ARARs for
40 activities conducted within the Z Plant Aggregate Area. However, remedial
41 actions selected for cleanup may require projects in or near floodplains
42 (e.g., construction of a treatment facility outfall at the Columbia River). In

1 such cases, location-specific floodplain requirements may be potential
2 ARARs.

- 3
- 4 ● **Wetlands, Shorelines, and Rivers and Streams.** Requirements related to
5 wetlands, shorelines, and rivers and streams are not ARARs for activities
6 conducted within the Z Plant Aggregate Area. However, remedial actions
7 selected for cleanup may require projects on a shoreline or wetland, or
8 discharges to wetlands (e.g., construction of a treatment facility outfall at
9 the Columbia River). In such cases, location-specific shoreline and
10 wetlands requirements may be potential ARARs.
 - 11
 - 12 ● **Threatened and Endangered Species Habitats.** As discussed in Section 3.6,
13 various threatened and endangered species inhabit portions of the Hanford
14 Site and may occur in the Z Plant Aggregate Area (American peregrine
15 falcon, bald eagle, white pelican, and sandhill crane). Therefore, critical
16 habitat protection for these species would constitute a potential ARAR.
 - 17
 - 18 ● **Wild and Scenic Rivers.** The Columbia River Hanford Reach is currently
19 undergoing study pursuant to the federal Wild and Scenic Rivers Act.
20 Pending results of this study, actions that may impact the Hanford Reach
21 may be restricted. This requirement would not be an ARAR for remedial
22 activities within the Z Plant Aggregate Area. However, Wild and Scenic
23 Rivers Act requirements may be ARARs for actions taken as a result of Z
24 Plant cleanup efforts that could affect the Hanford Reach.
 - 25

26

27 6.4 ACTION-SPECIFIC REQUIREMENTS

28

29 Action-specific ARARs are requirements that are triggered by specific remedial
30 actions at the site. These remedial actions will not be fully defined until a remedial
31 approach has been selected. However, the universe of action-specific ARARs defined by
32 a preliminary screening of potential remedial action alternatives will help focus the
33 selection process. Potential action-specific ARARs are outlined below. (Note that
34 contaminant- and location-specific ARARs discussed above will also include provisions
35 for action-specific ARARs to be applied once the remedial action is selected.)
36

37

38 6.4.1 Federal Requirements

39

40 6.4.1.1 Comprehensive Environmental Response, Compensation, and Liability Act.

41 CERCLA, and regulations adopted pursuant to CERCLA contained in the National
42 Contingency Plan (40 CFR Part 300), include selection criteria for remedial actions.

1 Under the criteria, excavation and off-site land disposal options are least favored when
2 on-site treatment options are available. Emphasis is placed on alternatives that
3 permanently treat or immobilize contamination. Selected alternatives must be protective
4 of human health and the environment, which implies that federal and state ARARs be
5 met. However, a remedy may be selected that does not meet all ARARs if the
6 requirement is technically impractical, if its implementation would produce a greater risk
7 to human health or the environment, if an equivalent level of protection can otherwise be
8 provided, if state standards are inconsistently applied, or if the remedy is only part of a
9 complete remedial action which attains ARARs.

10
11 CERCLA gives state cleanup standards essentially equal importance as federal
12 standards in guiding cleanup measures in cases where state standards are more stringent.
13 State standards pertain only if they are generally applicable, were passed through formal
14 means, were adopted on the basis of hydrologic, geologic, or other pertinent
15 considerations, and do not preclude the option of land disposal by a state-wide ban.
16 Most importantly, CERCLA provides that cleanup of a site must ensure that public
17 health and the environment are protected. Selected remedies should meet all ARARs,
18 but issues such as cost-effectiveness must be weighed in the selection process.

19
20 **6.4.1.2 Resource Conservation and Recovery Act.** RCRA, and regulations adopted
21 pursuant to RCRA, describe numerous action-specific requirements that may be ARARs
22 for cleanup activities. The primary regulations are promulgated under 40 CFR Parts 262,
23 264, and 265, and include such action-specific requirements as:

- 24
25 ● Packaging, labeling, placarding, and manifesting of off-site waste shipments;
26
27 ● Inspecting waste management areas to ensure proper performance and safe
28 conditions;
29
30 ● Preparation of plans and procedures to train personnel and respond to
31 emergencies;
32
33 ● Management standards for containers, tanks, incinerators, and treatment
34 units;
35
36 ● Design and performance standards for land disposal facilities; and
37
38 ● Groundwater monitoring system design and performance.

39
40 Many of these requirements will depend on the particular remediation activity
41 undertaken, and will have to be identified as remediation proceeds.
42

1 One key potential area of action-specific RCRA ARARs are the 40 CFR Part 268
2 land disposal restrictions. In addition to the contaminant-specific constituent
3 concentration limits established in the land disposal restrictions (as previously discussed
4 in Section 6.2.1.3), EPA has identified best demonstrated available treatment
5 technologies (BDATs) for various waste streams. EPA could require the use of BDATs
6 prior to allowing land disposal of wastes generated during remediation of Z Plant. EPA's
7 imposition of the land disposal restrictions and BDAT requirements will depend on
8 various factors.

9
10 Applicability to CERCLA actions is based on determinations of waste
11 "placement/disposal" during a remediation action. According to OSWER Directive
12 9347.3-05FS, EPA concludes that Congress did not intend in situ consolidation,
13 remediations, or improvement of structural stability to constitute placement or disposal.
14 Placement or disposal would be considered to occur if:

- 15
16 ● Wastes from different units are consolidated into one unit (other than a
17 land disposal unit within an area of contamination);
18
19 ● Waste is removed and treated outside a unit and redeposited into the same
20 or another unit (other than a land disposal unit within an area of
21 contamination); or
22
23 ● Waste is picked up from a unit and treated within the area of
24 contamination in an incinerator, surface impoundment, or tank and then
25 redeposited into the unit (except for in situ treatment).
26

27 Consequently, the requirement to use BDAT would not apply under the land
28 disposal restrictions standards unless placement or disposal had occurred. However,
29 remediation actions involving excavation and treatment could trigger the requirements to
30 use BDAT for wastes subject to the land disposal restrictions standards. In addition, the
31 agencies could consider BDAT technologies to be relevant and appropriate when
32 developing and evaluating potential remediation technologies.
33

34 Two additional components of the land disposal restrictions program should be
35 considered with regard to an excavate and treat remedial action. First, a national
36 capacity variance was issued by EPA for contaminated soil and debris for a two-year
37 period ending May 8, 1992 (54 FR 26640). Second, a series of variances and exemptions
38 may be applied under an excavate and treat scenario. These include:

- 39
40 ● A no-migration petition;
41
42 ● A case-by-case extension to an effective date;

- 1 • A treatability variance; and
- 2
- 3 • Mixed waste provisions of a federal Facilities Compliance Act (when
- 4 enacted).
- 5

6 The applicability and relevance of each of these options will vary based on the
7 specific details of a Z Plant Aggregate Area excavate and treat option. An analysis of
8 these variances can be developed once engineering data on the option becomes available.
9

10 The effect of the land disposal restrictions program on mixed waste management
11 is significant. Currently, limited technologies are available for effective treatment of
12 these waste streams and no commercially available treatment facilities exist except for
13 liquid scintillation counting fluids used for laboratory analysis and testing. The EPA
14 recognized that inadequate capacity exists and issued a national capacity variance until
15 May 8, 1992, to allow for the development of such treatment capacity.
16

17 Lack of treatment and disposal capacity also presents implications for storage of
18 these materials. Under 40 CFR 268.50, mixed wastes subject to land disposal restrictions
19 may be stored for up to one year. Beyond one year, the owner/operator has the burden
20 of proving such storage is for accumulating sufficient quantities for treatment. On
21 August 29, 1991, EPA issued a mixed waste storage enforcement policy providing some
22 relief from this provision for generators of small volumes of mixed wastes. However, the
23 policy was limited to facilities generating less than 28 m³ (1,000 ft³) of land disposal-
24 prohibited waste per year. Congress is considering amendments to RCRA postponing
25 the storage prohibition for another five years; however, final action on these amendments
26 has not occurred.
27

28 **6.4.1.3 Clean Water Act.** Regulations adopted pursuant to the Clean Water Act under
29 the NPDES mandate use of best available treatment technologies prior to discharging
30 contaminants to surface waters. NPDES requirements would not be ARARs for actions
31 conducted only within the Z Plant Aggregate Area. However, NPDES requirements
32 could constitute ARARs for cleanup actions which would result in discharge of treated
33 wastewaters to the Columbia River, and associated treatment systems could be required
34 to utilize best available treatment technologies.
35

36 **6.4.1.4 DOE Order 5480.1b - Standards for Environmental Protection, Safety, and**
37 **Health Program for DOE Operations.** The purpose and scope of this order is to
38 establish the Environment, Safety, and Health (ES&H) Program for DOE operations.
39 This order outlines guides that apply to all departmental elements and contractors
40 performing work for DOE. This work may be required by law and/or contract and be
41 implemented by the appropriate contracting officer.
42

1 The ES&H Program includes all DOE requirements, activities, and functions that
2 are concerned with controlling air, water, and soil pollution. It limits the risk to both
3 operating personnel and the general public to acceptably low levels. Radioactive and
4 hazardous waste management functions are included in this program. This order applies
5 to the ES&H programs at all Government-owned contractor-operated facilities.
6

7 This order establishes the responsibilities and authorities necessary for effective
8 performance of the program. Overall responsibility and authority for DOE programs is
9 given to the Under Secretary.
10

11 **6.4.1.5 DOE Order 5480.3 - Safety Requirements for the Packaging and Transportation**
12 **of Hazardous Materials, Hazardous Substances, and Hazardous Wastes.** The purpose of
13 this order is to establish requirements for the packaging and transportation of hazardous
14 materials, hazardous substances, and hazardous wastes. This order outlines guides that
15 apply to all Departmental Elements and contractors performing work for the DOE. This
16 work may be required by law and/or contract and be implemented by the appropriate
17 contracting officer who is involved with the packaging and/or transportation of hazardous
18 materials, hazardous substances, or hazardous wastes. This order is applicable to the
19 extent that wastes would need to be packaged or transported.
20

21 DOE 5480.3 states: "when offered to the carrier, each shipment of hazardous
22 materials, hazardous substances, or hazardous wastes shall be in compliance with this
23 order, and the applicable safety regulations of the Department of Transportation." The
24 package standards outlined in 5480.3 include the standards for radioactive materials in
25 amounts greater than Type A quantities, structural standards for Type B packaging, and
26 criticality standards for fissile material packages. Standards for normal conditions of
27 transport and standards for hypothetical accident conditions for a single package have
28 been outlined depending on the quantity and type of material contained. All off-site
29 shipping containers must meet quality assurance procedures for fabrication, assembly,
30 and testing.
31

32 **6.4.1.6 DOE Order 5480.4 - Environmental Protection, Safety, and Health Protection**
33 **Standards.** The purpose of this order is to specify and provide requirements for the
34 application of the mandatory ES&H standards applicable to all DOE and DOE
35 contractor operations; to provide a listing of reference ES&H standards; and to identify
36 the sources of the mandatory and reference ES&H standards.
37

38 Facility design, construction, operation, modification, and decommissioning will be
39 covered by this order. The facilities of concern are those of permanent or temporary
40 nature that are owned, leased, or otherwise controlled by the DOE or leased by DOE
41 contractors for use in work for the DOE. If DOE has the authority to establish and

1 enforce ES&H Program requirements under the contractual arrangements for the work
2 to be performed, this order is applicable.

3
4 The Occupational Safety and Health Administration (OSHA) standards are also
5 applied through this order. OSHA requirements provide detailed guidance on the
6 procedures and equipment personnel are to have and wear when conducting an on-site
7 remedial action at a hazardous waste site. The standards also require the development
8 of Health and Safety Plans by each employer involved with the remediation.

9
10 **6.4.1.7 DOE 5400.4 Comprehensive Environmental Response, Compensation, and**
11 **Liability Act Requirements.** On October 6, 1989, DOE rescinded its existing
12 administrative order (DOE 5480.14) guiding CERCLA response actions at DOE
13 facilities. It was replaced with DOE Administrative Order 5400.4. This order
14 incorporates two provisions important to remedial actions at the Z Plant Aggregate Area
15 as follows:

- 16
17 • DOE facilities are authorized to enter into Interagency Agreements and/or
18 Federal Facility Agreements at both NPL and non-NPL sites, with federal,
19 state, and local entities for the execution of remedial actions under the
20 requirements prescribed in DOE 5400.2A [Environmental Compliance
21 Issue Coordination] and under Section 120(e) of CERCLA.
22
23 • Where the remedial action is being conducted in parallel with the
24 development of an Environmental Impact Statement (EIS) under the
25 National Environmental Policy Act (NEPA), coordination of data collection
26 and analysis is encouraged. The primary instrument for the integration of
27 these two programs is the RI/FS process. Public review of the two
28 compliance programs are also to be integrated.
29

30 This order is a key document that will be guiding compliance actions at the Z
31 Plant Aggregate Area.
32

33 **6.4.1.8 DOE Order 5820.2A - Radioactive Waste Management.** DOE Order 5820.2A
34 applies to all DOE contractors and subcontractors performing work that involves
35 management of waste containing radioactivity. This order requires that wastes be
36 managed in a manner that assures protection of the health and safety of the public,
37 operating personnel, and the environment. DOE Order 5820.2A establishes
38 requirements for management of high-level, transuranic, and low-level wastes as well as
39 wastes containing naturally occurring or accelerator produced radioactive material,
40 decommissioning of facilities and the format for a waste management plan. The
41 requirements applicable to the Z Plant Aggregate Area remediation activities include

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1 those related to transuranic waste, low-level radioactive waste and the waste management
2 plan. These are summarized below.

3
4 **6.4.1.8.1 Management of Transuranic Waste.** Transuranic waste resulting from
5 the Z Plant Aggregate Area remedial action must be managed to protect the public and
6 worker health and safety, and the environment, and performed in compliance with
7 applicable radiation protection standards and environmental regulations. Practical and
8 cost-effective methods must be used to reduce the volume and toxicity of transuranic
9 waste.

10
11 Transuranic waste must be certified in compliance with the Waste Isolation Pilot
12 Plant (WIPP) Acceptance Criteria, placed in interim storage, if required, and sent to the
13 WIPP. Any transuranic waste that the DOE has determined, with the concurrence of the
14 EPA Administrator, does not need the degree of isolation provided by a geologic
15 repository or transuranic waste that cannot be certified or otherwise approved for
16 acceptance at the WIPP must be disposed of by alternative methods. Alternative
17 disposal methods must be approved by DOE Headquarters and comply with NEPA
18 requirements and EPA/state regulations.

19
20 **6.4.1.8.2 Management of Low-Level Radioactive Waste.** The requirements for
21 management of low-level radioactive waste presented in DOE Order 5820.2A are
22 relevant to the remedial alternative of removal and disposal of the Z Plant Aggregate
23 Area wastes. Performance objectives for this option shall ensure that external exposure
24 to the radioactive material released into surface water, groundwater, soil, plants, and
25 animals does not result in an effective dose greater than 25 mrem/yr to the public.
26 Releases to the environment shall be at levels as low as reasonably achievable. An
27 inadvertent intruder after the institutional control period of 100 years is not to exceed
28 100 mrem/yr for continuous exposure or 500 mrem for a single acute exposure. A
29 performance assessment is to be prepared to demonstrate compliance with the above
30 performance objectives.

31
32 Other requirements under DOE Order 5820.2A which may affect remediation of
33 the Z Plant Aggregate Area include waste volume minimization, waste characterization,
34 waste acceptance criteria, waste treatment, and shipment. The low-level radioactive
35 waste may be stored by appropriate methods prior to disposal to achieve the
36 performance objectives discussed above. Disposal site selection, closure/post-closure,
37 monitoring, and records requirements are also discussed in this order.

38
39 **6.4.1.8.3 Waste Management Plan.** Each site that treats, stores, or disposes of
40 DOE radioactive waste is responsible for complying with the standards of DOE Order
41 5820.2A and to document this compliance in a Waste Management Plan. The Waste
42 Management Plan shall include an executive summary; general site information; a

1 description of radioactive, mixed, and hazardous waste management operations; a
2 schedule and cost summary; and a description of environmental monitoring programs.

3
4 **6.4.1.9 DOE Order 5480.11 - Radiation Protection for Occupational Workers.** DOE
5 Order 5480.11 establishes radiation protection standards and program requirements for
6 the protection of workers from ionizing radiation. These radiation standards are
7 consistent with EPA guidance based on recommendations by the National Council on
8 Radiation Protection and Measurements and the International Commission on
9 Radiological Protection.

10
11 DOE policy published in DOE 5480.11 requires that occupational exposure to
12 radiation be maintained as low as reasonably achievable. The exposure of an
13 occupational worker shall not exceed the following limiting values.

- 14
15 ● Stochastic Effects. The annual effective dose from internal and external
16 sources is 5 rem.
- 17
18 ● Nonstochastic Effects. The annual dose equivalent for individual organs is:
19
20 lens of eye = 15 rem
21 skin of the whole body = 50 rem
22 extremity = 50 rem
23 organ or tissue = 50 rem
- 24
25 ● Unborn Child. The annual dose equivalent to the unborn child during the
26 gestation period is 0.5 rem.

27
28 Non-emergency planned special exposures may, under unusual circumstances,
29 exceed the annual effective dose equivalent limits established above.

30
31 **6.4.1.10 DOE Order 6430.1A - General Design Criteria.** The criteria provide mandatory,
32 minimally acceptable requirements for facility design. Criteria apply to any building
33 acquisition, new facility addition and alteration including on-site constructed buildings,
34 pre-engineered buildings, plant-fabricated modular buildings, and temporary facilities.
35 Criteria will apply in planning, design, and development.

36 37 38 **6.4.2 State of Washington Requirements**

39
40 **6.4.2.1 Hazardous Waste Management.** As discussed in Section 6.4.1.2, there are various
41 requirements addressing the management of hazardous wastes that may be potential
42 action-specific ARARs. Pertinent Washington regulations appear in Chapter 173-303

1 WAC and generally parallel federal management standards. Determination of ARARs
2 will be on a case-by-case basis as cleanup actions proceed.
3

4 **6.4.2.2 Solid Waste Management.** Washington State regulations describe management
5 standards for solid waste in Chapter 173-304 WAC. Some of these management
6 standards may be potential ARARs for disposal of cleanup wastes within the Z Plant
7 Aggregate Area. Solid waste standards include such requirements as:

- 8
- 9 ● Inspecting waste management areas to ensure proper performance and safe
10 conditions;
- 11
- 12 ● Management standards for incinerators and treatment units;
- 13
- 14 ● Design and performance standards for landfills; and
- 15
- 16 ● Groundwater monitoring system design and performance.
17

18 Many of these requirements will depend on the particular remediation activity
19 undertaken, and will have to be identified as remediation proceeds.
20

21 **6.4.2.3 Water Quality Management.** Chapter 90.48 RCW, the Washington State Water
22 Pollution Control Act, requires use of all known, available, and reasonable treatment
23 technologies for treating contaminants prior to discharge to waters of the state.
24 Implementing regulations appear principally at Chapters 173-216, 173-220, and 173-240
25 WAC.
26

27 The Water Pollution Control Act requirements for groundwater could be potential
28 ARARs for actions conducted within the Z Plant Aggregate Area if such actions would
29 result in discharge of liquid contaminants to the soil column. In this event, Ecology may
30 require use of all known, available, and reasonable treatment technologies to treat the
31 liquid discharges prior to soil disposal.
32

33 The Water Pollution Control Act requirements for surface water would not be
34 ARARs for actions conducted only within the Z Plant Aggregate Area. However, these
35 requirements could constitute ARARs for cleanup actions which would result in
36 discharge of treated wastewaters to the Columbia River and associated treatment systems
37 could be required to demonstrate they meet all known, available, and reasonable
38 treatment technologies.
39

40 **6.4.2.4 Air Quality Management.** The Toxic Air Pollutant regulations for new air
41 emission sources, promulgated in Chapter 173-460 WAC, require use of best available
42 control technology for air toxics. The Toxic Air Pollutant regulations may be potential

1 ARARs for cleanup actions at the Z Plant Aggregate Area that could result in emissions
2 of toxic contaminants to the air. Ecology may require the use of best available control
3 technology for air toxics, to treat such air emissions.
4
5

6 **6.5 OTHER CRITERIA AND GUIDANCE TO BE CONSIDERED**

7

8 In addition to the potential ARARs presented, other federal and state criteria,
9 advisories, and guidance are "to be considered" (TBC) in determining the appropriate
10 degree of remediation for the Z Plant Aggregate Area. A myriad of resources may be
11 potentially evaluated. The following represents an initial assessment of pertinent TBC
12 provisions.
13
14

15 **6.5.1 Health Advisories**

16
17 The EPA Office of Drinking Water publishes advisories identifying contaminants
18 for which health advisories have been issued.
19
20

21 **6.5.2 International Commission of Radiation Protection/National Council on Radiation 22 Protection**

23
24 The International Commission of Radiation Protection and the National Council
25 on Radiation Protection have a guidance standard of 100 mrem/yr whole body dose of
26 gamma radiation. These organizations also issue recommendations on other areas of
27 interest regarding radiation protection.
28
29

30 **6.5.3 EPA Proposed Corrective Actions for Solid Waste Management Units**

31
32 In the July 27, 1990, federal register (55 FR 30798), EPA published proposed
33 regulations for performing corrective actions (cleanup activities) at solid waste
34 management units associated with RCRA facilities. The proposed 40 CFR Part 264
35 Subpart S include requirements that would be TBCs for determining an appropriate level
36 of cleanup at the Z Plant Aggregate Area. In particular, EPA included an appendix,
37 "Appendix A - Examples of Concentrations Meeting Criteria for Action Levels", which
38 presented recommended contaminant concentrations warranting corrective action. These
39 contaminant-specific TBCs are included in Table 6-1 for the preliminary contaminants of
40 concern.
41
42

6.6 POINT OF APPLICABILITY

A significant factor in the evaluation of remedial alternatives for the Z Plant Aggregate Area will be the determination of the point at which compliance with identified ARARs must be achieved (i.e., the point of a specific ARAR's applicability). These points of applicability are the boundaries at which the effectiveness of a particular remedial alternative will be assessed.

For most individual radioactive species transported by either water or air, Ecology and Health standards generally require compliance at the boundaries of the Hanford Site. The assumed point of compliance for radioactive species is the point where a member of the public would have unrestricted access to live and conduct business, and, consequently, to be maximally exposed. Although Health is charged with the responsibility of monitoring and enforcing the air standards promulgated by Ecology, and generally recognizes the site boundary as the point of applicability, Ecology has recently indicated that compliance may be required at the point of emission.

The point at which compliance with identified ARARs must be achieved will be a significant factor in evaluating appropriate remedial alternatives in the Z Plant Aggregate Area. Applicability of ARARs at the point of discharge, at the boundary of the disposal unit, at the boundary of the AAMS, at the boundary of the Hanford Site, and/or at the point of maximum exposure will need to be determined.

6.7 ARARs EVALUATION

Evaluation of ARARs is an iterative process that will be conducted at multiple points throughout the remedial process.

- When the public health evaluation is conducted to assess risks at the Z Plant Aggregate Area, the contaminant-specific ARARs and advisories and location-specific ARARs will be identified more comprehensively and used to help determine the cleanup goals; and
- During detailed analysis of alternatives, all the ARARs and advisories for each alternative will be examined to determine what is needed to comply with other laws and to be protective of public health and the environment.

Following completion of the investigation, the remedial alternative selected must be able to attain all ARARs unless one of the six statutory waivers provided in Section 121 (d)(4)(A) through (f) of CERCLA is invoked. Finally, during remedial design, the

1 technical specifications of construction must ensure attainment of ARARs. The six
2 reasons ARARs can be waived are as follows:

- 3
- 4 ● The remedial action is an interim measure, where the final remedy will
5 attain ARARs upon completion.
- 6
- 7 ● Compliance will result in greater risk to human health and the environment
8 than will other options.
- 9
- 10 ● Compliance is technically impracticable.
- 11
- 12 ● An alternative remedial action will attain the equivalent performance of the
13 ARAR.
- 14
- 15 ● For state ARARs, the state has not consistently applied (or demonstrated
16 the intention to consistently apply) the requirements in similar
17 circumstances.
- 18
- 19 ● For CERCLA-financed actions under Section 104, compliance with the
20 ARAR will not provide a balance between the need for protecting public
21 health, welfare, and the environment at the facility, and the need for fund
22 money to respond to other sites (this waiver is not applicable at the
23 Hanford Site).

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Table 6-1. Potential Contaminant-Specific ARARs and TBCs for Preliminary Inorganic and Organic Contaminants of Concern. (Sheet 1 of 2)

	RCRA TCLP Designation Limits in mg/L	RCRA Land Ban Limits Non-wastewater		MTCA Method A Cleanup Levels Industrial Soil mg/kg	WCAA Toxic Air Pollutants ASIL in ug/m ³	RCRA Corrective Action Levels (1) --(Proposed)--	
		CCWE in mg/L	CCW in mg/kg			Air in ug/m ³	Soil in mg/kg
INORGANICS							
Asbestos	----	----	----	----	4.2 (2)	----	----
Barium	100.0	100.0	----	----	1.7	0.4	4000.0
Beryllium	----	----	----	----	0.00042	0.0004	0.2
Boron	----	----	----	----	----	----	----
Cadmium	1.0	1.0	----	10.0	0.00056	0.0006	40.0
Chromium (VI)	5.0	5.0	----	500.0	0.000083	0.00009	40.0
Chromium (III)	5.0	----	----	500.0	1.7	----	----
Copper	----	----	----	----	3.3	----	----
Lead	5.0	5.0	----	1000.0	----	----	----
Mercury	0.2	0.2	----	1.0	----	----	20.0
Nickel	----	----	----	----	----	----	2000.0
Silver	5.0	5.0	----	----	0.3	----	----
Zinc	----	----	----	----	----	----	----
Cyanide	----	----	590 (3)	----	16.7	----	2000.0
Fluoride	----	----	----	----	8.3	----	----
Nitrate (as Nitrogen)	----	----	----	----	----	----	----
Nitrite (as Nitrogen)	----	----	----	----	----	----	----

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Table 6-1. Potential Contaminant-Specific ARARs and TBCs for Preliminary Inorganic and Organic Contaminants of Concern. (Sheet 2 of 2)

	RCRA	RCRA		MTCA	WCAA	RCRA	
	TCLP	Land Ban Limits		Method A	Toxic Air Pollutants	Corrective Action Levels (1)	
	Designation	Non-wastewater		Cleanup Levels	ASIL	--(Proposed)--	
	Limits in	CCWE	CCW	Industrial Soil	in ug/m ³	Air	Soil
	mg/L	in mg/L	in mg/kg	mg/kg		in ug/m ³	in mg/kg
ORGANICS							
Acetone	----	0.59	160.0	----	5927.4	----	8000.0
Acetonitrile	----	----	----	----	233.1	----	500.0
Benzene	0.5	----	3.7	0.5	0.12	----	----
Carbon tetrachloride	0.5	0.96	5.6	----	0.067	0.03	5.0
Chlorobenzene	100	0.05	5.7	----	1165.5	20.0	2000.0
Chloroform	6.0	----	5.6	----	0.043	0.04	100.0
Creosote	----	----	----	----	----	----	----
Cyclohexanone	----	0.75	----	----	333.0	----	----
Dibutyl phosphate	----	----	----	----	16.7	----	----
1,2-Dichloroethane	0.5	----	7.2	----	0.04	0.04	8.0
cis-1,2-Dichloroethylene	----	----	----	----	2630.7	----	----
trans-1,2-Dichloroethylene	----	----	33.0	----	2630.7	----	----
Ethylbenzene	----	0.053	6.0	20.0	1448.6	----	8000.0
Methylene chloride	----	0.96	33.0	0.5	2.0	0.3	90.0
Methyl isobutyl ketone	----	0.33	33.0	----	682.7	70.0	4000.0
Polychlorinated biphenyls	----	----	----	10.0	----	----	0.09
Tetrachloroethylene	0.7	0.05	5.6	0.5	1.1	1.0	10.0
Toluene	----	0.33	28.0	40.0	1248.8	7000.0	20,000.0
Tributyl phosphate	----	----	----	----	8.3	----	----
1,1,1-Trichloroethane	----	0.41	5.6	20.0	6327.0	1000.0	7000.0
Trichloroethylene	0.5	0.091	5.6	0.5	0.8	----	60.0
Vinyl chloride	0.2	----	33.0	----	0.023	----	----
Xylenes (Total)	----	0.15	28.0	20.0	1448.6	1000.0	200,000.0

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FOOTNOTES

ASIL = Acceptable Source Impact Level
 CCWE = Constituent Concentration in Waste Extract
 CCW = Constituent Concentration in Waste
 MTCA = Washington State Model Toxics Control Act

RCRA = Federal Resource Conservation and Recovery Act
 TCLP = Toxicity Characteristic Leaching Procedure
 WCAA = Washington State Clean Air Act
 mg/L = milligrams per liter
 mg/kg = milligrams per kilogram
 ug/m³ = micrograms per cubic meter

- (1) RCRA Corrective Action Levels are only proposed at this time (40 CFR Part 264 Subpart S), so are not ARARs yet; they are "To Be Considered."
- (2) Measured as fibers per cubic meter.
- (3) Total cyanide. 30 mg/kg for amenable cyanide.

Table 6-2. Potential Location-Specific ARARs. (Sheet 1 of 5)

Location	Requirement	Prerequisite	Citation	ARAR
<u>GEOLOGICAL</u>				
Within 200 feet of a fault displaced in Holocene time	New treatment, storage or disposal of hazardous waste prohibited	Hazardous waste management near Holocene fault	40 CFR 264.18; WAC 173-303-420	Not ARAR. No Holocene fault.
Holocene faults and subsidence areas	New solid waste disposal facilities prohibited over faults with displacement in Holocene time, and in subsidence areas	New solid waste management activities near Holocene fault	WAC 173-304-130	Not ARAR. No Holocene fault.
Unstable slopes	New solid waste disposal areas prohibited from hills with unstable slopes	New solid waste disposal on an unstable slope	WAC 173-304-130	Not ARAR. No unstable slope.
100-year floodplains	Solid and hazardous waste disposal facilities must be designed, built, operated, and maintained to prevent washout	Solid or hazardous waste disposal in a 100-year floodplain	40 CFR 264.18; WAC 173-303-420; WAC 173-304-460	Potential ARAR.
	Avoid adverse effects, minimize potential harm, restore/preserve natural and beneficial values in floodplains	Actions occurring in a floodplain	40 CFR Part 6 Subpart A; 16 USC 661 <u>et seq</u> ; 40 CFR 6.302	Potential ARAR.
Salt dome and salt bed formations, underground mines, and caves	Placement of non-containerized or bulk liquid hazardous wastes is prohibited	Hazardous waste placement in salt dome, salt bed, mine, or cave	40 CFR 264.18	Not ARAR. None of these units.

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Table 6-2. Potential Location-Specific ARARs. (Sheet 2 of 5)

Location	Requirement	Prerequisite	Citation	ARAR
<u>SURFACE WATER</u>				
Wetlands	New hazardous waste disposal facilities prohibited in wetlands (including within 200 feet of shoreline)	Hazardous waste disposal within 200 feet of surface water	WAC 173-303-420	Potential ARAR.
	New solid waste disposal facilities prohibited within 200 feet of surface water (stream, lake, pond, river, salt water body)	Solid waste disposal within 200 feet of surface water	WAC 173-304-130	Potential ARAR.
	New solid waste disposal facilities prohibited in wetlands (swamps, marshes, bogs, estuaries, and similar areas)	Solid waste disposal in a wetland (swamp, marsh, bog, estuary, etc.)	WAC 173-304-130	Not ARAR. No wetlands present.
	Discharge of dredged or fill materials into wetlands prohibited without a permit	Discharges to wetlands and navigable waters	40 CFR Part 230; 33 CFR Parts 303, and 320 to 330	Potential ARAR.
	Minimize potential harm, avoid adverse effects, preserve and enhance wetlands	Construction or management of property in wetlands	40 CFR Part 6 Appendix A	Not ARAR. No wetlands present.
Shorelines	Actions prohibited within 200 feet of shorelines of statewide significance unless permitted	Actions near shorelines	Chapter 90.58 RCW; Chapter 173-14 WAC	Potential ARAR.
Rivers and streams	Avoid diversion, channeling or other actions that modify streams or rivers, or adversely affect fish or wildlife habitats and water resources	Actions modifying a stream or river and affecting fish or wildlife	40 CFR 6.302	Potential ARAR.

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Table 6-2. Potential Location-Specific ARARs. (Sheet 3 of 5)

Location	Requirement	Prerequisite	Citation	ARAR
<u>GROUNDWATER</u>				
Sole source aquifer	New solid and hazardous waste land disposal facilities prohibited over a sole source aquifer	Disposal over a sole source aquifer	WAC 173-303-402; WAC 173-304-130	Not ARAR. No sole source aquifer.
Uppermost aquifer	Bottom of lowest liner of new solid waste disposal facility must be at least 10 feet above seasonal high water in uppermost aquifer (5 feet if hydraulic gradient controls installed)	New solid waste disposal	WAC 173-304-130	Not ARAR. Groundwater is deeper than 10 feet.
Aquifer Protection Areas	Activities restricted within designated Aquifer Protection Areas	Activities within an Aquifer Protection Area	Chapter 36.36 RCW	Not ARAR. Not an Aquifer Protection Area
Groundwater Management Areas	Activities restricted within Ground Water Management Areas	Activities within a Groundwater Management Area	Chapter 90.44 RCW; Chapter 173-100 WAC	Not ARAR. Not a Groundwater Management Area.
<u>DRINKING WATER SUPPLY</u>				
Drinking water supply well	New solid waste disposal areas prohibited within 1000 feet upgradient, or 90 days travel time, of drinking water supply well	New solid waste disposal within 1000 feet of drinking water supply well	WAC 173-304-130	Not ARAR. No drinking water supply wells.
Watershed	New solid waste disposal areas prohibited within a watershed used by a public water supply system for municipal drinking water	New solid waste disposal in a public watershed	WAC 173-304-130	Not ARAR. Not a public watershed.
<u>AIR</u>				
Non-attainment areas	Restrictions on air emissions in areas designated as non-attainment areas under state and federal air quality programs	Activities in a designated non-attainment area	Chapter 70.94 RCW; Chapters 173-400 and 173-403 WAC	Not ARAR. Not a non-attainment area.

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Table 6-2. Potential Location-Specific ARARs. (Sheet 4 of 5)

Location	Requirement	Prerequisite	Citation	ARAR
<u>SENSITIVE ENVIRONMENTS</u>				
Endangered/threatened species habitats	New solid waste disposal prohibited from areas designated by US Fish and Wildlife Service as critical habitats for endangered/threatened species	New solid waste disposal in critical habitats	WAC 173-304-130	Not ARAR. Not a critical habitat.
Parks	Actions within critical habitats must conserve endangered/threatened species	Activities where endangered or threatened species exist	50 CFR Parts 200 and 402	Potential ARAR.
	No new solid waste disposal areas within 1,000 feet of state or national park	New solid waste disposal near state/national park	WAC 173-304-130	Not ARAR. No state/national park.
Wilderness areas	Restrictions on activities in areas that are designated state parks, or recreation/conservation areas	Activities in state parks or recreation/conservation areas	Chapter 43.51 RCW; Chapter 352-32 WAC	Not ARAR. None of these state areas.
	Actions within designated wilderness areas must ensure area is preserved and not impaired	Activities within designated wilderness areas	16 USC 1131 <i>et seq</i> ; 50 CFR 35.1 <i>et seq</i>	Not ARAR. Not a wilderness area.
Wildlife refuge	Restrictions on actions in areas that are part of the National Wildlife Refuge System	Activities within designated wildlife refuges	16 USC 668dd <i>et seq</i> ; 50 CFR Part 27	Not ARAR. Not a wildlife refuge.
Natural areas preserves	Activities restricted in areas designated as having special habitat value (Natural Heritage Resources)	Activities within identified Natural Area Preserves	Chapter 79.70 RCW; Chapter 332-60 WAC	Not ARAR. Not a Natural Area Preserve
Wild, scenic, or recreational rivers	Avoid actions that would have adverse effects on designated wild, scenic, or recreational rivers	Activities near wild, scenic, and recreational rivers	16 USC 1271 <i>et seq</i> ; 40 CFR 6.302; Chapter 79.72 RCW	Potential ARAR.
Columbia River Gorge	Restrictions on activities that could affect resources in the Columbia River Gorge	Activities within the Columbia River Gorge	Chapter 43.97 RCW	Not ARAR. Not in Columbia River Gorge.

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Table 6-2. Potential Location-Specific ARARs. (Sheet 5 of 5)

Location	Requirement	Prerequisite	Citation	ARAR
UNIQUE LANDS AND PROPERTIES				
Natural resource conservation areas	Restrictions on activities within designated Conservation Areas	Activities within designated Conservation Areas	Chapter 79.71 RCW	Not ARAR. Not a Conservation Area.
Forest lands	Activities restricted within state forest lands to minimize fire hazards and other adverse impacts	Activities within state forest lands	Chapter 76.04 RCW; Chapter 332-24 WAC	Not ARAR. Not a forest land.
Public lands	Restrictions on activities in state and federal forest lands	Activities within state and federal forest lands	16 USC 1601; Chapter 76.09 RCW	Not ARAR. Not a forest land.
	Activities on public lands are restricted, regulated or proscribed	Activities on state-owned lands	Chapter 79.01 RCW	Not ARAR. Not a state land.
Scenic vistas	Restrictions on activities that can occur in designated scenic areas	Activities in designated scenic vista areas	Chapter 47.42 RCW	Not ARAR. Not a scenic area.
Historic areas	Actions must be taken to preserve and recover significant artifacts, preserve historic and archaeological properties and resources, and minimize harm to national landmarks	Activities that could affect historic or archaeological sites or artifacts	16 UST 469, 470 <i>et seq</i> ; 36 CFR Parts 65 and 800; Chapters 27.34, 27.53 and 27.58 RCW	Not ARAR. No historic or archaeological sites.
LAND USE				
Neighboring properties	No new solid waste disposal areas within 100 feet of the facility's property line	New solid waste disposal within 100 feet of facility property line	WAC 173-304-130	Not ARAR. Not near facility boundary.
	No new solid waste disposal areas within 250 feet of property line of residential zone properties	New solid waste disposal within 250 feet of property line of residential property	WAC 173-304-130	Not ARAR. No residential property near.
Proximity to airports	Disposal of garbage that could attract birds prohibited within 10,000 feet (turbojet aircraft)/ 5000 feet (piston-type aircraft) of airport runways	Garbage disposal near airport	WAC 173-304-130	Not ARAR. No airports near.

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7.0 PRELIMINARY REMEDIAL ACTION TECHNOLOGIES

Previous sections identified contaminants of concern at the Z Plant Aggregate Area, potential routes of exposure, and applicable or relevant and appropriate requirements (ARARs). Section 7.0 identifies preliminary remedial action objectives (RAOs) and develops preliminary remedial action alternatives consistent with reducing the potential hazards of this contamination and satisfying ARARs. The overall objective of this section is to identify viable and innovative remedial action alternatives for media of concern at the Z Plant Aggregate Area.

The process of identifying viable remedial action alternatives consists of several steps. In Section 7.1, RAOs are first identified. Next, in Section 7.2, general response actions are determined along with specific treatment, resource recovery, and containment technologies within the general response categories. Specific process options belonging to each technology type are identified, and these process options are subsequently screened based on their effectiveness, implementability, and cost (Section 7.3). The combining of process options into alternatives occurs in Section 7.4. Here the alternatives are described and diagrammed. Criteria are then identified in Section 7.5 for preliminary screening of alternatives that may be applicable to the waste management units and unplanned release sites identified in the Z Plant Aggregate Area. Figure 7-1 is a matrix summarizing the development of the remedial action alternatives starting with media-specific RAOs.

Because of uncertainty regarding the nature and extent of contamination at the Z Plant Aggregate Area waste sites, recommendations for remedial alternatives are general and cover a broad range of actions. Remedial action alternatives will be considered and more fully developed in future focused feasibility studies. The *Hanford Past-Practice Strategy* (Thompson 1991) is used to focus the range of remedial action alternatives that will be evaluated in focused studies. In general, the *Hanford Past-Practice Strategy* remedial investigation (RI)/feasibility study (FS) and the Resource Conservation Recovery Act (RCRA)/Corrective Measures Studies are defined as the combination of interim remedial measures (IRMs), limited field investigations (LFIs) for final remedy selection where interim actions are not clearly justified, and focused or aggregate area feasibility/treatability studies for further evaluation of treatment alternatives. After completion of an IRM, data will be evaluated including concurrent characterization and monitoring data to determine if a final remedy can be selected.

A secondary purpose of the evaluation of preliminary remedial action alternatives is the identification of additional information needed to complete the evaluation. This

1 information may include field data needs and treatability tests of selected technologies.
2 Additional data will be developed for most sites or waste groups during future data
3 gathering activities (e.g., LFIs, characterization supporting IRM, or treatability studies).
4 These data may be used to refine and supplement the RAOs and proposed alternatives
5 identified in this initial study. Data needs are defined in Section 8.0. Alternatives
6 involving technologies that are not well demonstrated under the conditions of interest are
7 identified in Sections 7.3 and 7.5. These technologies may require bench-scale and
8 pilot-scale treatability studies. The intent is to conduct treatability studies for promising
9 technologies early in the RI/FS process. Conclusions regarding the feasibility of some
10 individual technologies may change after new data become available.
11

12 The bias-for-action philosophy of addressing contamination at the Hanford Site
13 requires an expedited process for implementing remedial actions. Implementation of
14 general response actions may be accomplished using an observational or "learn-as-you-go"
15 approach. This observational approach is an iterative process of data acquisition and
16 refinement of the conceptual model. Data needs are determined by the model, and data
17 collected to fulfill these needs are used as additional input to the model. Use of the
18 observational approach while conducting response actions in the 200 Area will allow
19 integrating these actions with longer range objectives of final remediation of similar areas
20 and the entire 200 Area. Site characterization and remediation data will be collected
21 concurrently with the use of LFIs, IRMs, and treatability testing. The knowledge gained
22 through these different activities will be applied to similar areas. The overall goal of this
23 approach is convergence on an appropriate response action as early as possible while
24 continuing to obtain valuable characterization information during remediation phases.
25

26

27 7.1 PRELIMINARY REMEDIAL ACTION OBJECTIVES

28

29 The RAOs are remediation goals for protection of human health and the
30 environment that specify the contaminants and media of concern, exposure pathways, and
31 allowable contaminant levels. The RAOs discussed in this section are considered to be
32 preliminary and may change or be refined as new data are acquired and evaluated.
33

34 The fundamental objective of the corrective action process at the Z Plant
35 Aggregate Area is to protect environmental resources and/or human receptors from the
36 potential threats that may exist because of known or suspected contamination. Specific
37 interim and final RAOs will depend in part on current and reasonable potential future
38 land use in the Z Plant Aggregate Area and the 200 Area.
39

40 Potential future land use will affect the risk-based cleanup objectives, potential
41 ARARs, and point of compliance. The RAOs for protecting human health for
42 residential or agricultural land use would be based on risk assessment exposure scenarios

1 requiring cleanup to lower contaminant levels than for recreational or industrial land
2 uses. It is important that potential future land use and the RAOs be clearly defined and
3 agreed upon by DOE, EPA, and Ecology before further and more detailed evaluation of
4 remedial actions. The Hanford Site remedial Action Environmental Impact Statement is
5 intended to resolve the land use issues. A Record of Decision for this environmental
6 impact statement is expected in the spring of 1994.

7
8 To focus the corrective actions with a bias for action through implementing IRMs,
9 preliminary RAOs are identified for the 200 Areas and Z Plant Aggregate Area. The
10 overall objective for the 200 Areas is as follows:

11
12 Reduce the risk of harmful effects to the environment and
13 human users of the area by reducing the toxicity, mobility, or
14 volume of contaminants from the source areas to meet
15 ARARs or risk-based levels that will allow industrial use of
16 the area (this is a potential final RAO, and an interim action
17 objective based on current use of the 200 Areas).

18
19 The RAOs are further developed in Table 7-1 for media of concern and
20 applicable exposure pathways (see Sections 4.1 and 4.2) for the Z Plant Aggregate Area.
21 The media of concern for the Z Plant Aggregate Area include:

- 22
- 23 • Radiation contaminated soils that could result in direct exposure or
24 inhalation;
 - 25
 - 26 • Contaminated soils that are or could contribute to groundwater
27 contamination;
 - 28
 - 29 • Vadose zone vapors that could cause ambient air impacts or contribute to
30 the lateral and vertical migration of contaminants in the soil and to the
31 groundwater; and
 - 32
 - 33 • Biota that could mobilize radionuclides or chemical contaminants and could
34 thereby degrade the integrity of other controls, such as caps.
- 35

36 Preliminary contaminant concentration standards that were applied to media-
37 specific RAOs were developed from the preliminary identification of potential ARARs in
38 Section 6.0 or by numerical assessment of the expected exposures and associated risks for
39 each contaminant.

40
41 Waste materials currently stored in single-shell tanks that contribute or may
42 contribute contaminants to environmental media will not be addressed by this AAMS

1 program but rather by the Single-Shell Tank program. In addition, groundwater as an
2 exposure medium is not addressed in this source AAMSR but will be addressed in the
3 200 West Groundwater AAMSR.
4

5 6 **7.2 PRELIMINARY GENERAL RESPONSE ACTIONS** 7

8 General response actions represent broad classes of remedial measures that may
9 be appropriate to achieve both interim and final RAOs at the Z Plant Aggregate Area,
10 and are presented in Table 7-2. The following are the general response actions for the Z
11 Plant Aggregate Area followed by brief descriptions:
12

- 13 • No action (applicable to specific facilities;
- 14 • Institutional controls;
- 15 • Waste removal and treatment or disposal;
- 16 • Waste containment;
- 17 • In situ waste treatment; and
- 18 • Combinations of the above actions.

19
20
21
22
23
24
25 No action is included for evaluations as required by the National Environmental
26 Policy Act (NEPA) and National Contingency Plan (NCP) [40 CFR 300.68 (f)(1)(v)] to
27 provide a baseline for comparison with other response actions. The no action alternative
28 may be appropriate for some facilities and sources of contamination if risk assessments
29 determine acceptable natural resource or human health risks posed by those sources or
30 facilities and no exceedences of contaminant-specific ARARs occur.
31

32 Institutional controls involve the use of physical barriers or access restrictions to
33 reduce or eliminate public exposure to contamination. Considering the nature of the Z
34 Plant Aggregate Area and the 200 Areas as a whole, institutional controls will likely be
35 an integral component of all interim remedial alternatives. Many access and land use
36 restrictions are currently in place at the Hanford Site and will remain in place during
37 implementation of interim remedial measures. Institutional controls may also be
38 important for final remedial measure alternatives. The decisions regarding future
39 long-term land use at the 200 Areas will be important in determining whether
40 institutional controls will be a part of the remedial measure alternatives, and the type of
41 controls required.
42

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1 Waste removal and treatment or disposal involves excavation of contamination
2 sources for eventual treatment and/or disposal either on a small- or large-scale basis.
3 One approach being considered for large-scale waste removal is macro-engineering,
4 which is based on high volume excavation using conventional surface mining technologies.
5 Waste removal on a macro-engineering scale would be used over large areas such as
6 groups of waste management units, operable units, or operational areas as a final
7 remedial action. Waste removal on a small scale would be conducted for individual
8 waste management units on a selective basis. Small-scale waste removal could be
9 conducted as either an interim or final remedial action. One potential problem with off-
10 site disposal is the lack of an alternate disposal location that will decrease the potential
11 human exposure over the long time required for many of the contaminants. Waste
12 removal actions may not be needed, or only be required on a small scale, to protect
13 human health or the environment for industrial uses of the 200 Areas.

14
15 Waste treatment involves the use of biological, thermal, physical, or chemical
16 technologies. Typical treatment options includes biological land farming, thermal
17 processing, soil washing/dechlorination, and fixation/solidification/stabilization. Some
18 treatment technologies may be pilot tested at the highest priority facilities. Waste
19 treatment could be conducted either as an interim or final action and may be appropriate
20 in meeting RAOs for all potential future land uses.

21
22 Waste containment includes the use of capping technologies (i.e., capping and
23 grouting) to minimize the driving force for downward or lateral migration of
24 contaminants. Capping also provides a radiation exposure barrier and barrier to direct
25 exposure. In addition, these barriers provide long-term stability with relatively low
26 maintenance requirements. Containment actions may be appropriate for either interim
27 or final remedial actions.

28
29 In situ waste treatment includes thermal, chemical, physical, and biological
30 technology types, of which there are several specific process options including in situ
31 vitrification, in situ grouting or stabilization, soil flushing, and in situ biotreatment. The
32 distinguishing feature of in situ treatment technologies is the ability to attain RAOs
33 without removing the wastes. The final waste form generally remains in place. This
34 feature is advantageous when exposure during excavation would be significant or when
35 excavation is technically impractical. In situ treatment can be difficult because the
36 process conditions may not be easily controlled.

37
38 Combinations of the above actions may be used in several different alternatives.
39 For example, containment actions could be used in combination with removal actions for
40 highly contaminated areas, and institutional controls (i.e., fences and deed restrictions) to
41 prevent disruption of the containment system.

42

1 Implementation of the general response actions may be accomplished using an
2 observational approach. Such an approach is iterative, where each iteration results in a
3 more refined conceptual model. Data needs are determined by the model, and data
4 collected as a result of an action to fulfill these needs are used as additional input to the
5 model. Use of the observational approach while conducting response actions of the 200
6 Areas will result in the opportunity for integrating these actions with the longer range
7 objectives of final site remediation including other analogue areas. Site characterization
8 and remediation data will be collected concurrently with the use of LFIs, IRMs, and
9 treatability testing to apply knowledge gained to similar areas. The overall goal of this
10 approach is convergence on a response action as early as possible while continuing to
11 obtain valuable characterization information during remediation phases.
12

13 In the next section, specific process options within these technology groups are
14 evaluated.
15

16 17 **7.3 TECHNOLOGY SCREENING** 18

19 In this section, potentially applicable technology types and process options are
20 identified. These process options are then screened using effectiveness, implementability,
21 and relative cost as criteria to eliminate those process options that would not be feasible
22 at the site. The remaining applicable processes are then grouped into remedial
23 alternatives in Sections 7.4.
24

25 The effectiveness criteria focus on: (1) the potential effectiveness of process
26 options in handling the estimated areas or volumes of media and meeting the remedial
27 action objectives; (2) the potential impacts to human health and the environment during
28 the construction and implementation phase; and (3) how proven and reliable the process
29 is with respect to the contaminants and conditions at the site. These criteria also
30 concentrate on the ability of a process option to treat a contaminant type (organics,
31 inorganics, metals, radionuclides, etc.) rather than a specific contaminant (nitrate,
32 cyanide, chromium, plutonium, etc.).
33

34 The implementability criteria place greater emphasis on the institutional aspects of
35 implementability, such as the ability to obtain necessary permits for off-site actions; the
36 availability of treatment, storage, and disposal services; and the availability of necessary
37 equipment and skilled workers to implement the technology. They also focus on the
38 process option's developmental status, whether it is an experimental or established
39 technology.
40

41 The relative cost criteria are an estimate of the overall cost of a process, including
42 capital and operating costs. At this stage in the process, the cost analysis is made on the

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1 basis of engineering judgement, and each process is evaluated as to whether costs are
2 high, medium, or low relative to other process options.
3

4 A process option is rated effective if it can handle the amount of area or media
5 required, if it does not impact human health or the environment during the construction
6 and implementation phases, and if it is a proven or reliable process with respect to the
7 contaminants and conditions at the site. Also a process option is considered more
8 effective if it treats a wide range of contaminants rather than a specific contaminant. An
9 example of a very effective process option would be vitrification because it treats
10 inorganics, metals, and radionuclides. On the other hand, chemical reduction may only
11 treat chromium (VI), making it a less useful option.
12

13 An easily implemented process option is one that is an established technology;
14 uses readily available equipment and skilled workers; uses treatment, storage, and
15 disposal services that are readily available; and has few regulatory constraints.
16 Preference is given to technologies that are easily implemented.
17

18 Preference is given to lower cost options, but cost is not an exclusionary criterion.
19 A process option is not eliminated based on cost alone.
20

21 Results of the screening process are shown in Table 7-3. Brief descriptions are
22 given of the process options, followed by comments regarding the evaluation criteria.
23 The last column of the table indicates whether the process option is rejected or carried
24 forward for possible alternative formation. The table first lists technologies that address
25 soil RAOs. Next, technologies pertaining to biota RAOs are presented. All the
26 biota-specific technologies happen to be technologies that were listed for soil RAOs. Air
27 RAOs are dealt with as soil remediation issues because the air contamination is a result
28 of the contaminants in the soil; addressing and remediating the air pathways would be
29 unnecessary and ineffective as long as there is soil contamination. If the soil is
30 remediated, the source of the air contamination would be removed.
31

32 The conclusions column of Table 7-3 indicates that besides no action, monitoring,
33 3 institutional process options, and 16 other process options are retained for further
34 development of alternatives. These options are carried forward into the development of
35 preliminary alternatives.
36
37

38 **7.4 PRELIMINARY REMEDIAL ACTION ALTERNATIVES**

39

40 This section develops and describes several remedial alternatives applicable to
41 disposal sites that contain hazardous chemicals, radionuclides, and volatile organic
42 compounds. These alternatives are not intended as recommended actions for any

1 individual site, but are intended only to provide potential options applicable to most sites
2 where multiple contaminants are present. Selection of actual remedial alternatives that
3 should be applied to the individual sites would be partly based on future expedited or
4 interim actions and limited field investigations, as recommended in Section 9.0 of this
5 report. Selection of proper alternatives would be conducted within the framework of the
6 *Hanford Past-Practice Strategy* (Thompson 1991), and the strategy outlined in Section 9.4.
7

8 The remedial alternatives are developed in Section 7.4.1. Then, in Section 7.4.2
9 through Section 7.4.7, the remedial action alternatives are described. Detailed
10 evaluations and costs are not provided because site-specific conditions must be further
11 investigated before meaningful evaluations can be conducted.
12
13

14 **7.4.1 Development of Remedial Alternatives**

15

16 Potentially feasible remedial technologies were described and evaluated in Section
17 7.3. Some of those technologies have been proven to be effective and constructible at
18 industrial waste sites, while other technologies are in the developmental stages. EPA
19 guidance on feasibility studies for uncontrolled waste management units recommends that
20 a limited number of candidate technologies be grouped into "Remedial Alternatives."
21 For this study, technologies were combined to develop remedial alternatives and provide
22 at least one alternative for each of the following general strategies:
23

- 24 • No action;
- 25
- 26 • Institutional controls;
- 27
- 28 • Removal, above-ground treatment, and disposal;
- 29
- 30 • Containment; and
- 31
- 32 • In situ treatment.
33

34 The alternatives are intended to treat all or a major component of the Z Plant
35 Aggregate Area contaminated waste management units or unplanned releases.
36 Consistent with the development of RAOs and technologies, alternatives were developed
37 based on treating classes of compounds (radionuclides, heavy metals, inorganics, and
38 organics) rather than specific contaminants. At a minimum, the alternative must be a
39 complete package. For example, disposal of radionuclide-contaminated soil must be
40 combined with excavation and backfilling of the excavated site.
41

1 One important factor in the development of the preliminary remedial action
2 alternatives is the fact that radionuclides, heavy metals, and some inorganic compounds
3 cannot be destroyed. Rather, these compounds must be physically immobilized,
4 contained, isolated, or chemically converted to less mobile forms to satisfy RAOs.
5 Organic compounds can be destroyed, but may represent a small amount of the overall
6 contamination. Both no action and institutional controls are required as part of
7 CERCLA RI/FS guidance. The purpose of including both of these alternatives is to
8 provide decision makers with information on the entire range of available remedial
9 actions.

10
11 For the containment alternative, an engineered multimedia cover, with or without
12 vertical barriers (depending on the specifics of the remediation) was selected. Two
13 alternatives were selected to represent the excavation and treatment strategy. One of
14 these deals with disposal of transuranic-contaminated soils. Finally, three in situ
15 alternatives were identified. One deals with vapor extraction for volatile organic
16 compounds, one with stabilization of soils, and the other with vitrification of soils. It is
17 recognized that this does not represent an exhaustive list of all applicable alternatives.
18 However, these do provide a reasonable range of remedial actions that are likely to be
19 evaluated in future feasibility studies. The remedial action alternatives are summarized
20 as follows:

- 21 • No action;
- 22 • Institutional controls;
- 23 • Engineered multimedia cover with or without vertical barriers
24 (containment);
- 25 • In situ grouting or stabilization of soil (in situ treatment);
- 26 • Excavation, above-ground treatment, and disposal of soil (removal,
27 treatment and disposal);
- 28 • In situ vitrification of soil (in situ treatment);
- 29 • Excavation, treatment, and geologic disposal of soil containing transuranic
30 Radionuclides (removal, treatment and disposal);
- 31 • In situ soil vapor extraction of volatile organic compounds (in situ
32 treatment).

1 These alternatives, with the exception of no action and institutional controls, were
2 created because they satisfy a number of RAOs simultaneously and use technologies that
3 are appropriate for a wide range of contaminant types. For example, constructing an
4 engineered multi-media cover can effectively contain radionuclides, heavy metals,
5 inorganic compounds, and organic compounds simultaneously. It satisfies the RAOs of
6 protecting human health and the environment from exposures from contaminated soil,
7 bio-mobilization, and airborne contaminants. It is possible that some waste management
8 units may require a combination of the identified alternatives to completely address all
9 contaminants. In situ soil vapor extraction is more specific than the other alternatives,
10 but it addresses a contaminant class (volatile organic compounds) that is not easily
11 treated using the other options, such as in situ stabilization. It is possible that some
12 waste management units may require a combination of the identified alternatives to
13 completely address all contaminants.

14
15 The use of contaminant-specific remedial technologies was avoided because there
16 appear to be few, if any, waste management units where a single contaminant has been
17 identified. It is possible to construct alternatives that include several contaminant-specific
18 technologies, but the number of combinations of technologies would result in an
19 unmanageable number of alternatives. Moreover, the possible presence of unidentified
20 contaminants may render specific alternatives unusable. Alternatives may be refined as
21 more contamination data are acquired. For now, the alternatives will be directed at
22 remediating the major classes of compounds (radionuclides, heavy metals, inorganics, and
23 organics).

24
25 In all action alternatives except the no action alternative, it is assumed that
26 monitoring and institutional controls are required, although they may be temporary.
27 These features are not explicitly mentioned, and details are purposely omitted until a
28 more detailed evaluation may be performed in subsequent studies.

29
30 In the next sections, the preliminary remedial action alternatives are described in
31 more detail, with the exception of the no action and institutional control options.

32 33 34 **7.4.2 Alternative 1 - Engineered Multimedia Cover with or without Vertical Barriers**

35
36 Alternative 1 consists of an engineered multi-media cover. Vertical barriers such
37 as grout curtains or slurry walls may be used in conjunction with the cover. Figure 7-2
38 shows a schematic diagram of an engineered multi-media cover without the vertical
39 barriers. If the affected area includes either a naturally occurring or engineered
40 depression, then imported backfill would be placed to control runoff and run-on water.
41 The engineered cover itself may consist of clay, gravel, sand, asphalt, soil, and synthetic
42 liners. A liquid collection layer could also be included. The specific details of the cover

1 and vertical barriers would be the subject of a treatability study or a focused FS. The
2 barrier would be designed to minimize infiltration of surface water and to minimize
3 biological intrusion (e.g., deep-rooting plants and burrowing animals). The covered area
4 would be fenced, and warning signs posted.
5

6 Alternative 1 would provide a permanent cover over the affected area. The cover
7 would accomplish the following: reduce migration of surface runoff into the affected soil;
8 reduce the migration of windblown dust that originated from contaminated surface soils;
9 reduce the potential for direct exposure to contaminated soils; and reduce the
10 volatilization of volatile organic compounds and tritium to the atmosphere. If vertical
11 barriers are included, they would limit the amount of lateral migration of contaminants.
12
13

14 **7.4.3 Alternative 2 - In Situ Grouting or Stabilization of Soil**

15
16 Radioactive and hazardous soil would be grouted in this alternative using in situ
17 injection methods to significantly reduce the leachability of hazardous contaminants,
18 radionuclides and/or volatile organic compounds from the affected soil. Grouting may
19 also be used to fill voids, such as in cribs, thereby reducing subsidence. Another
20 variation of this alternative would be to stabilize the soil using in situ mixing of soil with
21 stabilizing compounds such as pozzolanics or fly ash.
22

23 Figure 7-3 shows a schematic diagram of the in situ grout injection process.
24 Grouting wells would be installed and screened throughout the affected vertical zones.
25 Specially formulated cement grout (determined by treatability studies) would be injected
26 and allowed to cure. In situ stabilization would be conducted in a similar manner, except
27 a cutting-head tool would be used to mix the contaminated soil with stabilizing
28 compounds fed into the soil.
29

30 Alternative 2 would provide a combination of immobilization and containment of
31 heavy metal, radionuclide, and inorganic contamination. Thus, this alternative would
32 reduce migration of surface runoff water into the affected soil; reduce the migration of
33 windblown dust that originated from contaminated surface soils; reduce the potential for
34 direct exposure to contaminated soils; and reduce the volatilization of volatile organic
35 compounds.
36
37

38 **7.4.4 Alternative 3 - Excavation, Soil Treatment, and Disposal**

39
40 Under Alternative 3, radioactive and hazardous soil would be excavated using
41 conventional techniques, with special precautions to minimize fugitive dust generation. It
42 was also assumed that sheet pile shoring would be installed to facilitate the excavation.

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1 The soil would be treated above ground. Several treatment options could be selected
2 from the physical, chemical, and thermal treatment process options screened in Section
3 7.3. For example, thermal desorption with off-gas treatment could be used if organic
4 compounds are present; soil washing could be used to remove contaminated silts and
5 sands or specific compounds; and stabilization could be used to immobilize radionuclides
6 and heavy metals. The specific treatment method would depend on site-specific
7 conditions (determined in part through bench-scale testing). The treated soil would be
8 backfilled into the original excavation or landfilled. Soil treatment by-products may
9 require additional processing or treatment. Figure 7-4 shows a schematic diagram of this
10 alternative.

11
12 Alternative 3 would be effective in treating a full range of contamination,
13 depending on the type of treatment processes selected. Attainment of soil RAOs would
14 depend on the depth to which the soil was excavated. If near surface soil was treated,
15 airborne contamination, direct exposure to contaminated soil, and bio-mobilization of
16 contamination would be minimized. Because of practical limits on deep excavation, deep
17 contamination may not be removed and would be subject to migration into groundwater.
18 Alternative 3 could be used in conjunction with Alternative 1 (multi-media cap) to reduce
19 this possibility.

20 21 22 **7.4.5 Alternative 4 - In Situ Vitrification of Soil**

23
24 In this alternative, the contaminated soil in a subject site would be immobilized by
25 in situ vitrification. Figure 7-5 shows a schematic diagram of the alternative. Import fill
26 would initially be placed over the affected area to reduce exposures to the remediation
27 workers from surface contamination. High power electrodes would be used to vitrify the
28 soil under the site, down to a depth below where contamination is present. A large fume
29 hood would be constructed over the site before the start of the vitrification process to
30 collect and treat emissions. After completion of the vitrification, the site would be built
31 back to original grade with imported backfill. Fences and warning signs may be placed
32 around the vitrified monolith to minimize disturbance and potential exposure.

33
34 In situ vitrification would be effective in treating radionuclide, heavy metal, and
35 inorganic contamination and may also destroy organic contaminants. This would reduce
36 the potential for exposures by leaching to groundwater, windblown dust and direct
37 dermal contact. However, this alternative would not reduce the mass or toxicity of the
38 radionuclides present onsite. Also, in situ vitrification may be limited to depths of less
39 than about 30.5 meters (100 feet), which may not be adequate to immobilize deep
40 contamination.

41

1 It should be noted that in situ vitrification is a relatively new technology which is
2 experiencing some "growing pains". Therefore, using this technology at the Hanford Site
3 will likely require extensive pilot testing.
4
5

6 **7.4.6 Alternative 5 - Excavation, Above-Ground Treatment, and Geologic Disposal of** 7 **Soil with Transuranic Radionuclides** 8

9 Figure 7-6 shows a schematic diagram of Alternative 5. It is assumed that sheet
10 pile shoring would be installed to facilitate the excavation. Special excavation procedures
11 would have to be used to minimize fugitive dust. Non-transuranic "overburden" may have
12 to be removed, temporarily stored, and returned to the excavation after the transuranic
13 soil was removed. Imported backfill would be used to restore the site to original grade.
14 The excavated transuranic soil would be vitrified or stabilized by an above-ground
15 treatment plant. The vitrified or stabilized soil would then be shipped to a transuranic
16 waste repository. Long-term storage may be required until a suitable facility could be
17 sited and constructed. An engineered multimedia cover (Alternative 1) could be installed
18 over the completed site to reduce exposure to any remaining contaminated,
19 non-transuranic soils.
20

21 For Alternative 5, soil containing transuranic radionuclides at concentrations
22 exceeding 100 nCi/g would be excavated, treated, and disposed. Thus, potential exposure
23 to and migration of transuranic-wastes would be minimized. Potential exposure to other
24 contaminants would be determined by other remedial alternatives implemented. At sites
25 containing transuranic and non-transuranic wastes, the use of Alternative 5 alone may not
26 satisfy all RAOs.
27
28

29 **7.4.7 Alternative 6 - In Situ Soil Vapor Extraction for Volatile Organic Compounds** 30

31 Figure 7-7 shows a schematic diagram of a representative soil vapor extraction
32 system. The soil vapor extraction system would consist of venting wells, manifold
33 piping, condensed water collectors, High Efficiency Particulate Air filters, and a catalytic
34 oxidizer. The condensed water might contain volatile organic compounds and
35 radionuclides, so it might have to be disposed of as radioactive mixed waste. The vented
36 air may contain radionuclide-containing dust particles, so High Efficiency Particulate Air
37 filters would be installed to remove the particulate radionuclides. The vented vapors
38 would be treated by the catalytic incinerator to provide at least 95% destruction.
39

40 In situ soil vapor extraction is a proven technology for removal of volatile organic
41 compound, from the vadose zone soils. Soil vapor extraction would reduce downward
42 migration of the volatile organic compound vapors through the vadose zone, and thereby

1 minimize potential cross-media migration into the groundwater. Soil vapor extraction
2 would reduce upward migration of volatile organic compound through the soil column
3 into the atmosphere, and thereby minimize inhalation exposures to the contaminants. In
4 some cases the radionuclides were discharged to the disposal sites as aqueous wastewater
5 that contained the radionuclides dissolved in carrier solutions consisting of surfactants
6 and volatile organic compound (e.g., carbon tetrachloride). Removal of the volatile
7 organic compound by implementing soil vapor extraction could reduce the mobility of the
8 radionuclides, and thereby reduce the potential for downward migration of the
9 radionuclides. Finally, soil vapor extraction would enhance partitioning of the volatile
10 organic compound off of the soil and into the vented air stream, resulting in the
11 permanent removal and destruction of the volatile organic compound. Alternative 6 may
12 be used in conjunction with other alternatives if contaminants other than volatile organic
13 compounds are present.

14
15
16 **7.5 PRELIMINARY REMEDIAL ACTION ALTERNATIVES APPLICABLE TO**
17 **WASTE MANAGEMENT UNITS AND UNPLANNED RELEASE SITES**

18
19 The purpose of this section is to discuss which preliminary remedial action
20 alternatives could be used to remediate each Z Plant Aggregate Area waste management
21 unit or unplanned release site. The criteria used for deciding this are as follows:

- 22
- 23 • Installing an engineered multimedia cover with or without vertical barriers
24 (Alternative 1) could be used on any site where contaminants may be
25 leached or mobilized by surface water infiltration or if surface/near-surface
26 contamination exists.
 - 27
 - 28 • In situ grouting or stabilization (Alternative 2) could be used on any waste
29 management unit or unplanned release site that contains heavy metals,
30 radionuclides, and/or other inorganic compounds. In situ grouting could
31 also be effective in filling voids for subsidence control.
 - 32
 - 33 • Excavation and soil treatment (Alternative 3) could be used at most waste
34 management units or unplanned release sites that contain radionuclides,
35 heavy metals, other inorganics compounds, and/or semivolatile organic
36 compounds.
 - 37
 - 38 • In situ vitrification (Alternative 4) could be used at most waste
39 management units or unplanned release sites, although vapor extraction
40 may be needed when volatile organic compounds are present. Waste
41 management units or unplanned release sites where in situ vitrification may
42 not be effective include reverse wells and other sites where the

1 | contamination is present in a very narrow geometry. In situ vitrification is
2 | also not considered for surface spills.

- 3 |
4 | • Excavation, treatment, and geologic disposal of transuranic-containing soils
5 | (Alternative 5) could only be used on those sites that contain transuranic
6 | radionuclides. Since a geologic repository is likely to accept only
7 | transuranic radioactive soils, the non-transuranic radioactive soils will not
8 | be remediated using this alternative.
9 |
10 | • In situ soil vapor extraction (Alternative 6) could be used on any waste
11 | management unit or unplanned release site that contains volatile organic
12 | compounds.

13 |
14 | Using these criteria, Table 7-4 was created showing possible preliminary remedial
15 | action alternatives that could be used to remediate each of the waste management units
16 | and unplanned release sites. Each waste management unit or unplanned release site may
17 | require just one alternative or a combination of many alternatives. Furthermore, similar
18 | sites may be remediated simultaneously. Also, more specific waste treatment alternatives
19 | could be identified and evaluated as more information is obtained. Note that a single
20 | alternative may not be sufficient to remediate all contamination at a single site. For
21 | example, soil vapor extraction could precede in situ vitrification to remove organic
22 | contaminants. Also, different combinations of technologies are possible besides those
23 | presented in these preliminary alternatives. Table 7-4 excludes sites that are covered by
24 | other programs. For example, single-shell tanks are excluded because they are addressed
25 | by the single-shell tank program.

26 |
27 | Technology development studies will be needed for the in situ vitrification process;
28 | and treatability studies will be needed for the in situ grouting or stabilization process and
29 | soil treatment processes to make sure that they will effectively remediate the
30 | contaminants. Specifically, organic waste mobility may be a problem for in situ
31 | vitrification; grouting agents and the resulting reduction of contaminant leachability will
32 | need to be determined before in situ grouting can be performed; and appropriate
33 | treatment protocols and systems will need to be identified before soil washing can be
34 | used. Capping, soil vapor extraction, and disposal options are all proven processes, but
35 | they may require site-specific performance assessment (treatability) studies.

36 |
37 | Focused feasibility studies will be required to evaluate alternative designs for all of
38 | the alternatives evaluated, as they relate to the specific waste management unit being
39 | remediated. A site-by-site economic evaluation is also required before making a decision.
40 | This evaluation will require site-specific information obtained in LFIs and focused FSs.

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7F-1

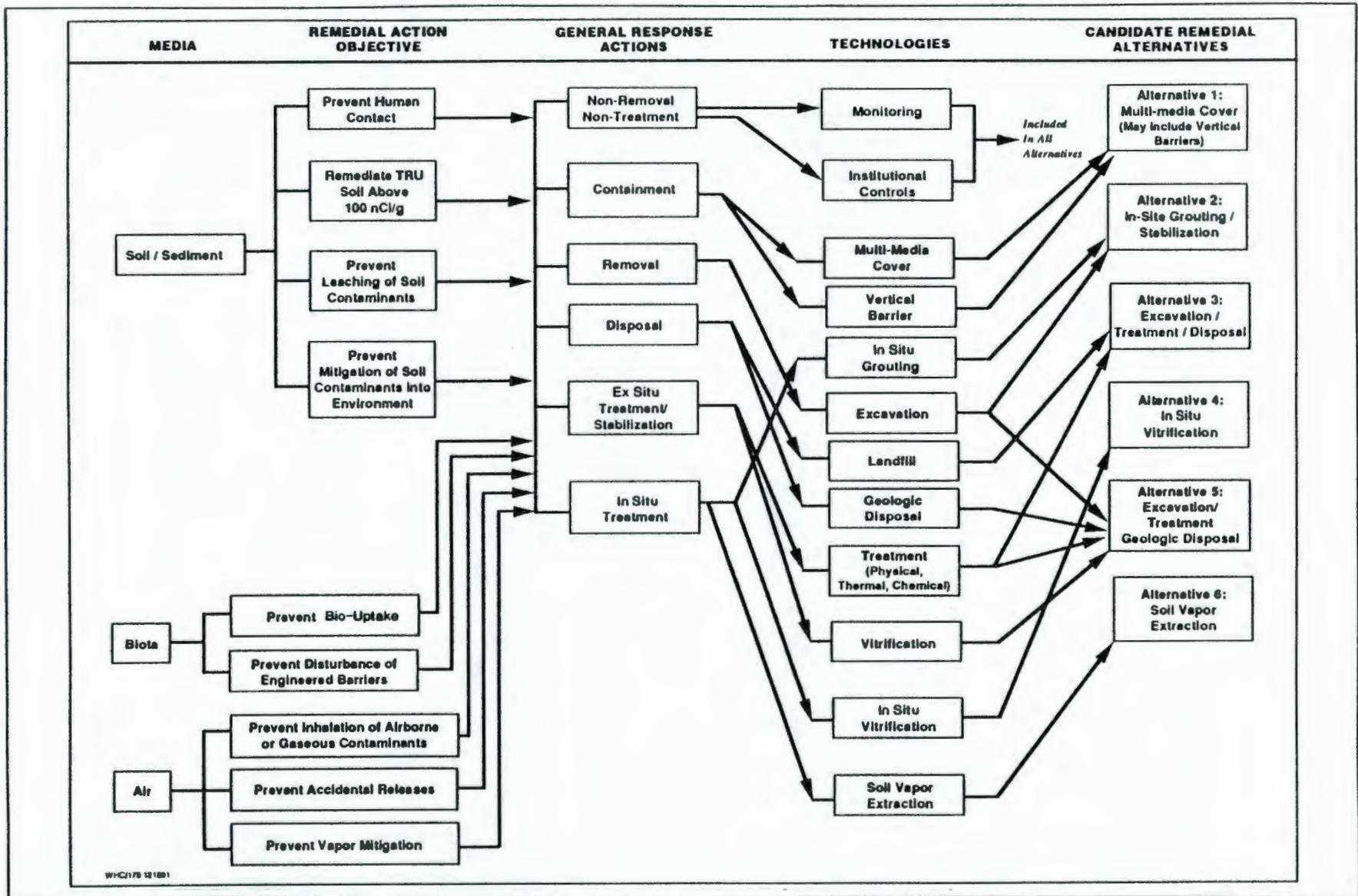
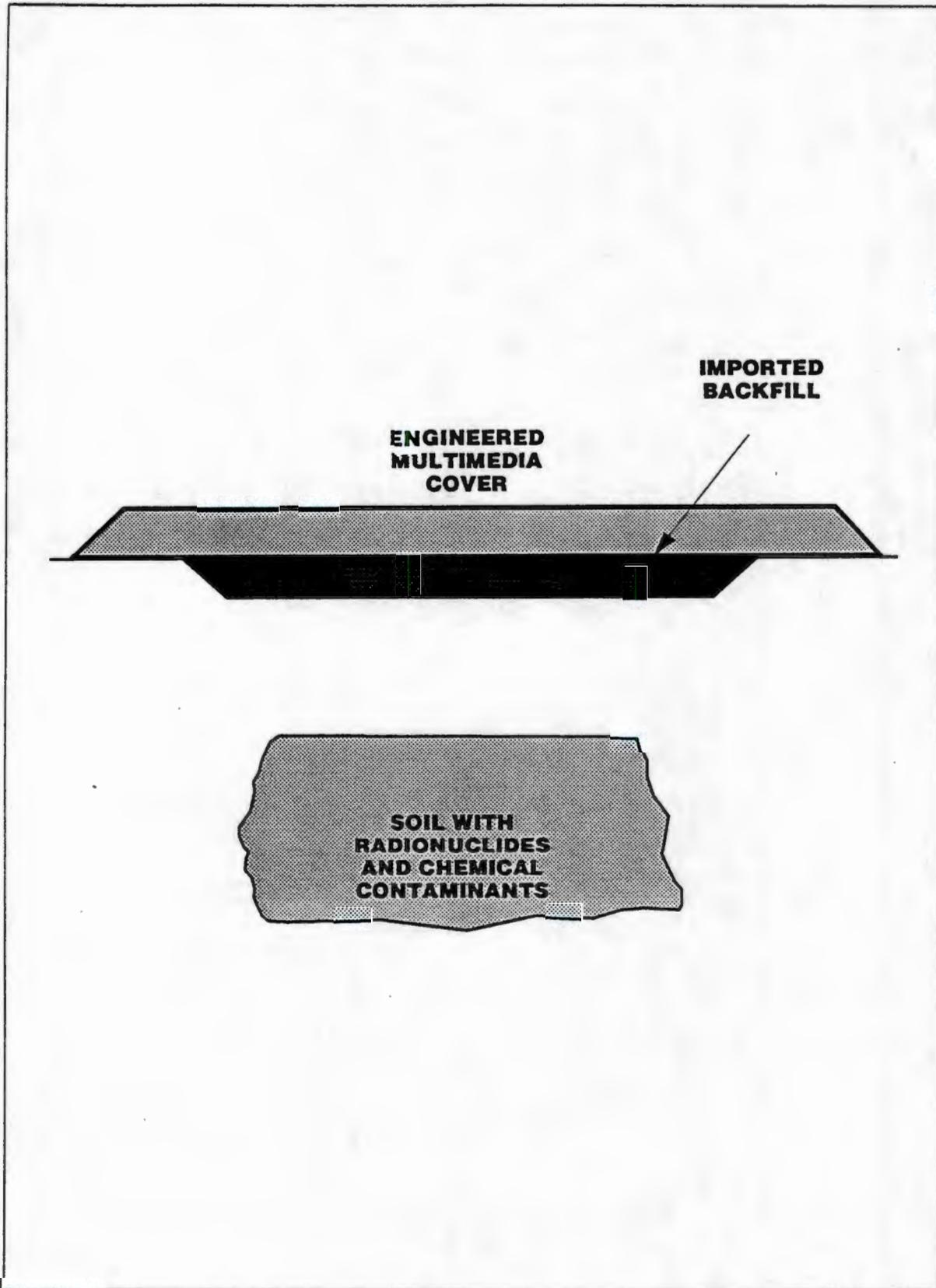


Figure 7-1. Development of Candidate Remedial Alternatives for Z Plant Aggregate Area.



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Figure 7-2. Alternative 1 - Multi-Media Cover.

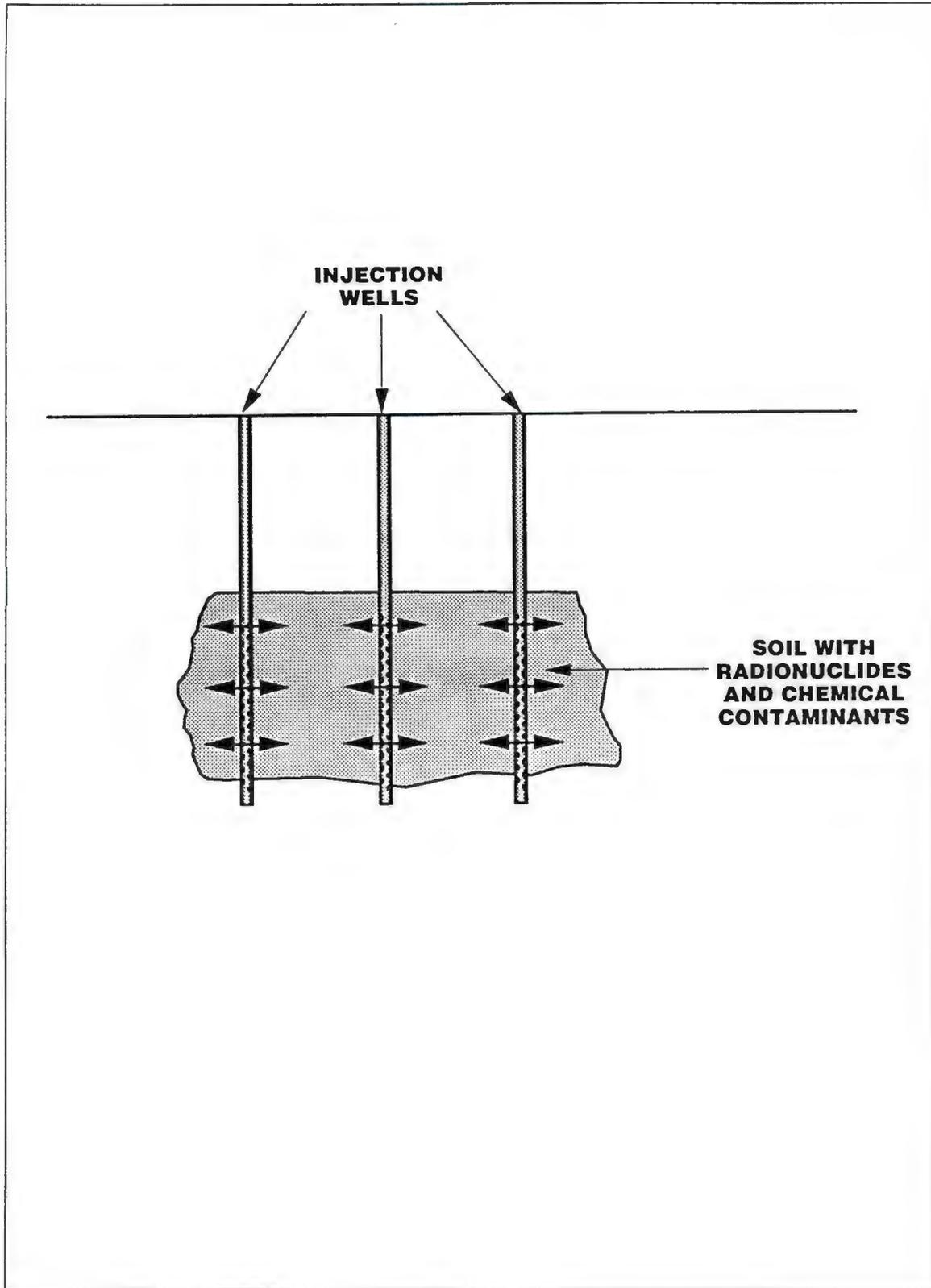
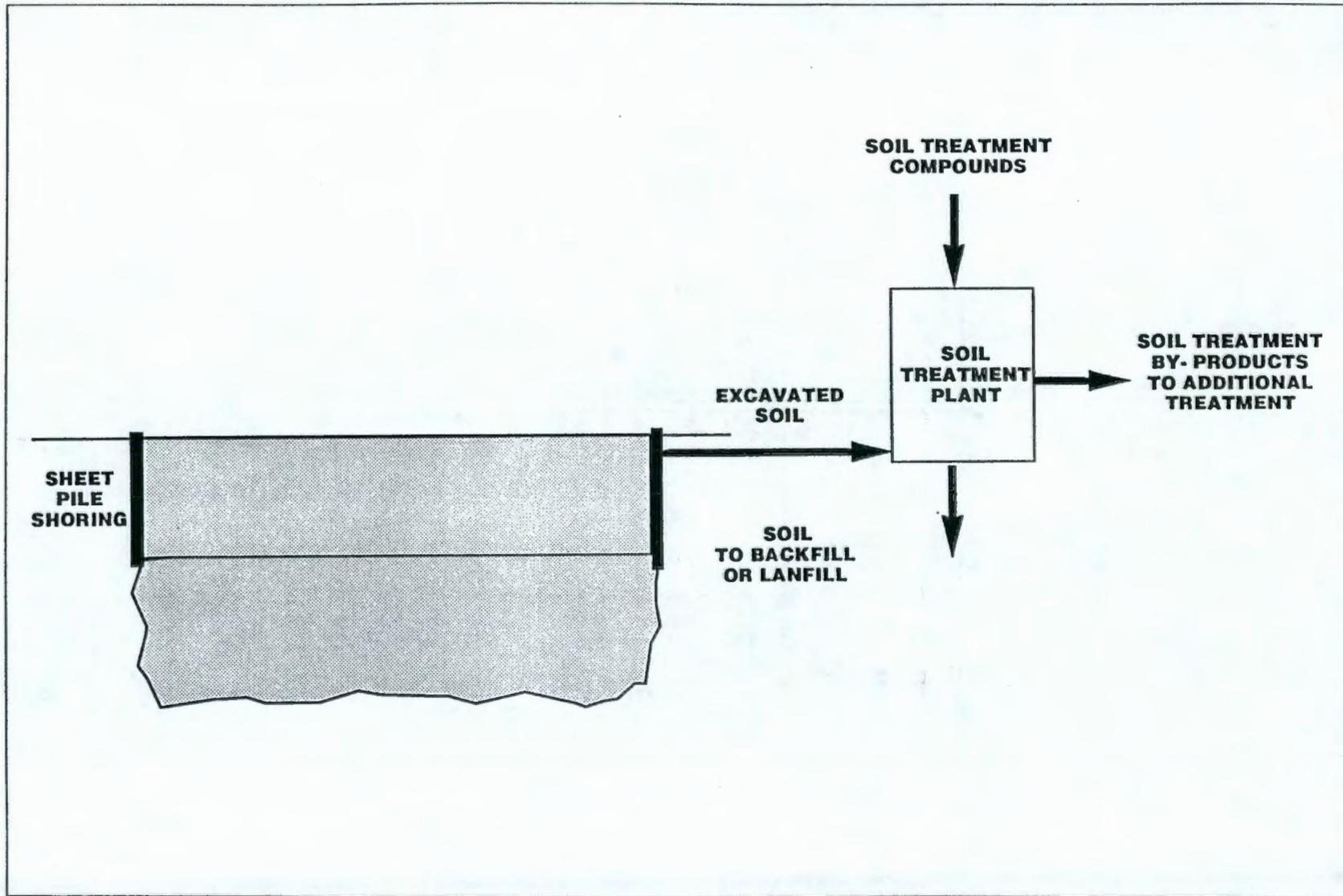


Figure 7-3. Alternative 2 - In Situ Grouting of Soil.

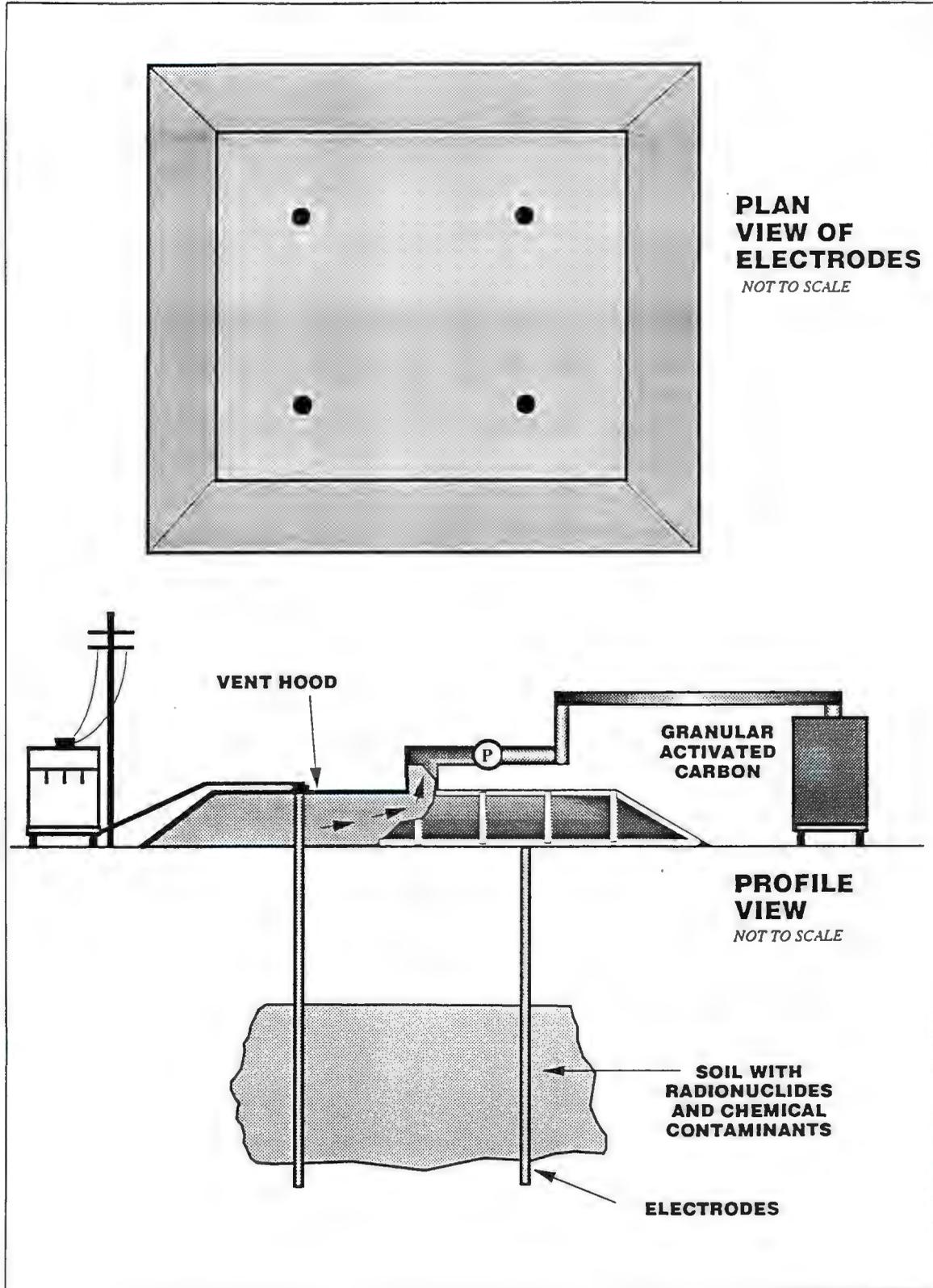
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Figure 7-4. Alternative 3 - Excavation, Treatment, and Disposal.



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Figure 7-5. Alternative 4 - In Situ Vitrification of Soil.

7F-6

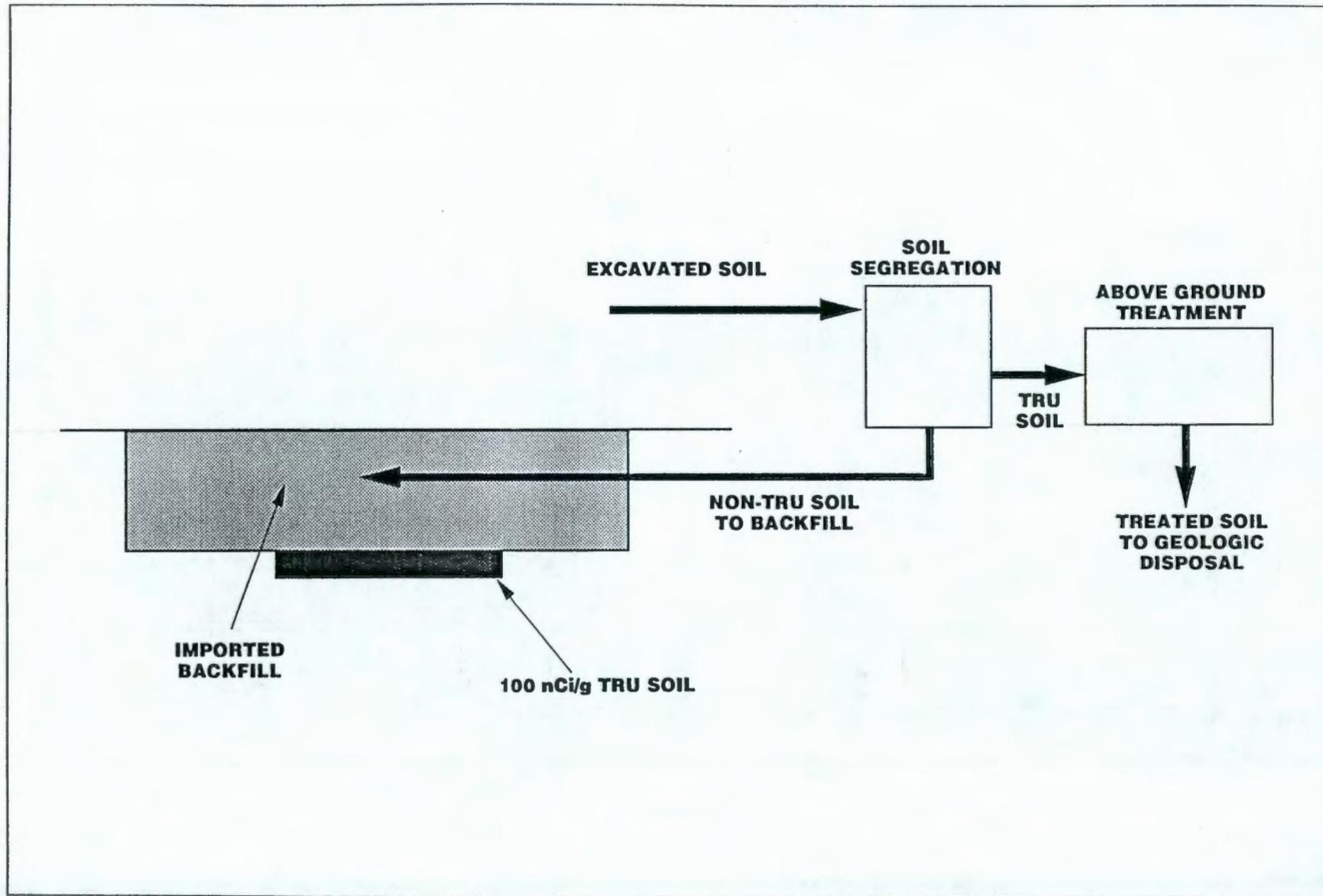


Figure 7-6. Alternative 5 - Excavation, Treatment, and Geologic Disposal of Soil with Transuranic Radionuclides.

7F-7

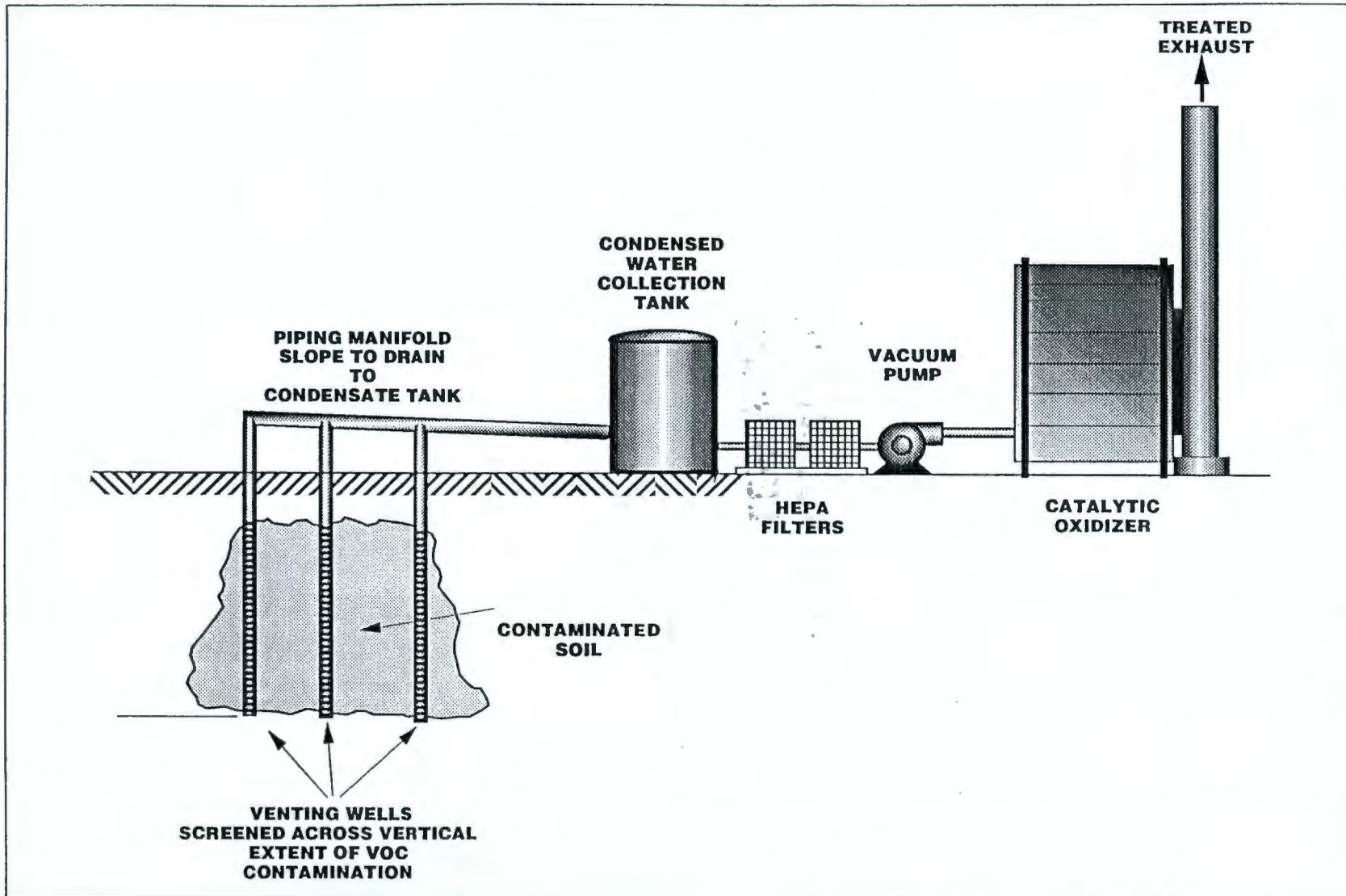


Figure 7-7. Alternative 6 - Soil Vapor Extraction for Volatile Organic Compounds.

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**Table 7-1. Preliminary Remedial Action Objectives
and General Response Actions. (Sheet 1 of 2)**

Remedial Action Objectives			
Environmental Media	Human Health	Environmental Protection	General Response Actions
Soils/ Sediments	<ul style="list-style-type: none"> Prevent ingestion, inhalation, or direct contact with solids containing radioactive and/or hazardous constituents present at concentrations above MTCA and DOE standards for industrial sites (or subsequent risk-based standards). Remediate soils containing TRU contamination above 100 nCi/g in accordance with 40 CFR 191 requirements. Prevent leaching of contaminants from the soil into the groundwater that would cause groundwater concentrations to exceed MTCA and DOE standards at the compliance point location. 	<ul style="list-style-type: none"> Prevent migration of radionuclides and hazardous constituents that would result in groundwater, surface water, air, or biota contamination with constituents at concentrations exceeding ARARs. 	<ul style="list-style-type: none"> No Action Institutional Controls/Monitoring Containment Excavation Treatment Disposal In Situ Treatment
Biota	<ul style="list-style-type: none"> Prevent bio-uptake by plants. Prevent disturbance of engineered barriers by biota. 	<ul style="list-style-type: none"> Prevent bio-uptake of radioactive contaminants. 	<ul style="list-style-type: none"> No Action Institutional Controls/Monitoring Excavation Disposal Containment
Air (1)	<ul style="list-style-type: none"> Prevent inhalation of contaminated airborne particulates and/or volatile emissions exceeding MTCA and DOE limits from soils/sediments. Prevent accidental release from collapse of containment structures. 	<ul style="list-style-type: none"> Prevent adverse environmental impacts on local biota. 	
Tank Waste	<ul style="list-style-type: none"> Interim stabilization of tanks and ancillary piping and transfer facilities to prevent release to the environment (remediation will be remanded to RCRA). 	<ul style="list-style-type: none"> Prevent adverse environmental impacts. 	<ul style="list-style-type: none"> Removal of Drainable Liquid/Isolation of Source Materials for Environment

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Table 7-1. Preliminary Remedial Action Objectives and General Response Actions. (Sheet 2 of 2)

Remedial Action Objectives			
Environmental Media	Human Health	Environmental Protection	General Response Actions
Buried Containers	<ul style="list-style-type: none"> Prevent leakage of liquids from buried containers that would cause groundwater concentrations to exceed MTCA standards at the compliance point location, or which could result in volatilization emissions of leaking chemicals to the atmosphere. 	<ul style="list-style-type: none"> Prevent wind erosion of soil cover material that would expose buried wastes. Prevent wind erosion of contaminated soil that would lead to exposure exceeding MTCA or DCG's. 	<ul style="list-style-type: none"> No Action/Institutional Controls/Monitoring Wind Barriers Installed Capping Drum Removal Subsurface Barriers
<p>Note: (1) No General Response Actions are required for the air because soil remediation will eliminate the air contamination source.</p>			

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Table 7-2. Preliminary Remedial Action Technologies. (Sheet 1 of 3)

Media	General Response Action	Technology Type	Process Option	Contaminants Treated
Soil	No Action	No Action	No Action	NA
	Institutional Controls	Land Use Restrictions	Deed Restrictions	NA
			Access Controls	NA
			Entry Control	NA
			Monitoring	NA
	Containment	Capping	Multi-Media	I,M,R,O
			Vertical Barriers	I,M,R,O
			Grout Curtains	I,M,R,O
			Cryogenic Walls	I,M,R,O
			Dust & Vapor Suppression	I,M,R,O
	Excavation	Excavation	Standard Construction Equipment	I,M,R,O
	Treatment	Thermal Treatment	Vitrification	I,M,R,O
			Incineration	O
			Thermal Desorption	O
			Calcination	I,M,R,O
			Chemical Treatment	Chemical Reduction
			Hydrolysis	I,O

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Table 7-2. Preliminary Remedial Action Technologies. (Sheet 2 of 3)

Media	General Response Action	Technology Type	Process Option	Contaminants Treated
		Physical Treatment	Soil Washing	I,M,R,O
			Solvent Extraction	O
			Physical Separation	I,M,R,O
			Fixation/Solidification/ Stabilization	I,M,R,O
			Containerization	I,M,R,O
		Biological Treatment	Aerobic	O
			Anaerobic	O
	Disposal	Landfill Disposal	Landfill Disposal	I,M,R,O
		Geologic Repository	Geologic Repository	R (I,M,O if mixed with R)
	In Situ Treatment	Thermal Treatment	Vitrification	I,M,R,O
			Thermal Desorption	O
		Chemical Treatment	Reduction	M,O
		Physical Treatment	Soil Flushing	I,M,R,O
			Vapor Extraction	O
	Grouting		I,M,R	
		Fixation/Solidification/ Stabilization	I,M,R,O	
		Biological Treatment	Aerobic	O
			Anaerobic	O

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Table 7-2. Preliminary Remedial Action Technologies. (Sheet 3 of 3)

Media	General Response Action	Technology Type	Process Option	Contaminants Treated
Biota	No Action	No Action	No Action	NA
	Institutional Controls	Land Use Restrictions	Deed Restrictions	NA
			Access Controls	Signs/Fences
		Monitoring	Entry Control	NA
			Monitoring	Monitoring
	Excavation	Excavation	Standard Construction Equipment	I,M,R,O
	Disposal	Landfill Disposal	Landfill Disposal	I,M,R,O
	Containment	Capping	Multi-Media	I,M,R,O
I = Other Inorganics contaminants applicability M = Heavy Metals contaminants applicability R = Radionuclide contaminants applicability O = Organic contaminants applicability NA = Not Applicable				

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Table 7-3. Screening of Process Options. (Sheet 1 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
SOIL TECHNOLOGIES:						
No Action	No Action	Do nothing to cleanup the contamination or reduce the exposure pathways.	Not effective in reducing the contamination or exposure pathways.	Easily implemented, but might not be acceptable to regulatory agencies, local governments, and the public.	Low	Retained as a "baseline" case.
Land Use Restrictions	Deed Restrictions	Identify contaminated areas and prohibit certain land uses such as farming.	Depends on continued implementation. Does not reduce contamination.	Administrative decision is easily implemented.	Low	Retained to be used in conjunction with other process options.
Access Controls	Signs/Fences	Install a fence and signs around areas of soil contamination.	Effective if the fence and signs are maintained.	Easily implemented. Restrictions on future land use.	Low	Retained to be used in conjunction with other process options.
	Entry Control	Install a guard/monitoring system to prevent people from becoming exposed.	Very effective in keeping people out of the contaminated areas.	Equipment and personnel easily implemented and readily available.	Low	Retained to be used in conjunction with other process options.
Monitoring	Monitoring	Analyze soil and soil gas samples for contaminants and scan with radiation detectors.	Does not reduce the contamination, but is very effective in tracking the contaminant levels.	Easily implemented. Standard technology.	Low	Retained to be used in conjunction with other process options.
Capping	Multi-Media	Fine soil over synthetic membrane or other layers and covered with soil; applied over contaminated areas.	Effective on all types of contaminants, not likely to crack. Likely to hold up over time.	Easily implemented. Restrictions on future land use will be necessary.	Medium	Retained because of potential effectiveness and implementability.

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Table 7-3. Screening of Process Options. (Sheet 2 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Vertical Barriers	Slurry Walls	Trench around areas of contamination is filled with a soil (or cement) bentonite slurry.	Effective in blocking lateral movement of all types of soil contamination. May not be effective for deep contamination.	Commonly used practice and easily implemented with standard earth moving equipment. May not be possible for deep contamination.	Medium	Retained for shallow contamination.
	Grout Curtains	Pressure injection of grout in a regular pattern of drilled holes.	Effective in blocking lateral movement of all types of soil contamination.	Commonly used practice and easily implementable, but depends on soil type. May be difficult to ensure continuous wall.	Medium	Retained because of potential effectiveness and implementability.
	Cryogenic Walls	Circulate refrigerant in pipes surrounding the contaminated site to create a frozen curtain with the pond water.	Effective in blocking lateral movement of all types of soil contamination.	Specialized engineering design required. Requires ongoing freezing.	Medium	Rejected because it is difficult to implement.
Dust and Vapor Suppression	Membranes/ Sealants/Wind Breaks/Wetting Agents	Using membranes, sealants, wind breaks, or wetting agents on top of the contaminated soil to keep the contaminants from becoming airborne.	Effective in blocking the airborne pathways of all the soil contaminants, but may require regular upkeep.	Commonly used practice and very easy to implement, but land restrictions will be necessary.	Low	Rejected because of limited duration of integrity and protection.
Excavation	Standard Excavating Equipment	Moving soil around the site and loading soil onto process system equipment.	Effective in moving and transporting soil to vehicles for transportation, and for grading the surface.	Equipment and workers are readily available.	Low	Retained because of potential effectiveness and implementability.

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Table 7-3. Screening of Process Options. (Sheet 3 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Thermal Treatment	Vitrification	Convert soil to glassy materials by application of electric current.	Effective in destroying organics and immobilizing the inorganics and radionuclides. Off-gas treatment for volatiles may be required.	Implementable. Commercial units are available. Laboratory testing required to determine additives, operating conditions, and off gas treatment. Must pre-treat soil to reduce size of large materials.	High	Retained because of potential ability to immobilize radionuclides and destroy organics.
	Incineration	Destroy organics by combustion in a fluidized bed, kiln, etc.	Effectively destroys the organic soil contaminants. Some heavy metals will volatilize. Radionuclides will not be treated.	Implementable. Technology is well developed. Mobile units are available for relatively small soil quantities. Off-site treatment is available. Air emissions and wastewater generation should be addressed.	High	Rejected because of potential air emissions and wastewater generation and low organic content of soils.
	Thermal Desorption	Organic volatilization at 150 to 400°C (300 to 800°F) by heating contaminated soil followed by off gas treatment.	Effectively destroys the organic soil contaminants. Heavy metals less likely to volatilize than in high temperature treatments. Radionuclides will not be treated.	Potentially implementable. Successfully demonstrated on a pilot-scale level. Full-scale remediation yet to be demonstrated. Pilot testing essential.	Medium	Retained because of potential effectiveness and implementability.

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Table 7-3. Screening of Process Options. (Sheet 4 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
	Calcination	High temperature decomposition of solids into separate solid and gaseous components without air contact.	Effective in the decomposition of inorganics such as hydroxides, carbonates, nitrates, sulfates, and sulfites. Removes organic components but does not combust them because of the absence of air. Radionuclides will not be treated.	Commercially available. Most often used for concentration and volume reduction of liquid or aqueous waste. Off-gas treatment is required.	High	Rejected because of limited effectiveness on non-liquid or aqueous wastes.
Chemical Treatment	Chemical Reduction	Treat soils with a reducing agent to convert contaminants to a more stable or less toxic form.	May be effective in treating heavy metal soil contaminants. Radioactivity will not be reduced.	Difficult to implement. Virtually untested on treating soils. Competing reactions may reduce efficiency.	Medium	Rejected because of limited applicability and implementation problems.
	Hydrolysis	Acid- or base-catalyst reaction in water to break down contaminants to less toxic components.	Very effective on compounds generally classified as reactive. Limited effectiveness on stable compounds. Radioactivity will not be reduced.	Difficult to implement. Common industrial process. Use for treatment of soils not well demonstrated.	Medium	Rejected because of limited effectiveness and unproven for soils.

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Table 7-3. Screening of Process Options. (Sheet 5 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Physical Treatment	Soil Washing	Leaching of waste constituents from contaminated soil using a washing solution.	Effectiveness is contaminant specific. Generally more effective on contaminants than partition to the fine soil fraction. Radioactivity will not be reduced.	Implementable. Treatability tests are necessary. Well developed technology and commercially available.	Medium	Retained because of potential effectiveness and implementability.
	Solvent Extraction	Contacting a solvent with contaminated soils to preferentially dissolve the contaminants into the solvent.	The selected solvent is often just as hazardous as the contaminants presented in the waste. May lead to further contamination. Radioactivity will not be reduced.	Implementable. Laboratory testing necessary to determine appropriate solvent and operating conditions.	Medium	Rejected because the solvent may lead to further contamination.
	Physical Separation	Separating soil into size fractions.	Effective as a concentration process for all contaminants that partition to a specific soil size fraction.	Implementable. Most often used as a pretreatment to be combined with another technology. Equipment is readily available.	Low	Retained because of potential effectiveness and implementability.
	Fixation/Solidification/Stabilization	Form low permeability solid matrix by mixing soil with cement, asphalt, or polymeric materials.	Effective in reducing inorganic and radionuclide mobility. Effectiveness for organic stabilization is highly dependent on the binding agent.	Implementable. Stabilization has been implemented for site remediations. Treatability studies are needed. Volume of waste is increased.	Medium	Retained because of potential effectiveness and implementability.

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Table 7-3. Screening of Process Options. (Sheet 6 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
	Containerization	Enclosing a volume of waste within an inert jacket or container.	Effective for difficult to stabilize, extremely hazardous, or reactive waste. Reduces the mobility of radionuclides.	May be implementable for low concentration waste. Disposal or safe storage of containers required. Regulatory constraints may prevent disposal of containers with certain waste types.	Low	Retained because of potential effectiveness and implementability.
Biological Treatment	Aerobic	Microbial degradation in an oxygen-rich environment.	Effectiveness is very contaminant- and concentration-specific. Treatment has been demonstrated on a variety of organic compounds. Not effective on inorganics or radionuclides.	Potentially implementable. Various options are commercially available to produce contaminant degradation. Treatability tests are required to determine site-specific conditions.	Medium	Rejected because of limited applicability and difficult implementation.
	Anaerobic	Microbial degradation in an oxygen deficient environment.	Effectiveness is contaminant- and concentration-specific. Treatment has been demonstrated on a variety of organic compounds. Not effective on inorganics or radionuclides.	Potentially implementable. Various options are commercially available to produce contaminant degradation. Treatability tests are required to determine site-specific conditions.	Medium	Rejected because of limited applicability and difficult implementation.
Disposal	Landfill Disposal	Place contaminated soil in an existing onsite landfill.	Does not reduce the soil contamination but moves all forms of contamination to a more secure place.	Easily implemented if sufficient storage is available in an on site landfill area.	Medium	Retained because of potential effectiveness and implementability.

Table 7-3. Screening of Process Options. (Sheet 7 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
	Geologic Repository	Put the contaminated soil in a safe geologic repository.	Does not reduce the soil contamination, but is a very effective long-term method of storing radionuclides. Probably unnecessary for nonradioactive waste.	Difficult to implement because of limited site availability, and permits for transporting radioactive wastes are hard to get.	High	Retained because of effectiveness on transuranic wastes.
In Situ Thermal Treatment	Vitrification	Electrodes are inserted into the soil and a carbon/glass frit is placed between the electrodes to act as a starter path for initial melt to take place.	Effective in immobilizing radionuclides and most inorganics. Effectively destroys some organics through pyrolysis. Some volatilization of organics and inorganics may occur.	Potentially implementable. Implementability depends on site configuration, e.g., lateral and vertical extent of contamination. Treatability studies required.	High	Retained because of potential ability to immobilize radionuclides and destroy organics.
	Thermal Desorption	Soil is heated in situ by radio-frequency electrodes or other means of heating to temperatures in the 80 to 400°C (200 to 750°F) range thereby causing desorption of volatile and semi-volatile organics from the soil.	Effective for removal of volatile and semi-volatile organics from soil. Ineffective for most inorganics and radionuclides. Contaminants are transferred from soil to air.	Implementable for shallow organics contamination. Not implementable for radionuclides and inorganics. Emission treatment and treatability studies required.	Medium	Rejected because of limited applicability.
In Situ Chemical Treatment	Chemical Reduction	Reducing agent is added to the soil to change oxidation state of target contaminant.	Effective for certain inorganics, e.g., chromium. Ineffective for organics. Limited applicability.	Difficult to implement in situ because of distribution requirements for reducing agent.	Low	Rejected because of limited applicability and implementation problems.

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Table 7-3. Screening of Process Options. (Sheet 8 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
In Situ Physical Treatment	Soil Flushing	Solutions are injected through injection system to flush and extract contaminants.	Potentially effective for all contaminants. Effectiveness depends on chemical additives and hydrogeology. Flushing solutions posing environmental threat likely to be needed. Difficult recovery of flushing solution.	Difficult to implement. Not implementable for complex mixtures of contaminants. Flushing solution difficult to recover. Chemical additives likely to pose environmental threat.	Medium	Rejected because of implementation problems.
	Vapor Extraction	Vacuum is applied by use of wells inducing a pressure gradient that causes volatiles to flow through air spaces between soil particles to the extraction wells.	Effective for volatile organics. Ineffective for inorganics and radionuclides. Emission treatment required.	Easily implementable for proper site conditions. Requires emission treatment for organics and capture system for radionuclides and volatilized metals.	Medium	Retained for potential application to volatile organics.
	Grouting	Involves drilling and injection of grout to form barrier or injection to fill voids.	Effective in limiting migration of leachate, but difficult to maintain barrier integrity. Potentially effective in filling voids.	Implementable as barrier and for filling voids. Implementability depends on site conditions.	Medium	Retained because of ability to limit contaminant migration and potential use for filling void spaces.
	Fixation/Solidification/Stabilization	Solidification agent is applied to soil by mixing in place.	Effective for inorganics and radionuclides. Potentially effective for organics. Effectiveness depends on site conditions and additives used.	Implementable. Treatability studies required to select proper additives. Thorough characterization of subsurface conditions and continuous monitoring required.	Medium	Retained because of potential effectiveness and implementability.

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Table 7-3. Screening of Process Options. (Sheet 9 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
In Situ Biological Treatment	Aerobic	Microbial growth utilizing organic contaminants as substrate is enhanced by injection of or spraying with oxygen source and nutrients.	Effective for most organics under proper conditions. Ineffective for inorganics and radionuclides.	Difficult to implement. Treatability studies and thorough subsurface characterization required.	Low	Rejected because of limited applicability and difficult implementation.
	Anaerobic	Microbial growth utilizing organic contaminants as substrate is enhanced by addition of nutrients.	Effective for some volatile and complex organics. Not effective for inorganics and radionuclides.	Difficult to implement. Anoxic ground conditions required. Treatability studies and thorough subsurface characterization necessary.	Low	Rejected because of limited applicability and difficult implementation.
BIOTA TECHNOLOGIES:						
No Action	No Action	Do nothing to clean-up the contamination or reduce the exposure pathways.	Not effective in reducing the contamination or exposure pathways.	Easily implemented, but might not be acceptable to regulatory agencies, local governments, and the public.	Low	Retained as a "baseline" case.
Land Use Restrictions	Deed Restrictions	Identify contaminated areas and prohibit certain land uses such as agriculture.	Ineffective if entered. Does not reduce contamination.	Administrative decision is easily implemented.	Low	Retained to be used in conjunction with other process options.
	Access Controls	Signs/Fences	Install a fence and signs around areas of contamination to keep people out and the biota in.	Effective in limiting access if fencing is maintained.	Easily implemented. Restrictions on future land use.	Low
	Entry Control	Install a guard/monitoring system to eliminate people from coming in contact with the contamination.	Very effective in keeping people out of the contaminated areas.	Easily implemented equipment and personnel and readily available.	Low	Retained to be used in conjunction with other process options.

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Table 7-3. Screening of Process Options. (Sheet 10 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Monitoring	Monitoring	Biota sampling and testing for contaminants.	Does not reduce the contamination, but is very effective tracking the contaminant levels.	Easily implemented. Standard Technology.	Low	Retained to be used in conjunction with other process options.
Capping	Multi-Media	Fine soil over synthetic membrane or other layers and covered with soil; applied over contaminated areas.	Effective in reducing the uptake of contaminants, not likely to crack. Likely to hold up over time.	Easily implemented. Restrictions on future land use will also be necessary.	Medium	Retained because of potential effectiveness and implementability.
Excavation	Standard Excavating Equipment	Remove affected biota and load it onto process system equipment.	Effective in moving and transporting biota.	Easily implemented. Equipment and workers are readily available.	Low	Retained because of potential effectiveness and implementability.
Disposal	Landfill Disposal	Place contaminated biota in an existing landfill.	Does not reduce the biota contamination but moves all of the contamination to a more secure place.	Easily implemented if sufficient storage is available in landfill.	Medium	Retained because of potential effectiveness and implementability.

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Table 7-4. Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites. (Sheet 1 of 4)

Waste Management Unit or Unplanned Release	Alt 1. Multimedia Cover With or Without Vertical Barriers	Alt 2. In Situ Grouting	Alt 3. Excavation and Treatment	Alt 4. In Situ Vitrification	Alt 5. Excavation, Treatment, and Geologic Disp. of TRU Soil	Alt 6. In Situ Soil Vapor Extraction for VOCs
Tanks and Vaults						
216-Z-8 Settling Tank	•	•	•	•	•	
241-Z-361 Settling Tank	•	•	•	•	•	
Cribs and Drains						
216-Z-1 & 216-Z-2 Cribs	•	•	•	•	•	
216-Z-3 Crib	•	•	•	•	•	
216-Z-5 Crib	•	•	•	•	•	
216-Z-6 Crib	•	•	•	•	•	
216-Z-7 Crib	•	•	•	•	•	
216-Z-12 Crib	•	•	•	•	•	
216-Z-16 Crib	•	•	•	•	•	
216-Z-18 Crib	•	•	•	•	•	•
216-Z-8 French Drain	•	•	•	•	•	
216-Z-13 French Drain (1)	•	•	•	•		
216-Z-14 French Drain (1)	•	•	•	•		
216-Z-15 French Drain (1)	•	•	•	•		
216-Z-1A Tile Field	•	•	•	•	•	•

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Table 7-4. Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites. (Sheet 2 of 4)

Waste Management Unit or Unplanned Release	Alt 1. Multimedia Cover With or Without Vertical Barriers	Alt 2. In Situ Grouting	Alt 3. Excavation and Treatment	Alt 4. In Situ Vitrification	Alt 5. Excavation, Treatment, and Geologic Disp. of TRU Soil	Alt 6. In Situ Soil Vapor Extraction for VOCs
Reverse Wells						
216-Z-10 Reverse Well	•	•			•	
Ponds, Ditches, and Trenches						
216-Z-4 Trench	•	•	•	•	•	
216-Z-9 Trench	•	•	•	•	•	•
216-Z-17 Trench	•	•	•	•	•	
Septic Tanks and Associated Drain Fields						
2607-Z Septic Tank & Field (1)	•	•	•	•		
2607-Z-1 Septic Tank & Field (1)	•	•	•	•		
2607-WA Septic Tank & Field (1)	•	•	•	•		
2607-WB Septic Tank & Field (1)	•	•	•	•		
2607-W-8 Septic Tank & Field (1)	•	•	•	•		
Basins						
241-Z Retention Basin	•		•			
216-Z-21 Seepage Basin (1)	•	•	•	•		
Burial Sites						
218-W-1 Burial Ground	•	•	•	•	•	•

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Table 7-4. Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites. (Sheet 3 of 4)

Waste Management Unit or Unplanned Release	Alt 1. Multimedia Cover With or Without Vertical Barriers	Alt 2. In Situ Grouting	Alt 3. Excavation and Treatment	Alt 4. In Situ Vitrification	Alt 5. Excavation, Treatment, and Geologic Disp. of TRU Soil	Alt 6. In Situ Soil Vapor Extraction for VOCs
218-W-1A Burial Ground	•	•	•	•	•	•
218-W-2 Burial Ground	•	•	•	•	•	•
218-W-3 Burial Ground	•	•	•	•	•	•
218-W-4A Burial Ground	•	•	•	•	•	•
218-W-11 Burial Ground	•	•	•	•	•	•
Z Plant Burn Pit	•	•	•	•		
Unplanned Releases						
UN-200-W-11	•	•	•	•	•	
UPR-200-W-16	•	•	•	•	•	
UN-200-W-23	•	•	•	•	•	
UPR-200-W-26	•	•	•	•		
UN-200-W-44	•	•	•	•		
UPR-200-W-53	•	•	•	•		
UPR-200-W-72	•	•	•	•		
UPR-200-W-84	•	•	•	•		
UN-200-W-89 (2)						
UN-200-W-90 (2)						

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Table 7-4. Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites. (Sheet 4 of 4)

Waste Management Unit or Unplanned Release	Alt 1. Multimedia Cover With or Without Vertical Barriers	Alt 2. In Situ Grouting	Alt 3. Excavation and Treatment	Alt 4. In Situ Vitrification	Alt 5. Excavation, Treatment, and Geologic Disp. of TRU Soil	Alt 6. In Situ Soil Vapor Extraction for VOCs
UN-200-W-91	•	•	•	•	•	
UN-200-W-103	•	•	•	•	•	
UN-200-W-130	•	•	•	•		
UN-200-W-132	•	•	•	•	•	
UPR-200-W-134	•	•	•	•	•	
UPR-200-W-158	•	•	•	•		
UN-200-W-159 (2)						

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- Notes: (1) This is an active unit.
 (2) Records indicate that all environmental contamination resulting from this unplanned release was removed and disposed. Therefore no applicable alternative(s) was identified.

1
2
3
4 **8.0 DATA QUALITY OBJECTIVES**
5
6

7 The Z Plant Aggregate Area Management Study (AAMS), as part of the *Hanford*
8 *Past-Practice Strategy*, is designed to focus the RI/FS process, integrated with the
9 RFI/CMS process for RCRA sites, toward an ultimate goal of comprehensive cleanup or
10 closure of all contaminated areas in the Z Plant Aggregate Area at the Hanford Site at
11 the earliest possible date and in the most effective manner. The fundamental principle
12 of *Hanford Past-Practice Strategy* is a "bias for action" which emphasizes the maximum use
13 of existing data to shorten the RI/FS process as well as allow decisions about work that
14 can be done at the site early in the process, such as expedited response actions (ERAs),
15 interim remedial measures (IRMs), limited field investigations (LFIs), and focused
16 feasibility studies (FFS). Data, whether existing or newly-acquired, can only be used for
17 these purposes if it meets the requirements of data quality as defined by the data quality
18 objective (DQO) process developed by the EPA for use at CERCLA sites (EPA 1987).
19 However, due to the limited target compound list/target analyte list used in the EPA
20 Contract Laboratory Program (CLP) routine analytical services the EPA DQO
21 methodology has been modified to more accurately reflect the analytical and operational
22 concerns at the Hanford Site. This modification introduces a two-tiered process whereby
23 screening and validated data are used as the basis for the definition of subsequent
24 sampling and analysis needs (WHC 1991b).
25

26 We have, however, maintained the three-stage process defined by EPA in the
27 guidance document for DQO development (EPA 1987). The process involves the
28 following three stages:
29

- 30 ● Stage 1 Identify decision types (Section 8.1);
31 ● Stage 2 Identify data uses and needs (Section 8.2); and
32 ● Stage 3 Design a data collection program (Section 8.3).
33

34 These stages have been used as the basis for presenting the DQOs for the Z Plant
35 AAMS, as modified by the two-tiered data quality strategy developed by Westinghouse
36 Hanford. Included within these sections are discussions of comparable requirements that
37 conform to DOE 5700.6B, *Quality Assurance (9/23/86)*, *Quality Assurance Program*
38 *Requirements for Nuclear Facilities* (ANSI/ASME, 1989), and *Interim Guidelines and*
39 *Specifications for Preparing Quality Assurance Project Plans* (EPA 1983b). These three
40 documents form the basis of the quality assurance program at the Hanford Site and will
41 be used in conjunction with the EPA guidance to establish and define the DQOs for the
42 Z Plant Aggregate Area and evaluate the quality of the available data.

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1
2 **8.1 DECISION TYPES (STAGE 1)**
3

4 Stage 1 of the DQO process is undertaken to identify:

- 5
6 ● The decision makers (thus data users) relying on the data to be developed
7 (Section 8.1.1);
8 ● The data available to make these decisions (Section 8.1.2);
9 ● The conceptual model in which these data must be incorporated (Section
10 8.1.3); and
11 ● The objectives and decisions which must evolve from the data (Section
12 8.1.4).
13

14 These issues serve to define the types of remediation and risk assessment
15 decisions which will be made for subsequent Z Plant Aggregate Area corrective and
16 remedial actions.
17

18
19 **8.1.1 Data Users**
20

21 The data users for the Z Plant AAMS (and subsequent investigations such as
22 LFIs, RI/FSs, and RFIs/CMSs) are:
23

- 24 ● The decision makers for policies and strategies on remedial action at the
25 Hanford Site. These are the signatories of the Tri-Party Agreement,
26 (Ecology et al. 1990) including:
27 ● The U.S. Department of Energy (DOE)
28 ● The Environmental Protection Agency (EPA), and
29 ● The Washington State Department of Ecology (Ecology).
30

31 Nominally, these responsibilities are assigned to the heads of these agencies
32 (the Secretary of Energy for DOE, the Administrator of EPA [and the
33 Region 10 Regional Administrator], and the Director of Ecology). The
34 EPA Regional Administrator and the Ecology Director have delegated
35 oversight responsibilities to the Federal Facilities Branch and the Hanford
36 Project Office, respectively. DOE issues responsibilities and authorities for
37 quality assurance policy coordination and overview, development,
38 implementation, and evaluation through DOE 5700.6B, Quality Assurance.
39

- 40 ● Unit managers of Westinghouse Hanford, and other Hanford Site
41 contractors who will be tasked with implementing remedial activities at the
42 Z Plant Aggregate Area. Staff of these contractors will have to make the

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1 implementation decisions about appropriate scheduling of activities and
2 allocation of resources (funding, personnel, and equipment) to accomplish
3 the recommendations of the AAMS.
4

- 5 ● Concerned members of the wider community involved with the Hanford
6 Site. These may include:
7 ● Other states (Oregon and Idaho),
8 ● Other federal agencies,
9 ● Affected Indian tribes,
10 ● Special interest groups, and
11 ● The general public.
12

13 These latter groups will be involved in the decision process through the
14 implementation of the Community Relations Plan (CRP), and will apply their concerns
15 through the "primary" data users, the signatories of the Tri-Party Agreement.
16

17 The needs of the above listed users will play a pivotal role in defining the DQOs
18 relevant to specific remedial and corrective activities.
19

20 21 **8.1.2 Available Information** 22

23 The *Hanford Past-Practice Strategy* presents a strategy for meeting the statutory
24 requirements and integrating CERCLA RI/FS and RCRA RFI/CMS guidance. The
25 *Hanford Past-Practice Strategy* specifies a "bias for action" which promotes the use of
26 existing data with a limited and focused RI/FS or RFI/CMS process. This "bias for
27 action" concept was first promoted in the Proposed Rule for the revised (40 CFR Part
28 300) and demonstrates both EPA's and DOE's commitment to streamlining the decision-
29 making process at remedial action sites. The use of existing data, with appropriate
30 qualifiers, for making informed decisions about further sampling and analysis needs,
31 remediation alternatives, and risk assessment objectives helps to expedite and further
32 focus subsequent programmatic needs. However, this emphasis can only be implemented
33 if the existing data is adequate for the purposes listed.
34

35 Available data for the Z Plant Aggregate Area are presented in Sections 2.0, 3.0,
36 and 4.0. As described in Section 1.2.2, data are needed to address the following issues:
37

- 38 ● Issue 1: Facility and process descriptions and operational histories for
39 waste sources (Sections 2.2 and 2.3);
40 ● Issue 2: Waste disposal records defining the dates of disposal, waste types,
41 and waste quantities (Sections 2.3 and 2.4);

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- 1 ● Issue 3: Sampling events of waste effluent and affected media (Sections 2.3
2 and 4.1);
- 3 ● Issue 4: Site conditions including the site physiography, geology, hydrology,
4 meteorology, ecology, demography, and archaeology (Section 3.0);
- 5 ● Issue 5: Environmental monitoring data for affected media including air,
6 surface water, sediment, soil, groundwater, and biota (Section 4.1, except
7 that groundwater data is presented in the separate 200 West Groundwater
8 Aggregate Area Management Study); and
- 9 ● Issue 6: Environmental parameter measurements needed to characterize
10 fate and transport of contaminants (Section 4).

11
12 A major requirement for adequate characterization of the area of concern is the
13 identification of the chemical and radiological constituents associated with the sites, with
14 a view toward determining the contaminants of concern at specific waste management
15 units. The data reported for the various waste management units in the Z Plant
16 Aggregate Area have been found to describe:

- 17
18 ● **Inventory.** Generally estimated from chemical process data and
19 emphasizing radionuclides. (Issues 1 and 2)
- 20
21 ● **Surface Radiological Surveys.** Undifferentiated radiation levels, without
22 identification of radionuclides present, presented in terms of the extent of
23 alpha, beta, and gamma radiation in excess of background levels. (Issue 5)
- 24
25 ● **External Radiation Monitoring.** Similar to the surface radiological surveys
26 but providing less information because with a fixed-point
27 thermoluminescent detector (TLD) no spatial distribution is provided. In
28 addition, data are also available for some TLDs placed at points not
29 associated with specific waste management units. (Issue 5)
- 30
31 ● **Waste, Soil, or Sediment Sampling.** These include sediment sampling in
32 basins, ponds, cribs, and ditches. There is record of 21 unplanned releases
33 as listed in Table 2-1. (Issue 5)
- 34
35 ● There is also a set of soil sampling and analysis data which was conducted
36 for several years on a grid pattern that extends across all three operable
37 units in the Z Plant Aggregate Area. These data indicate impacts from
38 historical operations at the Hanford Site in the vicinity of the grid points.
39 However, the impacts cannot be ascribed to particular units and do not
40 contribute to the decision-making process on a unit-by-unit basis.
- 41

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- 1 ● **Biota Sampling.** These data could assist assessment of radiological
2 contamination through bio-uptake and -transfer. The sampling points
3 include: soil grid point 2W22 (rabbit feces), 231-Z fenceline (rabbit feces),
4 a site west of Z Plant (mouse feces), and the 216-Z-10 Crib (rabbit feces).
5 (Issue 5)
6
- 7 ● **Borehole Geophysics.** These data, for a number of waste management
8 units which discharged to the soil column (selected cribs and french drains)
9 were designed to detect the presence of radionuclides in the subsurface and
10 to indicate whether these materials are migrating vertically. (Issue 5)
11
- 12 ● **Soil Physical and Chemical Properties.** Moisture contents, particle size
13 distributions, and calcium carbonate contents have been measured in soil
14 samples from monitoring wells in the Z Plant Aggregate Area. These
15 parameters can be used to estimate transport of contaminants in the
16 subsurface. (Issue 6)
17

18 8.1.3 Evaluation of Existing Data

19
20 The potential uses of the existing sampling and analysis and field survey data are
21 limited to some extent by changes in analytical methodology or quality control
22 requirements that have occurred since the data were collected. These changes include
23 improvement in analytical methodologies, leading to improved accuracy and precision
24 and lower detection limits, as well as development of improved techniques. In addition,
25 older data may not be representative of current conditions at the site due to decay or
26 transformation of contaminants, intermedia or intramedia transport, and interim
27 remediation actions at the site (e.g., stabilization efforts conducted under the RARA
28 program).
29

30 The primary existing information that can be used to evaluate the occurrence and
31 extent of contamination at Z Plant Aggregate Area waste management units is the
32 chemical and radionuclide inventories in the WIDS database and the waste disposal
33 inventories from the Solid Waste Burial Grounds. The quality of the inventory data vary
34 widely since some are based on estimates from plant operations and disposal histories
35 from the early days of the Hanford Site whereas others are based on waste manifests.
36 Waste inventories are not available for transfer units or treatment tanks, or for many of
37 the unplanned releases. In addition, the limited suite of chemicals and radionuclides
38 reported in WIDS does not include many constituents expected to be present based on
39 historical association with waste producing processes. Thus, this type of information is
40 best used to guide future sampling efforts and to provide an approximate indication of
41 the possible nature and extent of contamination.
42

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1 The gross gamma borehole logging is limited by methodological problems, such as
2 low sensitivity due to logging through well casings and lack of element-specific spectra.
3 Thus, these data provide only qualitative indication of subsurface contamination.
4

5 EPA (1987) has specified indicators of data quality, five "PARCC" parameters,
6 which can be used to evaluate the existing data, and to specify requirements for future
7 data collection. These are:
8

- 9 ● Precision — the reproducibility of the data;
- 10 ● Accuracy — the lack of a bias in the data;
- 11 ● Representativeness — the degree to which the appropriate parameters
12 have been sampled;
- 13 ● Completeness — the fraction of samples which are considered "valid"; and
- 14 ● Comparability — the confidence that can be placed on the comparison of
15 two data sets.
16

17 The limitations in precision and accuracy of the existing analytical data are mainly
18 due to improvements in analytical techniques and increases in quality control
19 requirements since the time the samples were collected. Data which do not meet formal
20 CLP QA/QC requirements for data validation may not be usable to support a ROD;
21 however, these data should be used to the maximum extent possible, as recommended by
22 the *Hanford Past-Practice Strategy*. These data can be used: to formulate the conceptual
23 model, to conduct a qualitative risk assessment, to prepare work plans, and also as an
24 initial data set which can be the basis for a fully-qualified data set through a process of
25 review, evaluation, and confirmation.
26

27 The representativeness of the existing analytical data is the primary shortcoming
28 of the data. Data are nonrepresentative because only a limited range of analytes was
29 tested for in the samples (e.g., analyzing for radionuclides by not for hazardous
30 chemicals), radionuclides were not differentiated in surveying methods (gamma logging
31 and surface radiation surveys), and sampling locations were generally not selected to be
32 representative of concentrations in environmental media.
33

34 Representativeness is of concern for data used to determine subsurface and
35 surface soil concentrations and extent of contamination. Subsurface investigations have
36 been undertaken at only three waste management units in the Z Plant Aggregate Area,
37 and no surface soil sampling specific to waste management units was located. Concerns
38 relating to worker exposures and possible release or spread of contamination limits the
39 ability to drill within waste management units.
40

41 Due to these limitations, the existing data have limited usefulness for evaluating
42 the full range of contamination or the distribution of contaminants at particular waste

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1 management units. The result of this data gap is that concentrations in environmental
2 media cannot be compared to levels of regulatory concern and a quantitative risk
3 assessment cannot be conducted with existing data. However, the data may be used to
4 direct future sampling efforts and, for those waste management units where subsurface
5 sampling and analysis was performed, to indicate the extent of downward migration in
6 the subsurface.

7
8 The completeness and comparability of the existing analytical data are unknown
9 for the existing data because quality control information needed to evaluate these
10 parameters were not located. Indications are that varying levels of quality control were
11 applied in the course of site investigations, due to changes in QA procedures over time.

12
13 None of the data which have been gathered in the Z Plant Aggregate Area have
14 been "validated" in accordance with the EPA CLP protocol, although some (varying)
15 levels of quality control have been applied to the sampling and analysis procedures. The
16 best indication of the validity of the data is the reproducibility of the results, and where it
17 can be observed through duplicate samples, this is one of the less significant problems
18 with the data.

19
20 While these limitations cannot in most cases be quantified (and some such as
21 representativeness are specifically non-quantifiable), certain features of most of the data
22 collected to date in the Z Plant Aggregate Area can be cited as failing one or more of
23 the PARCC parameters. These data should, however, be used to the maximum extent
24 possible in the development of work plans for site field investigations, prioritization of
25 the various units, and to determine, to the extent possible, where contamination is or is
26 not present.

27
28 In addition to these site-specific data, there are also a limited number of non site-
29 specific sampling events that are being developed to determine background levels of
30 naturally occurring constituents (Hoover and LeGore 1991). These data, when available,
31 can be used to differentiate the effect of the environmental releases from naturally
32 occurring background levels.

33 34 35 **8.1.4 Conceptual Models**

36
37 The initial (scoping) conceptual model of the sites in the Z Plant Aggregate Area
38 is presented and described in Section 4.2.1 (Figure 4-5). The model is based on best
39 estimates of where contaminants were discharged and the potential for migration of
40 contaminants from the point-of-release to the current location. The conceptual model is
41 designed to be conservative and assumes insufficient data for delineation of the full
42 extent of chemical and radiological contamination. This means that a migration pathway

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1 was included in the model if there was any possibility of contamination travelling through
2 it, historically or presently. In most cases there may not be a significant flux of such
3 contaminant migration for many of the pathways shown on the figure. Significant refers
4 to a quantity causing an unacceptable risk for the receptors of the pathway.
5

6 There are many significant uncertainties regarding the contaminant levels in the
7 migration pathways shown on the conceptual model. Yet, almost none of these pathways
8 have been sampled to determine whether any contamination still exists in any of the
9 locations specified in the conceptual model. Likewise for those locations that have been
10 sampled, there is little data regarding which constituents are present, to what extent they
11 are present, and what the contaminant levels are in the various media. Until these data
12 are available, the various pathways cannot be prioritized. This affects the ability of DOE
13 and Westinghouse Hanford to specify appropriate remedial response actions and to
14 specify the risk assessment objectives.
15

16 8.1.5 AAMS Objectives and Decisions

17
18 The specific objectives of the Z Plant AAMS are listed in Section 1.3 above. They
19 include:
20

- 21 ● Assemble site data (as described in Section 8.1.2 above);
- 22 ● Develop a site conceptual model (see Section 4.0);
- 23 ● Identify contaminants of concern and their distribution (Section 5.0);
- 24 ● Identify preliminary applicable, or relevant and appropriate, regulations
25 (ARARs, Section 6.0);
- 26 ● Define preliminary remedial action objectives and screen potential remedial
27 technologies (Section 7.0);
- 28 ● Recommend expedited, interim, or limited actions (Section 9.0, below); and
- 29 ● Define and prioritize work plan activities with emphasis on supporting early
30 cleanup actions and records of decision.
31

32
33 The decisions that will have to be made on the basis of this AAMS can be
34 described according to the *Hanford Past-Practice Strategy* flow chart (Figure 1-2) which
35 must be conducted on a site-by-site basis. Decisions are shown on the flow chart as
36 diamond-shaped boxes, and include:
37

- 38 ● Is an ERA justified? (Point B on the flow chart)
- 39 ● Is less than five months' response needed (is the ERA time critical)? (Yes
40 exit from Point B)
- 41 ● Are data sufficient to formulate the conceptual model and perform a
42 qualitative risk assessment? (Point C)

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- 1 ● Is an IRM justified? (Yes exit from Point C)
- 2 ● Can the remedy be selected? (Yes exit from previous question)
- 3 ● Can additional required data be obtained by limited field investigation
- 4 (LFI)? (Point D)
- 5 ● Are data (from field investigations) sufficient to perform risk assessment?
- 6 ● Can Operable Unit/Aggregate Area ROD be issued?
- 7

8 The last two questions will only be asked after additional data are obtained
9 through field investigations. Upon acquisition of additional analytical data DQO issues can
10 be more clearly defined. The DQOs presented herein are designed for assessing the
11 scoping objectives for these investigations. However, most of these decisions are actually
12 a complicated mixture of many smaller questions, and will be addressed in Section 9.0
13 through more detailed flow charts.

14
15 Similarly, the tasks which will need to be performed for the AAMS, and will
16 therefore drive the data needs for the study are found in the rectangular boxes on the
17 flow chart. These include:

- 18
- 19 ● ERA (if justified);
- 20 ● Definition of threshold contamination levels, and formulation of a
- 21 conceptual model, performance of a qualitative risk assessment and FS
- 22 screening (IRM preliminaries);
- 23 ● Focused Feasibility Studies for IRM selection;
- 24 ● Determination of minimum data requirements for the IRM pathway;
- 25 ● Negotiation of a Scope of Work, relative priority, and incorporation into an
- 26 integrated schedule, performance of a LFI; and
- 27 ● Determination of minimum data needs for a RA and final Remedy
- 28 Selection (preparation of RI/FS path).
- 29

30 The use of the screening methodology discussed in *A Proposed Data Quality*
31 *Strategy for Hanford Site Characterization* (McCain and Johnson 1990) is also important
32 for achieving schedule and cost-control objectives for answering the questions posed at
33 points B, C, and D of the *Hanford Past-Practice Strategy* diagram. The screening
34 methodology will allow for the analysis of large numbers of samples quickly and at a
35 sufficient level of confidence to allow effective decisions to be made. The screening
36 methods can be verified by comparison with validated laboratory data. This will ensure
37 defensibility of the screening data while at the same time allow for expedited decision-
38 making for determining whether an ERA is needed, whether data are sufficient for
39 further refinement of the conceptual model, and whether additional data can be obtained
40 through limited field investigations. The 200 AAMS Decision-Making Flow Chart
41 (Figure 9-1) presents a modified version of the *Hanford Past-Practice Strategy* that
42 incorporates the objective of providing a defensible basis for determining the need for an

1 ERA. The screening methodology promoted above may also be used to expedite and
2 substantiate subsequent decisions that will be made for the Z Plant operable units.
3
4

5 **8.2 DATA USES AND NEEDS (STAGE 2 OF THE DQO PROCESS)**

6
7 Stage 2 of the DQO development process (EPA 1987) defines data uses and
8 specifies the types of data needed to meet the project objectives. These data uses and
9 needs are based on the Stage 1 results, but must be more specific. The elements of this
10 stage of the DQO process include:
11

- 12 ● Identifying data uses (Section 8.2.1);
- 13 ● Identifying data types (Section 8.2.2.1);
- 14 ● Identifying data quality needs (Section 8.2.2.2);
- 15 ● Identifying data quantity needs (Section 8.2.2.3);
- 16 ● Evaluating sampling/analysis options (Section 8.2.2.4); and
- 17 ● Reviewing data quality parameters (Section 8.2.2.5).

18
19 Stage 2 is developed on the basis of the conceptual model presented in Section 4.0
20 of this report.
21
22

23 **8.2.1 Data Uses**

24
25 For the purposes of the remediation in the Z Plant Aggregate Area, most data
26 uses fall into one or more of four general categories:
27

- 28 ● Site characterization;
- 29 ● Public health evaluation and human health and ecological risk assessments;
- 30 ● Evaluation of remedial action alternatives; and
- 31 ● Worker health and safety.

32
33 Site characterization refers to a process that includes determination and evaluation
34 of the physical and chemical properties of any wastes and contaminated media present at
35 a site, and an evaluation of the nature and extent of the contamination. This process
36 involves the collection of basic geologic, hydrologic, and meteorologic data but more
37 importantly, data on specific chemical and radiological contaminants and sources which
38 can be incorporated into a conceptual model to indicate the relative significance of the
39 various pathways. Site characterization is not an end in itself. But rather, the data
40 generated during site characterization must support the objective of assessing the need
41 for remediation (according to risk assessment methods, either qualitative or quantitative)
42 and providing appropriate means of remediation (through an FFS, FS, or CMS). The

9 3 1 2 8 6 5 1 0 5 3

1 understanding of the site characterization, based on existing data, is presented in Sections
2 2.0 and 3.0, and is summarized in the conceptual model (Section 4.2).

3
4 Data required to conduct a public health evaluation, and human health and
5 ecological risk assessments at the waste management units in the Z Plant Aggregate Area
6 include the following: input parameters for evaluating chemical fate and transport; site
7 characteristics; and contaminant data required to evaluate the threat to public and
8 environmental health and welfare through exposure to the various media. These needs
9 usually overlap with site characterization needs. An extensive discussion of risk
10 assessment data uses and needs is presented in the *Risk Assessment Guidance for*
11 *Superfund* (EPA 1989). The present understanding of site risks is presented in the
12 selection of constituents of concern (Section 4.2), and evaluation of potential human
13 health impacts from Z Plant Aggregate Area waste management units (Section 5).
14 Quantitative risk assessments will be conducted at the Hanford Site with a methodology
15 under development, and the data needs for this methodology will be considered in
16 developing site specific sampling and analysis plans.

17
18 Data collected to support evaluation of remedial action alternatives for ERAs,
19 IRMs, FFSs, or the full RI/FS, include site screening of alternatives, feasibility-level
20 design, and preliminary cost estimates. Once an alternative is selected for
21 implementation, much of the data collected during site investigations (LFI or RI) can
22 also be used for the final engineering design. Generally, collection of information during
23 the investigations specifically for use in the final design, is not cost-effective. It is
24 preferable to gather such specific information during a separate predesign investigation.
25 Based on existing data, broad remedial action technologies and objectives were identified
26 in Section 7.0.

27
28 The worker health and safety category includes data collected to establish the
29 required level of protection for workers during various investigation activities. These
30 data are used to determine if there is concern for the personnel working in the vicinity of
31 the operable unit. The results of these assessments are also used in the development of
32 the Radiation Work Permit.

33
34 It should be noted that each of these data use categories (site characterization,
35 risk assessment needs, remedial actions, and health and safety) will be required at each
36 decision point on the *Hanford Past-Practice Strategy* flow chart, as discussed at the end of
37 Section 8.1.5. To the extent possible, however, not all waste management units will be
38 investigated to the same degree but only those with the highest priority (representative).
39 These results will then be extended to the other, analogous sites which have similar
40 geology and disposal histories (see Section 9.5.2).

1 The existing data can be used for two main purposes:
2

- 3 ● Development of site-specific sampling plans (site characterization); and
- 4
- 5 ● Screening for health and safety (worker health and safety).
- 6

7 Table 8-1 presents a summary of the availability of existing data for these uses.
8

9 For the purposes of developing sampling plans, existing information is available
10 for:

- 11
- 12 ● The location of waste management units — many of the waste
13 management units have surface expressions, markers, or have been
14 surveyed in the past; however, the exact boundaries of some of the units
15 are uncertain. The unplanned releases are generally lacking in this
16 information.
- 17
- 18 ● Possible contamination found at the waste management units — these data
19 are derivable from the inventories of the waste management units (mainly
20 for the cribs and other liquid waste disposal facilities) as well as from
21 limited subsurface soil sampling which has been done at the 216-Z-1A,
22 216-Z-9, and 216-Z-12 Cribs and on the periphery of the Solid Waste
23 Burial Grounds.
- 24
- 25 ● The likely depth of contamination - this information is mainly obtained
26 from gross gamma borehole logging, but core sampling information is
27 available for the three cribs noted above. In addition, rough estimates of
28 the extent of contamination can be developed based on fluid volumes
29 released to the waste management units.
- 30

31 For the waste management units where sampling data are available, samples have
32 been analyzed for a limited range of analytical parameters, to fulfill the specific
33 objectives of the investigation. For example, soils beneath the 216-Z-1A Trench were
34 analyzed for plutonium and americium, but were not analyzed for other likely
35 radionuclide, inorganic, or organic contaminants.
36

37 Two types of information are available for the purposes of worker health and
38 safety, and will be used for the development of future health and safety documents:
39

- 40 ● Levels of surface radiation — derived from the on-going periodic
41 radiological surveys done under the Environmental Surveillance program.
42 It should be noted that surface radiation conditions are transient,

9 3 1 2 8 6 5 1 0 5 5

1 depending on surface disturbance and stabilization activities undertaken
2 under the RARA program. Therefore, a confirmatory radiological survey is
3 recommended prior to commencing field work at a waste management unit.
4

- 5 • Expected contaminant levels - Extensive sampling to characterize the range
6 of contaminant concentrations in subsurface soils has been performed only
7 for plutonium and americium beneath the 216-Z-1A Trench.
8

9 Table 8-1 also may be used to identify the data needs for the individual waste
10 management units in the Z Plant Aggregate Area, which must be addressed for
11 remediation approaches to be developed.
12

13 14 **8.2.2 Data Needs**

15
16 Site characterization is contingent upon an adequate set of data to establish
17 locations and migration patterns and to evaluate the risks that contamination may pose.
18 A critical component of this process is clear definition of the data needs, including: 1)
19 data types; 2) data quality; 3) data quantity; 4) sampling and analysis options; and 5) data
20 quality parameters. These five data classifications are discussed below.
21

22 **8.2.2.1 Data Types.** Data use categories described in Section 8.2.1 define the general
23 purpose and intent for collecting additional data. Based on the intended uses, a concise
24 statement regarding the data types needed can be developed. Data types specified at
25 this stage should not be limited to chemical parameters, but should also include necessary
26 physical parameters such as bulk density and moisture content. Since environmental
27 media and source materials are interrelated, data types used to evaluate one media may
28 also be useful to characterize another media.
29

30 Identifying data types by media exposes overlapping data needs. Data objectives
31 by media, data needs, and types to be collected in the site investigations at sites in the Z
32 Plant Aggregate Area are identified in Table 8-2. These are discussed in greater detail in
33 Section 8.3 to provide focus to investigatory methods which may be employed.
34

35 The data type requirements for the preliminary remedial action technologies
36 developed in Section 7.0 are summarized in Table 8-3.
37

38 **8.2.2.2 Data Quality Needs.** The various tasks and phases of a CERCLA investigation
39 may require different levels of data quality. Important factors in defining data quality
40 include selecting appropriate analytical levels, validation methodologies, and contaminant
41 levels of concern as described below. *A Proposed Data Quality Strategy for Hanford Site*
42 *Characterization*, will be used to help define these levels (McCain and Johnson 1990).

9 3 1 2 8 6 5 1 0 5 6

1 Chemical and radionuclide laboratory analysis will be one of the most important
2 data types required at virtually all of the sites in the Z Plant Aggregate Area. In general,
3 increasing accuracy and precision, and lower detection limits are obtained with increasing
4 cost and time. Therefore, the analytical level used to obtain data should be
5 commensurate with the intended use. Table 8-3 defines five analytical levels associated
6 with different types of characterization efforts. Individual DQO and the appropriate
7 analytical levels associated with each data need are given in Table 8-4.

8
9 Before laboratory and field data can be used in the remedial action process, it
10 must first be validated. Exceptions are made for initial evaluations of the operable unit
11 using existing data, which may not be able to be validated. Other screening data (e.g.,
12 estimates of contaminant concentration inferred from field analyses), and screening data
13 collected in accordance with the strategy outlined in McCain and Johnson (1990) may
14 also be accepted. Validation involves determining the usability and quality of the data.
15 Once data are validated, they can be used to successfully complete the remedial action
16 selection process. Activities involved in the data validation process include the following:

- 17 ● Verification of chain of custody and sample holding times;
- 18 ● Confirmation that laboratory data meet QA/Quality Control (QC) criteria;
- 19 ● Confirmation of the usability and quality of field data, which includes
20 geological logs, hydrologic data, and geophysical surveys; and
- 21 ● Proper documentation and management of data so that they are usable.

22
23
24
25
26
27 Validation may be performed by qualified WHC personnel from the Office of
28 Sample Management, or a qualified independent participant subcontractor. Data
29 validation will be performed in accordance with the Westinghouse Hanford document
30 *Sample Management and Administration* (WHC 1990c).

31
32 To accomplish the second point, all laboratory data must meet the requirements
33 of the specific QA/QC parameters as set up in the Quality Assurance Project Plan for
34 the project before it can be considered usable. The QA/QC parameters address
35 laboratory precision and accuracy, method blanks, instrument calibration, and holding
36 times.

37
38 The usability of field data must be assessed by a trained and qualified person.
39 The project geohydrologist/geophysicist will review the geologic logs, hydrologic data,
40 geophysical surveys, and results of physical testing, on a daily basis, and senior technical
41 reviews will be conducted periodically throughout the project.

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1 Data management procedures are also necessary for the validation. Data
2 management includes proper documentation of field activities, sample management and
3 tracking, and document and inventory control. Specific consistent procedures are
4 discussed in the Data Management Plan (Appendix D).
5

6 **8.2.2.3 Data Quantity Needs.** The number of samples that need to be collected during
7 an RI/FS can be determined by using several approaches. In instances where data are
8 lacking or are limited (such as for contamination in the vadose zone soils), a phased
9 sampling approach will be appropriate. In the absence of any available data, an
10 approach or rationale will need to be developed to justify the sampling locations and the
11 numbers of samples selected. Specific locations and numbers of samples will be
12 determined based on data collected during screening activities. For example, the number
13 and location of beta/gamma spectrometer probe locations can be based on results of
14 surface geophysical and radiation surveys. These may help locate some subsurface
15 features, which may not be adequately documented. Details of any subsurface soil
16 sampling scheme will depend on results of geophysics surveys, surface radiation surveys,
17 and beta/gamma spectrometer probe surveys. In situations where available data are
18 more complete, statistical techniques may be useful in determining the additional data
19 required.
20

21 **8.2.2.4 Sampling and Analysis Options.** Data collection activities are structured to
22 obtain the needed data in a cost-effective manner. Developing a sampling and analysis
23 approach which ensures that appropriate data quality and quantity are obtained with the
24 resources available may be accomplished by using a phased approach and field screening
25 techniques. The investigations on sites in the Z Plant Aggregate Area should take
26 advantage of this approach for a comprehensive characterization of the site in a
27 cost-effective manner.
28

29 A combination of lower level (Levels I, II, and III) and higher level analytical data
30 (Levels IV and V) should be collected. For instance, at least one of the samples
31 collected from each source (including contaminated soil at unplanned release locations)
32 should be analyzed at DQO Level IV or V and validated to provide high quality data.
33 This approach would provide the certainty necessary to determine contaminants present
34 near the sources. Samples will be analyzed by methods indicated in Table 8-5.
35

36 **8.2.2.5 Data Quality Parameters.** Precision, accuracy, representativeness, completeness,
37 and comparability (PARCC) parameters are indicators of data quality. Ideally, the end
38 use of the data collected should define the necessary PARCC parameters. Once the
39 PARCC requirements have been identified, then appropriate analytical methods can be
40 chosen to meet established goals and requirements. Definitions of the PARCC
41 parameters are presented in Section 8.1.2 above.
42

9 3 1 2 8 6 5 1 0 5 8

1 In general the precision and accuracy objectives are governed by the capabilities
2 of the available methodologies and in most cases these are more than adequate for the
3 needs of the investigations. Chemical analyses can usually be pushed to the parts per
4 billion detection range in soils and water, and this level is adequate to the needs of the
5 RA for most analytes. Radiological analyses reach similar levels. Some constituents
6 (e.g., arsenic) would require analysis to much lower levels, but this is impossible because
7 of the limitations of analytical methods and the effects of natural background levels. In
8 addition, a RA is conventionally computed only to a single digit of precision and uses
9 conservative assumptions, which reduce the impact of measurements with lower accuracy.

10
11 For other measurements, such as physical parameters, the precision and accuracy
12 capabilities of existing measurement technologies are sufficient for the evaluation
13 methods used to produce characterization data, so the objectives are based on the
14 limitations of the analysis methodologies.

15
16 Representativeness is maintained by fitting the sampling program to the governing
17 aspects of the sources and transport processes of the site, as demonstrated in the site
18 conceptual model (Section 4.2.2). Initial sampling should concentrate on sources, which
19 are fairly well-understood, and on representative locations of anticipated transport
20 mechanisms. If necessary, following activities can focus on aspects or locations that were
21 not anticipated but were demonstrated by the more general results.

22
23 Completeness is generally attained by specifying redundancy on critical samples
24 and maintaining quality control on their acquisition and analysis. As with
25 representativeness, the initial sampling program may lead to modifications of which
26 samples should be considered critical during subsequent sampling activities.

27
28 Comparability will be met through the use of standard procedures, generally as
29 incorporated into the *Environmental Investigation and Site Characterization Manual*
30 (WHC 1988b) or in other standard references.

31
32 **8.2.2.6 Data Gaps.** Considering the data needs developed in Section 8.2.2 and the data
33 available to meet those needs as presented in Section 8.1.2, it is apparent that a number
34 of data gaps can be identified for the Z Plant Aggregate Area. These are summarized,
35 by waste management unit type, in Table 8-6.

36
37 In addition to the data needs that specifically address contamination problems at
38 individual waste management units and unplanned releases in this aggregate area, there
39 are general data needs which will be required to characterize the possible transport
40 pathways, as presented in the conceptual model. These needs include characterization of
41 the following:
42

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- 1 • Geologic stratigraphy of the vadose zone and possible perched water zones;
- 2
- 3 • Factors affecting air transport of contaminants (e.g., surface soil particle
- 4 size distribution);
- 5
- 6 • Potential releases from process effluent lines between facilities and waste
- 7 disposal sites; and
- 8
- 9 • Ecological impacts and transport mechanisms (bio-uptake,
- 10 bioconcentration).
- 11
- 12

13 **8.3 DATA COLLECTION PROGRAM (STAGE 3)**

14

15 The data collection program is Stage 3 of the process to develop DQOs.

16 Conducting an investigation in phases is a common method for optimizing the quantity

17 and quality of the data collected. It would be very inefficient and overly expensive to

18 specify beforehand all the types of samples and analyses that will yield the most complete

19 and accurate understanding of the contamination and physical behavior of the site. Data

20 adequate to achieve all the goals and objectives for remedial action decisions are

21 obtained at a lower cost by using the information obtained in each step to focus the

22 investigation in succeeding steps.

23

24 Initial sampling should collect new data believed most necessary to confirm and

25 refine the conceptual model. Subsequent phases of sampling may be needed to further

26 reduce uncertainty, to fill in remaining data gaps, to collect more detailed information for

27 certain points where such information is required, and to conduct any needed treatability

28 studies or otherwise support the data needs of the remedial action selection process.

29 The need for subsequent investigation phases will be assessed early in the investigation

30 activities and as data become available. Assessing completeness of the investigation data

31 through a formal statistical procedure is not possible, however, given the complexity and

32 uncertainty of the parameters required to describe the site. Rather, the use of

33 engineering judgement is considered sufficient to the decision process.

34

35

36 **8.3.1 General Rationale**

37

38 The general rationale for the investigation of sites in the Z Plant Aggregate Area

39 is to collect needed data that are not currently available. Because of the size of the

40 Z Plant Aggregate Area, the complexity of past operations, and the number of

41 unplanned releases and waste management units, a large amount of new information will

42 be required.

9 3 1 2 8 6 5 1 0 6 0

1 The following work plan approach will be used for LFIs and RI/FS in the Z Plant
2 Aggregate Area. The results are described in Sections 8.3.2 and 8.3.3 in a general form.
3

- 4 ● Existing data as described in Sections 2.0 and 3.0 should be used to the
5 maximum extent possible. Although existing data are not validated fully,
6 the data are still useful in refining the preliminary conceptual model
7 (Section 4.2.2) and in helping to focus and guide the investigations.
8
- 9 ● Additional validated data should be collected to obtain the maximum
10 amount of useful information for the amount of time and resources
11 invested in the investigation.
12
- 13 ● Data should be collected to support the intended data uses identified in
14 Section 8.2.1.
15
- 16 ● Nonintrusive sampling (e.g., geophysical surveys, surface radiation surveys,
17 soil gas, and beta/gamma probe surveys), and surficial and source sampling
18 should be conducted early in any investigation effort to identify necessary
19 interim response actions.
20
- 21 ● Data collected from initial investigation activities should be used to confirm
22 and refine the conceptual model (Section 4.2), refine the analyte
23 constituents of concern, and provide information to conduct IRA or RA
24 activities.
25
- 26 ● Subsequent investigation activities will support (if needed) long-term risk
27 assessments for final cleanup actions and further refine the conceptual
28 model.
29
- 30 ● Field investigation techniques should be used to minimize the amount of
31 hazardous or mixed waste generated; however, any waste generated will be
32 handled in accordance with EII 4.2, *Interim Control of Unknown Suspected*
33 *Hazardous and Mixed Waste* (WHC 1988c).
34

35 36 **8.3.2 General Strategy**

37
38 The overall objective of any field investigation (LFI or RI) of the sites in the Z
39 Plant Aggregate Area will be to gather additional information to support risk assessment
40 and remedial action selection. The general approach or strategy for obtaining this
41 additional information is presented below.
42

- 1 • Analytical parameter selection should be based on verifying overall
2 conditions and then narrowed to specific constituents of concern, in
3 consideration with regulatory requirements and site conditions. Periodic
4 analyses of the long list of parameters should be conducted to verify that
5 the list of constituents of concern has not changed, either because new
6 constituents are identified or some of those originally considered as a
7 potential concern do not appear to be significant.
8
- 9 • Dangerous and radioactive wastes may be generated during the field
10 investigation. While efforts should be made to minimize these wastes, any
11 waste generated will be handled in accordance with EII 4.2, *Interim Control*
12 *of Unknown Suspected Hazardous and Mixed Waste* (WHC 1988c). The
13 analyses of samples for constituents of concern analytes will allow wastes
14 generated to be adequately designated.
15

17 8.3.3 Investigation Methodology

18
19 Initial field investigations may include some or all of the following integrated
20 methodologies:

- 21 • Source Investigation (Section 8.3.3.1)
- 22 • Geological Investigation (Section 8.3.3.2)
- 23 • Surface Water and Sediment Investigation (Section 8.3.3.3)
- 24 • Soil Investigation (Section 8.3.3.4)
- 25 • Air Investigation (Section 8.3.3.5)
- 26 • Ecological Investigation (Section 8.3.3.6)
- 27 • Seismic Reflection Survey (Section 8.3.3.7)
- 28 • Process Effluent Pipeline Integrity Assessment (Section 8.3.3.8)
- 29 • Geodetic Survey (Section 8.3.3.9)

30
31
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37
38
39
40 Each investigation methodology is briefly outlined in the following sections; more
41 detailed descriptions will be included in site-specific work plans for waste management

1 units which require these investigations. A summary of applicable methods for each
2 waste site is presented in Table 8-7.

3
4 **8.3.3.1 Source Investigation.** The purpose of source investigation activities in the Z
5 Plant Aggregate Area is to characterize the known waste management units and
6 unplanned releases that exist in the operable unit and may contribute to the
7 contamination of surface soil, vadose zone, surface water, sediment, air, and biota. The
8 completeness of the characterization effort will be assessed according to the needs of risk
9 assessment and remedial action selection, which will also determine what levels of the
10 various constituents of concern comprise "contamination."

11
12 Source sampling should be conducted at waste management units or unplanned
13 release locations where the available data indicate that dangerous, mixed, or radioactive
14 wastes may be present. Activities which are proposed to be performed during the source
15 investigations include the following:

- 16
17 ● Compile and evaluate additional existing data for the purpose of: verifying
18 locations, specifications of engineered facilities, and pipelines, and waste
19 stream characteristics; assessment of the construction and condition of
20 boreholes/wells that exist in the operable unit and their suitability for use
21 for investigation activities, QA/QC information, and raw data regarding
22 radiological and hazardous substances monitoring; and integrating any
23 additional environmental modeling data into the conceptual model. This
24 has been done (on an aggregate area basis) in this report; the process will
25 be extended to site-specific planning and on-going assessments of the
26 investigation/remediation as it is carried out.
- 27
28 ● Conduct surface radiological surveys of suspected or known source areas to
29 verify locations of surface and subsurface radiological contamination.
30 Conditions at specific sources should also be noted in order to plan
31 sampling remediation activities and worker health and safety.
- 32
33 ● Conduct nonintrusive geophysical surveys (Electromagnetic Induction and
34 Ground Penetrating Radar) at specific waste management units (e.g, the
35 2607-Z-1 Septic Tank and Field) and unplanned release locations to verify
36 locations and physical characteristics of source locations. Data generated
37 from these activities can be used in planning intrusive source sampling
38 activities.
- 39
40 ● Conduct beta/gamma spectrometer probe surveys to screen for near-surface
41 contamination and to confirm the absence or presence of some specific
42 radionuclides, which may be of particular concern. Westinghouse Hanford

9 3 1 2 8 6 5 1 0 6 3

1 will develop an EII Procedure for the beta/gamma spectrometer probe
2 surveys. The beta/gamma spectrometer probe survey serves two purposes
3 depending on the source conditions: to confirm the absence of
4 contamination in the near-surface soils; and to serve as a screening tool to
5 choose locations and quantities of vadose zone soil borings. The need to
6 conduct these surveys will be based (at least in part) on the results of the
7 surface surveys and on information about historical site burials.
8

- 9 ● Soil gas surveys should be conducted at waste management units where
10 volatile organic chemicals are suspected, as a screening method to identify
11 compounds such as solvents and degreasers that may have been used
12 during construction activities. The soil gas survey should not be considered
13 conclusive that volatile organic compounds at lower concentrations may not
14 be present. Soil gas survey methods of EII 5.9 should be followed. Data
15 from the soil gas surveys can be used to help locate surface and near-
16 surface samples and vadose zone borings.
17
- 18 ● Collect surface and near-surface samples of contaminated soils and/or
19 waste materials at selected locations. Specific sampling sites will be chosen
20 to assess particular facilities or releases. Additional sampling sites may be
21 specified based on results from nonintrusive investigations.
22
- 23 ● Wipe samples should be collected as part of the investigations of surface
24 contamination or building (or pavement) surfaces. The wipe sample
25 locations can be chosen based on visual observations and a surface
26 radiation survey conducted during a site walkthrough.
27

28 **8.3.3.2 Geologic Investigation.** A geologic investigation should be performed to better
29 characterize the vadose zone and the nature of unsaturated sediments that make up this
30 system. The geologic investigation will include the following tasks:
31

- 32 ● Borings may be advanced into zones where an accurate interpolation of the
33 subsurface stratigraphy is important to understanding migration pathways in
34 the vadose zone. An investigation of the Plio-Pleistocene layer, which may
35 be causing perched water zones, may be especially valuable.
36
- 37 ● Geologic data collected during the ongoing vadose zone soil (Section
38 8.3.3.4) and other (deeper) investigations (e.g., geologic and geophysical
39 logs) will be compared, compiled, and evaluated.
40

1 **8.3.3.3 Surface Water and Sediment Investigation.** A surface water and sediment
2 investigation should be conducted. The investigation will include:

- 3
- 4 ● Radiation survey along ditches, trenches, and ponds for health and safety
5 purposes and to locate areas of elevated radiation for selection of specific
6 soil sampling locations.
- 7
- 8 ● Sampling of surface water and sediment in any ditches, ponds, and trenches
9 which still contain water.
- 10

11 **8.3.3.4 Soil Investigation.** The purpose of soil investigations is to determine physical and
12 chemical properties of the soil and to determine the nature, type, and extent of soil
13 contamination associated with waste management units and unplanned releases.

14 Sampling will include:

- 15
- 16 ● Samples of vadose zone soil will be collected and analyzed for constituents
17 of concern when wells are drilled for other studies (i.e., groundwater
18 investigations) in the vicinity of a waste management unit or unplanned
19 release with reported liquid disposals or spills. Organic vapor and radiation
20 sampling will also be performed.
- 21
- 22 ● Data collected during this investigation will be evaluated to further
23 understand the contribution of contaminants to the vadose zone from
24 specific waste management units and/or unplanned releases and to define
25 the hydrology and water quality in the vadose zone system.
- 26

27 **8.3.3.5 Air Investigation.** Any air investigations should consist of on-site particulate
28 sampling as part of the health and safety program. In addition, high-volume air samplers
29 should be placed in appropriate on-site locations based on evaluation of existing
30 meteorological data. The purpose of these samplers will be to determine if any
31 migration of airborne contaminants occurs.

32

33 **8.3.3.6 Ecological Investigation.** Ecological investigation activities should include a
34 literature search and data review, and a site walkthrough. These activities are intended
35 to identify potential biota concerns which need to be addressed in later phases of the site
36 investigation. Particular emphasis should be given to identifying potential exposure
37 pathways to biota that migrate off site or that introduce contaminants into the food web.

38

39 A cultural resource investigation should be conducted in the Z Plant Aggregate
40 Area to verify the locations of known archeological sites by reviewing existing data. The
41 focus of the investigation will be to confirm that no archaeological resources are present
42 at proposed drilling sites.

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1 **8.3.3.7 Seismic Reflection Survey.** A seismic reflection survey will be conducted across
2 the operable unit to help characterize the geology and hydrogeology of the vadose zone.
3 Of particular interest are perched water zones and the caliche layer (an important
4 aquitard) in the Plio-Pleistocene Unit.
5

6 **8.3.3.8 Process Effluent Pipeline Integrity Assessment.** An assessment of process
7 effluent pipeline integrity should be conducted early in site investigation activities to look
8 for potential leaks and therefore possible areas of contamination. Initially, as part of this
9 effort, drawings of the process lines and encasements within the operable unit should be
10 reviewed and their construction, installation, and operation evaluated. Specific lines will
11 then be selected for integrity assessment with emphasis on lines serving the waste
12 management units that have received large volumes of liquid (e.g., cribs). Results of the
13 integrity assessments will be evaluated and additional sampling activities may be
14 recommended for subsequent studies.
15

16 **8.3.3.9 Geodetic Survey.** Geodetic surveys will be conducted after the installation and
17 completion of each phase of investigation. The survey will be to locate the horizontal
18 locations of surface and near-surface soil samples; corners of geophysics, soil gas, and
19 beta/gamma probe surveys; and surface water and sediment sample locations. Horizontal
20 and vertical locations of all vadose zone soil borings and perched zone wells will be
21 surveyed. The geodetic survey will be conducted by a professional surveyor licensed in
22 the state of Washington.
23
24

25 **8.3.4 Data Evaluation and Decision-Making**

26
27 Data will be evaluated as soon as results for each episode (e.g., soil gas, round of
28 water sampling, drilling program) become available for use in restructuring and focusing
29 the investigation activities. Data reports will be developed that summarize and interpret
30 new data. Data will be used to refine the conceptual model, further assess potential
31 contaminant-specific ARARs, develop the risk assessment, and assess remedial action
32 alternatives.
33

34 The objectives of data evaluation are:

- 35
- 36 ● To reduce and integrate data to ensure that data gaps are identified and
37 that the goals and objectives of the Z Plant AAMS are met; and
- 38
- 39 ● To confirm that data are representative of the media sampled and that
40 QA/QC criteria have been met.
41

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9 3 1 0 2 5 1 0 5 7

Table 8-1. Uses of Existing Data for Z Plant Aggregate Area Waste Management Units. (Sheet 1 of 5)

Waste Management Unit	Development of Sampling Plans			Health and Safety	
	Location	Possible Contamination	Depth of Contamination	Surface Radiation	Expected Max. Level
Plants, Buildings, and Storage Areas					
232-Z Incinerator	X				
234-5Z HWSA	X				
WRAP	X				
RMW Storage Facility	X				
Tanks and Sanitary Vaults					
216-Z-8 Settling Tank	X	X			
241-Z-361 Settling Tank	X				
241-Z Treatment Tank	X	X		X	
Cribs, Trenches, and Tile Fields					
216-Z-1 and 216-Z-2 Cribs	X	X	X	X	
216-Z-3 Crib	X	X	X	X	
216-Z-5 Crib	X	X	X	X	
216-Z-6 Crib	X	X	X	X	
216-Z-7 Crib	X	X	X	X	
216-Z-12 Crib	X	X	X	X	
216-Z-16 Crib	X	X	X	X	
216-Z-18 Crib	X	X	X	X	

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Table 8-1. Uses of Existing Data for Z Plant Aggregate Area Waste Management Units. (Sheet 2 of 5)

Waste Management Unit	Development of Sampling Plans			Health and Safety	
	Location	Possible Contamination	Depth of Contamination	Surface Radiation	Expected Max. Level
216-Z-8 French Drain	X	X	X	X	X
216-Z-13 French Drain	X	X		X	
216-Z-14 French Drain	X	X		X	
216-Z-15 French Drain	X	X		X	
216-Z-1A Tile Field	X	X	X	X	X
Reverse Well					
216-Z-10 Reverse Well	X	X	X	X	
Ponds, Ditches, and Trenches					
216-Z-4 Trench	X	X		X	
216-Z-9 Trench	X	X	X	X	X
216-Z-17 Trench	X	X	X	X	
Septic Tanks					
2607-Z Septic Tank & Field	X				
2607-Z-1 Septic Tank & Field	X				
2607-WA Septic Tank & Field	X				
2607-WB Septic Tank & Field	X				
2607-W-8 Septic Tank & Field	X				

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Table 8-1. Uses of Existing Data for Z Plant Aggregate Area Waste Management Units. (Sheet 3 of 5)

Waste Management Unit	Development of Sampling Plans			Health and Safety	
	Location	Possible Contamination	Depth of Contamination	Surface Radiation	Expected Max. Level
Transfer Facilities, Diversion Boxes, and Pipelines					
241-Z Diversion Box No.1	X	X			
241-Z Diversion Box No. 2	X	X			
231-Z-151 Sump	X	X			
Basins					
207-Z Retention Basin	X	X			
216-Z-21 Seepage Basin	X	X			
Solid Waste Burial Sites					
218-W-1 Burial Ground	X	X		X	
218-W-1A Burial Ground	X	X		X	
218-W-2 Burial Ground	X	X		X	
218-W-2A Burial Ground	X	X		X	
218-W-3 Burial Ground	X	X		X	
218-W-3A Burial Ground	X	X		X	
218-W-3AE Burial Ground	X	X		X	
218-W-4A Burial Ground	X	X		X	
218-W-4B Burial Ground	X	X		X	
218-W-4C Burial Ground	X	X		X	

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Table 8-1. Uses of Existing Data for Z Plant Aggregate Area Waste Management Units. (Sheet 4 of 5)

Waste Management Unit	Development of Sampling Plans			Health and Safety	
	Location	Possible Contamination	Depth of Contamination	Surface Radiation	Expected Max. Level
218-W-5 Burial Ground	X	X		X	
218-W-6 Burial Ground					
218-W-11 Burial Ground	X	X		X	
Z-Plant Burn Pit	X				
Unplanned Releases					
UN-200-W-11	X	X			
UPR-200-W-16	X	X			
UN-200-W-23	X	X			
UPR-200-W-26	X	X			
UN-200-W-44	X	X			
UPR-200-W-45		X			
UPR-200-W-53	X	X			
UPR-200-W-72		X			
UN-200-W-74	X	X			
UN-200-W-75	X	X			
UN-200-W-79	X	X			
UPR-200-W-84		X			
UN-200-W-89	X	X			

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Table 8-1. Uses of Existing Data for Z Plant Aggregate Area Waste Management Units. (Sheet 5 of 5)

Waste Management Unit	Development of Sampling Plans			Health and Safety	
	Location	Possible Contamination	Depth of Contamination	Surface Radiation	Expected Max. Level
UN-200-W-90	X	X			
UN-200-W-91	X	X			
UN-200-W-103	X	X		X	
UN-200-W-130	X	X			
UN-200-W-132	X				
UPR-200-W-134	X				
UPR-200-W-158	X	X			
UN-200-W-159	X	X			

Notes:

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Table 8-2. Data Collection Objectives for the Z Plant Aggregate Area. (Sheet 1 of 2)

Data Objectives	Data Needs	Data Types
<u>Sources</u>		
Refine understanding of facility characteristics	Locations of contaminant source	<ul style="list-style-type: none"> • Source data compilation
Determine waste characteristics and spatial distribution of contaminants	Physical, chemical and radiological characterization of the sources	<ul style="list-style-type: none"> • Chemical and radiological properties • Geophysical properties
<u>Geologic</u>		
Identify pathways for contaminant migration	Stratigraphy, structure	<ul style="list-style-type: none"> • Lithology • Soil/sediment type
<u>Surface Soil</u>		
Determine presence or absence of contaminants	Contaminant characterization	<ul style="list-style-type: none"> • Concentrations • Physicochemical and radiological properties
<u>Vadose Zone</u>		
Determine presence or absence and spatial distribution of contamination	Contaminant characterization of the soil column	<ul style="list-style-type: none"> • Chemical and radiological properties
Refine concepts of unsaturated flow and recharge and contaminant transport characteristics	Soil physicochemical properties	<ul style="list-style-type: none"> • Physicochemical properties
<u>Surface Water/Sediment</u>		
Determine presence or absence of contaminants	Characterization of the water quality and sediments	<ul style="list-style-type: none"> • Field parameters (water quality) • Chemical and Radiological Properties

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Table 8-2. Data Collection Objectives for the Z Plant Aggregate Area. (Sheet 2 of 2)

Data Objectives	Data Needs	Data Types
<u>Air</u>		
Determine presence or absence of contaminants around field activities	Air quality	<ul style="list-style-type: none"> • Physical properties • Chemical and radiological concentrations
<u>Aquatic Biota</u>		
Determine the biotic communities present	Identification of critical habitats	<ul style="list-style-type: none"> • Literature review • Field observations
Determine presence or absence of contaminants	Contaminant characterization of the biota	<ul style="list-style-type: none"> • Literature review • Chemical and radiological concentrations
<u>Cultural Resources</u>		
Identify archaeological or historic sites.	Literature review Field survey	<ul style="list-style-type: none"> • Locations • Site protection requirements

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Table 8-3. Data Needs for Preliminary Remedial Action Technologies. (Sheet 1 of 2)
 for Z Plant Aggregate Area Waste Management Units

Technology Group	Physical Attribute	Chemical Attribute
<u>Removal/Recovery</u>		
Examples: <ul style="list-style-type: none"> • excavation • remote retrieval • pumping (hydraulic removal) • mechanical removal • french drains 	<ul style="list-style-type: none"> • areal extent • depth • relationship to natural features and man-made structures • geologic constraints • medium 	<ul style="list-style-type: none"> • toxicity/radioactivity • levels of contaminants (worker/public exposure)
<u>Ex Situ Treatment</u>		
Examples: <ul style="list-style-type: none"> • ion exchange • vitrification • bioremediation • air stripping • encapsulation • incineration • volatilization • soil washing • physical separation • fixation/stabilization • thermal treatment • ceramic forming 	<ul style="list-style-type: none"> • particle size • medium 	<ul style="list-style-type: none"> • specific treatment is contaminant dependent • contaminant heterogeneity • geochemistry of soil medium

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Table 8-3. Data Needs for Preliminary Remedial Action Technologies. (Sheet 2 of 2)
for Z Plant Aggregate Area Waste Management Units

Technology Group	Physical Attribute	Chemical Attribute
<u>In Situ Treatment</u>		
<p>Examples:</p> <ul style="list-style-type: none"> • vitrification • solidification • vapor vacuum extraction • bioremediation • grouting • precipitation • flushing • Chemical extraction • Aeration/air stripping 	<ul style="list-style-type: none"> • areal extent • depth • relationship to natural features and man-made structures • geologic constraints • medium 	<ul style="list-style-type: none"> • specific treatment is contaminant dependent
<u>In Situ Isolation/Containment</u>		
<p>Examples</p> <ul style="list-style-type: none"> • slurry walls • capping • grout curtains • cryogenic barriers • backfill • revegetation 	<ul style="list-style-type: none"> • areal extent • depth • relationship to natural features and man-made structures • geologic constraints • medium 	<ul style="list-style-type: none"> • may be important in choosing compatible materials for barrier
<u>Disposal</u>		
<p>Example:</p> <ul style="list-style-type: none"> • on-site disposal • RCRA permitted landfill • geologic repository • disposal vaults 	<ul style="list-style-type: none"> • siting a new facility requires space availability, geologic considerations, and medium to be disposed of 	<ul style="list-style-type: none"> • must meet chemical-specific disposal criteria

Source: Modified from EPA 1987

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**Table 8-4. Comprehensive List of Analytes and Parameters. (Sheet 1 of 5)
for the Z Plant Aggregate Area**

Radionuclides	Soil/Sediment				Water			
	Analysis ¹	PQL ¹ in pCi/g	Precision ² in RPD	Accuracy ² in %	Analysis ¹	PQL ¹ in pCi/L	Precision ² in RPD	Accuracy ² in %
Gross Alpha	900.0 M	TBD	±30	±25	900.0	10	±25	±25
Gross Beta	900.0 M	TBD	±30	±25	900.0	5	±25	±25
Gross Gamma	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Actinium-225	907.0 M	TBD	±30	±25	907.0	TBD	±25	±25
Actinium-227	TBD	TBD	±30	±25	TBD	TBD	±25	±20
Americium-241	Am-01	TBD	±30	±25	Am-03	TBD	±25	±25
Americium-242	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Americium-242m	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Americium-243	Am-01	TBD	±30	±25	Am-03	TBD	±25	±25
Barium-133	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Bismuth-210	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Bismuth-211	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Bismuth-213	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Bismuth-214	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Carbon-14	C-01 M	TBD	±30	±25	TBD	TBD	±25	±25
Cesium-134	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Cesium-137	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Cobalt-60	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Curium-242	907.0 M	TBD	±30	±25	907.0	TBD	±25	±25

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**Table 8-4. Comprehensive List of Analytes and Parameters. (Sheet 2 of 5)
for the Z Plant Aggregate Area**

Radionuclides	Soil/Sediment				Water			
	Analysis ^{1/}	PQL ^{1/} in pCi/g	Precision ^{2/} in RPD	Accuracy ^{2/} in %	Analysis ^{1/}	PQL ^{1/} in pCi/L	Precision ^{2/} in RPD	Accuracy ^{2/} in %
Iodine-129	902.0 M	TBD	±30	±25	902.0	TBD	±25	±25
Lead-209	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Lead-210	Pb-01 M	TBD	±30	±25	Pb-01	TBD	±25	±25
Lead-211	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Lead-212	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Lead-214	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Neptunium-237	907.0 M	TBD	±30	±25	907.0	TBD	±25	±25
Neptunium-239	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Nickel-59	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Nickel-63	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Niobium-93m	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Plutonium	Pu-02	TBD	±30	±25	Pu-10	TBD	±25	±25
Plutonium-238	Pu-02	TBD	±30	±25	Pu-10	TBD	±25	±25
Plutonium-239/240	Pu-02	TBD	±30	±25	Pu-10	TBD	±25	±25
Plutonium-241	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Polonium-214	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Polonium-215	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Polonium-218	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Potassium-40	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25

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**Table 8-4. Comprehensive List of Analytes and Parameters. (Sheet 3 of 5)
for the Z Plant Aggregate Area**

Radionuclides	Soil/Sediment				Water			
	Analysis ^{1/}	PQL ^{1/} in pCi/g	Precision ^{2/} in RPD	Accuracy ^{2/} in %	Analysis ^{1/}	PQL ^{1/} in pCi/L	Precision ^{2/} in RPD	Accuracy ^{2/} in %
Selenium-79	TBD	TBD	±30	±25	TBD	2.5	±25	±25
Sodium-22	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Strontium-90	Sr-02	TBD	±30	±25	Sr-02	TBD	±25	±25
Technetium-99	Tc-01 M	TBD	±30	±25	Tc-01	TBD	±25	±25
Thallium-204	TBD	TBD	±30	±25	TBD	300	±25	±25
Thorium-227	00-06	TBD	±30	±25	00-07	TBD	±25	±25
Thorium-229	00-06	TBD	±30	±25	00-07	TBD	±25	±25
Thorium-230	00-06	TBD	±30	±25	00-07	TBD	±25	±25
Thorium-231	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Tritium	906.0 M	TBD	±30	±25	906.0	300	±25	±25
Uranium-233	U	TBD	±30	±25	908.0	TBD	±25	±25
Uranium-234	U	TBD	±30	±25	908.0	TBD	±25	±25
Uranium-235	U	TBD	±30	±25	908.0	TBD	±25	±25
Uranium-236	U	TBD	±30	±25	908.0	TBD	±25	±25
Uranium-238	U	TBD	±30	±25	908.0	TBD	±25	±25
Yttrium-90	Sr-02	TBD	±30	±25	Sr-02	TBD	±25	±25

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**Table 8-4. Comprehensive List of Analytes and Parameters. (Sheet 4 of 5)
for the Z Plant Aggregate Area**

Inorganics	Soil/Sediment				Water			
	Analysis ¹	PQL ¹ in mg/kg	Precision ² (RPD)	Accuracy ² (%)	Analysis ¹	PQL ¹ in µg/L	Precision ² (RPD)	Accuracy ² (%)
Aluminum	6010	0.45	±25	±30	6010	450	±20	±25
Ammonia	350.2 M	500	±25	±30	350.2	500	±20	±25
Arsenic	7061	0.02	±25	±30	7061	10	±20	±25
Barium	6010	0.02	±25	±30	6010	20	±20	±25
Boron	6010	TBD	±25	±30	6010	TBD	±20	±25
Cadmium	6010	0.09	±25	±30	6010	1	±20	±25
Chromium	6010	0.07	±25	±30	6010	10	±20	±25
Copper	6010	0.06	±25	±30	220.2	10	±20	±25
Cyanide	9010	TBD	±25	±30	335.3	50	±20	±25
Fluoride	300 M	TBD	±25	±30	300	50	±20	±25
Iron	6010	20	±25	±30	6010	70	±20	±25
Lead	6010	0.45	±25	±30	6010	450	±20	±25
Manganese	6010	0.02	±25	±30	6010	20	±20	±25
Mercury	7471	0.002	±25	±30	245.2	2	±20	±25
Nickel	6010	1.5	±25	±30	6010	50	±20	±25
Nitrate	300 M	TBD	±25	±30	300	130	±20	±25
Nitrite	300 M	TBD	±25	±30	300	40	±20	±25
Selenium	6010	0.75	±25	±30	270.2	20	±20	±25
Titanium	6010	TBD	±25	±30	6010	TBD	±20	±25
Vanadium	6010	0.08	±25	±30	286.2	40	±20	±25
Zinc	6010	0.02	±25	±30	6010	20	±20	±25

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**Table 8-4. Comprehensive List of Analytes and Parameters. (Sheet 5 of 5)
for the Z Plant Aggregate Area**

Organics	Soil/Sediment				Water			
	Analysis ^{1/}	PQL ^{1/} in mg/kg	Precision ^{2/} (RPD)	Accuracy ^{2/} (%)	Analysis ^{1/}	PQL ^{1/} in µg/L	Precision ^{2/} (RPD)	Accuracy ^{2/} (%)
Acetone	8240	0.1	±25	±30	8240	100	±20	±25
Carbon tetrachloride	8240	0.005	±25	±30	8240	1	±20	±25
Chloroform	8240	0.005	±25	±30	8240	5	±20	±25
DDT	8080	0.008	±25	±30	8080	0.1	±20	±25
Kerosene	8015	20	±35	±30	8015	500	±35	±25
Methylene chloride	8240	0.005	±25	±30	8240	5	±20	±25
MIBK	8240	0.5	±25	±30	8240	5	±20	±25
Toluene	8240	0.005	±25	±30	8240	5	±20	±25
Tributyl phosphate	TBD	TBD	±35	±30	TBD	TBD	±30	±25

TBD = To Be Determined

M = EPA method modified to include extraction from the solid medium, extraction method is matrix- and laboratory-specific if herefore TBD.

^{1/} *Prescribed Procedures for Measurements of Radioactivity in Drinking Water* (EPA 1980a)
Test Methods for Evaluation of Solid Waste (SW 846) Third Edition (EPA 1986)
Methods for Chemical Analysis of Water and Waste (EPA 1983a)

^{2/} Precision and accuracy are goals. Since these parameters are highly matrix dependent they could vary greatly from the goals listed.

Table 8-5. Analytical Levels for the Z Plant Aggregate Area.

Level	Description
I	Field Screening. This level is characterized by the use of portable instruments which can provide real-time data to assist in the optimization of sampling point locations and for health and safety support. Data can be generated regarding the presence or absence of certain contaminants (especially volatiles) at sampling locations.
II	Field Analysis. This level is characterized by the use of portable analytical instruments which can be used onsite, or in mobile laboratories stationed near a site (close-support laboratories). Depending on the types of contaminants, sample matrix, and personnel skill, qualitative and quantitative data can be obtained.
III	This level is used primarily in support of engineering studies using standard EPA-approved procedures. Some procedures may be equivalent to Contract Laboratory Program (CLP) Routine Analytical Services without the CLP requirements for documentation.
IV	Contract Laboratory Program (CLP) Routine Analytical Services. This level is characterized by rigorous QA/QC protocols and documentation and provides qualitative and quantitative analytical data. Some regions have obtained similar support via their own regional laboratories, university laboratories, or other commercial laboratories.
V	Nonstandard Methods. Analyses which may require method modification and/or development are considered Level V by CLP Special Analytical Services.

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Table 8-6. Data Gaps by Waste Management Unit Category.

Waste Management Unit Category	Identified Data Gaps
Tanks	<ul style="list-style-type: none"> ● Integrity of tanks and piping ● Contaminant concentrations in tank wastes ● Volume of tank wastes ● Contaminant concentrations and distributions in soils beneath tank
Cribs, Trenches, Tile Fields, Drain Fields	<ul style="list-style-type: none"> ● Surface soil contaminant concentrations ● Subsurface soil contaminant concentrations ● Soil gas contaminant concentrations ● Vertical/lateral extent of contamination ● Specific constituents (especially organics and heavy metals)
French Drains, Reverse Wells	<ul style="list-style-type: none"> ● Subsurface soil contaminant concentrations ● Vertical/lateral extent of contamination ● Specific constituents
Transfer Facilities, Waste Handling Facilities	<ul style="list-style-type: none"> ● Surface radiation readings
Burn Pit	<ul style="list-style-type: none"> ● Specific constituents (organics, heavy metals)
Retention Basin	<ul style="list-style-type: none"> ● Surface radiation readings ● Surface sediment contaminant concentrations ● Subsurface soil contaminant concentrations ● Specific constituents
Seepage Basin	<ul style="list-style-type: none"> ● Surface water concentrations ● Sediment concentrations ● Vertical/lateral extent of contamination
Burial Grounds	<ul style="list-style-type: none"> ● Surface soil contaminant concentrations ● Subsurface soil contaminant concentrations ● Vertical/lateral extent of contamination ● Specific constituents (organics/heavy metals)
Unplanned Releases	<ul style="list-style-type: none"> ● Constituents and concentrations in surface and subsurface soils. ● Distribution/extent of subsurface contamination.

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**Table 8-7. Applicable Characterization Methods. (Sheet 1 of 5)
at Z Plant Aggregate Area Waste Management Units**

Waste Management Unit	Surface Radiation Survey	Subsurface Spectral Geophysics	Surface Geophysics (EM/GPR)	Soil Gas Survey	Surface Soil Sampling	Wipe Samples	Subsurface Soil Sampling	Perched Zone Monitoring Wells	Remarks
Plants, Buildings, and Structures									
232-Z Incinerator									No Further Action
234-5Z HWSA									No Further Action
WRAP									Proposed Facility
RMW Storage Facility	X								No Further Action
Tanks and Vaults									
216-Z-8 Settling Tank	X				X	X	X		
241-Z-361 Settling Tank	X			X	X	X	X		
241-Z Treatment Tank	X				X	X	X		See UPR-200-W-79
Cribs and Drains									
216-Z-1 & 216-Z-2 Cribs	X	X		X	X		X	X	
216-Z-3 Crib	X	X		X	X		X	X	
216-Z-5 Crib	X	X			X		X	X	
216-Z-6 Crib	X	X			X		X	X	
216-Z-7 Crib	X	X			X		X	X	
216-Z-12 Crib	X	X		X	X		X	X	
216-Z-16 Crib	X	X			X		X	X	
216-Z-18 Crib	X	X		X	X		X	X	
216-Z-8 French Drain	X	X			X	X	X	X	

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Table 8-7. Applicable Characterization Methods. (Sheet 2 of 5)
at Z Plant Aggregate Area Waste Management Units

Waste Management Unit	Surface Radiation Survey	Subsurface Spectral Geophysics	Surface Geophysics (EM/GPR)	Soil Gas Survey	Surface Soil Sampling	Wipe Samples	Subsurface Soil Sampling	Perched Zone Monitoring Wells	Remarks
216-Z-13 French Drain	X						X		
216-Z-14 French Drain	X						X		
216-Z-15 French Drain	X						X		
216-Z-1A Tile Field	X	X		X	X		X	X	
Reverse Well									
216-Z-10 Reverse Well	X	X			X		X	X	
Ponds, Ditches, and Trenches									
216-Z-4 Trench	X	X			X		X	X	
216-Z-9 Trench	X	X		X	X		X	X	
216-Z-17 Trench	X	X			X		X	X	
Septic Tanks									
2607-Z Septic Tank & Field			X				X	X	
2607-Z-1 Septic Tank & Field			X				X		
2607-WA Septic Tank & Field			X				X	X	
2607-WA Septic Tank & Field			X				X		
2607-W-8 Septic Tank & Field			X				X		
Transfer Facilities, Diversion Boxes, and Pipeline									
241-Z Diversion Box No. 1	X			X	X	X	X		
241-Z Diversion Box No. 2	X			X	X	X	X		

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Table 8-7. Applicable Characterization Methods. (Sheet 3 of 5)
at Z Plant Aggregate Area Waste Management Units

Waste Management Unit	Surface Radiation Survey	Subsurface Spectral Geophysics	Surface Geophysics (EM/GPR)	Soil Gas Survey	Surface Soil Sampling	Wipe Samples	Subsurface Soil Sampling	Perched Zone Monitoring Wells	Remarks
231-Z-151 Sump	X				X	X	X		
Basins									
241-Z Retention Basin	X				X		X		
216-Z-21 Steeple Basin					X		X	X	
Burial Sites									
218-W-1 Burial Ground					X		X		
218-W-1A Burial Ground					X		X		
218-W-2 Burial Ground					X		X		
218-W-2A Burial Ground					X		X		
218-W-3 Burial Ground					X		X		
218-W-3A Burial Ground					X		X		
218-W-3AE Burial Ground	X				X		X		
218-W-4A Burial Ground					X		X		
218-W-4B Burial Ground					X		X		
218-W-4C Burial Ground	X				X		X		
218-W-5 Burial Ground	X				X		X		
218-W-6 Burial Ground									Proposed Facility
218-W-11 Burial Ground	X				X		X		
Z Plant Burn Pit	X				X		X		

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**Table 8-7. Applicable Characterization Methods. (Sheet 4 of 5)
at Z Plant Aggregate Area Waste Management Units**

Waste Management Unit	Surface Radiation Survey	Subsurface Spectral Geophysics	Surface Geophysics (EM/GPR)	Soil Gas Survey	Surface Soil Sampling	Wipe Samples	Subsurface Soil Sampling	Perched Zone Monitoring Wells	Remarks
Unplanned Releases									
UN-200-W-11	X				X				
UPR-200-W-16	X				X				
UN-200-W-23	X				X		X		
UPR-200-W-26	X				X				
UN-200-W-44	X				X				
UPR-200-W-45	X				X		X		
UPR-200-W-53	X				X		X		
UPR-200-W-72									
UN-200-W-74	X				X				
UN-200-W-75	X				X				
UN-200-W-79	X				X				
UPR-200-W-84	X				X				
UN-200-W-89	X				X				
UN-200-W-90	X				X				
UN-200-W-91	X				X				
UN-200-W-103	X				X		X		
UN-200-W-130	X				X		X		
UN-200-W-132	X				X		X		

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**Table 8-7. Applicable Characterization Methods. (Sheet 5 of 5)
at Z Plant Aggregate Area Waste Management Units**

Waste Management Unit	Surface Radiation Survey	Subsurface Spectral Geophysics	Surface Geophysics (EM/GPR)	Soil Gas Survey	Surface Soil Sampling	Wipe Samples	Subsurface Soil Sampling	Perched Zone Monitoring Wells	Remarks
UPR-200-W-134									
UPR-200-W-158	X				X				
UN-200-W-159	X				X				

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4 **9.0 RECOMMENDATIONS**
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6

7 The purpose of the AAMS is to compile and evaluate the existing body of knowledge
8 to support the *Hanford Past-Practice Strategy* (Thompson 1991) decision-making process. A
9 primary task in achieving this purpose is to assess each waste management unit and
10 unplanned release within the aggregate area to determine the most expeditious path for
11 remediation within the statutory requirements of CERCLA and RCRA. The existing body of
12 pertinent knowledge regarding Z Plant Aggregate Area waste management units and
13 unplanned releases has been summarized and evaluated in the previous sections of this study.
14 A data evaluation process has been established that uses the existing data to develop
15 preliminary recommendations on the appropriate remediation process path for each waste
16 management unit and unplanned release. This data evaluation process is a refinement of the
17 *Hanford Past-Practice Strategy* (Figure 1-2) and establishes criteria for selecting appropriate
18 *Hanford Past-Practice Strategy* paths (expedited response action, ERA; interim remedial
19 measures, IRM; limited field investigation, LFI; and final remedy selection) for individual
20 waste management units and unplanned releases within the 200 Areas.
21

22 This section presents recommended assessment paths for the waste management units
23 and unplanned releases at the Z Plant Aggregate Area. These recommendations are only
24 proposed at this time and are subject to adjustment and change. Factors that may affect
25 development of final recommendations include, but are not limited to, comments and advice
26 from EPA, Ecology, or DOE, identification and development of new information, and
27 modification of the criteria used in the assessment path decision-making process. Changes in
28 recommendations will be addressed, and more detail on recommended assessment paths for
29 waste management units and unplanned releases will be included, in work plans as they are
30 developed for the actual investigation and remediation activities.
31

32 A discussion of the criteria for assessment path selection is provided in Section 9.1.
33 Figure 9-1 provides a flowchart of the data evaluation process that will be discussed. The
34 results of the data evaluation process are provided in Section 9.2. Recommendations for
35 redefining operable unit boundaries and prioritizing operable units for work plan development
36 are provided in Section 9.3. Sections 9.4 and 9.5 provide recommendations for focused
37 feasibility studies and treatability studies, respectively.
38

39 Table 9-1 provides a summary of the recommendations of the remediation process
40 path assessment for Z Plant Aggregate Area waste management units and unplanned releases.
41 Table 9-2 provides a summary of decisions made during the data evaluation process path

1 assessment for Z Plant Aggregate Area waste management units and unplanned releases.
2 Decisions and recommendations are summarized in the following paragraphs and discussed in
3 detail in the remainder of this section.
4

5 Two septic tanks and associated sanitary drain fields were recommended for an ERA
6 to assess whether the liquid discharged to the system is mobilizing contamination beneath the
7 216-Z-3 Crib, 216-Z-8 French Drain, and 216-Z-9 Trench and to take corrective action, if
8 required. An ERA for liquid removal from two tanks, the 216-Z-361 Settling Tank and the
9 216-Z-8 Settling Tank, is recommended to minimize potential leakage. Several waste
10 management units assessed within the ERA path were recommended for actions that fall
11 within the scope of existing operational programs. Wooden cribs with collapse potential and
12 waste management units with elevated levels of surface radionuclide contamination were
13 recommended for response under the Radiation Area Remedial Action (RARA) program.
14

15 A majority of waste management units and unplanned releases do not have
16 information regarding the nature and extent of contamination necessary for quantitative or
17 qualitative risk assessment, especially with regard to hazardous constituents, and were
18 recommended for additional investigation. LFIs were recommended for all cribs and
19 associated transfer units (241-Z Diversion Boxes No. 1 and No. 2 and the 231-Z-151 Sump),
20 all trenches, the 216-Z-1A Tile Field, and four solid waste burial sites (218-W-1, 218-W-2,
21 218-W-3, and 218-W-4A Burial Grounds). A risk assessment was recommended for four
22 unplanned releases for which sufficient information appears to exist to perform the
23 assessment; available information indicates that the risk assessment would likely conclude
24 that no further remediation will be necessary. Two remedial investigations were
25 recommended for the remaining liquid waste disposal units and solid waste disposal units,
26 along with their corresponding unplanned releases.
27

28 Several Z Plant Aggregate Area facilities are TSD facilities and are planned to be
29 addressed under the RCRA program for the Hanford Site. These facilities include: the 218-
30 W-2A, 218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, and 218-W-5 Burial Grounds, and
31 the proposed 218-W-6 Burial Ground; the Radioactive Mixed Waste (RMW) Storage
32 Facility; the proposed Waste Receiving and Processing (WRAP) facility; and the 241-Z
33 Treatment Tank (including Tanks D-4, D-5, D-7, and D-8). Because these facilities are
34 included in a RCRA Part B permit application and will be closed in accordance with the TSD
35 facility closure requirements, no action under the AAMS is contemplated. Six unplanned
36 releases (UPR-200-W-45, UN-200-W-74, UN-200-W-75, UN-200-W-79, UN-200-W-132,
37 and UPR-200-W-158) are closely associated with the TSD facilities and as a result are
38 similarly recommended for consideration under the RCRA program.
39

40 The 232-Z Incinerator Building is scheduled for decontamination and
41 decommissioning in fiscal year 1999 under the Hanford Surplus Facilities Program. Because

1 no information was found indicating releases to the soil column below the facility had
2 occurred or might occur in the near future, the 232-Z Incinerator Building was recommended
3 for consideration under the Surplus Facilities Program and no further action would be
4 pursued under the AAMS program. The 216-Z-9 Trench is also scheduled for
5 decontamination and decommissioning in fiscal year 2011 under the Hanford Surplus
6 Facilities Program. Due to its low to moderate relative risk ranking (Section 5.0), the 216-
7 Z-9 Trench is recommended for LFI in advance of the proposed decommissioning date to
8 evaluate the potential extent of radionuclide and organic chemical contamination in the soil
9 column beneath the facility.

12 9.1 DECISION-MAKING CRITERIA

14 The criteria used for assessing the most expeditious remediation process path are
15 based primarily on urgency for action and whether the data are adequate to proceed along a
16 given path (Figure 9-1). All waste management units and unplanned releases that are not
17 completely addressed under other Hanford Site programs are assessed in the data evaluation
18 process. All of the units and unplanned releases that are addressed in the data evaluation
19 process have been initially evaluated as candidates for an ERA. Units and unplanned
20 releases where a release has occurred or is imminent become a candidate for an ERA.
21 Conditions that might trigger an ERA are the determination of an unacceptable health or
22 environmental risk or a short time frame available to mitigate the problem (Thompson 1991).
23 As a result, ERA candidates were evaluated against a set of criteria to determine whether
24 potential for exposure to unacceptable health or environmental risks exists. Waste
25 management units and unplanned releases that are recommended for ERAs will undergo a
26 formal evaluation following the selection process outlined in *Prioritizing Sites for Expedited*
27 *Response Actions at the Hanford Site* (WHC 1991b).

29 Waste management units and unplanned releases that are not recommended for an
30 ERA continue through the data evaluation process. Units and unplanned releases continuing
31 through the process that potentially pose a high risk (refer to Section 5.0), become candidates
32 for an IRM. The criteria used to determine a potential for high risk, thereby indicating a
33 high priority site, were the HRS score used for nominating waste management units for
34 CERCLA cleanup (40 CFR 300), the mHRS scores, surface radiation survey data, and
35 rankings by the Environmental Protection Program (Huckfeldt 1991b). Units and unplanned
36 releases with HRS and mHRS scores greater than 28.5 (the CERCLA cleanup criterion) were
37 designated as IRM candidates. Units and unplanned releases that did not have an HRS score
38 were compared to similar sites to establish an estimated HRS score. Units and unplanned
39 releases with surface contamination greater than 2 mrem/hr exposure rate, 100 ct/min
40 beta/gamma above background or alpha greater than 20 ct/min were also designated as IRM
41 candidates. In addition, surface contamination sites which had an Environmental Protection

1 Program ranking of greater than 7 were further designated as IRM candidates. The IRM
2 candidates are listed in Table 5-1, which summarizes the high priority sites. IRM candidates
3 were then further evaluated to determine if an IRM is appropriate for the waste management
4 unit or unplanned release. IRM candidates that did not meet the IRM criteria were placed
5 into the final remedy selection path.

6
7 For certain units and unplanned releases, it was recognized that remedial actions
8 could be undertaken under an existing operational or other Hanford Site program (e.g.
9 RARA or Surplus Facility programs). As a result, recommendations were made that
10 remedial actions be undertaken (partially or completely) outside the 200 AAMS past practice
11 program. Units or unplanned releases that could be addressed only in part by another
12 program (e.g., surface contamination cleanup under the RARA program) remained in the 200
13 AAMS data evaluation process for further consideration. If it cannot be demonstrated that
14 these units or unplanned releases will be addressed under the operational program within a
15 time frame compatible with the past practice program, they will be readdressed by the 200
16 AAMS process.

17
18 Units and unplanned releases recommended for complete disposition under another
19 program (e.g., closure under the RCRA program) were not considered in the 200 AAMS
20 data evaluation process. In addition potentially new sites that were identified during the
21 AAMS were also not considered. It is recommended that a formal determination be made
22 regarding the regulatory status of all new sites following established procedures before they
23 are considered further under the 200 AAMS data evaluation process.

24
25 Specific criteria used to develop initial recommendations for ERA, LFI, and IRM for
26 waste management units and unplanned releases within the aggregate area are provided in
27 Sections 9.1.1. and 9.1.2. Units and unplanned releases not initially addressed under an
28 ERA, LFI, or IRM will be first evaluated under the final remedy selection path discussed in
29 Section 9.1.3.

30 31 32 **9.1.1 Expedited Response Action Path**

33
34 ERA candidates are evaluated to determine if they pose an unacceptable health or
35 environmental risk. All waste management units and unplanned releases, other than those
36 recommended for complete disposition under another Hanford program, are assessed against
37 the ERA criteria.

38
39 The *Hanford Past-Practice Strategy* describes conditions that might trigger abatement
40 of a candidate waste management unit or unplanned release under an ERA. Generally, these
41 conditions would rely on a determination of, or suspected, existing or future unacceptable

1 health or environmental risk, and a short time-frame available to mitigate the problem.

2 Conditions include, but are not limited to:

- 3
- 4 ● Actual or potential exposure to nearby human populations, biota, or the food
- 5 chain from hazardous substances and radioactive or mixed waste contaminants;
- 6
- 7 ● Actual or potential contamination of drinking water supplies or sensitive
- 8 ecosystems;
- 9
- 10 ● Threats of release of hazardous substances and radioactive or mixed waste
- 11 contaminants;
- 12
- 13 ● High levels of hazardous substances and radioactive or mixed waste
- 14 contaminants in soils that pose or may pose a threat to human health or the
- 15 environment, or have the potential for migration;
- 16
- 17 ● Weather conditions that may increase potential for release or migration of
- 18 hazardous substances and radioactive or mixed waste contaminants;
- 19
- 20 ● The availability of other appropriate federal or state response mechanisms to
- 21 respond to the release;
- 22
- 23 ● Time required to develop and implement a final remedy;
- 24
- 25 ● Further degradation of the medium which may occur if a response action is not
- 26 expeditiously initiated;
- 27
- 28 ● Risks of fire or explosion or potential for exposure as a result of an accident
- 29 or failure of a container or handling system; and
- 30
- 31 ● Other situations or factors that may pose threats to human health or welfare or
- 32 the environment.
- 33

34 These conditions were used as the initial screening criteria to identify candidate waste
35 management units and unplanned releases for an ERA. Candidate units and releases which
36 did not meet these conditions were not assessed through the ERA evaluation path. Additional
37 criteria for further, detailed screening of ERA candidates were developed based on the
38 conditions outlined in the *Hanford Past-Practice Strategy*. These additional screening criteria
39 are depicted on Figure 9-1 and are described below.

1 The initial criterion used to assess each ERA candidate is whether a driving force to
2 an exposure pathway exists or is likely to exist. Waste management units or unplanned
3 releases with contamination that is migrating or is likely to significantly migrate to a medium
4 that can result in exposure and harm to humans required additional assessment in the ERA
5 process. Waste management units or unplanned releases where contamination could spread
6 and, therefore, potentially require significantly more extensive remedial action if left
7 unabated, were also assessed in the ERA path.

8
9 Waste management units and unplanned releases with a driving force were assessed to
10 determine if unacceptable health or environmental risks exist from the release. The criteria
11 used to determine "unacceptable" are the quantity and concentration of the release. If the
12 release or imminent release is greater than 100 times the CERCLA reportable quantity for
13 any constituent, the waste management unit or unplanned release will remain in consideration
14 for an ERA. If the release or imminent release contains hazardous constituents at
15 concentrations that are 100 times the most applicable standard, the unit or unplanned release
16 continues to be considered for an ERA. In some cases, engineering judgment was used to
17 estimate the quantity and concentration of a postulated release. Standards applied include
18 Washington State Model Toxics Control Act standards for industrial sites and DOE and
19 Westinghouse Hanford radiation criteria (refer to Section 6.0). The application of these
20 standards does not signify they are recognized as ARARs.

21
22 If a release is imminent and substantial, a technology must be readily available to
23 control the release for a unit or unplanned release to be considered for an ERA. An example
24 that would require substantial technology development before implementation of cleanup
25 would be a tritium release since no control technology is available for tritium separation.

26
27 Another criterion for an ERA is to determine whether implementation of the available
28 technology would have adverse consequences that would offset the benefits of an ERA.
29 Examples of adverse consequences include: technologies where the exposure to cleanup
30 personnel would pose a much greater risk than the release; the ERA would foreclose future
31 remedial actions; or the ERA would prevent or greatly hinder future data collection
32 activities. If adverse consequences are not expected to be present then the wastement
33 management unit or unplanned release remained in consideration for an ERA.

34
35 The final criterion is to determine if the candidate ERA is within the scope of an
36 operational program. Maintenance and operation of active waste management facilities are
37 within the scope of activities administered by the Defense Waste Management Program.
38 Generally, active facilities will not be included in past practice investigations unless operation
39 is discontinued prior to initiation of the investigation. The Surplus Facilities and RCRA
40 programs are responsible for safe and cost-effective surveillance, maintenance, and
41 decommissioning of surplus facilities and RCRA closures at the Hanford Site. The Surplus

1 Facilities Program is also responsible for RARA activities that include surveillance,
2 maintenance, decontamination, and/or stabilization of inactive burial grounds, cribs, ponds,
3 trenches, and unplanned releases.
4

5 If the proposed ERA will not address all the contamination present, the waste
6 management unit or unplanned release continues through the process to be evaluated under a
7 second assessment path. Surface contamination cleanup under the RARA program is an
8 example where initial cleanup may not address subsurface contamination and, therefore,
9 additional investigation may be needed.
10

11 Final decisions regarding whether ERAs are justified in the aggregate area will be
12 made between DOE, EPA, and Ecology based, at least in part, on the recommendations
13 provided in this section, results of the final selection process outlined in *Prioritizing Sites for*
14 *Expedited Response Actions at the Hanford Site*, and availability of resources.
15

16 17 **9.1.2 Limited Field Investigation and Interim Remedial Measure Paths** 18

19 High priority waste management units and unplanned releases were evaluated to
20 determine if sufficient need and information exist such that an IRM could be pursued. An
21 IRM is desired for high priority waste management units and unplanned releases where
22 extensive characterization is not necessary to reach a defensible cleanup decision.
23 Implementation of an IRM with minimal characterization is expected to rely on observational
24 data acquired during remedial activities. Successful execution of this strategy is expected to
25 reduce both time and cost for cleanup of waste management units and unplanned releases
26 without impacting the effectiveness of the implemented action.
27

28 The initial step in the IRM assessment process is to categorize the waste management
29 units. The exposure pathways of interest are similar for each unit in a category; therefore, it
30 is effective to evaluate candidate waste management units as a group. The groupings used in
31 Section 2.3 (e.g., Cribs and Drains, Tanks and Vaults) will continue to be used to group the
32 waste management units for IRM assessment. Grouping waste management units is
33 especially effective for reducing characterization requirements. LFI(s) can be used to
34 characterize a representative waste management unit or units in detail to develop a remedial
35 alternative for the group of units. Observational data obtained during implementation of the
36 remedial alternative could be used to meet unit-specific needs.
37

38 Data adequacy is assessed in the next step. The existing data were evaluated to
39 determine if: 1) existing data were sufficient to develop a conceptual model and qualitative
40 risk assessment; 2) the IRM will work for this path; 3) implementing the IRM will have
41 adverse impacts on the environment, future remediation activities or data collection efforts;

1 and 4) the benefits of implementing the IRM are greater than the costs. If data are not
2 adequate an assessment was made to determine if a LFI might provide enough data to
3 perform an IRM. If a LFI would not collect sufficient data to perform an IRM, the unit was
4 addressed in the final remedy selection path.

5
6 The final step in the IRM evaluation process is to assess if the IRM will work without
7 adverse consequences. This includes: will the IRM be successful? will it create significant
8 adverse environmental impacts (e.g., environmental releases)? will the costs outweigh the
9 benefits? will it preclude future cleanup or data collection efforts? and will the risks of the
10 cleanup be greater than the risks of no action? Waste management units where remediation
11 is considered to be possible without adverse consequences are recommended for IRMs.

12
13 Final decisions will be made between DOE, EPA, and Ecology on whether particular
14 IRMs are justified based, at least in part, on the recommendation provided in this AAMSR,
15 results of a supporting LFI, and availability of resources.

16
17
18 **9.1.3 Final Remedy Selection Path**

19
20 Waste management units and unplanned releases recommended for initial
21 consideration in the final remedy selection path are those not recommended for IRMs, LFIs,
22 or ERAs, or were low priority sites. It is recognized that all waste management units and
23 unplanned releases within an operable unit or aggregate area will be addressed collectively
24 under the final remedy selection path to support a final Record of Decision (ROD). For the
25 purposes of this discussion, RI/FS and the RFI/CMS processes are synonymous; therefore,
26 RI/FS will be used throughout this discussion to represent either the CERCLA or RCRA
27 investigation past practices process.

28
29 The initial step in the final remedy selection path is to assess whether the combined
30 data from the AAMS, and any completed ERAs, IRMs, and LFIs are adequate for
31 performing a risk assessment (RA) and selecting a final remedy. Whereas the scope of an
32 ERA, IRM, and LFI is limited to individual waste management units or groups of similar
33 waste management units, the final remedy selection path will likely address an entire
34 operable unit or aggregate area.

35
36 If the data are collectively sufficient, an operable unit or aggregate area RA will be
37 performed. If sufficient data are not available, additional needs will be identified and data
38 collected.

1
2 **9.2 PATH RECOMMENDATIONS**
3

4 Initial recommendations for ERA, IRM, and LFI are discussed in Section 9.2.1
5 through 9.2.3, respectively. Waste management units and unplanned releases proposed for
6 initial consideration under the final remedy selection path are discussed in Section 9.2.4.
7 Table 9-1 provides a summary of the data evaluation process path assessment. A summary
8 of the responses to the decision points on the flowchart that led to the recommendations is
9 provided in Table 9-2. Following approval by DOE, EPA, and Ecology, these
10 recommendations will be further developed and implemented in work plans.
11
12

13 **9.2.1 Proposed Sites for Expedited Response Actions**
14

15 Several waste management units were evaluated along the ERA path. Two sanitary
16 waste disposal units, 2607-Z Septic Tank and Sanitary Drain Field and the 2607-WA Septic
17 Tank and Sanitary Drain Field were recommended for an ERA. Seven ERA candidates,
18 consisting of cribs with collapse potential and surface contamination sites, were
19 recommended for disposition under the RARA program. Two inactive settling tanks, 216-Z-
20 8 Settling Tank and 241-Z-361 Settling Tank, were recommended for an ERA. A discussion
21 of the recommendations for these waste management units are included in this section. Since
22 the anticipated response actions are not expected to fully remediate the ERA candidates, all
23 of the units will be included for further data evaluation in the assessment paths.
24

25 **9.2.1.1 Sites Potentially Causing Subsurface Contaminant Migration.** Two septic tanks
26 and associated sanitary drain fields in the Z Plant Aggregate Area discharge water to the soil
27 column adjacent to waste management units with known or suspected contamination. The
28 2607-Z Septic Tank and Sanitary Drain Field, located within approximately 50 meters of the
29 216-Z-3 Crib, discharges sanitary wastewater to the soil column at the rate of approximately
30 23 m³/day. The 2607-WA Septic Tank and Sanitary Drain Field, located approximately 50
31 meters from the 216-Z-8 French Drain and within 100 meters of the 216-Z-9 Trench,
32 discharges sanitary wastewater to the soil column at the rate of approximately 6 m³/day.
33

34 Thus, there is a significant flux of water through the vadose zone beneath these waste
35 management units. Discharged water could be remobilizing vadose zone contamination that
36 originated at the cribs. This problem may be especially significant in the perched water zone
37 above the Plio-Pleistocene caliche layer. At this location, there can be significant lateral
38 movement of vadose zone water. The septic system could be flushing contaminated water
39 that is more than 100 times the reportable quantity and the concentration standards into the
40 underlying aquifer.
41

1 The 2607-Z Septic Tank and Sanitary Drain Field and the 2607-WA Septic Tank and
2 Sanitary Drain Field should be investigated to determine if deactivation is necessary. The
3 volume of water flowing to these facilities needs to be confirmed. If the value is significant,
4 an investigation needs to be made to determine if the liquid is mobilizing contaminants
5 beneath the 216-Z-3 Crib, 216-Z-8 French Drain, and 216-Z-9 Trench. If so, it is
6 recommended that the nearby septic tanks and associated sanitary drain fields be deactivated.
7

8 **9.2.1.2 Cribs with Collapse Potential.** Five of the older cribs are open wooden structures
9 that could fail catastrophically. A sudden collapse could bring contaminated dust from the
10 buried crib to the surface. Based on crib inventory data, dust derived from the bottom of the
11 cribs would be expected to contain radionuclides at several orders of magnitude above
12 reportable quantities and concentration standards. Cribs with potential collapse problems
13 include:

- 14
- 15 ● 216-Z-1
- 16
- 17 ● 216-Z-2
- 18
- 19 ● 216-Z-5
- 20
- 21 ● 216-Z-6
- 22
- 23 ● 216-Z-7
- 24

25 Maintenance and contamination control measures for cribs with collapse potential are
26 implemented under the RARA program. Therefore, actions to mitigate environmental
27 releases from these facilities will be deferred to the RARA program. An engineering study
28 is planned under the RARA program for 1993 for the 200 Areas to evaluate the potential for
29 crib collapse.
30

31 Response actions such as the addition of clean fill material over the cribs or pressure
32 grouting void areas within the crib to prevent collapse may be considered for these waste
33 management units. Evaluation and recommendation of response actions for these facilities
34 will be performed under the RARA program.
35

36 **9.2.1.3 Sites with Significant Surface Contamination.** There are four waste management
37 units in the Z Plant Aggregate Area evaluated in the AAMS program with levels of surface
38 contamination that are high enough to be of immediate concern. Surface contamination is the
39 most immediately accessible to humans and biota. The potential for transport by the wind or
40 biota is also significant and so surface migration is also a problem. It is expected that the
41 releases of radionuclides and potential radiation exposure levels at these waste management

1 units would be greater than 100 times reportable quantity and concentration standards. The
2 corrective action for waste management units with surface contamination falls within the
3 scope of the RARA program.
4

5 As discussed in Section 5.2.2, recent radiation survey results indicate that the
6 following waste management units exceed surface contamination criteria:
7

- 8 • 216-Z-1 and 216-Z-2 Cribs
- 9
- 10 • 216-Z-1A Tile Field
- 11
- 12 • 218-W-2 Burial Ground
- 13
- 14 • 218-W-4A Burial Ground
- 15

16 Surface contamination control activities at these units are recommended for evaluation
17 and implementation under the RARA program.
18

19 **9.2.1.4 Tanks with Leak Potential.** Two tanks, the 241-Z-361 Settling Tank and the 216-
20 Z-8 Settling Tank, contain drainable liquids. These tanks are estimated to be over 35 years
21 old and have the potential to leak radioactive and hazardous liquid to the soil. The settling
22 tanks are inactive facilities. It is recommended that the liquid stored within the tanks be
23 removed to prevent future leakage.
24

25 **9.2.1.5 Non-ERA Sites.** The primary reason most waste management units and unplanned
26 releases were not recommended for ERAs was because of the lack of driving force to an
27 exposure pathway. Inactive cribs, ponds, ditches, and trenches are no longer receiving waste
28 and, therefore, no longer have artificial recharge as a driving force to move contaminants.
29 Natural recharge from local precipitation was not considered a significant short-term driving
30 force. Specifics for each waste management unit and unplanned release are provided in
31 Table 9-2.
32

33 Active facilities such as the 216-Z-21 Seepage Basin or the 216-Z-20 Crib (discussed
34 in the U Plant AAMSR; DOE/RL 1992) were considered as candidate ERAs because these
35 facilities do contain a driving force and are potentially releasing contaminants to the
36 environment. However, closing of these facilities cannot occur without constructing alternate
37 disposal facilities; therefore, there are potential adverse institutional consequences that would
38 not be offset by the benefits of an ERA. Thus, an ERA would not be an appropriate
39 recommendation for these facilities at this time.
40
41

1 **9.2.2 Proposed Sites for Interim Remedial Measures**
2

3 Seven of the 50 waste management units addressed in the Z Plant Aggregate Area
4 data evaluation process were identified as high priority sites (refer to Section 5.0) and were
5 assessed as candidates for IRMs. Three of the waste management units designated as high
6 priority sites (216-Z-7 Crib, 216-Z-17 Trench, and the 216-Z-10 Reverse Well) were so
7 designated because of high HRS scores. Three waste management units (216-Z-1A Tile
8 Field, 218-W-2 Burial Ground, and the 218-W-4A Burial Ground) were designated as high
9 priority because of surface radiation measurements. One waste management unit (216-Z-1
10 and 216-Z-2 Cribs) was identified as a high priority site due to high HRS scores and elevated
11 surface radiation measurements. Another thirteen waste management units (216-Z-3 Crib,
12 216-Z-5 Crib, 216-Z-6 Crib, 216-Z-12 Crib, 216-Z-16 Crib, 216-Z-18 Crib, 241-Z
13 Diversion Box No. 1, 241-Z Diversion Box No. 2, 231-Z-151 Sump, 216-Z-4 Trench, 216-
14 Z-9 Trench, 218-W-1 Burial Ground, and 218-W-3 Burial Ground) were tentatively identified
15 as having sufficient proximity and/or similarity to the high priority sites to warrant inclusion
16 in the IRM assessment path.
17

18 None of the 17 candidate waste management units are recommended for IRMs without
19 first conducting LFIs. The reason for this determination is that there was not adequate data
20 for any of the evaluated units to support performing a qualitative risk assessment and/or
21 select a final remedy. One waste management unit evaluated in the IRM path, the 216-Z-10
22 Reverse Well, does not remain as an IRM candidate because it was determined that an LFI
23 would not result in collecting sufficient data to proceed with consideration as an IRM
24 candidate. The 216-Z-10 Reverse Well was carried forward to the final remedy selection
25 path for further evaluation and is discussed in Section 9.2.4. Sixteen waste management
26 units remain as IRM candidates but require LFIs to obtain sufficient information to proceed
27 with the IRM evaluation. Discussion of the recommended LFIs is provided in Section 9.2.3.
28
29

30 **9.2.3 Proposed Sites for Limited Field Investigation Activities**
31

32 Sixteen waste management units are recommended to undergo LFIs. The LFIs have
33 been recommended to provide sufficient information to proceed with IRM evaluations.
34

35 IRM candidates that are recommended to undergo LFIs have been categorized into
36 two groups that contain similar released waste, release mechanisms, and design. The first
37 group contains cribs, trenches, and the tile field. The second group contains burial grounds.
38

39 **9.2.3.1 Cribs, Trenches, and Tile Field.** This group includes nine cribs and three
40 associated transfer units, three trenches, and one tile field. Cribs with collapse potential
41 have also been evaluated along the ERA path and have been recommended for actions under

1 the RARA program (see Section 9.2.1). The actions implemented under the RARA program
2 will precede the LFI activities. The cribs with collapse potential include:

- 3
- 4 ● 216-Z-1 and 216-Z-2
- 5
- 6 ● 216-Z-5
- 7
- 8 ● 216-Z-6
- 9
- 10 ● 216-Z-7
- 11

12 Cribs to be involved in LFI activities which do not require actions under the RARA
13 program (cribs without collapse potential) include:

- 14
- 15 ● 216-Z-3
- 16
- 17 ● 216-Z-12
- 18
- 19 ● 216-Z-16
- 20
- 21 ● 216-Z-18
- 22

23 The transfer units associated with the cribs include:

- 24
- 25 ● 241-Z Diversion Box No. 1
- 26
- 27 ● 241-Z Diversion Box No. 2
- 28
- 29 ● 231-Z-151 Sump
- 30

31 Trenches and tile fields are essentially long cribs and are therefore grouped with the
32 cribs. The trenches and tile field include:

- 33
- 34 ● 216-Z-4 Trench
- 35
- 36 ● 216-Z-9 Trench
- 37
- 38 ● 216-Z-17 Trench
- 39
- 40 ● 216-Z-1A Tile Field
- 41

1 The cribs with collapse potential were addressed in the IRM path after first being
2 assessed in the ERA path. The actions recommended for the units will not address the
3 subsurface contaminations in the facilities; therefore, they were included for assessment
4 under the remaining criteria. The 216-Z-1 and 216-Z-2 Cribs, the 216-Z-7 Crib, the 216-Z-
5 1A Tile Field, and the 216-Z-17 Trench were identified as high priority sites. The other
6 waste management units were included because of their similarity and proximity to the high
7 priority waste management units.

8
9 The initial decision point in the IRM path is to assess whether data are adequate to
10 conduct an IRM. The data available for most of the waste management units are screening
11 level data and estimated inventories which do not provide information on the nature and
12 extent of the contamination. Therefore, an IRM could not be implemented without further
13 investigation.

14
15 Similarities of units may make it possible to remediate them using the observational
16 approach after characterizing only a few of the units. It was expected that a LFI would
17 provide sufficient information to proceed with an IRM for waste management unit groups.
18 Therefore, the basis for recommending a LFI is that sufficient information can be gained
19 from a more detailed investigation of one or two of the cribs and a trench that would allow a
20 remedial decision to be made on the other waste management units with little or no additional
21 characterization.

22
23 Possible representative waste management units for the Z Plant Aggregate Area would
24 be the combined 216-Z-1 and 216-Z-2 Cribs and the 216-Z-17 Trench. The 216-Z-17
25 Trench is recommended as being representative of waste management units that received
26 waste during initial operations in the 231-Z Building in addition to being representative of
27 waste management units with a potential to have impacted underlying groundwater quality.
28 The 216-Z-1 and 216-Z-2 Cribs are recommended as being representative of cribs which
29 received waste during more recent operations in the 234-5Z Building in addition to being
30 representative of waste management units with a potential to have impacted underlying
31 groundwater quality. The rationale for IRM and LFI will be more completely developed in
32 work plans, however, the following addresses possible considerations during work plan
33 development.

34
35 Possible LFI objectives would be to:

- 36
37
- 38 ● Evaluate the potential for releases from the waste management unit to impact
39 underlying groundwater quality;
 - 40 ● Determine if contamination exists in the soil beneath the cribs and trench and,
41 if so, assess the extent; and

- Assess the extent of contaminant migration from the cribs and trench in support of focused feasibility studies.

If transuranic radionuclides and/or other hazardous chemicals are not found in soil below the representative cribs and trench, it is unlikely to be present below the other cribs, trenches, and tile field, therefore additional sampling for transuranic radionuclides and/or hazardous chemicals would likely not be necessary at the other units. The actual extent of transuranic contamination, if any, could be determined during implementation of an IRM (if justified) at the burial ground and would not need to be fully known prior to the decision to proceed. The extent of IRM actions for the other facilities would be based on measurements from the representative cribs and trench, therefore, no other sampling for extent of contamination at the other units would be anticipated.

9.2.3.2 Burial Grounds. This group includes four burial grounds. The four burial grounds are not covered under a RCRA closure or Part B permit action, and include:

- 218-W-1
- 218-W-2
- 218-W-3
- 218-W-4A

The 218-W-2 and the 218-W-4A Burial Grounds were identified as high priority waste management units and were designated as IRM candidates. Because the 218-W-1 and 218-W-3 Burial Grounds received similar wastes and are generally constructed in similar fashion, they were included in the group with the 218-W-2 and the 218-W-4A Burial Grounds. These waste management units have insufficient data to conduct an IRM, therefore they were recommended for LFIs. It is expected that sufficient information could be obtained from limited investigation of one or two burial grounds to continue with IRM assessments (if justified) with little or no additional characterization of the other burial grounds.

A possible representative burial ground for LFI would be the 218-W-4A Burial Ground. The 218-W-4A Burial Ground is recommended as being representative because it is a high priority site due to surface contamination and has had four unplanned releases associated with it. It is expected to contain similar wastes and to be similar in design to the other burial grounds. The 218-W-4A Burial Ground is expected to include trenches, caissons, and a final cover similar to those likely to be encountered at the other burial grounds. The rationale for IRM and LFI will be more completely developed in work plans, however, the following addresses possible considerations during work plan development.

Possible LFI objectives would be to:

- Conduct surface contamination surveys and assess likely source(s);
- Evaluate the potential for releases from the waste management unit to impact underlying groundwater quality;
- Determine if contamination exists in the soil beneath the burial ground and, if so, assess the extent; and
- Assess the nature and extent of radionuclide and hazardous chemical contaminants in near-surface and surface soils at the burial ground sufficient to support a focused feasibility study.

Additional field inspections and document reviews might be desirable to evaluate the relative integrity of existing burial ground caps and buried waste containers. Some geophysical survey work might be desirable to update information found regarding the location and construction of burial ground disposal units such as trenches and caissons, and to identify potential subsurface voids that have a potential for major settlement.

If transuranic radionuclides and/or other hazardous chemicals are not found in soil below the representative burial ground, it is unlikely to be present below the other burial grounds, therefore additional sampling for transuranic radionuclides and/or hazardous chemicals would likely not be necessary at the other units. The actual extent of transuranic contamination, if any, could be determined during implementation of an IRM (if justified) at the burial ground and would not need to be fully known prior to the decision to proceed. The extent of IRM actions for the other facilities would be based on measurements from the representative burial ground, therefore, no other sampling for extent of contamination at the other burial grounds would be anticipated.

9.2.4 Proposed Sites for Final Remedy Selection

A number of unplanned releases, along with several diverse waste management units which are unique because of design, contaminants received, or operational history, have been proposed for the final remedy selection path. It was determined that sufficient information may exist to perform a RA and select a final remedy for four unplanned releases; these are discussed in Section 9.2.4.2. RIs are recommended for the remainder of the waste management units and unplanned releases due to the lack of information to perform RAs and select final remedies. These waste management units and unplanned releases are discussed in Section 9.2.4.1.

1 **9.2.4.1 Proposed Sites for Remedial Investigation Activities.** RIs have been
2 recommended from the final remedy selection path for two basic groups of waste
3 management units. The first group would include units used for disposal of liquid wastes,
4 including the settling tanks, French drains, septic tanks and associated sanitary drain fields,
5 basins, and reverse well. The second group would include units used for disposal of solid
6 wastes, including the burial grounds and the burn pit. For purposes of integrating the
7 investigations, achieving economies in the level of investigation efforts, and focusing on
8 relevant remedies, two RIs would be more appropriate due to differences in the nature of the
9 wastes disposed and design of the disposal units. Thus, a RI is recommended to address
10 waste management units used for disposal of liquid wastes and a RI is recommended to
11 address waste management units used for disposal of solid wastes. Unplanned releases
12 associated with the respective liquid and solid waste disposal units would be addressed in the
13 corresponding RIs.

14
15 Except for the 216-Z-10 Reverse Well, the waste management units and unplanned
16 releases recommended for RI from the final remedy selection path are all low priority sites.
17 Most of the waste management units share common waste, design, and operational features
18 and they have been described together in the following discussions. Unplanned releases are
19 also described together. The 216-Z-10 Reverse Well and the Z Plant Burn Pit are described
20 separately. This organizational structure has been used only for discussion purposes; it does
21 not imply that separate RIs will be developed for each of the types of waste management
22 units and unplanned releases described. As previously stated, only two RIs are
23 recommended, one for liquid waste disposal units and one for solid waste disposal units.

24
25 **9.2.4.1.1 Settling Tanks.** A RI is recommended to include each of the settling
26 tanks:

- 27
- 28 ● 216-Z-8
- 29
- 30 ● 241-Z-361
- 31

32 The investigation at these settling tanks should begin after ERAs have been
33 completed. Both tanks were assigned low HRS scores and they are not sufficiently similar to
34 high priority units to warrant evaluation under the IRM path, so they could not be
35 recommended for LFIs.

36
37 There are no sampling or inventory data for any of these units and so RAs cannot be
38 performed. A RI is recommended which would include each of these units to provide nature
39 and extent of contamination information to perform a RA for final remedy selection.
40

1 **9.2.4.1.2 French Drains.** A RI is recommended to include each of the French
2 drains:

- 3
- 4 ● 216-Z-8
- 5
- 6 ● 216-Z-13
- 7
- 8 ● 216-Z-14
- 9
- 10 ● 216-Z-15
- 11

12 These four waste management units all are low priority sites and they are not
13 sufficiently similar to high priority units to warrant evaluation under the IRM path, so they
14 could not be recommended for LFIs.

15

16 Insufficient data exist at these units to conduct a RA. A RI is recommended which
17 would include each of these units to provide nature and extent of contamination information
18 to perform a RA for final remedy selection.

19

20 **9.2.4.1.3 Septic Tanks and Sanitary Drain Fields.** A RI is recommended to
21 include each of the septic tanks and sanitary drain fields:

- 22
- 23 ● 2607-Z
- 24
- 25 ● 2607-Z-1
- 26
- 27 ● 2607-WA
- 28
- 29 ● 2607-WB
- 30
- 31 ● 2607-W-8
- 32

33 The investigation at 2607-Z and 2607-WA should begin after ERAs have been
34 completed. These five waste management units all have been assigned low HRS scores by
35 comparison with other waste management units and they are not sufficiently similar to high
36 priority units to warrant evaluation under the IRM path, so they could not be recommended
37 for LFIs.

38

39 There are no sampling or inventory data for any of these units and so a RA cannot be
40 performed. The purpose of a limited sampling program under a RI would be to confirm that

1 no contamination exists in the septic tanks and sanitary drain fields. If no contamination is
2 found, then no further action would likely be recommended.

3
4 **9.2.4.1.4 Basins.** A RI is recommended to include each of the basins:

- 5
- 6 ● 241-Z Retention Basin
- 7
- 8 ● 216-Z-21 Seepage Basin
- 9

10 The 216-Z-21 Seepage Basin was first assessed in the ERA path, but due to potential
11 adverse consequences associated with halting discharges to the seepage basin, an ERA could
12 not be recommended. Both basins in this group are low priority units and they are not
13 sufficiently similar to high priority units to warrant evaluation under the IRM path, so they
14 could not be recommended for LFIs.

15
16 Insufficient data exist at these units to conduct a RA. Therefore, a RI is
17 recommended which would include each of these units to provide nature and extent of
18 contamination information to perform a RA for final remedy selection.

19
20 **9.2.4.1.5 Reverse Well.** The 216-Z-10 Reverse Well was initially evaluated along
21 the ERA path, but an ERA could not be recommended because it was determined that
22 appropriate technology for treating and remediating the unit in an expedited manner was not
23 available. The 216-Z-10 Reverse Well was further evaluated in the IRM path, but it was not
24 retained as an IRM candidate because it was determined that an LFI would not result in
25 collecting sufficient data to proceed with consideration as an IRM candidate.

26
27 Insufficient data exist at this unit to conduct a RA. Therefore, a RI is recommended
28 provide nature and extent of contamination information to perform a RA for final remedy
29 selection.

30
31 **9.2.4.1.6 Burial Grounds.** A RI is recommended to include each of two burial
32 grounds:

- 33
- 34 ● 218-W-1A
- 35
- 36 ● 218-W-11
- 37

38 Both burial grounds in this group are low priority units and they are not sufficiently
39 similar to high priority units to warrant evaluation under the IRM path, so they could not be
40 recommended for LFIs. Insufficient data exist at these units to conduct a RA. Therefore, a

1 RI is recommended which would include each of these units to provide nature and extent of
2 contamination information to perform a RA for final remedy selection.

3
4 **9.2.4.1.7 Z Plant Burn Pit.** A RI is recommended for the Z Plant Burn Pit. This
5 waste management unit has been assigned a low HRS score by comparison with other units
6 and it is not sufficiently similar to another high priority unit to warrant evaluation under the
7 IRM path, so it could not be recommended for LFI. No sampling or inventory data were
8 identified for the area, so a RA cannot be performed. Historical data regarding the Z Plant
9 Burn Pit does not indicate the disposal of any radioactive or hazardous material.

10
11 A RI was recommended for this unit to provide enough data to confirm that
12 contamination is not present. If no contamination is found, then no further action would
13 likely be recommended.

14
15 **9.2.4.1.8 Unplanned Releases.** Twelve unplanned releases are recommended as
16 candidates for inclusion in an aggregate area or operable unit RI. These unplanned releases
17 are:

- 18
- 19 ● UN-200-W-11
- 20
- 21 ● UPR-200-W-16
- 22
- 23 ● UN-200-W-23
- 24
- 25 ● UPR-200-W-26
- 26
- 27 ● UN-200-W-44
- 28
- 29 ● UPR-200-W-53
- 30
- 31 ● UN-200-W-89
- 32
- 33 ● UN-200-W-90
- 34
- 35 ● UN-200-W-91
- 36
- 37 ● UN-200-W-103
- 38
- 39 ● UN-200-W-130
- 40
- 41 ● UPR-200-W-158 (associated with 218-W-1A Burial Ground)

1 Unplanned releases UN-200-W-23, UPR-200-W-26, UN-200-W-44, UN-200-W-89,
2 UN-200-W-90, UN-200-W-103, and UPR-200-W-158 all have HRS scores below 28.5, and
3 do not have sufficient data to conduct a risk assessment. Unplanned releases UN-200-W-11,
4 UPR-200-W-16, UPR-200-W-53, UN-200-W-91, and UN-200-W-130 all have insufficient
5 information available for HRS scoring. However, each unplanned release is described as
6 having been cleaned up or released as a radiation zone as contamination decayed to
7 background levels. It is thus assumed that these five unplanned releases would also have low
8 HRS scores.

9
10 Unplanned release UPR-200-W-158 has actually been identified as occurring at three
11 separate locations; this has been attributed to wind dispersal of contaminants. Only the
12 release associated with the 218-W-1A Burial Ground is recommended as a candidate for RI.
13 The other two unplanned releases identified as UPR-200-W-158 in the 218-W-3A and 218-
14 W-6 Burial Grounds are being recommended for deferral to be addressed during RCRA
15 closure activities at those burial grounds.

16
17 A lack of soil sample data and inconsistent survey data prevent RA completion for
18 these twelve unplanned releases. RI has been recommended to provide enough data to
19 confirm that contamination does not exist. If no contamination is found, no further action
20 would likely be recommended.

21
22 **9.2.4.2 Proposed Sites for Risk Assessment.** Four candidates were recommended for RA
23 under the final remedy selection path, all of which are unplanned releases:

- 24
- 25 • UPR-200-W-72
- 26
- 27 • UPR-200-W-84
- 28
- 29 • UPR-200-W-134
- 30
- 31 • UN-200-W-159
- 32

33 Unplanned releases UPR-200-W-72, UPR-200-W-84, and UPR-200-W-134 were not
34 assigned HRS or mHRS scores. In each case, the release occurred in a solid waste burial
35 ground and the contaminated area was remediated by excavating affected soil and placing it
36 in a solid waste burial ground trench. Unplanned release UN-200-W-159 was assigned a
37 "low" HRS score (less than 28.5) by comparison to other unplanned releases. The exact
38 location of the unplanned release was not identified. The contaminated area was remediated
39 by excavating affected soil and placing it in a solid waste burial ground trench.

1 It is recommended that a RA be performed encompassing each of these unplanned
2 releases using available information. If the RA confirms that no contamination warranting
3 remediation remains, it is likely that no further action will be required at these unplanned
4 releases.

7 **9.3 SOURCE OPERABLE UNIT REDEFINITION AND PRIORITIZATION**

8
9 The investigation process can be made more efficient if units with similar histories
10 and waste constituents are studied together. The data needs and remedial actions required for
11 similar waste management units are generally the same. It is much easier to ensure a
12 consistent level of effort and investigation methodology if like units are grouped together.
13 Economies of scale also make the investigation process more cost effective if similar units
14 are studied together.

17 **9.3.1 Sites Deferred to Other Aggregate Areas or Programs**

18
19 No Z Plant Aggregate Area waste management units and unplanned releases are
20 recommended for consideration under other aggregate areas. Twelve waste management
21 units and six unplanned releases are recommended for consideration under other Hanford
22 programs. These programs are the Surplus Facilities Program and the RCRA closure and/or
23 Part B permit program for TSD facilities.

24
25 One waste management unit is recommended for consideration under the Surplus
26 Facilities Program:

- 27 ● 232-Z Incinerator

28
29
30 Remediation of this unit can be most effectively addressed through decontamination
31 and decommissioning efforts under the Surplus Facilities Program.

32
33 Waste management units and associated unplanned releases which will be or are
34 recommended to be considered under the RCRA program include:

- 35 ● 234-5Z Hazardous Waste Staging Area (HWSA)
- 36 ● Waste Receiving and Processing (WRAP)
- 37 ● RMW Storage Facility

- 1 • 241-Z Treatment Tank and unplanned releases UN-200-W-74, UN-200-W-75,
2 and UN-200-W-79
- 3
- 4 • 218-W-2A Burial Ground and unplanned release UPR-200-W-45
- 5
- 6 • 218-W-3A Burial Ground and unplanned release UN-200-158
- 7
- 8 • 218-W-3AE Burial Ground
- 9
- 10 • 218-W-4B Burial Ground
- 11
- 12 • 218-W-4C Burial Ground and unplanned release UN-200-W-132
- 13
- 14 • 218-W-5 Burial Ground
- 15
- 16 • 218-W-6 Burial Ground and unplanned release UN-200-158
- 17

18 Remediation of the waste management units would be addressed as part of the facility
19 closure and/or final status permitting that will occur under RCRA. The unplanned releases
20 associated with these units would most logically be remediated during the RCRA closure
21 and/or permitting activities.

22
23 The 216-Z-20 Crib has been recommended at this time for transfer from the U Plant
24 Aggregate Area to the Z Plant Aggregate Area. Transfer of this waste management unit
25 would allow it to be investigated with other waste management units with similar waste
26 histories.

27 28 29 **9.3.2 Z Plant Operable Unit Redefinition**

30
31 Redefinition of the 200-ZP-1, 200-ZP-2, and 200-ZP-3 Operable Units is suggested
32 based on the data evaluation in this report. In general, it is recommended that:

- 33
- 34 • Investigation of groundwater be removed from the scope of the Z Plant
35 Operable Units and considered under the 200 West Groundwater AAMS;
- 36
- 37 • The 232-Z Incinerator be removed from the scope of the Z Plant Operable
38 Units and considered under the Surplus Facilities Program; and
- 39

- 1 ● Several waste management units subject to RCRA closure and/or final status
2 permitting, along with associated unplanned releases, be addressed entirely by
3 the RCRA program.
4

5 For the 200-ZP-1 and 200-ZP-2 Operable Units, it is recommended that:

- 6
- 7 ● All liquid waste disposal units (e.g., cribs, trenches, French drains) be
8 consolidated and the current boundaries be reconfigured to only one Operable
9 Unit encompassing all of the liquid waste disposal units;
10
- 11 ● Unplanned releases within the reconfigured boundary be included in the
12 consolidated Operable Unit; and
13
- 14 ● The geographic boundaries be redefined to include the 216-Z-20 Crib.
15

16 It is recommended that the 200-ZP-3 Operable Unit be reconfigured to encompass the
17 burial grounds. It is recommended that the Z Plant Burn Pit also be assigned to this
18 Operable Unit even though geographically it may fall within the boundaries of the liquid
19 waste disposal Operable Unit. The 2607-WB Septic Tank and Sanitary Drain Field would be
20 reassigned to the liquid waste disposal Operable Unit. Unplanned releases within the
21 reconfigured boundary would be included in the burial grounds Operable Unit.
22

23

24 **9.3.3 Investigation Prioritization**

25

26 Very little if any data exist to rank the waste management units and unplanned
27 releases within the Z Plant Aggregate Area on a risk-related basis. The HRS and surface
28 contamination data which were used to sort the waste management units and unplanned
29 releases into either high or low priority are indicators of potential risk but are not suitable to
30 develop a risk-related ranking. The most useful data for indicating potential risk are
31 probably the waste inventories and facility construction or operation information.
32

33 Based on available information about inventories of wastes and contaminants, facility
34 construction, and operational history, it is recommended that investigations be prioritized as
35 follows:
36

- 37 ● Facilities which discharged liquid waste containing radionuclides and/or
38 hazardous constituents to the soil column should be evaluated first. First
39 priority within this grouping is recommended for the cribs and associated
40 transfer units, which received the largest quantities of contamination, with

1 secondary priority given to the trenches, the reverse well, the tile field, the
2 French drains, the basins, and the settling tanks;

- 3
- 4 ● The burial grounds pose a potential for wind erosion and subsequent release to
5 air, therefore they should be evaluated second; and
 - 6
 - 7 ● Other facilities which discharged liquid wastes that are not suspected of
8 containing radionuclides and hazardous constituents, such as the septic tanks
9 and associated sanitary drain fields, should be evaluated third.

10

11 Specific priorities for each waste management unit will be developed in subsequent
12 work plans.

13

14 9.3.4 RCRA Facility Interface

15

16

17 As previously discussed in Section 9.3.1, there are a number of RCRA facilities in
18 the Z Plant Aggregate Area. These facilities belong to a separate program with separate Tri-
19 Party Agreement milestones. Some environmental releases at these facilities may have
20 commingled and interacted with other source units at the Z Plant Aggregate Area, depending
21 on the extent of contamination that has occurred. For example, contamination from the 218-
22 W-2A and 218-W-3A Burial Grounds, which are TSD facilities deferred to the RCRA
23 program, may have affected the 218-W-3 Burial Ground, which is covered under this
24 AAMS. Given the number of RCRA facilities in the Z Plant Aggregate Area and their
25 proximity to other units, it is expected that there will be a need for RCRA facility interface
26 for some of the Z Plant waste management units.

27

28 The RCRA Part B permit application for the burial grounds proposes that final
29 closure be initiated in about the year 2081, with partial closures of portions of the burial
30 grounds to occur as each portion is filled. A definitive schedule for partial closures has not
31 been established yet. Corrective actions associated with ongoing activities and future closure
32 actions have not been defined in the Part B permit application at this time. A site-wide
33 RCRA permit is currently being negotiated which will eventually finalize Hanford Facility
34 closure schedules and corrective actions. All closure schedules and corrective actions at the
35 burial grounds are still subject to regulatory agency approval until the final RCRA permit is
36 issued.

37

38 Investigations have been recommended for several non-RCRA burial ground units
39 under this AAMS. Since partial closures and corrective actions of the RCRA burial grounds
40 have not been established, the recommended investigations may precede or overlap with
41 RCRA activities. It will be necessary to ensure that investigations at non-RCRA units are

1 integrated with schedules and proposed actions for the RCRA burial grounds as they are
2 incorporated into the final status permit.

3
4 In addition, there are a number of unplanned releases associated with RCRA TSD
5 facilities within the Z Plant Aggregate Area which are recommended to be addressed during
6 RCRA closure and/or permitting activities. Investigation and remediation of affected soils
7 associated with these unplanned releases, if any, would result in a need to interface with the
8 planned RCRA facility activities.

11 **9.4 FEASIBILITY STUDY**

12
13 Two types of the FS will be conducted to support remediation in the 200 Areas
14 including focused and the final FS. Focused feasibility studies (FFSs) are studies in which a
15 limited number of units or remedial alternatives are considered. Final FS will be prepared to
16 provide the data necessary to support the preparation of final ROD. Insufficient data exists
17 to prepare either a focused or final FS for any units or group of units within the Z Plant
18 Aggregate Area. Sufficient data are considered available to prepare a FFS on selected
19 remedial alternatives.

22 **9.4.1 Focused Feasibility Study**

23
24 Both LFIs and IRMs are planned for the Z Plant Aggregate Area for individual waste
25 management units or waste management unit groups. The IRMs will be implemented as they
26 are approved, and the FFS will be prepared to support their implementation. The FFS
27 applied in this manner is intended to examine a limited number of alternatives for a specific
28 site or groups of sites. The FFS supporting IRMs will be based on the technology screening
29 process applied in Section 7.0, engineering judgement, and/or new characterization data such
30 as that generated by a LFI.

31
32 Recommendations for the FFS in support of IRMs are not provided in this report
33 because of the limited data availability. In most cases, LFIs will be conducted at waste
34 management units or unplanned releases initially identified for IRMs. The information
35 gathered is considered necessary prior to making a final determination whether an IRM is
36 actually necessary or whether a remedy can be selected.

37
38 Rather than being driven by an IRM, the FFS will also be prepared to evaluate select
39 remedial alternatives. In this case the FFS focuses on technologies or alternatives that are
40 considered to be viable based on their implementability, cost, and effectiveness and have

1 broad application to a variety of sites. The following recommendations are made for FFSs
2 that focus on a particular technology or alternative:

- 3
- 4 ● Capping
- 5
- 6 ● Ex situ treatment of contaminated soils
- 7
- 8 ● In situ stabilization
- 9

10 These recommendations reflect select technologies developed in Section 7.0 of this report.

11
12 The FFS is intended to provide a detailed analysis of select remedial alternatives.
13 The results of the detailed analysis provides the basis for identifying preferred alternatives.
14 The detailed analysis for alternatives consists of the following components:

- 15
- 16 ● Further definition of each alternative, if appropriate, with respect to the
17 volumes or areas of contaminated environmental media to be addressed, the
18 technologies to be used, and any performance requirements associated with
19 those technologies. Remedial investigations and treatability studies, if
20 conducted, will also be used to further define applicable alternatives.
- 21
- 22 ● An assessment and summary of each alternative against evaluation criteria
23 specified in EPA's *Guidance for Conducting Remedial Investigations and*
24 *Feasibility Studies under CERCLA* (EPA 1988).
- 25
- 26 ● A comparative analysis of the alternatives that will facilitate the selection of
27 the remedial action.
- 28
- 29

30 **9.4.2 Final Feasibility Study**

31
32 To complete the remediation process for an aggregate area, a final or summary FS
33 will be prepared. This study will address those waste management units and unplanned
34 releases not previously evaluated and will summarize the results of preceding evaluations.
35 The overall study and evaluation process for an aggregate area will consist of a number of
36 FFSs, field investigations, and interim RODs. All of this study information will be
37 summarized in one final FS to provide the data necessary for the final ROD. The summary
38 FS will likely be conducted on an aggregate area basis; however, future considerations may
39 indicate that a larger scope is appropriate.

1 **9.5 TREATABILITY STUDIES**
2

3 A range of technologies which are likely to be considered for remediation of waste
4 management units and unplanned releases within the Z Plant Aggregate Area were discussed
5 in Section 7.3. The range of technologies included:
6

- 7 ● Engineered multimedia cover
- 8
- 9 ● In situ grouting
- 10
- 11 ● Excavation and soil treatment
- 12
- 13 ● In situ vitrification
- 14
- 15 ● Excavation, treatment, and disposal of transuranic radionuclides
- 16
- 17 ● In situ soil vapor extraction of volatile organic compounds
- 18

19 Treatability testing will be required to conduct a detailed analysis for most of the
20 technologies. A summary of treatability testing needs outlined in Section 7.3 is as follows:
21

- 22 ● Engineered multimedia cover - performance testing (pilot-scale testing) of
23 conceptual designs is needed.
- 24
- 25 ● In situ grouting - testing required to optimize injection properties of grout and
26 verify effectiveness in stabilizing contaminants.
- 27
- 28 ● Excavation and soil treatment - testing of dust control measures, soil treatment
29 reagents, and contacting methods will be required. Some limited soil washing
30 bench scale studies have been initiated.
- 31
- 32 ● In situ vitrification - testing required to verify contaminant stabilization
33 effectiveness and to establish operating parameters. Some vitrification pilot
34 testing is ongoing.
- 35
- 36 ● Excavation, treatment, and disposal of transuranic radionuclides - testing to
37 evaluate dust control measures and stabilization or vitrification effectiveness
38 and to establish operating parameters is required.
39

- 1
2 • In situ soil vapor extraction of volatile organic compounds - extraction
3 effectiveness needs to be verified and operating parameters require
4 development. A program is currently under way for field testing of vapor
5 extraction techniques.
6

7 As treatability testing of the various alternatives progresses, other parameters are
8 likely to be identified which require further development. Guidance exists from various
9 regulatory agencies (e.g., EPA) for designing and implementing treatability studies; relevant
10 guidance will be relied upon as treatability studies begin and progress.
11

12
13 **9.6 PROPOSED AGGREGATE AREA BASED FIELD CHARACTERIZATION**
14 **STUDY**
15

16 It has been established that carbon tetrachloride emanates from the Z Plant Aggregate
17 Area soils and wells during certain meteorological conditions. In addition, other volatile
18 gases have caused work shutdowns to protect employees in the area. Presently, little is
19 understood regarding the nature and sources of these volatile gases, yet there remains a
20 strong need to respond to this health and safety issue for worker protection purposes. As a
21 result of this need, an aggregate area based field characterization program is proposed. This
22 effort will characterize the volatile gases in the Z Plant Aggregate Area (primarily carbon
23 tetrachloride) and associated meteorological effects. Additional consideration should also be
24 given to extending the program to other portions of the 200 West Area where ambient air
25 quality may be a concern.
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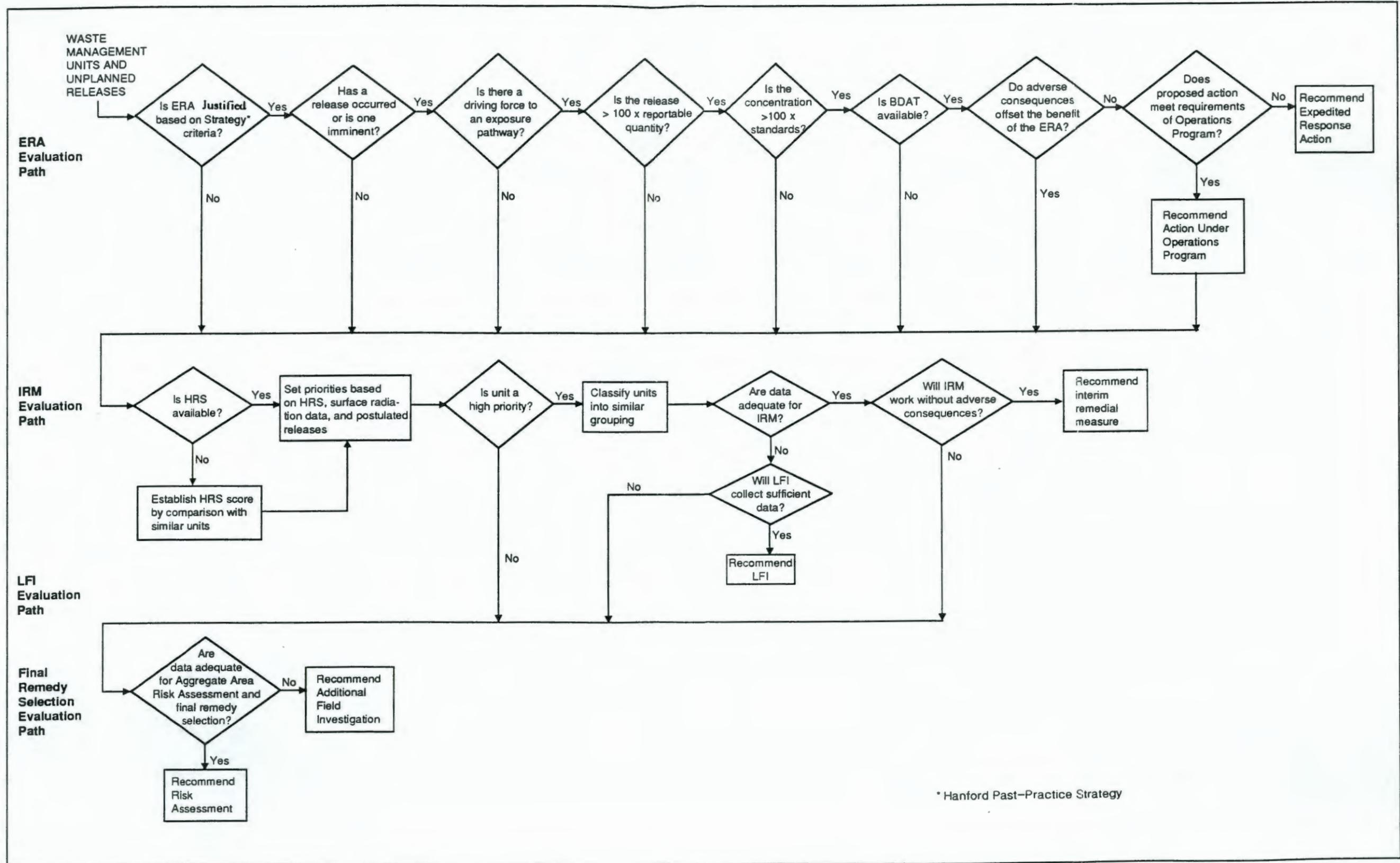


Figure 9-1. 200 Aggregate Area Management Study Data Evaluation Process.

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Table 9-1. Summary of Results of Data Evaluation Process Assessment for Z Plant Aggregate Area. (Sheet 1 of 3)

Waste Management Unit or Unplanned Release	ERA	IRM	LFI	RA	RI	OPS	Remarks
Tanks and Vaults							
216-Z-8 Settling Tank	X				X		Remove drainable liquids.
241-Z-361 Settling Tank	X				X		
Cribs and Drains							
216-Z-1 & 216-Z-2 Cribs			X			X	Address under RARA program engineering study.
216-Z-3 Crib			X				
216-Z-5 Crib			X			X	Address under RARA program engineering study.
216-Z-6 Crib			X			X	
216-Z-7 Crib			X			X	
216-Z-12 Crib			X				
216-Z-16 Crib			X				
216-Z-18 Crib			X				
216-Z-8 French Drain					X		
216-Z-13 French Drain					X		
216-Z-14 French Drain					X		
216-Z-15 French Drain					X		
216-Z-1A Tile Field			X			X	Address under RARA program.
Reverse Well							
216-Z-10 Reverse Well					X		
Ponds, Ditches, and Trenches							
216-Z-4 Trench			X				
216-Z-9 Trench			X				
216-Z-17 Trench			X				
Septic Tanks and Associated Drain Fields							
2607-Z Septic Tank & Field	X				X		To halt recharge in vicinity of 216-Z-3 Crib.
2607-Z-1 Septic Tank & Field					X		

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Table 9-1. Summary of Results of Data Evaluation Process Assessment for Z Plant Aggregate Area. (Sheet 2 of 3)

Waste Management Unit or Unplanned Release	ERA	IRM	LFI	RA	RI	OPS	Remarks
2607-WA Septic Tank & Field	X				X		To halt recharge in vicinity of 216-Z-8' French Drain and 216-Z-9 Trench.
2607-WB Septic Tank & Field					X		
2607-W-8 Septic Tank & Field					X		
Transfer Facilities, Diversion Boxes, and Pipelines							
241-Z Diversion Box No. 1			X				
241-Z Diversion Box No. 2			X				
231-Z-151 Sump			X				
Basins							
241-Z Retention Basin					X		
216-Z-21 Seepage Basin					X		
Burial Sites							
218-W-1			X				
218-W-1A					X		
218-W-2			X			X	Address under RARA program.
218-W-3			X				
218-W-4A			X			X	Address under RARA program.
218-W-11					X		
Z Plant Burn Pit					X		
Unplanned Releases							
UN-200-W-11					X		
UPR-200-W-16					X		
UN-200-W-23					X		
UPR-200-W-26					X		
UN-200-W-44					X		
UPR-200-W-53					X		
UPR-200-W-72				X			
UPR-200-W-84				X			

Table 9-1. Summary of Results of Data Evaluation Process Assessment for Z Plant Aggregate Area. (Sheet 3 of 3)

Waste Management Unit or Unplanned Release	ERA	IRM	LFI	RA	RI	OPS	Remarks
UN-200-W-89					X		
UN-200-W-90					X		
UN-200-W-91					X		
UN-200-W-103					X		
UN-200-W-130					X		
UPR-200-W-134				X			
UPR-200-W-158					X		Only the portion of the release associated with 218-W-1A Burial Ground.
UN-200-W-159				X			

Notes:

ERA Expedited Response Action

IRM Interim Remedial Measure

LFI Limited Field Investigation

RA Risk Assessment

RI Remedial Investigation; Feasibility study will be conducted if RA indicates remedial action necessary.

OPS Operational Programs

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Table 9-2. Z Plant Aggregate Area Data Evaluation Decision Matrix. (Sheet 1 of 4)

Waste Management Unit or Unplanned Release	ERA Evaluation Path								IRM Evaluation Path			LFI Path	Final Remedy
	Is An ERA Justified?	Release?	Pathway?	Quantity?	Concentration?	Treatment Available?	Adverse Consequences?	Operational Programs?	High Priority?	Data Adequate?	Adverse Consequences?	Collect Data?	Data Adequate?
Tanks and Vaults													
216-Z-8 Settling Tank	Y	Y	Y	Y	Y	Y	N	N	N	-	-	-	N
241-Z-361 Settling Tank	Y	Y	Y	Y	Y	Y	N	N	N	-	-	-	N
Cribs and Drains													
216-Z-1 & 216-Z-2 Cribs	Y	Y	Y	Y	Y	Y	N	Y	Y	N	-	Y	-
216-Z-3 Crib	Y	Y	N	-	-	-	-	-	N	N	-	Y	-
216-Z-5 Crib	Y	Y	Y	Y	Y	Y	N	Y	N	N	-	Y	-
216-Z-6 Crib	Y	Y	Y	Y	Y	Y	N	Y	N	N	-	Y	-
216-Z-7 Crib	Y	Y	Y	Y	Y	Y	N	Y	Y	N	-	Y	-
216-Z-12 Crib	Y	Y	N	-	-	-	-	-	N	N	-	Y	-
216-Z-16 Crib	Y	Y	N	-	-	-	-	-	N	N	-	Y	-
216-Z-18 Crib	Y	Y	N	-	-	-	-	-	N	N	-	Y	-
216-Z-8 French Drain	Y	Y	N	-	-	-	-	-	N	-	-	-	N
216-Z-13 French Drain	Y	N	-	-	-	-	-	-	N	-	-	-	N
216-Z-14 French Drain	Y	N	-	-	-	-	-	-	N	-	-	-	N
216-Z-15 French Drain	Y	N	-	-	-	-	-	-	N	-	-	-	N
216-Z-1A Tile Field	Y	Y	Y	Y	Y	Y	N	Y	Y	N	-	Y	-

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Table 9-2. Z Plant Aggregate Area Data Evaluation Decision Matrix. (Sheet 2 of 4)

Waste Management Unit or Unplanned Release	ERA Evaluation Path								IRM Evaluation Path			LFI Path	Final Remedy
	Is An ERA Justified?	Release?	Pathway?	Quantity?	Concentration?	Treatment Available?	Adverse Consequences?	Operational Programs?	High Priority?	Data Adequate?	Adverse Consequences?	Collect Data?	Data Adequate?
Reverse Well													
216-Z-10 Reverse Well	Y	Y	Y	Y	Y	N	-	-	Y	N	-	N	N
Ponds, Ditches, and Trenches													
216-Z-4 Trench	Y	Y	N	-	-	-	-	-	N ^u	N	-	Y	-
216-Z-9 Trench	Y	Y	N	-	-	-	-	-	N ^u	N	-	Y	-
216-Z-17 Trench	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
Septic Tanks and Associated Drain Fields													
2607-Z Septic Tank & Field	Y	Y	Y	Y	Y	Y	N	N	N	-	-	-	N
2607-Z-1 Septic Tank & Field	Y	N	-	-	-	-	-	-	N	-	-	-	N
2607-WA Septic Tank & Field	Y	Y	Y	Y	Y	Y	N	N	N	-	-	-	N
2607-WB Septic Tank & Field	Y	N	-	-	-	-	-	-	N	-	-	-	N
2607-W-8 Septic Tank & Field	Y	N	-	-	-	-	-	-	N	-	-	-	N
Transfer Facilities, Diversion Boxes, and Pipelines													
241-Z Diversion Box No. 1	Y	N	-	-	-	-	-	-	N ^u	N	-	Y	-
241-Z Diversion Box No. 2	Y	N	-	-	-	-	-	-	N ^u	N	-	Y	-
231-Z-151 Sump	Y	Y	N	-	-	-	-	-	N ^u	N	-	Y	-

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Table 9-2. Z Plant Aggregate Area Data Evaluation Decision Matrix. (Sheet 3 of 4)

Waste Management Unit or Unplanned Release	ERA Evaluation Path								IRM Evaluation Path			LFI Path	Final Remedy
	Is An ERA Justified?	Release?	Pathway?	Quantity?	Concentration?	Treatment Available?	Adverse Consequences?	Operational Programs?	High Priority?	Data Adequate?	Adverse Consequences?	Collect Data?	Data Adequate?
Basins													
241-Z Retention Basin	Y	N	-	-	-	-	-	-	N	-	-	-	N
216-Z-21 Seepage Basin	Y	Y	Y	Y	Y	Y	Y	-	N	-	-	-	N
Burial Sites													
218-W-1	Y	Y	N	-	-	-	-	-	N ^v	N	-	Y	-
218-W-1A	Y	Y	N	-	-	-	-	-	N	-	-	-	N
218-W-2	Y	Y	Y	Y	Y	Y	N	Y	Y	N	-	Y	-
218-W-3	Y	Y	N	-	-	-	-	-	N ^v	N	-	Y	-
218-W-4A	Y	Y	Y	Y	Y	Y	N	Y	Y	N	-	Y	-
218-W-11	Y	Y	N	-	-	-	-	-	N	-	-	-	N
Bum Pit	Y	Y	N	-	-	-	-	-	N	-	-	-	N
Unplanned Releases													
UN-200-W-11	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UPR-200-W-16	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-23	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UPR-200-W-26	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-44	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UPR-200-W-53	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UPR-200-W-72	Y	Y	N	-	-	-	-	-	N	-	-	-	Y
UPR-200-W-84	Y	Y	N	-	-	-	-	-	N	-	-	-	Y

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Table 9-2. Z Plant Aggregate Area Data Evaluation Decision Matrix. (Sheet 4 of 4)

Waste Management Unit or Unplanned Release	ERA Evaluation Path								IRM Evaluation Path			LFI Path	Final Remedy
	Is An ERA Justified?	Release?	Pathway?	Quantity?	Concentration?	Treatment Available?	Adverse Consequences?	Operational Programs?	High Priority?	Data Adequate?	Adverse Consequences?	Collect Data?	Data Adequate?
UN-200-W-89	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-90	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-91	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-103	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-130	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UPR-200-W-134	Y	Y	N	-	-	-	-	-	N	-	-	-	Y
UPR-200-W-158 (1)	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-159	Y	Y	N	-	-	-	-	-	N	-	-	-	Y

Y Yes

N No

- Indicates decision point not reached.

^{a/} Evaluated as high priority site because of proximity and/or similarity to other high priority sites.

(1) Only the unplanned release UPR-200-W-158 associated with the 218-W-1A Burial Ground.

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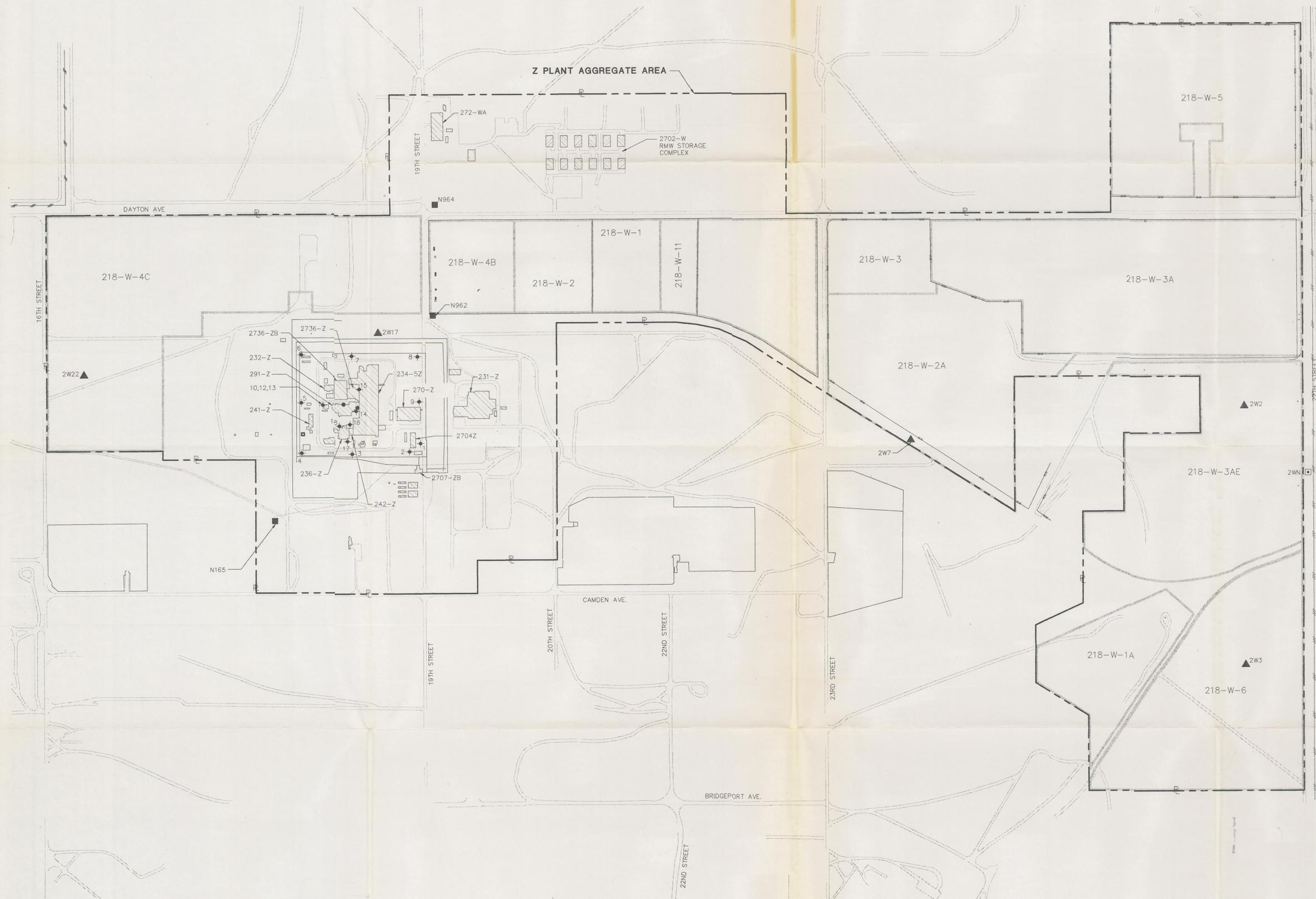
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Z-PLANT BUILDING LOCATION AND NUMBER
- 
218-W-3 SOLID WASTE BURIAL GROUND LOCATION AND NUMBER
- 
2W7 ANNUAL SURFACE GRID POINT SAMPLING LOCATION AND NUMBER
- 
N165 ANNUAL AIR MONITORING STATION LOCATION AND NUMBER
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2WN FENCELINE SURFACE SAMPLE LOCATION AND NUMBER
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2 1990 Z PLANT SOIL SAMPLE LOCATION AND NUMBER

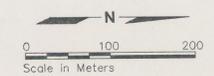
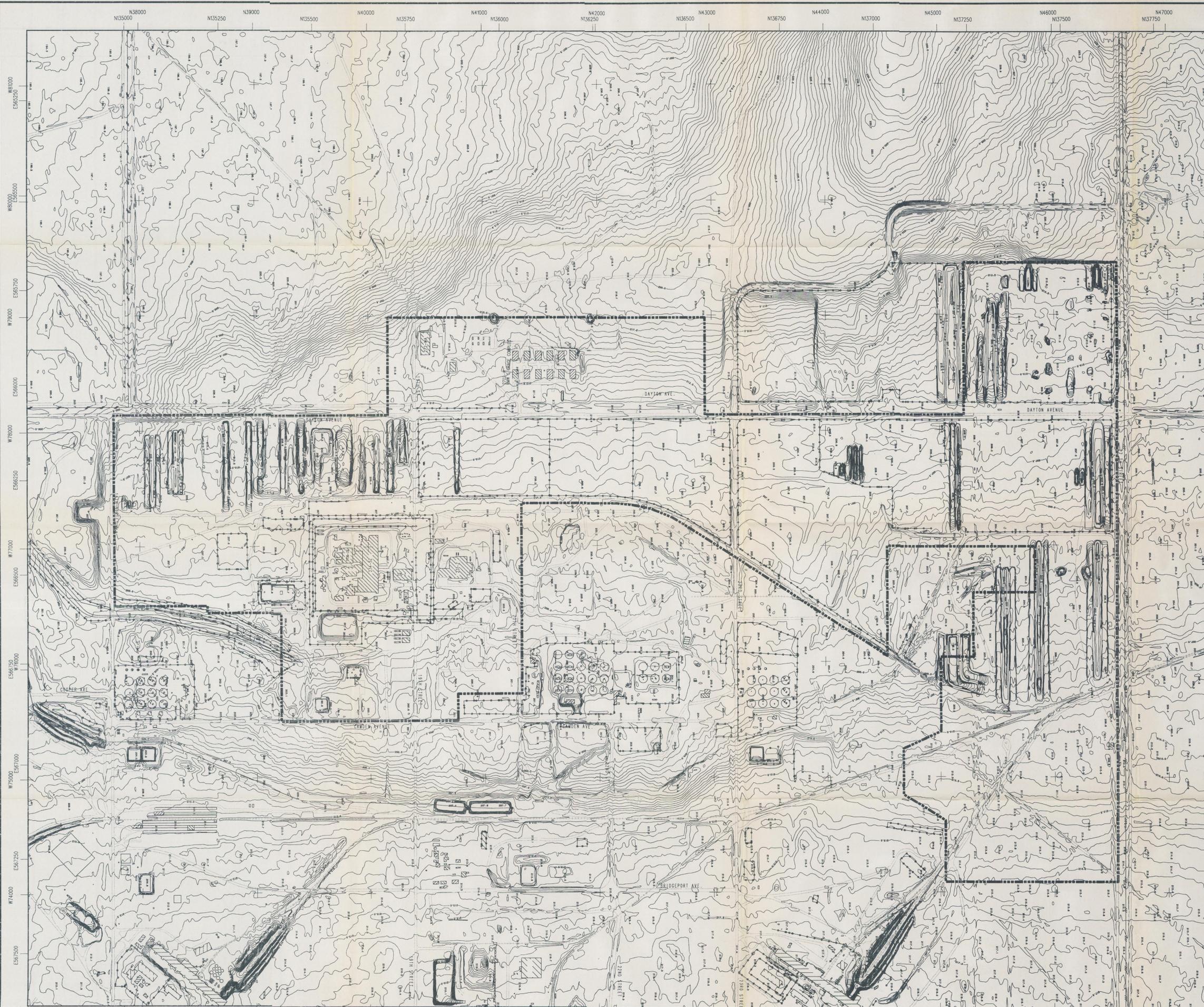


Plate 2. Z Plant Aggregate Area Surface Media and Air Sampling Locations.

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 Aggregate Area Management Studies
 Z PLANT AGGREGATE AREA
 PLATE 1 - Topography

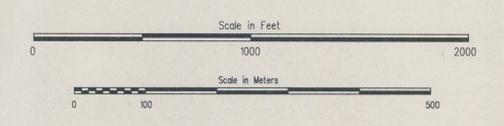
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-  Aggregate Area Boundary
-  Security Systems/Fences
-  Perimeter Boundary
-  Buildings

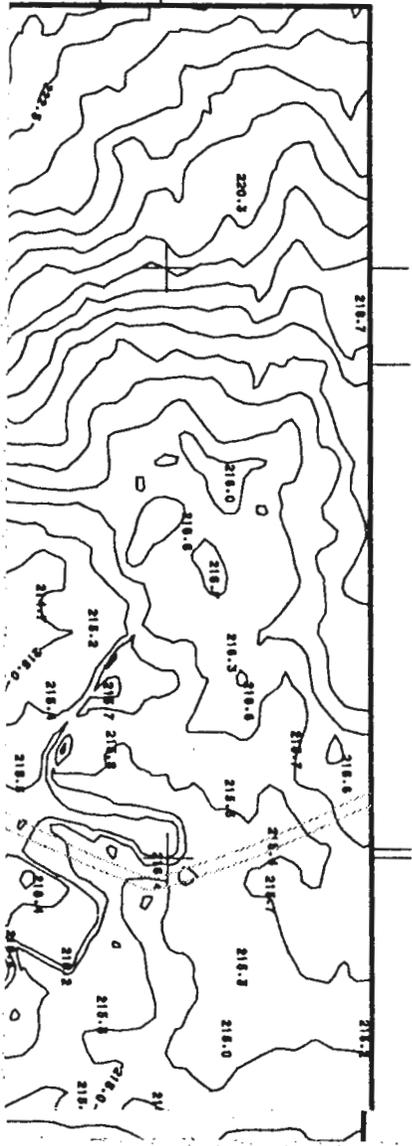
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NOTE: Compiled from variety of source data. This map may not meet National Map Accuracy Standards.



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Westinghouse Hanford Company
Aggregate Area Management Studies

Z PLANT AGGREGATE AREA
PLATE 1 - Topography

Z PLANT BURIAL
LOCATION AND NUMBER



218-W-3

SOLID WASTE BURIAL GROUND
LOCATION AND NUMBER

2W7 ▲

ANNUAL SURFACE GRID POINT SAMPLING
LOCATION AND NUMBER

N165 ■

ANNUAL AIR MONITORING STATION
LOCATION AND NUMBER

2WN □

FENCELINE SURFACE SAMPLE
LOCATION AND NUMBER

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1990 Z PLANT SOIL SAMPLE
LOCATION AND NUMBER

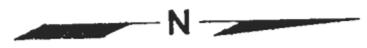


Plate 2. Z Plant Aggregate Area Surface Media and Air Sampling Locations.

APPENDIX A
SUPPLEMENTAL DATA

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SUPPLEMENTAL DATA**

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A.1.0 SUBSURFACE GEOPHYSICAL LOGS

Geophysical well logging has been conducted at the Z Plant Aggregate Area since at least as early as 1954 as a surveillance technique to evaluate radionuclide migration in the unsaturated zone underlying or adjacent to waste disposal or storage areas. Vadose-zone monitoring wells and groundwater monitoring wells have been constructed at many of the Z Plant Aggregate Area waste management units. Geophysical well logs have been acquired from monitoring wells at the following eighteen waste management units, the remaining waste management units did not have monitoring structures in the immediate vicinity:

- 216-Z-1 Crib
- 216-Z-2 Crib
- 216-Z-3 Crib
- 216-Z-5 Crib
- 216-Z-7 Crib
- 216-Z-12 Crib
- 216-Z-16 Crib
- 216-Z-18 Crib
- 216-Z-1A Tile Field
- 216-Z-9 Trench
- 216-W-3A Burial Ground
- 216-W-3AE Burial Ground
- 216-W-4B Burial Ground
- 216-W-4C Burial Ground
- 216-W-5 Burial Ground
- 216-W-6 Burial Ground
- 216-W-11 Burial Ground.

As part of this Aggregate Area Management Study, select geophysical well logs from these twenty-four waste management units were examined to provide a preliminary appraisal of migration of radionuclides in the unsaturated zone. The objectives of the geophysical well log study were to qualitatively and, if possible, quantitatively evaluate the extent and rate of vertical and lateral migration of radionuclides. Several previously conducted studies provide important background information. Most notable is a three-volume document by Fecht et al. (1977), in which gross gamma-ray logs were reviewed and evaluated for potential contamination. Several additional published and unpublished documents exist such as gross-gamma logs acquired from monitoring inactive cribs and logs acquired as part of the low-level

1 burial ground monitoring well installation program (Chamness et al. 1991). Pertinent
2 results of previously conducted studies or observations are discussed along with results
3 of this study in sections describing individual waste management units.
4

5 The following vadose zone fluid migration pathways have been recognized in
6 the 200 West Area: 1) vertical downward migration; 2) lateral migration at the
7 interface of an underlying coarser-grained zone or low permeability zone; 3) a
8 combination of vertical and lateral migration that may be manifested in adjacent wells
9 as digitate clean and contaminated zones; and 4) vertical downward migration along
10 the well casings in poorly constructed wells. Additional complications in interpreting
11 the migration of contaminants include the natural decay of radionuclides and the
12 different migration rates of various radionuclides.
13

14 15 **A.1.1 AVAILABLE GEOPHYSICAL WELL LOGS**

16
17 The array of geophysical logs acquired from the Z Plant Aggregate Area
18 includes gross gamma-ray logs, gamma-gamma logs, neutron-epithermal-neutron logs,
19 density logs, sonic logs, and temperature logs. Spectral gamma-ray logs have been
20 acquired at two locations within the Z Plant Aggregate Area: within the 216-Z-1A
21 Tile Field and along the 216-Z-20 Ditch. However, because the 216-Z-20 Ditch is a
22 U Plant Aggregate Area waste management unit, it is not discussed in this report.
23 The gross gamma-ray log was by far the most common log acquired, and, with the
24 exception of the spectral gamma-ray log, is the most useful for evaluating migration of
25 anthropogenic radionuclides in the unsaturated zone. Ancillary logs, such as the
26 neutron and density logs, may also provide useful information. The interpretation of
27 those logs, however, is complicated by several factors, including: the presence of
28 multiple casing strings, the complications of logging in unsaturated zones,
29 uncertainties in well construction and modifications, and questionable tool geometry
30 and response characteristics. Consequently, the ancillary logs were not evaluated as
31 part of this study.
32

33 The available gross gamma-ray logs were acquired from Z Plant Aggregate
34 Area monitoring wells by the Pacific Northwest Laboratory (PNL) under contract by
35 the primary Department of Defense (DOD) Westinghouse Hanford contractor.
36

37 PNL began recording gross gamma-ray logs from Z Plant Aggregate Area
38 monitoring wells in 1958. On the basis of log presentation, three generations of
39 logging equipment have been used in the Z Plant Aggregate Area since 1958.
40 However, based on conversations with long-term Westinghouse Hanford and PNL
41 employees, several more subtle equipment modifications were made within
42 generations of logging equipment. In fact, judging from the normalization factors

1 used by Fecht et al. (1977), procedural or equipment modifications may even have
2 been made annually. Beginning in 1982, procedures were implemented to improve
3 log quality and consistency (Lewis 1991). Further improvements in logging
4 procedures were implemented in 1989. Since 1976, two probes with similar response
5 characteristics have been used by PNL. Beginning in 1982, the serial number of the
6 probe used has been recorded on the log header. Detailed logging procedures are
7 described in WHC (1991).
8

9 The gross gamma-ray logs identified for this study are listed in Table A-9. The
10 logs listed in Table A-9 constitute a comprehensive list of all logs acquired in the
11 Z Plant Aggregate Area through 1990. Logs were identified for eight cribs, one tile
12 field, one trench, and eight burial grounds.
13

14 15 **A.1.2 LOG QUALITY**

16
17 An assessment of gross gamma-ray log quality is difficult, particularly for the
18 very early logs, because of a lack of accessible documentation of procedures and
19 results. Evaluation of log quality ultimately encompasses a large number of factors
20 including documentation of design specifications, modifications, and repairs; detailed
21 performance tests of probes and instrumentation; evaluation of the precision and
22 accuracy of the depth measurement system; probe response; and periodic calibration.
23 Of equal importance to equipment considerations is documentation of monitoring
24 well construction and modifications ("as-built" diagrams) and reference elevations.
25 PNL has vastly improved their quality control procedures over the last decade.
26 Beginning in 1979, a designated test well (399-5-2) was logged on a quarterly basis,
27 and probe serial numbers were recorded along with basic logging information.
28 "Calibration" logs acquired between 1979 and 1988, when more sophisticated
29 procedures were implemented, are fairly uniform with respect to log intensity and bed
30 resolution. No known quality control information exists for logs acquired by PNL
31 prior to 1979. Since 1988, a significant campaign has been mounted to improve PNL
32 log quality.
33

34 Without documentation, the only means to evaluate log quality is to compare
35 logs collected from the same well. There is substantial variability in probe sensitivity
36 both between and within the three generations of equipment, although reproducibility
37 increases significantly after 1980. There also appears to be variability in the linearity
38 of probe response, because peak to background ratios are not consistent. Resolution
39 of marker beds seems to be consistent between generations, but depths typically vary
40 by ± 2 ft. Both intensity and depth measurements are very difficult to assess on major
41 peaks from the 1958-1959 logs (Esterline-Angus recorder).
42

A.1.3 TECHNICAL APPROACH

To facilitate differentiation of peaks resulting from natural and anthropogenic radionuclides, geologic cross sections of the waste management units were constructed (Figures A-2, A-3, A-5, A-6, A-8, and A-9) using representative gross gamma-ray logs acquired from the main waste management units. Cross section locations are shown on Figures A-1, A-4, and A-7. Correlations shown on the cross sections are based on geologic descriptions by Last et al. (1989) and typical gamma-ray log characteristics (Schlumberger 1972 and 1979; Dresser Atlas 1982).

In the Z Plant Aggregate Area, the upper 12 to 28 m (40 to 90 ft) consist of coarse sand, gravelly sand, and sandy gravel identified as the Pasco gravel member of the Hanford formation. This horizon typically has a fairly low and uniform natural gamma response. The low gamma response frequently observed in the upper 6 m (20 ft) is probably due to attenuation by conductor casing. Underlying the Pasco gravels member is the basal slack-water sequence of the Hanford formation. The fine-grained nature of this unit produces a slightly higher, but still uniform, gamma-ray response.

One of the most striking features of many logs is the relatively high gamma-ray response resulting from the fine-grained eolian sand and silt (loess) comprising the Early "Palouse" soil. That unit is typically 6 to 9 m (20 to 30 ft) thick and has one or two peaks yielding the greatest gamma-ray response of the natural radionuclides. The underlying Pliocene-Pleistocene basaltic gravels and caliche-rich paleosal (calcrete) units are not easily recognizable on the logs, although they often display a relatively low gamma-ray response (as low as the Pasco gravels). Zones of especially low response are probably gravel and rich, whereas zones of especially high response may result from the calcrete layers. Underlying the Plio-Pleistocene horizons, is the middle Ringold Formation, consisting of sand and gravels and occasional lenses of sand and clay. In the southern portion of the site the Upper Ringold Formation is present. The discontinuous fine sands and muds of the Upper Ringold produce a fairly high gamma-ray response comparable to the Early "Palouse" soils.

The "regional" stratigraphic framework described above provides a baseline for more detailed evaluation of logs from an individual waste management unit. For each waste management unit, logs from nearby wells were correlated and compared to the cross section of the waste management unit to identify log-profile anomalies that might represent anthropogenic radionuclides. For many of the more recently constructed wells and later gross gamma-ray logs were acquired in the 20 cm (8 in) diameter casing and then shortly thereafter in 15 cm (6 in) diameter casing. Generally, only the later logs provided useful information on anthropogenic radionuclide peaks.

Results of the log interpretations for each of the waste management units are presented in the following sections.

A.1.4 EVALUATION OF DATA IDENTIFIED FOR WASTE MANAGEMENT UNITS

Based on availability of both gross gamma and geologic logs for a particular waste management unit and indications of elevated gamma activity, an analysis of the potential nature and extent of radionuclide contamination was performed. Sections A.1.4.1 through A.1.4.3 discuss data identified for the following representative waste management units:

- The 216-Z-18 Crib
- The 216-Z-9 Trench
- The 216-Z-1A Tile Field, 216-Z-1 & 216-Z-2 Cribs, and 216-Z-3 Crib.

A.1.4.1 216-Z-18 Crib

A.1.4.1.1 Waste Description. This section briefly summarizes information presented in Tables 2-1 and 2-2, and Sections 2.3 and 4.1.

Source - High salt, acidic, organic waste from 236-Z Building.

Service Dates - 1969 - 1973.

Fluid Volume Received (Liters) - 3,860,000.

Quantity of Radionuclides Disposed of in Unit (Curies)

Waste Management Unit	Total Pu in gm	238U	137Cs	106Ru	90Sr	60Co	239 Pu	240 Pu
216-Z-18 Crib	23,000						1,310	353

A.1.4.1.2 Scintillation Probe Profile Evaluation. Cross sections A-A' and B-B' through the 216-Z-18 Crib are shown on Figures A-2 and A-3. Figure A-1 shows the cross section locations. As shown on Figure A-2, elevated gamma response is observed just beneath the base of the northeast corner of the crib in monitoring well

299-W18-9. Additional intervals of elevated gamma response are observed at depths of 10 m (30 feet) below ground surface in monitoring wells 299-W18-94 and 299-W18-93 (Figure A-2). Monitoring well 299-W18-98, approximately 8 m (25 feet) north of the crib, shows only natural gamma response. Monitoring wells 299-W18-9 and 299-W18-10 exhibit intervals of elevated gamma response from the base of the crib to the top of the Early "Palouse" soil horizon. Intervals of elevated gamma response, likely associated with minor fine-grained soil horizons, also are evident in well 299-W18-10 below the base of the Plio-Pleistocene horizon. Monitoring well 299-W18-12, located near the center of the crib exhibits only natural gamma response.

Review of these gamma scintillation logs suggests that radionuclide migration to the top of the Early "Palouse" soil horizon and possibly deeper has occurred in the northeastern portion of the crib.

A.1.4.2 216-Z-9 Trench

A.1.4.2.1 Waste Description. This section briefly summarizes information presented in Tables 2-1 and 2-2, and Sections 2.3 and 4.1.

Source - Radioactive, acidic, organic wastes from RECUPLEX process (234-5Z Building), 242-Z Building inorganic process wastes, and 236-Z CAW

Service Dates - 1955 - 1962.

Fluid Volume Received (Liters) 4,090,000

Quantity of Radionuclides Disposed of in Unit (Curies)

Waste Management Unit	Total Pu in gm	238U	137Cs	106Ru	90Sr	60Co	239Pu	240Pu
216-Z-9 Trench	48,000	2 x 10 ⁻⁵	0.052 (0.0556)	1.9 x 10 ⁻⁸	0.049 (0.0535)	0.00395	2,190	590

A.1.4.2.2 Scintillation Probe Profile Evaluation. Cross sections C-C' and D-D' through the 216-Z-9 Trench are shown on Figures A-5 and A-6. Figure A-4 shows the cross section locations. As shown on Figure A-5, elevated gamma response is observed at a depth of approximately 11 m (35 feet) beneath ground surface in well 299-W15-86 which is located approximately 8 m (25 feet) southwest of the trench. Monitoring well 299-W15-101, located on the east side of the trench, exhibits elevated

1 gamma response from ground surface to a depth of 6 m (20 feet). A second interval
2 of elevated gamma response in monitoring 299-W15-86 corresponds with the top of
3 the Early Palouse horizon and may be natural.
4

5 Radionuclide migration below the Early "Palouse" and Plio-Pleistocene horizons are
6 not evident at the 216-Z-9 Trench.
7

8 9 **A.1.4.3 216-Z-1A Tile Field, 216-Z-1 & 216-Z-2 Cribs, and 216-Z-3 Crib**

10
11 **A.1.4.3.1 Waste Description.** This section briefly summarizes information presented in
12 Tables 2-1 and 2-2, and Sections 2.3 and 4.1.
13

14 **Source**

15
16 216-Z-1A Tile Field - Overflow from the 216-Z-1, 216-Z-2, or 216-Z-3 Cribs, PFP
17 process wastes (234-5Z Building, PRF process waste (236-Z Building), and 242-Z
18 process wastes.
19

20 216-Z-1 & 216-Z-2 Cribs - PRF (236-Z) and 242-Z process waste, 234-5Z laboratory
21 wastes.
22

23 216-Z-3 Crib - 234-5Z process, analytical, and development wastes via 241-Z Settling
24 Tank.
25

26 **Service Dates**

27
28 216-Z-1A Tile Field - 1949 to 1959; 1964 to 1969.
29

30 216-Z-1 & 216-Z-2 Cribs - 1949 to 1952; 1964 to 1966; 1968 to 1969.
31

32 216-Z-3 Crib - 1952 to 1959.
33

34 **Fluid Volume Received (Liters)**

35
36 216-Z-1A Tile Field - 5,210,000
37

38 216-Z-1 & 216-Z-2 Cribs - 33,700,000
39

40 216-Z-3 Crib - 178,000,000
41
42

1 **Quantity of Radionuclides Disposed of in Unit (Curies)**
2

3

Waste Management Unit	Total Pu in gm	238U	137Cs	106Ru	90Sr	60Co	239 Pu	240 Pu
216-Z-1A Tile Field	57,000		0.16	5.2×10^6	0.15		137	37
216-Z-1 & 216-Z-2 Cribs	7,000	0.027	.04 (0.165)	1.6×10^{-11}	.037 (0.0159)	0.0171	2,680	992
216-Z-3 Crib	5,700	1.7×10^{-3}	.048	6.0×10^{-9} (16.9)	.045		325	87.8

11
12

13 **A.1.4.3.2 Scintillation Probe Profile Evaluation.** 216-Z-1A Tile Field - Cross sections
14 E-E' and F-F' through the 216-Z-1A Tile Field are shown on Figures A-8 and A-9.
15 Figure A-7 shows the cross section locations. As shown on Figure A-8, elevated
16 gamma response is observed just beneath the base of the tile field in monitoring wells
17 299-W18-150, 299-W18-170, and 299-W18-159. Monitoring wells 299-W18-159 and
18 299-W18-167 exhibit secondary intervals of elevated gamma response immediately
19 above the contact between the upper coarse-grained Pasco gravels member and lower
20 fine-grained slack-water sequence of the Hanford formation and within the fine-
21 grained basal unit of the Hanford formation. Only minor gamma response peaks
22 which could be associated with the natural response of thin fine-grained horizons are
23 observed in peripheral wells 299-W18-6, 299-W18-7, 299-W18-171, and 299-W18-172.
24

25 Radionuclide migration to the top of the Early "Palouse" soil horizon beneath
26 the 216-Z-1A Tile Field appears likely. The lateral extent of radionuclide migration
27 appears to be limited to the edges of the tile field.
28

29 216-Z-1 and 216-Z-2 Cribs - Monitoring wells 299-W18-65 and 299-W18-61
30 (not shown) exhibit elevated gamma response from approximately 3 m (10 feet) to 15
31 m (45 feet) below the base of the cribs (Figure A-7). Both wells also exhibit
32 secondary intervals of elevated gamma response near the top of the fine-grained basal
33 unit of the Hanford formation. Elevated gamma response is also evident beneath the
34 cribs with the Early Palouse and Plio-Pleistocene horizons. Whether the elevated
35 gamma response is natural or due to the retention of radionuclides in these fine-
36 grained horizons is difficult to determine.
37

38 Radionuclide migration to within 8 m (25 feet) of the top of the Early
39 "Palouse" soil horizon appears evident. Only natural gamma response is observed in

1 monitoring well 299-W-172, located approximately 8 m (25 feet) north of the 216-Z-2
2 Crib, suggesting that the lateral extent of radionuclide migration is limited.

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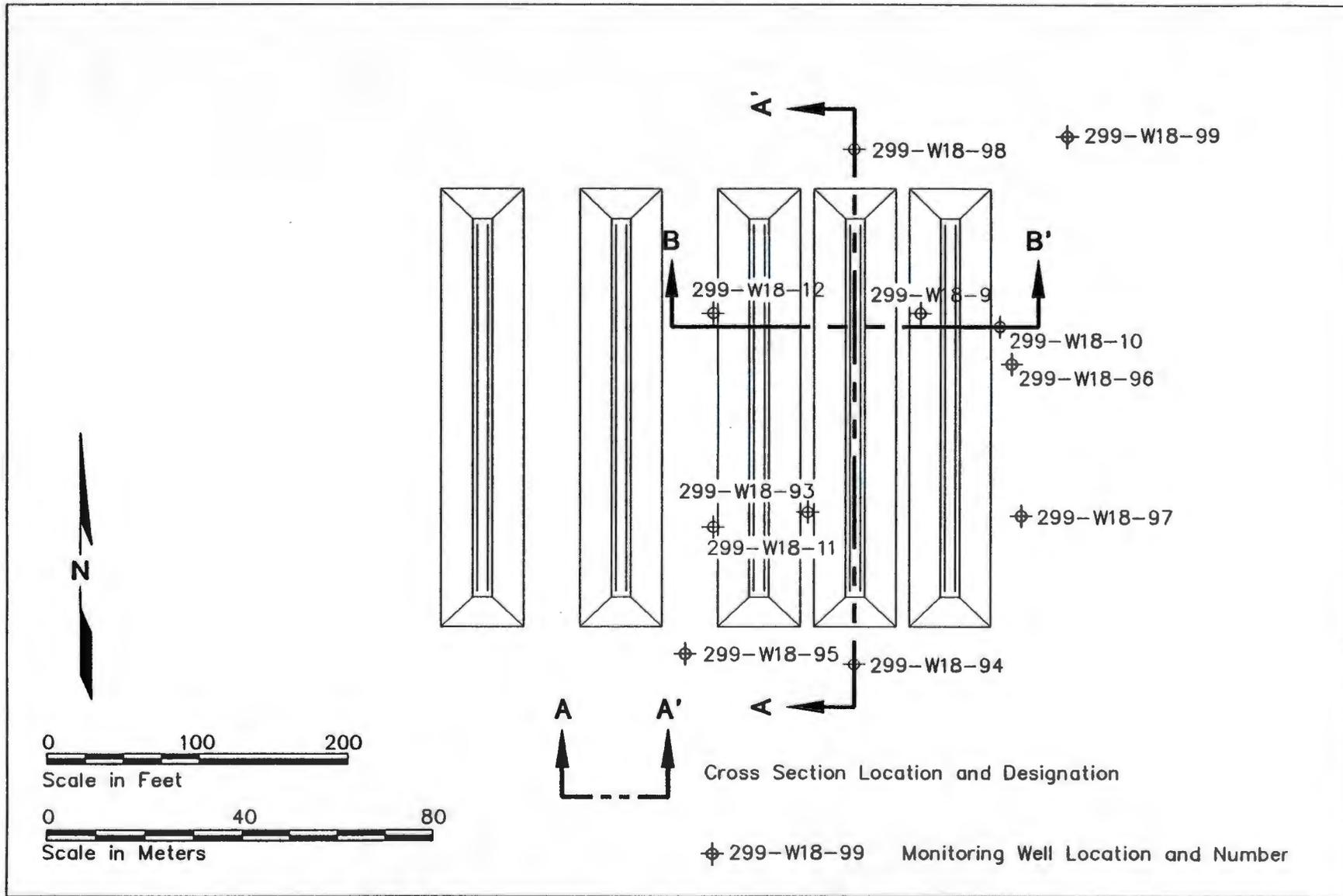


Figure A-1. Exploration Plan 216-Z-18 Crib.

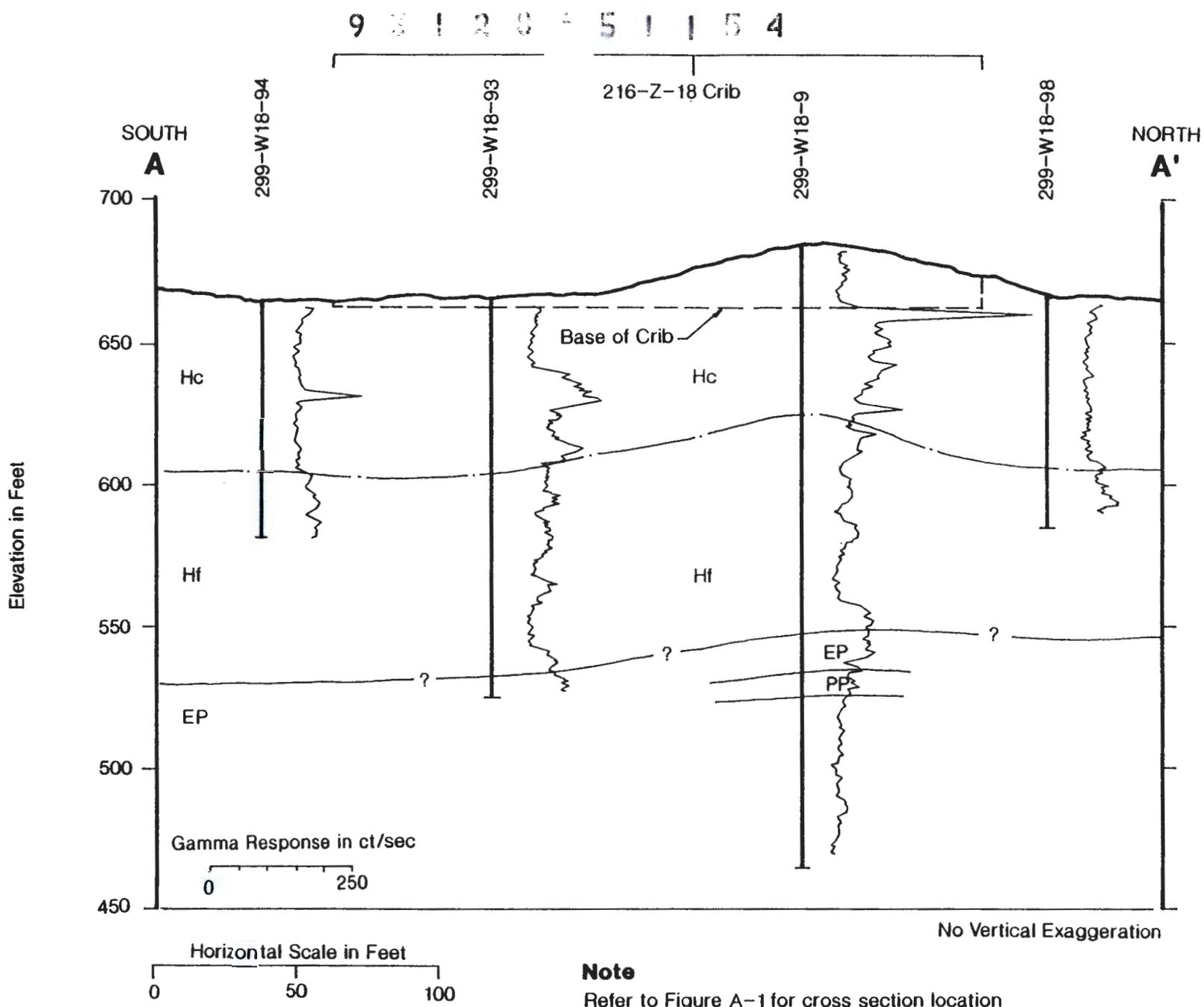
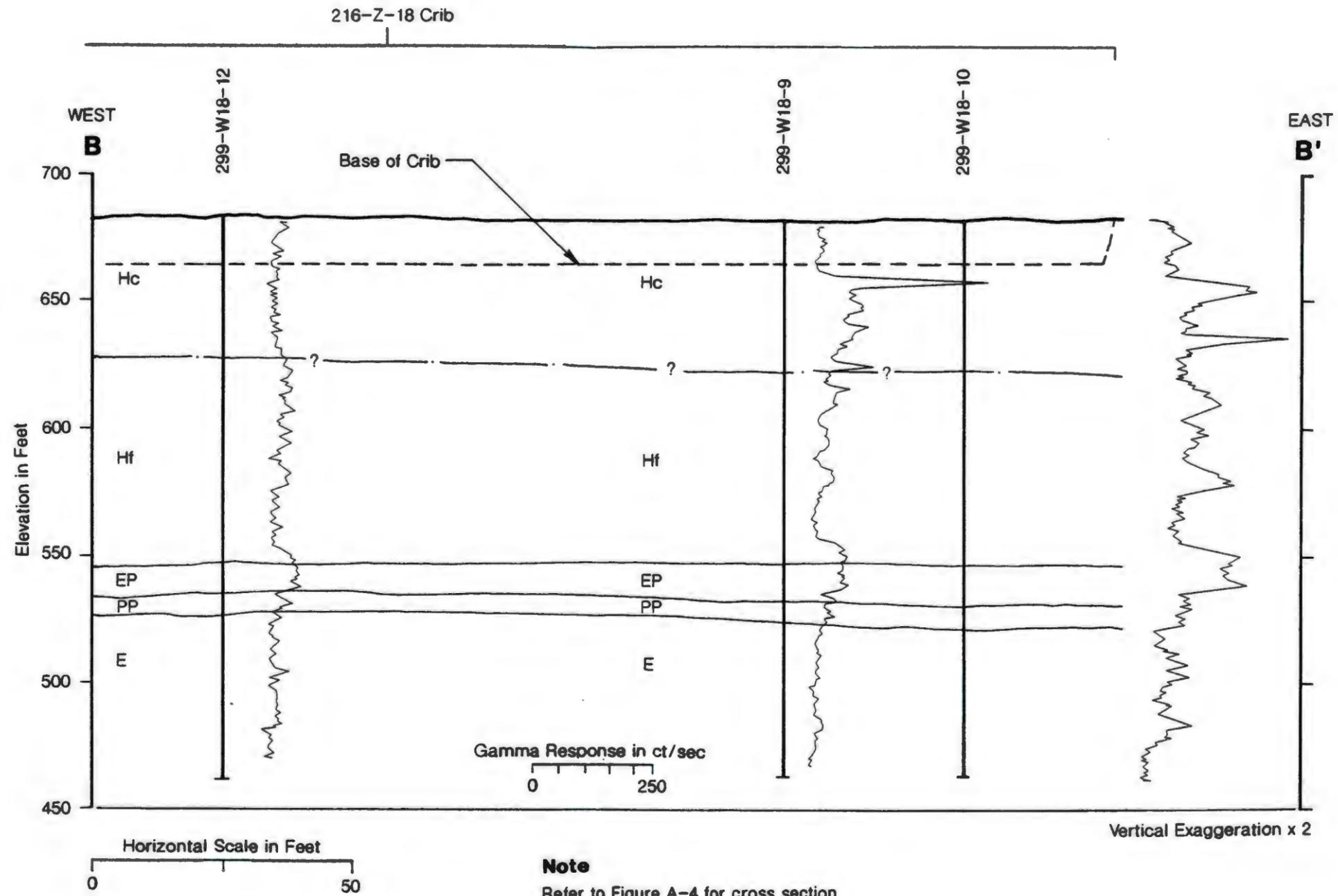


Figure A-2. Cross Section A-A'.

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Figure A-3. Cross Section B-B'.

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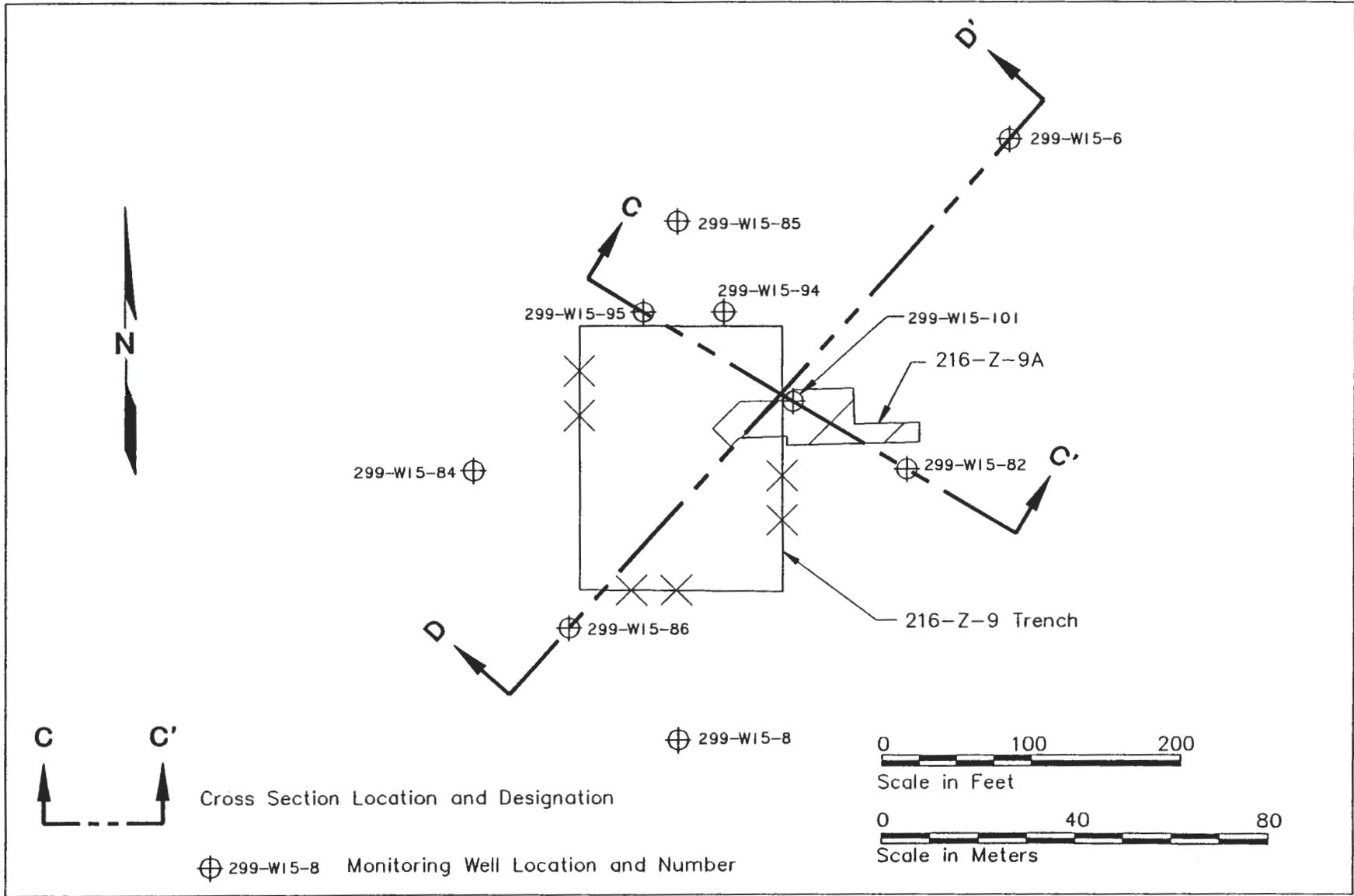


Figure A-4. Exploration Plan 216-Z-9 Trench.

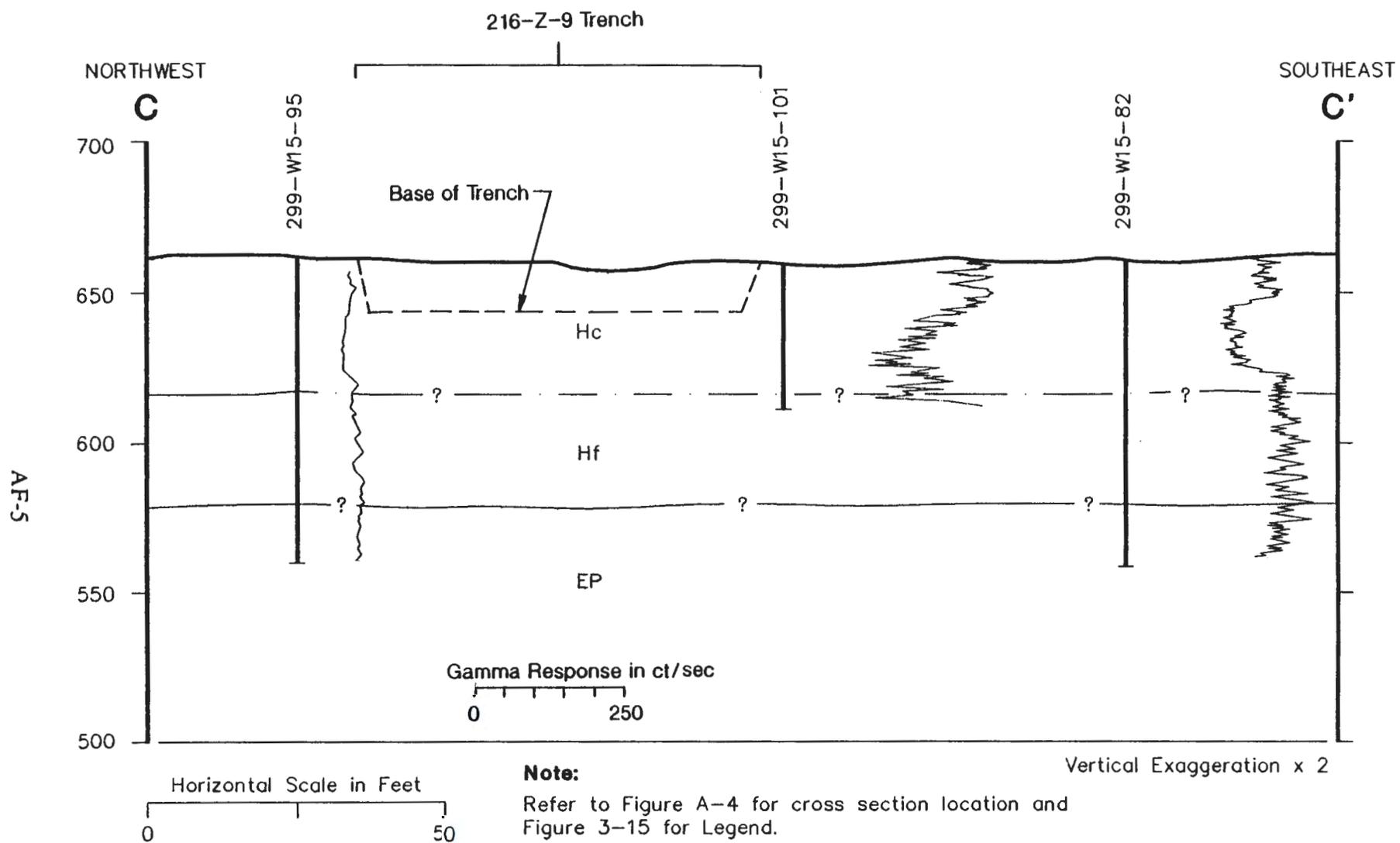
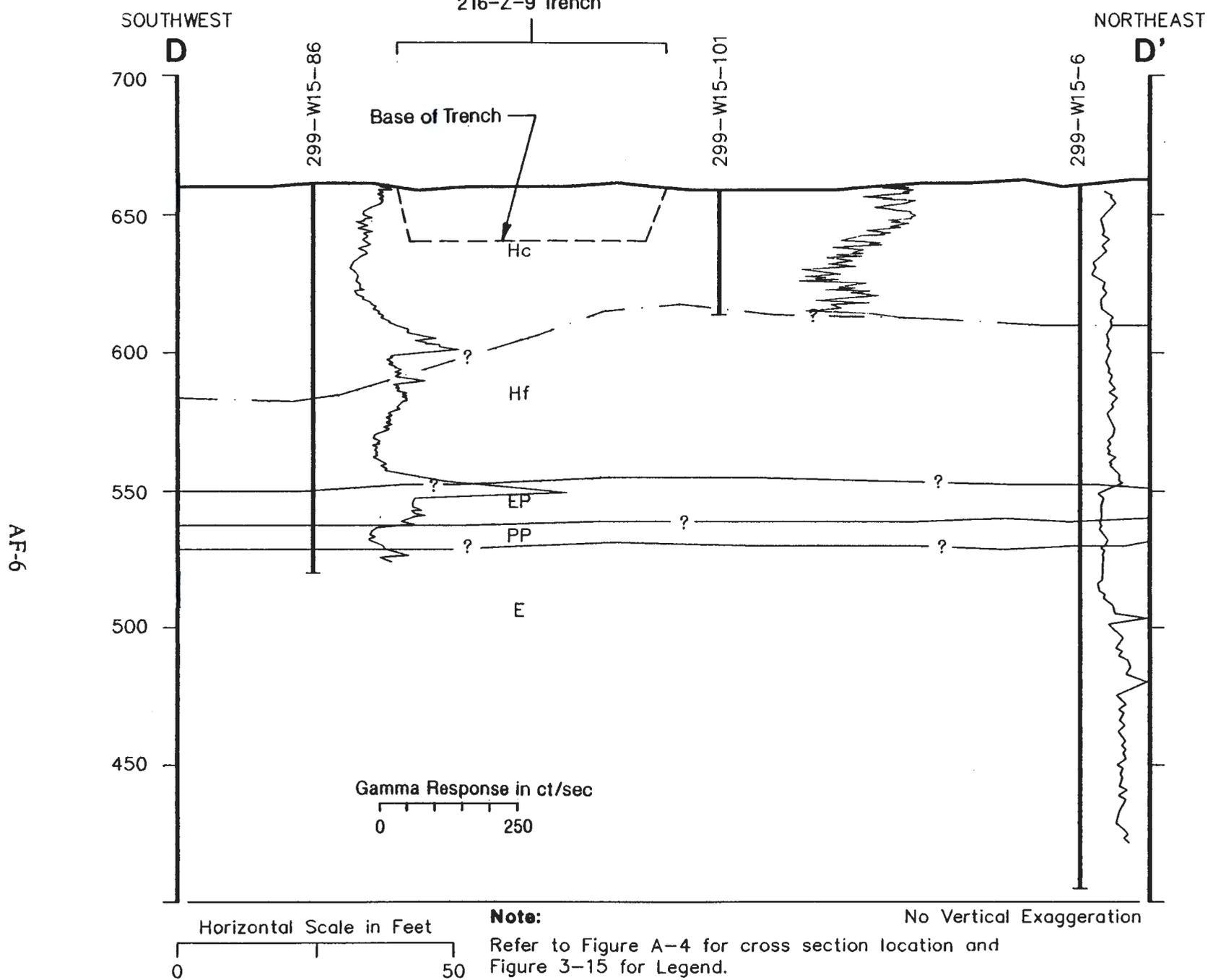


Figure A-5. Cross Section C-C'.

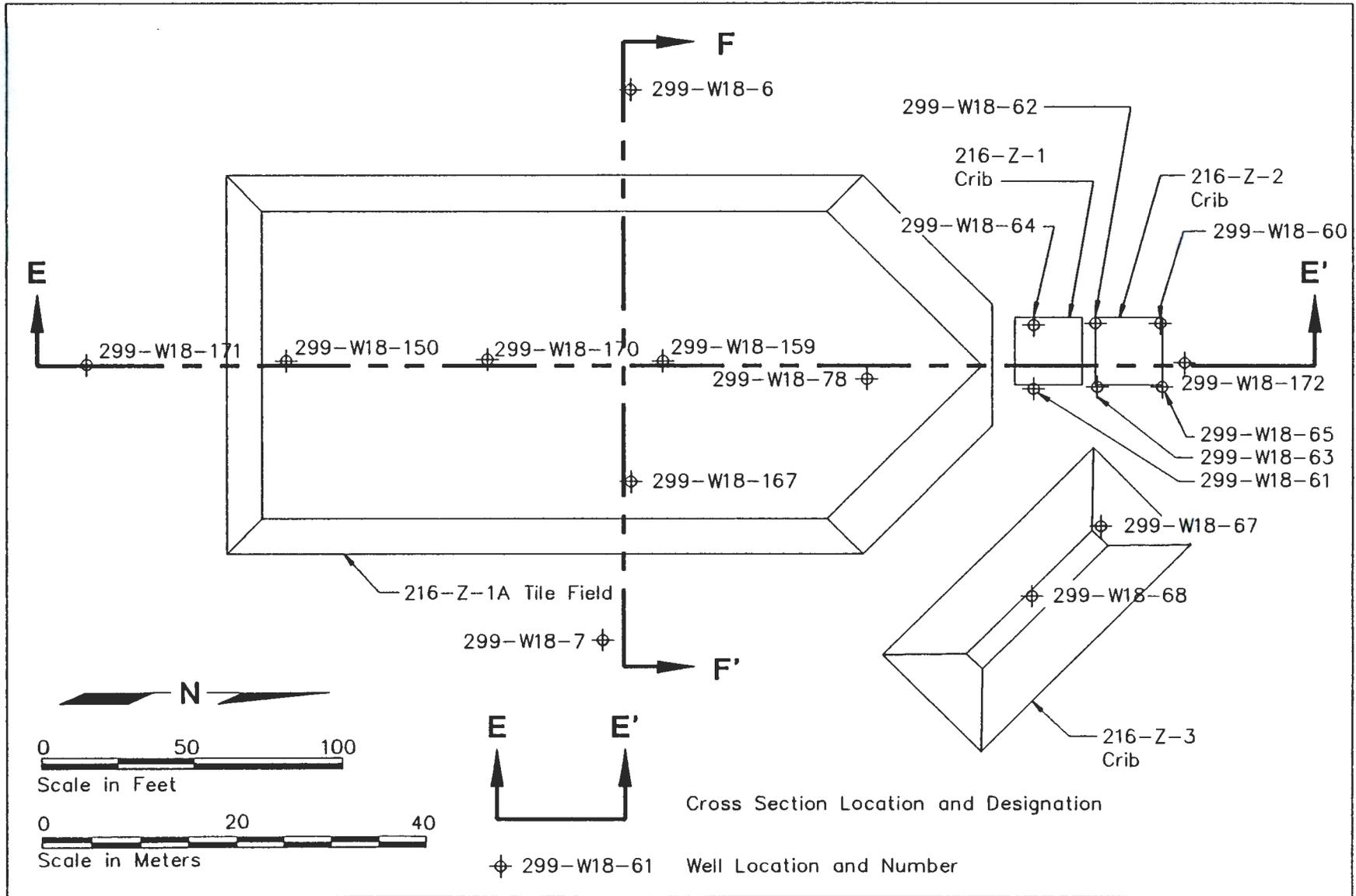


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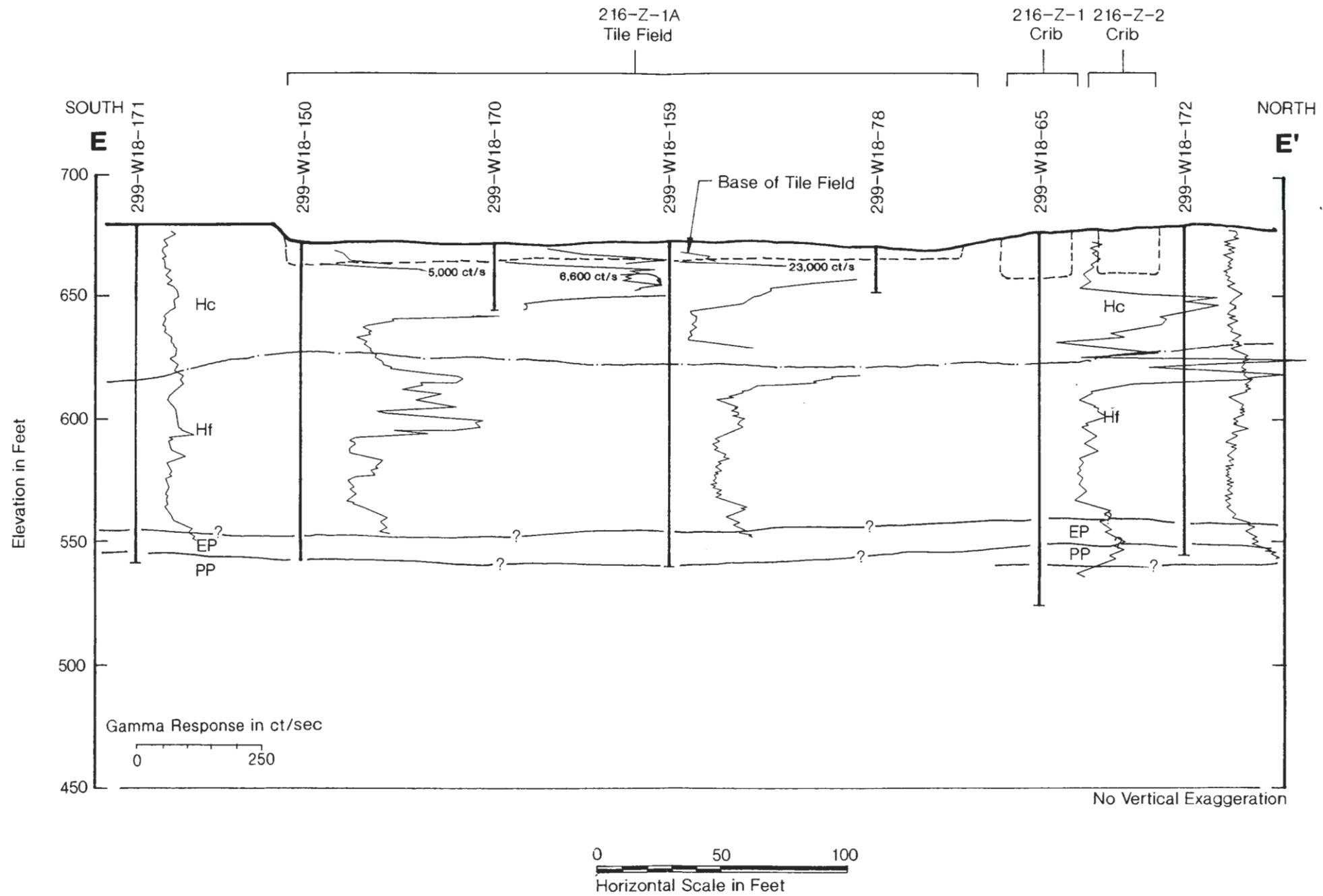
Figure A-6. Cross Section D-D'.

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Figure A-7. Exploration Plan 216-Z-1A Tile Field, 216-Z-1 Crib, and 216-Z-2 Crib.



Note

Refer to Figure A-7 for cross section location and Figure 3-15 for legend.

Figure A-8. Cross Section E-E'.

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216-Z-1A Tile Field

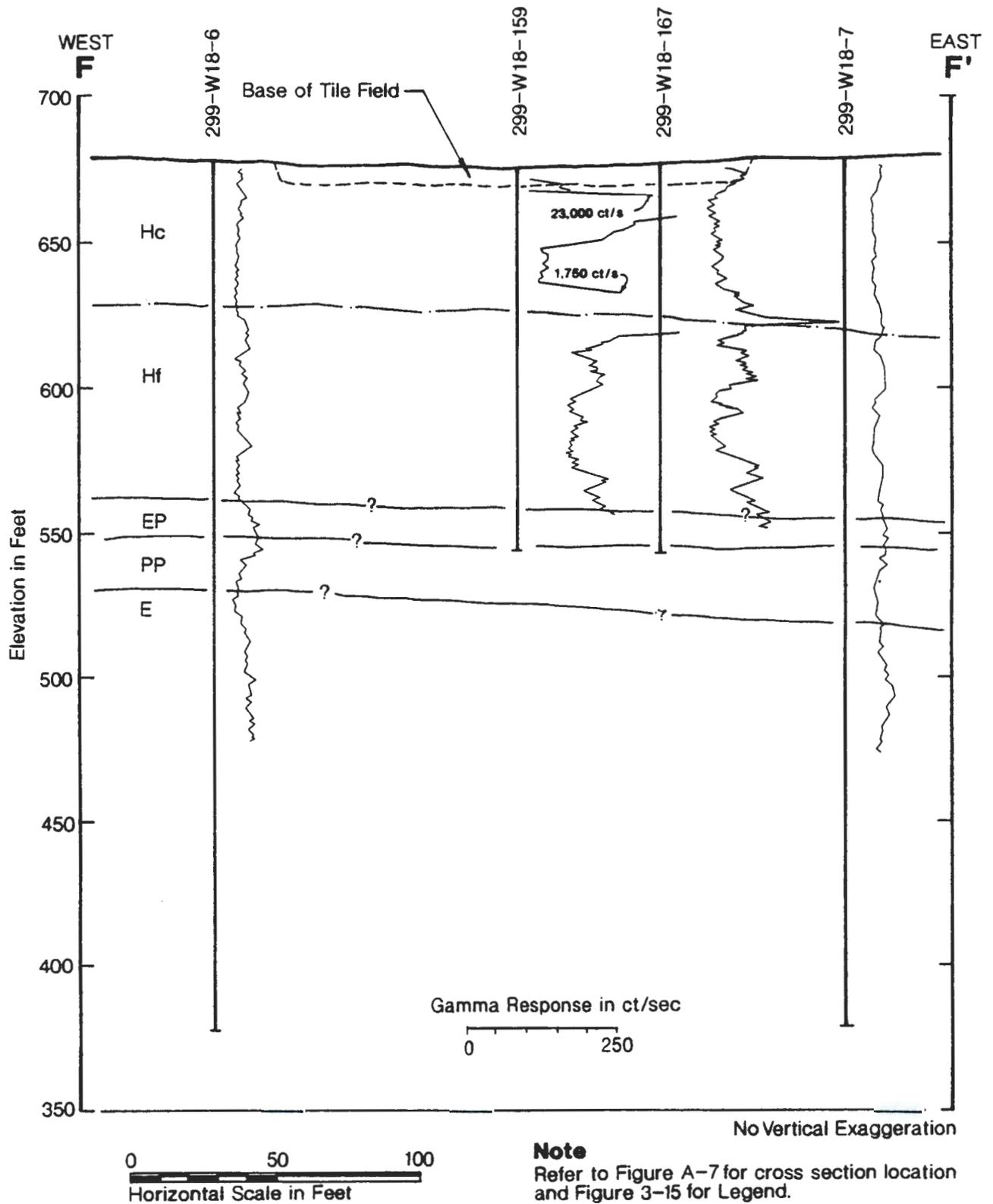


Figure A-9. Cross Section F-F'.

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Table A-1. Moisture Contents of Soil Samples from Z Plant Wells. (Sheet 1 of 5)

Well	Sediment Types	Sample Depth in Meters (Feet)	%H ₂ O	
299-W7-8 (Source: Barton et al. 1990)		0.6 (2)	3.13	
		1.2 (4)	2.43	
		1.8 (6)	1.98	
		2.7 (8.9)	2.02	
		3.5 (11.5)	2.18	
		4.3 (14)	4.36	
		4.9 (16)	3.03	
		6.3 (20.5)	3.09	
		7.2 (23.5)	5.15	
		7.8 (25.5)	5.75	
		8.5 (28)	5.64	
		9.3 (30.5)	11.70	
		9.9 (32.5)	7.40	
		10.7 (35)	4.86	
		11.3 (37)	13.40	
		11.9 (39)	13.40	
		12.5 (41)	18.02	
		13.4 (44)	4.34	
		14.0 (46)	5.30	
		14.6 (48)	6.28	
		15.3 (50)	6.40	
		HC -----	16.2 (53)	5.45
		PP	16.8 (55)	4.27
			17.4 (57)	9.95
			18.0 (59)	19.19
			18.9 (62)	5.84
			19.5 (64)	5.84
			20.1 (66)	5.17
			20.7 (68)	4.85
			21.4 (70)	5.65
			22.3 (73)	3.82
		----- E	23.8 (78)	3.00
			29.0 (95)	1.41
		30.5 (100)	0.87	
		32.0 (105)	1.37	
		33.6 (110)	1.26	
		35.1 (115)	1.27	
		36.6 (120)	3.26	
		38.1 (125)	1.21	
		39.7 (130)	1.39	
		41.2 (135)	1.12	

Table A-1. Moisture Contents of Soil Samples from Z Plant Wells. (Sheet 2 of 5)

Well	Sediment Types	Sample Depth in Meters (Feet)	%H ₂ O
299-W7-8 (Source: Goodwin and Bjornstad 1990)	HC	1.5 (5)	5.69
		3.1 (10)	2.74
		4.6 (15)	5.47
		6.1 (20)	3.97
		7.6 (25)	5.15
		9.2 (30)	4.22
		10.7 (35)	4.86
		12.2 (40)	2.94
299-W7-9 (Source: Barton et al. 1990)	HC <hr/> EP <hr/> PP <hr/> UR	1.2 (4)	1.79
		1.8-2.4 (6-8)	1.85
		3.7 (12)	2.29
		4.6 (15)	2.68
		6.1 (20)	2.24
		7.6 (25)	2.72
		9.2 (30)	2.91
		10.7 (35)	3.48
		13.7 (45)	4.59
		15.3 (50)	4.45
		16.8 (55)	4.29
		18.3 (60)	4.51
		19.8 (65)	5.27
		21.7 (71)	3.20
		22.3 (73)	3.21
		24.4 (80)	6.59
		26.2 (86)	3.70
27.5 (90)	3.77		
28.8 (94)	5.27		
31.1 (102)	3.18		
32.3 (106)	2.96		
33.6 (110)	2.16		
34.8 (114)	1.73		
36.6 (120)	1.72		
299-W7-7 (Source: Barton et al. 1990)	E	16.8 (55)	3.47
		18.3 (60)	4.06
		19.8 (65)	4.45

9 3 1 2 8 6 5 1 1 6 3

Table A-1. Moisture Contents of Soil Samples from Z Plant Wells. (Sheet 3 of 5)

Well	Sediment Types	Sample Depth in Meters (Feet)	%H ₂ O	
299-W15-21 (Source: Barton et al. 1990)		1.2 (4)	10.34	
		1.8 (6)	22.84	
		4.6 (15)	2.73	
		5.8 (19)	3.22	
		7.6 (25)	3.27	
		8.8 (29)	4.41	
		9.9 (32.5)	19.59	
		10.5 (34.5)	3.77	
		11.6 (38)	3.91	
		13.4 (44)	3.24	
		14.6 (48)	2.91	
		15.9 (52)	3.07	
		17.1 (56)	2.19	
		18.3 (60)	1.91	
		19.8 (65)	2.29	
		? HC _____	30.5 (100)	4.07
			32.3 (106)	9.28
			33.6 (110)	7.60
			35.4 (116)	4.93
			37.8 (124)	15.71
	? HF _____	38.9 (127.5)	6.81	
		40.3 (132)	2.57	
	EP	42.1 (138)	3.29	
		42.7 (140)	3.40	
		45.1 (148)	13.36	
		46.4 (152)	10.19	
		47.9 (157)	11.42	
299-W15-21 (Source: Goodwin and Bjornstad 1990)	HC?	4.6 (15)	3.69	
		6.1 (20)	3.83	
		7.6 (25)	6.78	
		9.2 (30)	14.69	
		10.7 (35)	3.76	
		12.2 (40)	6.88	
		13.7 (45)	9.63	

Table A-1. Moisture Contents of Soil Samples from Z Plant Wells. (Sheet 4 of 5)

Well	Sediment Types	Sample Depth in Meters (Feet)	%H ₂ O
299-W18-26 (Source: Barton et al. 1990)	HC <hr/> HF <hr/> EP	10.7 (35)	3.72
		12.2 (40)	3.96
		13.7 (45)	3.40
		15.3 (50)	2.66
		16.8 (55)	3.19
		35.1 (115)	7.37
		36.6 (120)	3.41
		38.1 (125)	2.39
		39.7 (130)	2.18
		41.2 (135)	2.06
		42.7 (140)	2.54
		44.2 (145)	5.91
		45.8 (150)	6.68
		47.3 (155)	12.73
		299-W15-20 (Source: Goodwin and Bjornstad 1990)	HC <hr/> HF
3.1 (10)	6.06		
4.6 (15)	7.25		
6.1 (20)	12.11		
7.6 (25)	3.19		
9.2 (30)	5.09		
10.7 (35)	3.57		
12.2 (40)	2.92		
13.7 (45)	4.39		
15.3 (50)	17.96		
16.8 (55)	3.11		
18.3 (60)	3.50		
25.9 (85)	7.55		
27.5 (90)	3.12		
29.0 (95)	3.03		
30.5 (100)	3.19		
32.0 (105)	3.60		
33.6 (110)	9.08		
35.1 (115)	4.22		
36.6 (120)	3.24		
38.1 (125)	3.18		
39.7 (130)	3.51		

Table A-1. Moisture Contents of Soil Samples from Z Plant Wells. (Sheet 5 of 5)

Well	Sediment Types	Sample Depth in Meters (Feet)	%H ₂ O
299-W15-19 (Source: Goodwin and Bjornstad 1990)	HC	6.1 (20)	2.73
		7.6 (25)	2.53
		9.2 (30)	3.40
		10.7 (35)	8.28
		12.2 (40)	3.09
		15.3 (50)	2.27
		16.8 (55)	2.34
		18.3 (60)	2.63
		21.4 (70)	5.29
		35.1 (115)	2.74
		36.6 (120)	2.77
		38.1 (125)	3.63
		39.7 (130)	8.19
		40.6 (133)	6.77
41.2 (135)	9.60		
299-W15-23 (Source: Goodwin and Bjornstad 1990)	HC <hr/> HF	1.5 (5)	5.69
		3.1 (10)	2.74
		4.6 (15)	5.47
		6.1 (20)	3.97
		7.6 (25)	5.15
		9.2 (30)	4.22
		10.7 (35)	4.86
		12.2 (40)	2.94
		30.5 (100)	3.80
		32.0 (105)	3.40
		33.6 (110)	4.23
		35.1 (115)	4.36
		36.6 (120)	4.43
		38.1 (125)	5.43
299-W15-24 (Source: Goodwin and Bjornstad 1990)	HC?	15.3 (50)	3.49
		16.8 (55)	2.02
299-W7-10 (Source: Goodwin and Bjornstad 1990)	HC	1.5 (5)	3.42
		3.1 (10)	2.46

Notes:

Moisture contents in weight percent H₂O. See Figure 3-15 for key to sediment units.

Sediment contact depths for wells W7-9, W7-10, W15-20, W15-23, and W18-26 taken from Lindsey et al. (1991) (solid line contacts).

Sediment contact depths for wells W7-7, W7-8, and W15-19 taken from Appendix C6, ERA proposal for 200 West Carbon Tetrachloride Plume (DOE/RL 1991b) (solid line contacts).

Sediment contact depths for wells W15-21 and 15-24 interpreted from well log information from Barton et al. (1990) and Goodwin and Bjornstad (1990) (dashed line contacts and question marks).

297828/TABLE.A-1

Table A-2. Calcium Carbonate Contents of Soil Samples from
Z Plant Aggregate Area Wells. (Sheet 1 of 4)

Well	Sediment Type	Sample Depth in Meters (Feet)	%CaCO ₃
299-W7-08 (Source: Goodwin and Bjornstad 1990)		1.2 (4)	3.5
		2.7 (9)	3.1
		4.3 (14)	2.6
		6.4 (21)	1.4
		8 (26)	4.4
		9.5 (31)	0.9
		10.7 (35)	4.8
		11.9 (39)	24.9
		13.4 (44)	0.7
		14.6 (48)	3.8
		16.2 (53)	3.0
		17.4 (57)	20.3
		19 (62)	3.0
		20.1 (66)	1.6
		21.3 (70)	2.0
		22.9 (75)	11.7
		23.8 (78)	2.2
		25.9 (85)	1.5
		27.4 (90)	1.2
		29.0 (95)	1.4
		30.5 (100)	1.0
		32.0 (105)	0.5
		33.5 (110)	0.7
		35.0 (115)	1.9
		36.6 (120)	0.1
		38.1 (125)	0.7
		39.6 (130)	0.9
		41.2 (135)	0.7
	42.7 (140)	0.6	
	44.2 (145)	0.8	
	45.7 (150)	0.2	
	47.2 (155)	0.2	
	48.8 (160)	0.3	
	50.3 (165)	0.1	
	51.8 (170)	0.1	
	53.3 (175)	0.1	
	54.9 (180)	0.1	
	56.4 (185)	0.2	
	57.9 (190)	0.5	
	59.4 (195)	0.2	
	61.0 (200)	0.2	
	62.5 (205)	0.2	

9 3 1 2 8 6 5 1 1 6 7

**Table A-2. Calcium Carbonate Contents of Soil Samples from
Z Plant Aggregate Area Wells. (Sheet 2 of 4)**

Well	Sediment Type	Sample Depth in Meters (Feet)	%CaCO ₃
	E	64.0 (210)	0.2
		65.5 (215)	0.2
		67.1 (220)	0.2
		68.6 (225)	0.2
		70.1 (230)	0.2
		71.6 (235)	0.2
		73.2 (240)	1.1
		74.1 (243)	0.5
299-W-7-9 (Source: Goodwin and Bjornstad 1990)		1.2 (4)	4.01
		2.1 (7)	2.0
		3.7 (12)	1.7
		4.6 (15)	2.9
		6.1 (20)	1.0
		7.6 (25)	1.4
		9.1 (30)	1.3
		10.7 (35)	3.1
		12.2 (40)	6.4
		13.7 (45)	3.0
		15.2 (50)	3.0
		16.8 (55)	5.8
		18.3 (60)	10.1
		19.8 (65)	3.6
		21.0 (69)	2.9
		22.9 (75)	25.4
		24.4 (80)	34.4
		26.2 (86)	0.8
		27.4 (90)	8.7
		29.3 (96)	22
		31.1 (102)	14.7
		32.3 (106)	3.7
		33.5 (110)	1.5
		34.7 (114)	0.8
		36.6 (120)	1.0
		37.8 (124)	0.7
		39.6 (130)	1.3
		40.8 (134)	2.2
42.1 (138)	2.6		
43.3 (142)	2.2		
44.2 (145)	0.8		
45.7 (150)	1.0		
47.2 (155)	0.7		
48.8 (160)	0.4		

**Table A-2. Calcium Carbonate Contents of Soil Samples from
Z Plant Aggregate Area Wells. (Sheet 3 of 4)**

Well	Sediment Type	Sample Depth in Meters (Feet)	%CaCO ₃
	E	50.3 (165)	0.4
		51.8 (170)	0.2
		53.3 (175)	0.0
		54.9 (180)	0.1
		56.4 (185)	0.3
		57.9 (190)	0.2
		59.4 (195)	0.3
		61.0 (200)	0.2
		62.5 (205)	3.0
		64.0 (210)	0.8
299-W15-21 (Source: Barton et al. 1990)		1.2 (4)	4.4
		2.4 (8)	0.7
		4.6 (15)	31.6
		5.8 (19)	2.4
		7.6 (25)	1.0
		8.8 (29)	N/A
		10.7 (35)	1.0
		12.2 (40)	1.0
		13.4 (44)	1.4
		14.6 (48)	1.0
		15.8 (52)	1.6
		17.1 (56)	1.1
		18.3 (60)	1.5
		21.3 (70)	1.6
		22.9 (75)	1.0
		24.4 (80)	0.7
		25.9 (85)	0.6
		27.4 (90)	0.7
		29.0 (95)	0.7
		30.5 (100)	1.9
		32.3 (106)	2.6
		33.5 (110)	19.4
		35.4 (116)	1.1
		36.6 (120)	2.0
		37.8 (124)	5.9
		39.0 (128)	1.6
		40.2 (132)	2.0
		40.8 (134)	2.0
42.7 (140)	1.6		
43.9 (144)	2.1		
45.1 (148)	2.3		
46.3 (152)	2.9		

**Table A-2. Calcium Carbonate Contents of Soil Samples from
Z Plant Aggregate Area Wells. (Sheet 4 of 4)**

Well	Sediment Type	Sample Depth in Meters (Feet)	%CaCO ₃
	? _____	47.9 (157)	42.8
	PP	50.3 (165)	6.1
	PP	51.5 (169)	21.6
	? _____	53.3 (175)	16.8
	UR	54.9 (180)	4.8
		56.4 (185)	2.2
	? _____	57.9 (190)	0.7
	E	59.4 (195)	0.3
		61.0 (200)	0.5
		62.5 (205)	0.2
		64.0 (210)	0.2
		65.5 (215)	0.2

Notes:

Calcium carbonate contents in weight percent. See Figure 3-15 for key to sediment units.

Sediment contact depths for well W-79 were taken from Lindsey et al. (1991).

Sediment contact depths for well W7-8 were taken from Appendix C6, ERA Proposal for 200 West Carbon Tetrachloride Plume (DOE/RL 1991b).

Sediment contact depths for well W15-21 were interpreted from well log information from Barton et al. (1990) and Goodwin and Bjornstad (1990).

TABLE A-2

Table A-3. Air Sampling Results. (Sheet 1 of 4)

Radionuclide in pCi/m ³	1985		1986		1987		1988		1989		Average Result	
	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error		
Sample N165: E-SE of Main Z Plant Building Complex												
Strontium-90	max	8.69E-03	---	2.68E-03	---	7.34E-05	---	6.20E-05	7.30E-05	1.70E-04	9.92E-05	---
	min	4.46E-05	---	9.57E-05	---	-1.88E-05	---	4.10E-05	6.60E-05	0.00E+00	5.58E-05	---
	avg	2.33E-03	8.84E-03	7.89E-04	2.53E-03	3.53E-05	9.15E-05	5.50E-05	1.00E-05	6.46E-05	7.89E-05	6.55E-04
Cesium-137	max	7.31E-04	---	6.43E-04	---	1.10E-03	---	7.60E-05	6.10E-04	4.46E-04	4.12E-04	---
	min	-3.04E-04	---	-6.22E-05	---	-2.89E-04	---	6.20E-04	5.70E-04	-1.09E-04	4.03E-04	---
	avg	1.88E-04	8.48E-04	1.99E-04	6.14E-04	3.45E-04	1.39E-03	2.30E-04	3.60E-04	1.81E-04	4.52E-04	1.37E-04
Plutonium-239	max	1.18E-04	---	4.82E-04	---	3.41E-04	---	9.00E-04	---	2.84E-04	3.82E-05	---
	min	7.91E-05	---	3.65E-05	---	6.49E-05	---	1.60E-04	---	1.09E-05	4.91E-06	---
	avg	9.50E-05	3.29E-05	3.07E-04	3.88E-04	1.98E-04	2.96E-04	4.20E-04	---	1.64E-04	2.47E-05	2.37E-04
Uranium (total)	max	1.94E-04	---	8.73E-05	---	3.20E-05	---	---	---	3.82E-05	1.81E-05	---
	min	5.27E-05	---	3.94E-05	---	9.05E-06	---	---	---	0.00E+00	1.79E-05	---
	avg	1.25E-04	1.18E-05	6.07E-05	4.92E-05	1.86E-05	1.93E-05	---	---	1.30E-05	1.68E-05	5.43E-05

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Table A-3. Air Sampling Results. (Sheet 2 of 4)

Radionuclide in pCi/m ³	1985		1986		1987		1988		1989		Average Result	
	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error		
Sample N962: SE Corner W-4B												
Strontium-90	max	1.91E-02	---	5.36E-03	---	1.06E-02	---	4.60E-04	1.80E-04	1.61E-03	4.57E-04	---
	min	1.78E-04	---	1.59E-04	---	-1.82E-04	---	2.20E-04	1.20E-04	7.79E-05	1.47E-04	---
	avg	5.01E-03	4.87E-03	1.75E-03	4.87E-03	3.57E-03	9.71E-03	3.10E-04	1.00E-04	6.07E-04	2.34E-04	2.25E-03
Cesium-137	max	7.04E-04	---	2.48E-05	---	1.00E-03	---	8.20E-04	7.20E-04	3.45E-03	1.09E-03	---
	min	-1.10E-04	---	1.09E-05	---	4.58E-04	---	3.40E-04	5.90E-04	4.16E-04	4.25E-04	---
	avg	3.32E-04	7.60E-04	2.50E-04	1.83E-03	7.33E-04	5.05E-04	4.30E-04	4.40E-04	1.23E-03	8.28E-04	5.95E-04
Plutonium-239	max	1.29E-05	---	2.48E-05	---	1.24E-04	---	1.70E-05	---	1.19E-04	2.09E-05	---
	min	0.00E+00	---	1.09E-05	---	3.02E-05	---	8.10E-06	---	7.34E-06	5.06E-06	---
	avg	7.42E-06	1.14E-05	1.67E-05	1.18E-05	6.75E-05	8.04E-05	2.40E-05	---	4.83E-05	1.08E-05	3.28E-05
Uranium (total)	max	1.24E-04	---	6.32E-05	---	5.40E-05	---	---	---	8.50E-05	3.35E-05	---
	min	3.57E-05	---	2.96E-05	---	1.57E-05	---	---	---	7.65E-07	2.08E-05	---
	avg	7.45E-05	8.45E-05	4.89E-05	2.81E-05	2.90E-05	3.47E-05	---	---	3.66E-05	2.72E-05	4.73E-05

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Table A-3. Air Sampling Results. (Sheet 3 of 4)

Radionuclide in pCi/m ³		1985		1986		1987		1988		1989		Average Result
		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sample N964: W of W-4B												
Strontium-90	max	1.24E-02	---	3.80E-04	---	1.77E-04	---	1.60E-04	9.70E-05	1.83E-04	1.21E-04	---
	min	7.42E-02	---	1.14E-04	---	1.06E-05	---	2.90E-05	6.50E-05	1.00E-05	5.61E-05	---
	avg	3.25E-03	1.22E-02	2.34E-04	2.19E-04	7.43E-05	1.45E-04	8.40E-05	6.60E-05	8.19E-05	9.03E-05	7.45E-04
Cesium-137	max	2.65E-04	---	9.33E-04	---	5.88E-04	---	1.70E-04	5.50E-04	4.10E-04	5.70E-04	---
	min	-2.11E-04	---	-6.10E-04	---	0.00E+00	---	-1.00E-04	4.60E-04	2.41E-04	6.15E-04	---
	avg	5.37E-05	3.97E-04	6.85E-05	1.33E-03	2.04E-04	5.55E-04	3.90E-05	2.20E-04	1.03E-04	5.40E-04	7.80E-05
Plutonium-239	max	2.11E-05	---	1.28E-04	---	1.08E-04	---	1.80E-05	---	3.65E-06	2.85E-06	---
	min	2.48E-06	---	2.17E-06	---	4.95E-06	---	-5.70E-07	---	1.61E-05	6.03E-06	---
	avg	1.20E-05	1.74E-05	3.52E-05	1.24E-04	4.10E-05	9.44E-05	6.20E-06	---	7.75E-06	4.06E-06	2.04E-05
Uranium (total)	max	1.20E-04	---	4.50E-05	---	3.60E-05	---	---	---	5.38E-05	2.33E-05	---
	min	2.25E-05	---	2.30E-05	---	1.02E-05	---	---	---	5.48E-07	1.92E-05	---
	avg	5.92E-05	8.44E-05	3.56E-05	1.90E-05	2.35E-05	2.22E-05	---	---	2.79E-05	2.13E-05	3.66E-05

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Table A-3. Air Sampling Results. (Sheet 4 of 4)

Radionuclide in pCi/m ³	1985		1986		1987		1988		1989		Average Result	
	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error		
Sample N994: Old Corner 200 West												
Strontium-90	max	---	---	1.51E-04	---	8.61E-05	---	2.30E-04	1.20E-04	3.00E-04	1.29E-04	---
	min	---	---	2.05E-05	---	-7.60E-06	---	1.70E-05	9.30E-05	2.00E-05	8.19E-05	---
	avg	---	---	1.04E-04	1.46E-04	4.33E-05	8.64E-05	8.60E-05	9.80E-05	7.95E-05	9.67E-05	6.26E-05
Cesium-137	max	---	---	3.31E-03	---	5.52E-05	---	6.10E-04	5.70E-04	2.72E-04	4.92E-04	---
	min	---	---	-1.40E-04	---	-6.29E-04	---	1.60E-04	4.90E-04	3.78E-05	6.06E-04	---
	avg	---	---	1.06E-03	3.91E-03	2.95E-04	6.35E-04	3.10E-04	2.10E-04	2.27E-04	5.47E-04	1.70E-04
Plutonium-239	max	---	---	9.12E-06	---	5.31E-06	---	2.60E-06	---	1.30E-06	1.94E-06	---
	min	---	---	2.62E-06	---	2.17E-07	---	-5.60E-07	---	6.51E-07	1.81E-06	---
	avg	---	---	5.76E-06	6.51E-06	3.03E-06	4.23E-06	7.00E-07	---	1.02E-06	2.08E-06	2.10E-06
Uranium (total)	max	---	---	1.05E-04	---	2.04E-05	---	---	---	5.36E-05	2.91E-05	---
	min	---	---	2.91E-05	---	8.65E-06	---	---	---	0.00E+00	1.85E-05	---
	avg	---	---	5.98E-05	8.00E-05	1.57E-05	1.00E-05	---	---	1.70E-05	1.86E-05	2.31E-05

Notes:

- indicates radionuclide not analyzed, or results not reported.
- Shaded entry indicates result less than error.
- Negative values indicate concentration at or near background levels for radioactivity (Ref: 1988 and 1989 data).
- Sample error data not available for 1985 through 1987.

Data Sources:

- Rockwell Hanford Operations Environmental Surveillance Annual Monitoring Reports -- 200/600 Areas (1985 and 1986).
- Westinghouse Hanford Operations Environmental Surveillance Annual Monitoring Reports -- 200/600 Areas (1987 through 1990).

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Table A-4. Results of Grid Soil Sampling. (Sheet 1 of 6)

Radionuclide in pCi/g	1985		1986 (1)		1987		1988		1989		Average Result
	Result	Error	Result	Error	Result	Error	Result	Error	Result (1)	Error	
Sample 2W2											
Cerium-141	---	---	---	---	---	---	---	---	---	---	---
Cerium-144	---	---	---	---	---	---	---	---	---	---	---
Cobalt-58	---	---	---	---	---	---	---	---	---	---	---
Cobalt-60	---	---	---	---	---	---	4.60E-03	1.60E-02	---	---	-4.60E-03
Cesium-134	---	---	---	---	---	---	---	---	---	---	---
Cesium-137	---	---	---	---	---	---	6.40E+00	6.50E-01	---	---	6.40E+00
Europium-152	---	---	---	---	---	---	5.90E-02	7.10E-02	---	---	5.90E-02
Europium-154	---	---	---	---	---	---	-2.30E-02	4.70E-02	---	---	-2.30E-02
Europium-155	---	---	---	---	---	---	5.50E-02	6.30E-02	---	---	5.50E-02
Iodine-129	---	---	---	---	---	---	---	---	---	---	---
Potassium-40	---	---	---	---	---	---	---	---	---	---	---
Manganese-54	---	---	---	---	---	---	1.30E-02	1.30E-02	---	---	1.30E-02
Niobium-95	---	---	---	---	---	---	3.20E-02	1.80E-02	---	---	3.20E-02
Lead-212	---	---	---	---	---	---	---	---	---	---	---
Lead-214	---	---	---	---	---	---	6.00E-01	8.80E-02	---	---	600E-01
Plutonium-238	---	---	---	---	---	---	1.70E-03	4.10E-04	---	---	1.70E-03
Plutonium-239	---	---	---	---	---	---	7.90E-01	7.00E-02	---	---	7.90E-01
Ruthenium-106	---	---	---	---	---	---	6.10E-02	1.50E-01	---	---	6.10E-02
Strontium-90	---	---	---	---	---	---	9.10E-02	1.70E-01	---	---	9.10E-01
Technetium-99	---	---	---	---	---	---	---	---	---	---	---
Uranium	---	---	---	---	---	---	3.00E-01	9.20E-02	---	---	3.00E-01
Zinc-65	---	---	---	---	---	---	---	---	---	---	---
Zirconium-95	---	---	---	---	---	---	3.70E-03	2.60E-02	---	---	3.70E-03

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Table A-4. Results of Grid Soil Sampling. (Sheet 2 of 6)

Radionuclide in pCi/g	1985		1986 (1)		1987		1988		1989		Average Result
	Result	Error	Result	Error	Result	Error	Result	Error	Result (1)	Error	
Sample 2W3											
Cerium-141	---	---	---	---	---	---	---	---	---	---	---
Cerium-144	---	---	---	---	---	---	---	---	---	---	---
Cobalt-58	1.30E-01	8.00E-02	---	---	---	---	---	---	---	---	1.30E-01
Cobalt-60	a	---	---	---	---	---	1.50E-03	1.70E-02	---	---	-1.50E-03
Cesium-134	a	---	5.00E-02	3.00E-02	---	---	---	---	---	---	5.00E-02
Cesium-137	3.05E+00	3.00E-01	8.70E-01	1.10E-01	---	---	1.30E+00	1.40E-01	---	---	1.74E+00
Europium-152	a	---	---	---	---	---	9.80E-02	8.10E-02	---	---	9.80E-02
Europium-154	a	---	---	---	---	---	1.80E-02	6.10E-02	---	---	1.80E-02
Europium-155	a	---	---	---	---	---	2.60E-02	6.10E-02	---	---	2.60E-02
Iodine-129	---	---	---	---	---	---	---	---	---	---	---
Potassium-40	---	---	---	---	---	---	---	---	---	---	---
Manganese-54	a	---	---	---	---	---	1.70E-02	1.70E-02	---	---	1.70E-02
Niobium-95	a	---	---	---	---	---	3.90E-02	2.20E-02	---	---	3.90E-03
Lead-212	---	---	---	---	---	---	---	---	---	---	---
Lead-214	---	---	---	---	---	---	6.20E-01	8.50E-02	---	---	6.20E-01
Plutonium-238	1.60E-03	6.00E-04	6.00E-04	4.00E-04	---	---	1.00E-03	3.10E-04	---	---	1.07E-03
Plutonium-239	1.70E-01	2.00E-02	4.00E-02	1.00E-02	---	---	3.30E-01	6.40E-02	---	---	1.80E-01
Ruthenium-106	a	---	---	---	---	---	0.00E+00	1.50E-01	---	---	3.30E-01
Strontium-90	1.05E+00	1.90E-01	2.50E-01	5.00E-02	---	---	---	---	---	---	6.50E-01
Technetium-99	---	---	---	---	---	---	---	---	---	---	---
Uranium	3.40E-01	1.10E-01	4.60E-01	1.50E-01	---	---	2.50E-01	8.00E-02	---	---	3.50E-01
Zinc-65	4.40E-01	1.50E-01	---	---	---	---	---	---	---	---	4.40E-01
Zirconium-95	a	---	---	---	---	---	2.00E-02	3.10E-02	---	---	2.00E-02

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Table A-4. Results of Grid Soil Sampling. (Sheet 3 of 6)

Radionuclide in pCi/g	1985		1986 (1)		1987		1988		1989		Average Result
	Result	Error	Result	Error	Result	Error	Result	Error	Result (1)	Error	
Sample 2W7											
Cerium-141	---	---	---	---	---	---	---	---	5.63E-02	7.40E-02	-5.63E-02
Cerium-144	---	---	---	---	---	---	---	---	2.48E-02	1.02E-01	-2.48E-02
Cobalt-58	a	---	---	---	---	---	---	---	6.82E-03	2.55E-02	-6.82E-03
Cobalt-60	a	---	---	---	---	---	5.90E-03	1.50E-02	9.28E-03	1.94E-02	7.59E-03
Cesium-134	a	---	5.00E-02	3.00E-02	---	---	---	---	4.96E-02	1.86E-02	4.98E-02
Cesium-137	9.85E+00	7.00E-01	4.50E+00	4.80E-01	---	---	2.40E+00	2.60E-01	1.27E+00	1.39E-01	4.51E+00
Europium-152	a	---	---	---	---	---	3.30E-02	7.20E-02	1.18E-01	7.59E-02	7.55E-02
Europium-154	a	---	---	---	---	---	3.60E-03	5.20E-02	6.61E-02	6.03E-02	-2.90E-02
Europium-155	a	---	---	---	---	---	4.70E-02	5.40E-02	1.92E-02	5.68E-02	3.31E-02
Iodine-129	---	---	---	---	---	---	---	---	1.58E-02	3.11E-01	-1.58E-02
Potassium-40	---	---	---	---	---	---	---	---	1.59E+01	1.76E+00	1.59E+01
Manganese-54	6.00E-02	4.00E-02	---	---	---	---	3.70E-03	1.40E-02	1.74E-03	1.85E-02	2.07E-02
Niobium-95	a	---	---	---	---	---	1.30E-02	1.70E-02	8.45E-02	5.93E-02	-4.88E-02
Lead-212	---	---	---	---	---	---	---	---	7.10E-01	8.29E-02	7.10E-01
Lead-214	---	---	---	---	---	---	5.40E-01	7.60E-02	5.32E-01	7.66E-02	5.36E-01
Plutonium-238	2.90E-03	7.00E-04	9.10E-03	2.90E-03	---	---	1.20E-03	3.40E-04	4.50E-04	2.00E-04	3.41E-03
Plutonium-239	7.00E-02	1.00E-02	1.00E-01	2.00E-02	---	---	4.40E-02	4.70E-03	1.13E-02	1.45E-03	5.63E-02
Ruthenium-106	a	---	4.00E-01	2.70E-01	---	---	4.60E-02	1.30E-01	7.92E-02	1.58E-01	1.44E-01
Strontium-90	9.50E-01	1.80E-01	4.30E-01	8.00E-02	---	---	2.10E-01	4.20E-02	1.64E-01	3.42E-02	4.39E-01
Technetium-99	---	---	---	---	---	---	---	---	1.27E-01	1.16E+00	1.27E-01
Uranium	2.60E-01	9.00E-02	3.80E-01	1.30E-01	---	---	2.50E-01	7.90E-02	3.77E-01	1.14E-01	3.17E-01
Zinc-65	a	---	---	---	---	---	---	---	1.04E-01	5.62E-02	-1.04E-01
Zirconium-95	a	---	---	---	---	---	5.50E-03	2.50E-02	8.83E-03	4.83E-02	-1.67E-03

AT-4c

DOE/RL-91-58
Draft A

Table A-4. Results of Grid Soil Sampling. (Sheet 4 of 6)

Radionuclide in pCi/g	1985		1986 (1)		1987		1988		1989		Average Result
	Result	Error	Result	Error	Result	Error	Result	Error	Result (1)	Error	
Sample 2W17											
Cerium-141	---	---	---	---	6.90E-03	4.10E-02	---	---	2.61E-02	7.53E-02	9.60E-03
Cerium-144	---	---	---	---	2.70E-02	1.10E-01	---	---	8.69E-02	9.44E-02	3.00E-02
Cobalt-58	a	---	---	---	2.40E-03	2.00E-02	---	---	1.57E-02	2.81E-02	-6.65E-03
Cobalt-60	a	---	---	---	1.80E-02	2.00E-02	1.90E-03	1.40E-02	8.89E-03	1.58E-02	-8.33E-03
Cesium-134	a	---	5.00E-02	3.00E-02	5.20E-02	2.30E-02	---	---	4.00E-03	1.52E-02	3.53E-02
Cesium-137	9.60E-01	1.40E-01	5.00E-01	8.00E-02	4.60E-01	6.10E-02	3.00E-01	4.00E-02	4.78E-01	6.20E-02	5.40E-01
Europium-152	1.80E-01	1.40E-01	---	---	1.30E-01	6.60E-02	2.10E-02	5.90E-02	4.65E-02	7.45E-02	9.44E-02
Europium-154	a	---	---	---	1.20E-02	4.60E-02	1.40E-02	4.60E-02	6.28E-03	5.08E-02	6.57E-03
Europium-155	2.00E-01	1.50E-01	---	---	6.10E-02	5.80E-02	3.70E-02	4.70E-02	5.38E-02	4.99E-02	8.80E-02
Iodine-129	---	---	---	---	---	---	3.90E+01	3.90E+01	2.52E-01	5.00E-01	1.96E+01
Potassium-40	---	---	---	---	---	---	---	---	1.36E+01	1.54E+00	1.36E+01
Manganese-54	a	---	---	---	2.70E-03	2.10E-02	3.60E-03	1.50E-02	1.78E-03	1.85E-02	-2.69E-03
Niobium-95	a	---	---	---	---	---	1.70E-02	1.60E-02	1.02E-01	6.44E-02	-5.95E-02
Lead-212	---	---	---	---	---	---	---	---	8.09E-01	9.32E-02	8.09E-01
Lead-214	---	---	---	---	---	---	4.80E-01	6.60E-02	6.59E-01	8.69E-02	5.70E-01
Plutonium-238	7.20E-03	1.30E-03	3.00E-03	1.00E-03	6.20E-03	1.00E-03	3.10E-02	6.20E-04	2.98E-03	6.45E-04	4.50E-03
Plutonium-239	1.40E-01	1.00E-02	9.00E-02	1.00E-02	1.10E-01	1.20E-02	1.00E-01	1.10E-02	1.34E-01	1.40E-02	1.15E-01
Ruthenium-106	a	---	---	---	1.30E-01	1.50E-01	4.50E-02	1.10E-01	1.91E-02	1.59E-01	6.47E-02
Strontium-90	4.50E-01	8.00E-02	1.70E-01	4.00E-02	1.60E-01	4.20E-02	1.40E-01	2.70E-02	1.27E-01	2.73E-02	2.09E-01
Technetium-99	---	---	---	---	---	---	---	---	7.71E-02	1.15E+00	-7.71E-02
Uranium	3.40E-01	1.10E-01	2.80E-01	9.00E-02	3.10E-01	9.20E-02	2.60E-01	8.10E-02	4.46E-01	1.35E-01	3.27E-01
Zinc-65	a	---	---	---	1.70E-03	3.90E-02	---	---	1.87E-03	4.56E-02	-1.79E-03
Zirconium-95	a	---	---	---	3.00E-02	3.90E-02	8.20E-03	2.40E-02	3.16E-03	6.04E-02	1.17E-02

AT-4d

DOE/RL-91-58
Draft A

Table A-4. Results of Grid Soil Sampling. (Sheet 5 of 6)

Radionuclide in pCi/g	1985		1986 (1)		1987		1988		1989		Average Result
	Result	Error	Result	Error	Result	Error	Result	Error	Result (1)	Error	
Sample 2W22											
Cerium-141	---	---	---	---	---	---	---	---	---	---	---
Cerium-144	---	---	---	---	---	---	---	---	---	---	---
Cobalt-58	a	---	---	---	---	---	---	---	---	---	---
Cobalt-60	3.00E-02	2.00E-02	---	---	---	---	1.10E-02	1.80E-02	---	---	9.50E-03
Cesium-134	a	---	3.00E-02	3.00E-02	---	---	---	---	---	---	3.00E-02
Cesium-137	1.45E+00	1.60E-01	8.30E-01	1.00E-01	---	---	1.00E+00	1.10E-01	---	---	1.90E+00
Europium-152	2.00E-01	1.30E-01	---	---	---	---	8.30E-02	7.60E-02	---	---	1.42E-01
Europium-154	a	---	---	---	---	---	1.80E-02	5.10E-02	---	---	1.80E-02
Europium-155	a	---	---	---	---	---	4.50E-02	5.70E-02	---	---	4.50E-02
Iodine-129	---	---	---	---	---	---	---	---	---	---	---
Potassium-40	---	---	---	---	---	---	---	---	---	---	---
Manganese-54	a	---	---	---	---	---	2.40E-03	1.60E-02	---	---	-2.4E-03
Niobium-95	a	---	---	---	---	---	1.70E-02	1.90E-02	---	---	-1.70E-02
Lead-212	---	---	---	---	---	---	---	---	---	---	---
Lead-214	---	---	---	---	---	---	6.50E-01	8.60E-02	---	---	6.50E-01
Plutonium-238	3.60E-03	9.00E-04	1.80E-03	6.00E-04	---	---	2.40E-03	5.20E-04	---	---	2.60E-03
Plutonium-239	7.00E-02	1.00E-02	3.00E-02	0.00E+00	---	---	7.20E-02	7.50E-03	---	---	5.73E-02
Ruthenium-106	4.40E-01	3.10E-01	---	---	---	---	1.70E-02	1.40E-01	---	---	2.29E-01
Strontium-90	9.40E-01	1.70E-01	5.00E-01	1.00E-01	---	---	4.60E-01	8.70E-02	---	---	6.33E-01
Technetium-99	---	---	---	---	---	---	---	---	---	---	---
Uranium	3.10E-01	1.10E-01	3.90E-01	1.30E-01	---	---	3.50E-01	1.10E-01	---	---	3.50E-01
Zinc-65	a	---	---	---	---	---	---	---	---	---	---
Zirconium-95	a	---	---	---	---	---	3.40E-02	2.90E-02	---	---	3.40E-02

AT-4e

DOE/RL-91-58
Draft A

Table A-5. 1990 Soil Samples from Z Plant near Building Complex.

Sample No.	Cesium-137 in pCi/g	Plutonium in pCi/g
1	0.4	<0.3
2	<0.3	0.8
3	<0.2	<0.3
4	1.6	2.9
5	0.5	1.5
6	<0.3	<0.3
7	0.5	<0.3
8	0.4	<0.3
9	0.5	<0.3
10	<0.3	0.9
11	0.6	3.9
12	0.4	1.8
13	<0.3	0.7

Notes:

< indicates result below analytical detection limit.

Source: Schmidt et al. 1991.

Sample locations are identified on Plate 2.

297828/TABLE.A-5

Table A-6. Grid Site Vegetation Results for 200 West Area. (Sheet 1 of 5)

Radionuclide in pCi/g	1985		1986 (1)		1987		1988		1989		Average Result
	Result	Error	Result	Error	Result	Error	Result	Error	Result (1)	Error	
Sample 2W2											
Cobalt-58	—	—	—	—	—	—	—	—	—	—	—
Cobalt-60	—	—	—	—	—	—	5.20E-03	2.00E-02	—	—	5.20E-03
Cesium-134	—	—	—	—	—	—	—	—	—	—	—
Cesium-137	—	—	—	—	—	—	1.40E-01	3.00E-02	—	—	1.40E-01
Europium-152	—	—	—	—	—	—	1.60E-02	8.40E-02	—	—	1.60E-02
Europium-154	—	—	—	—	—	—	3.50E-02	6.40E-02	—	—	3.50E-02
Europium-155	—	—	—	—	—	—	1.90E-02	4.90E-02	—	—	1.90E-02
Iodine-129	—	—	—	—	—	—	—	—	—	—	—
Niobium-95	—	—	—	—	—	—	5.40E-02	5.80E-02	—	—	5.40E-02
Plutonium-238	—	—	—	—	—	—	—	—	—	—	—
Plutonium-239	—	—	—	—	—	—	—	—	—	—	—
Ruthenium-103	—	—	—	—	—	—	—	—	—	—	—
Ruthenium-106	—	—	—	—	—	—	—	—	—	—	—
Strontium-90	—	—	—	—	—	—	—	—	—	—	—
Technetium-99	—	—	—	—	—	—	—	—	—	—	—
Zinc-65	—	—	—	—	—	—	—	—	—	—	—
Zirconium-95	—	—	—	—	—	—	—	—	—	—	—

AT-6a

DOE/RL-91-58
Draft A

Table A-6. Grid Site Vegetation Results for 200 West Area. (Sheet 2 of 5)

Radionuclide in pCi/g	1985		1986 (1)		1987		1988		1989		Average Result
	Result	Error	Result	Error	Result	Error	Result	Error	Result (1)	Error	
Sample 2W3											
Cobalt-58	a	—	—	—	—	—	—	—	—	—	—
Cobalt-60	a	—	—	—	—	—	5.30E-03	1.30E-02	—	—	5.30E-03
Cesium-134	a	—	9.60E-02	2.60E-02	—	—	—	—	—	—	9.60E-02
Cesium-137	a	1.51E-01	6.70E-02	2.10E-01	3.10E-02	—	—	—	—	—	1.84E-01
Europium-152	a	—	—	—	—	—	2.30E-02	5.80E-02	—	—	2.30E-02
Europium-154	a	—	—	—	—	—	1.20E-01	4.20E-02	—	—	1.20E-01
Europium-155	a	—	—	—	—	—	4.70E-04	2.70E-02	—	—	4.70E-04
Iodine-129	—	—	—	—	—	—	—	—	—	—	—
Niobium-95	a	—	—	—	—	—	3.60E-02	3.70E-02	—	—	3.60E-02
Plutonium-238	a	—	—	—	—	—	—	—	—	—	—
Plutonium-239	a	—	—	—	—	—	—	—	—	—	—
Ruthenium-103	—	—	1.19E-01	4.40E-02	—	—	—	—	—	—	1.19E-01
Ruthenium-106	—	—	—	—	—	—	—	—	—	—	—
Strontium-90	a	—	—	—	—	—	—	—	—	—	—
Technetium-99	—	—	—	—	—	—	—	—	—	—	—
Zinc-65	a	—	—	—	—	—	—	—	—	—	—
Zirconium-95	a	—	—	—	—	—	—	—	—	—	—

AT-6b

DOE/RL-91-58
Draft A

Table A-6. Grid Site Vegetation Results for 200 West Area. (Sheet 3 of 5)

Radionuclide in pCi/g	1985		1986 (1)		1987		1988		1989		Average Result	
	Result	Error	Result	Error	Result	Error	Result	Error	Result (1)	Error		
Sample 2W7												
Beryllium-7	—	—	—	—	—	—	—	—	1.19E+00	2.22E-01	1.19E+00	
Cerium-141	—	—	—	—	—	—	—	—	1.56E-02	2.01E-02	-1.56E-02	
Cobalt-58	a	—	—	—	—	—	—	—	—	—	—	
Cobalt-60	a	—	—	—	—	—	—	1.20E-02	1.90E-02	2.97E-03	1.61E-02	8.02E-03
Cesium-134	a	—	1.12E-01	3.20E-02	—	—	—	—	—	—	1.12E-01	
Cesium-137	2.96E-01	1.06E-01	3.04E-01	4.50E-02	—	—	1.20E-01	2.70E-02	8.18E-01	9.07E-02	3.85E-01	
Europium-152	a	—	—	—	—	—	1.20E-02	7.70E-02	6.64E-02	7.30E-02	2.72E-02	
Europium-154	a	—	1.33E-01	7.70E-02	—	—	4.90E-02	6.00E-02	2.11E-02	5.41E-02	2.10E-02	
Europium-155	a	—	—	—	—	—	3.20E-03	4.50E-02	1.75E-02	3.93E-02	1.04E-02	
Iodine-129	—	—	—	—	—	—	—	—	1.84E-02	3.05E-01	-1.84E-02	
Niobium-95	—	—	—	—	—	—	—	—	1.56E+01	1.70E+00	1.56E+00	
Plutonium-238	a	—	—	—	—	—	2.30E-02	5.70E-02	1.32E-02	1.92E-02	-4.90E-03	
Plutonium-239	—	—	—	—	—	—	—	—	4.10E-01	5.13E-02	4.10E-01	
Ruthenium-103	—	—	—	—	—	—	—	—	3.23E-01	5.27E-02	3.23E-01	
Ruthenium-106	a	—	—	—	—	—	—	—	1.04E-03	4.40E-04	1.04E-03	
Strontium-90	a	—	—	—	—	—	—	—	4.68E-03	9.89E-04	4.68E-03	
Technetium-99	—	—	1.70E-01	6.50E-02	—	—	—	—	—	—	1.70E-01	
Zinc-65	—	—	2.88E-01	1.66E-01	—	—	—	—	—	—	2.88E-01	
Zirconium-95	a	—	—	—	—	—	—	—	1.91E-01	4.04E-02	1.91E-01	
Tc-99	—	—	—	—	—	—	—	—	1.43E+00	1.26E+00	1.43E+00	
Zn-65	a	—	—	—	—	—	—	—	—	—	0.00E+00	
Zr-95	a	—	6.00E-02	5.70E-02	—	—	—	—	2.50E-03	2.64E-02	2.88E-02	

AT-6c

DOE/RL-91-58
Draft A

Table A-6. Grid Site Vegetation Results for 200 West Area. (Sheet 4 of 5)

Radionuclide in pCi/g	1985		1986 (1)		1987		1988		1989		Average Result	
	Result	Error	Result	Error	Result	Error	Result	Error	Result (1)	Error		
Sample 2W17												
Beryllium-7	—	—	—	—	—	—	—	—	2.13E+00	3.07E-01	2.13E+00	
Cerium-141	—	—	—	—	—	—	—	—	6.42E-03	1.99E-02	-6.42E-03	
Cobalt-58	a	—	—	—	—	—	—	—	—	—	—	
Cobalt-60	a	—	—	—	1.70E-01	1.60E-01	2.00E-04	1.40E-02	4.64E-03	1.54E-02	5.52E-02	
Cesium-134	a	—	—	—	—	—	—	—	—	—	—	
Cesium-137	a	—	1.98E-01	5.90E-02	1.10E-01	2.30E-02	3.20E-02	1.50E-02	5.50E-02	1.61E-02	9.88E-02	
Europium-152		1.22E-01	1.00E-01	2.06E-01	1.78E-01	5.40E-02	7.50E-02	6.80E-03	5.90E-02	4.50E-02	5.35E-02	6.24E-02
Europium-154	a	—	—	—	—	3.50E-02	6.10E-02	1.80E-02	4.10E-02	1.41E-02	4.88E-02	-1.04E-02
Europium-155	a	—	—	—	—	—	9.70E-04	3.20E-02	2.85E-02	2.99E-02	1.47E-02	
Iodine-129	—	—	—	—	—	—	1.60E-01	3.50E-01	3.87E-02	3.08E-01	6.07E-02	
Niobium-95	—	—	—	—	—	—	—	—	1.30E+01	1.45E+00	1.30E+01	
Plutonium-238		1.21E-01	6.40E-02	—	—	3.40E-02	4.10E-02	3.90E-02	5.40E-02	5.01E-03	2.23E-02	1.07E-02
Plutonium-239	—	—	—	—	—	—	—	—	5.94E-02	4.46E-02	5.94E-02	
Ruthenium-103	—	—	—	—	—	—	—	—	7.17E-02	3.22E-02	7.17E-02	
Ruthenium-106	a	—	—	—	—	—	—	—	8.07E-04	3.53E-04	8.07E-04	
Strontium-90	a	—	—	—	—	—	—	—	2.39E-02	3.16E-03	2.39E-02	
Technetium-99	—	—	8.30E-02	5.10E-02	—	—	—	—	—	—	8.30E-02	
Zinc-65	—	—	—	—	—	—	—	—	—	—	—	
Zirconium-95	a	—	1.46E-01	4.20E-02	—	—	4.50E-02	1.10E-02	3.08E-01	6.17E-02	1.66E-01	
Tc-99	—	—	—	—	—	—	1.30E+00	1.80E+00	1.47E+00	1.26E+00	1.39E+00	
Zn-65	—	—	—	—	—	—	—	—	—	—	—	
Zr-95		9.80E-02	8.40E-02	6.80E-02	6.20E-02	3.70E-02	4.30E-02	—	6.13E-03	2.91E-02	3.38E-02	

AT-6d

DOE/RL-91-58
Draft A

Table A-6. Grid Site Vegetation Results for 200 West Area. (Sheet 5 of 5)

Radionuclide in pCi/g	1985		1986 (1)		1987		1988		1989		Average Result
	Result	Error	Result	Error	Result	Error	Result	Error	Result (1)	Error	
Sample 2W22											
Cobalt-58	a	—	—	—	—	—	—	—	—	—	—
Cobalt-60	a	—	—	—	—	—	6.40E-03	1.80E-02	—	—	6.40E-03
Cesium-134	a	—	1.77E-01	3.70E-02	—	—	—	—	—	—	1.77E-01
Cesium-137	a	—	2.57E-01	4.70E-02	—	—	1.10E-01	2.60E-02	—	—	1.84E-01
Europium-152	a	—	—	—	—	—	2.70E-02	8.70E-02	—	—	-2.70E-02
Europium-154	a	—	—	—	—	—	7.10E-03	5.30E-02	—	—	7.10E-03
Europium-155	a	—	—	—	—	—	3.70E-02	4.70E-02	—	—	3.70E-02
Iodine-129	—	—	—	—	—	—	—	—	—	—	—
Niobium-95	a	—	—	—	—	—	5.50E-02	7.30E-02	—	—	5.50E-02
Plutonium-238	a	—	—	—	—	—	—	—	—	—	—
Plutonium-239	a	—	—	—	—	—	—	—	—	—	—
Ruthenium-103	—	—	1.69E-01	6.00E-02	—	—	—	—	—	—	—
Ruthenium-106	—	—	—	—	—	—	1.90E-01	3.70E-02	—	—	1.69E-01
Strontium-90	a	—	—	—	—	—	—	—	—	—	—
Technetium-99	—	—	—	—	—	—	—	—	—	—	1.90E-01
Zinc-65	a	—	—	—	—	—	—	—	—	—	—
Zirconium-95	—	—	—	—	—	—	—	—	—	—	—

Notes:

— indicates radionuclide not analyzed, or results not reported.

(a) designation indicates radionuclide concentration is less than detectable (ref: 1985 data only).

Results for 1986 reference sample 2W17b; 1986 listing for 2W17 not given.

Shaded entries indicate result less than error.

(1) Sample 2W17b reported for 1986; sample 2W17 not reported.

No data reported for 1990.

Negative values indicate concentration at or near background levels for radioactivity (refer to 1988 and 1989 data).

Data Sources:

Lindsay et al. 1991, DOE/RL 1991b, Barton et al. 1990, and Goodwind and Bjornstad 1990.

297828/TABLE A-6

AT-6e

DOE/RL-91-58
Draft A

Table A-7. Chemical Analysis Results of Z Plant Well Soil Samples. (Sheet 1 of 8)

Well 299-W7-9					
Chemical	Depth in Meters (Feet)				
	12.2 (40)	31.1 (102)	56.1 (184)	67.1 (220)	73.2 (240)
Nitrate in mg/kg	3.7	6.1	< 1	< 1	< 1
Sulfate in mg/kg	5.1	3.2	11.5	7.1	16.1
Fluoride in mg/kg	< 1	< 1	< 1	< 1	< 1
Chloride in mg/kg	1.4	< 1	2.1	< 1	4.7
Phosphate in mg/kg	< 2	< 2	< 2	< 2	< 2
Bromide in mg/kg	< 1	< 1	< 1	< 1	< 1
Nitrite in mg/kg	< 1	< 1	< 1	< 1	< 1
TOC in mg/kg	< 20	25	< 20	< 20	< 20
Beta in pCi/g	16.8	18.0	17.9	15.8	13.5
Sigma Beta in pCi/g	3.32	3.45	3.43	3.18	2.93
Lo-Alpha in pCi/g	1.73	1.59	1.45	1.71	2.32
Sigma Lo-Alpha in pCi/g	1.78	1.79	1.50	2.01	2.23
Methylene Chloride in $\mu\text{g}/\text{kg}$	< 59	< 67	—	—	—
Chloroform in $\mu\text{g}/\text{kg}$	< 3.4	< 3.9	< 7.6	13	< 3.4
Carbon Tetrachloride in $\mu\text{g}/\text{kg}$	< 0.2	< 0.2	0.20	12	< 0.08
Trichloroethene in $\mu\text{g}/\text{kg}$	< 1.0	< 1.2	< 2.3	8.8	< 1.1
Tetrachloroethene in $\mu\text{g}/\text{kg}$	—	—	< 2.7	4.4	< 1.2

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Table A-7. Chemical Analysis Results of Z Plant Well Soil Samples. (Sheet 2 of 8)

Well 299-W7-9					
Chemical	Depth in Meters (Feet)				
	12.2 (40)	31.1 (102)	56.1 (184)	67.1 (220)	73.2 (240)
1,1,1-Trichloroethane in $\mu\text{g}/\text{kg}$	< 2.1	< 2.5	< 4.6	23	< 2.1
Benzene in $\mu\text{g}/\text{kg}$	< 4.5	< 5.2	—	—	—
Toluene in $\mu\text{g}/\text{kg}$	< 10	< 12	< 18	200	< 8.0
1,2-Dichloroethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—
Ethylbenzene in $\mu\text{g}/\text{kg}$	—	—	—	—	—
1,1-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—
trans-1, 2-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—
cis-1, 2-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—
Chlorobenzene in $\mu\text{g}/\text{kg}$	—	—	—	—	—
m- and p-Xylene in $\mu\text{g}/\text{kg}$	—	—	< 20	76	< 9.0
o-Xylene in $\mu\text{g}/\text{kg}$	—	—	< 13	35	< 5.7
Bromodichloromethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—
1,1,2-Trichloroethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—
Fluoromethane in $\mu\text{g}/\text{kg}$	—	—	—	~ 3500	ND

AT-7b

DOE/RL-91-58
Draft A

Table A-7. Chemical Analysis Results of Z Plant Well Soil Samples. (Sheet 3 of 8)

Well 299-W7-10						
Chemical	Depth in Meters (Feet)					
	18.3 (60)	24.4 (80)	45.8 (150)	61.0 (200)	67.1 (220)	73.2 (240)
Nitrate in mg/kg	—	—	—	—	—	—
Sulfate in mg/kg	—	—	—	—	—	—
Fluoride in mg/kg	—	—	—	—	—	—
Chloride in mg/kg	—	—	—	—	—	—
Phosphate in mg/kg	—	—	—	—	—	—
Bromide in mg/kg	—	—	—	—	—	—
Nitrite in mg/kg	—	—	—	—	—	—
TOC in mg/kg	—	—	—	—	—	—
Beta in pCi/g	21.3	22.1	18.0	17.7	18.2	17.1
Sigma Beta in pCi/g	3.90	3.90	3.50	3.38	3.61	3.36
Lo-Alpha in pCi/g	7.19	8.00	1.59	2.88	3.10	3.64
Sigma Lo-Alpha in pCi/g	3.01	3.09	1.71	2.08	2.39	2.16
Methylene Chloride in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—
Chloroform in $\mu\text{g}/\text{kg}$	—	< 3	< 5	< 8	< 7	< 8
Carbon Tetrachloride in $\mu\text{g}/\text{kg}$	—	< 0.1	< 0.2	< 0.3	< 0.3	< 0.3
Trichloroethene in $\mu\text{g}/\text{kg}$	—	< 1	< 2	< 3	< 3	< 3
Tetrachloroethene in $\mu\text{g}/\text{kg}$	—	< 0.3	< 0.4	< 0.7	< 0.6	< 0.7

AT-7c

DOE/RL-91-58
Draft A

Table A-7. Chemical Analysis Results of Z Plant Well Soil Samples. (Sheet 4 of 8)

Well 299-W7-10						
Chemical	Depth in Meters (Feet)					
	18.3 (60)	24.4 (80)	45.8 (150)	61.0 (200)	67.1 (220)	73.2 (240)
1,1,1-Trichloroethane in $\mu\text{g}/\text{kg}$	—	< 1	< 2	9.1	< 3	< 3
Benzene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—
Toluene in $\mu\text{g}/\text{kg}$	—	< 6	< 9	< 14	< 12	< 14
1,2-Dichloroethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—
Ethylbenzene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—
1,1-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—
trans-1, 2-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—
cis-1, 2-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—
Chlorobenzene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—
m- and p-Xylene in $\mu\text{g}/\text{kg}$	—	< 3	< 5	17	< 7	< 8
o-Xylene in $\mu\text{g}/\text{kg}$	—	< 6	< 10	< 15	< 14	< 15
Bromodichloromethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—
1,1,2-Trichloroethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—
Fluoromethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—

AT-7d

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Draft A

Table A-7. Chemical Analysis Results of Z Plant Well Soil Samples. (Sheet 5 of 8)

Well 299-W15-21								
Chemical	Depth in Meters (Feet)							
	1.8 (6)	36.6 (120)	38.1 (125)	42.7 (140)	42.7 (140)	48.5 (159)	67.1 (220)	73.2 (240)
Nitrate in mg/kg	13.6	2.1	5.8	13.2	5.7	‡‡ 38.5	< 1	< 1
Sulfate in mg/kg	3.3	10.8	29.9	10.9	5.3	19.6	12.9	7.7
Fluoride in mg/kg	< 1	< 1	< 1.0	< 1	< 1	< 1	1.1	< 1
Chloride in mg/kg	2.0	2.3	8.6	< 1	< 1	1.2	2.6	1.4
Phosphate in mg/kg	< 2	< 2	< 2.0	< 2	< 2	< 2	< 2	< 2
Bromide in mg/kg	< 1	< 1	< 1.0	< 1	< 1	< 1	< 1	< 1
Nitrite in mg/kg	< 1	< 1	< 1.0	< 1	< 1	< 1	< 1	< 1
TOC in mg/kg	< 20	< 20	< 20	< 20	—	< 20	< 20	< 20
Beta in pCi/g	20.1	24.3	22.9	23.7	—	12.4	16.3	15.9
Sigma Beta in pCi/g	3.68	4.12	3.98	4.06	—	2.77	3.27	3.20
Lo-Alpha in pCi/g	4.62	6.39	3.00	4.51	—	5.46	12.2	4.43
Sigma Lo-Alpha in pCi/g	2.41	2.72	1.94	2.36	—	2.68	3.78	2.29
Methylene Chloride in µg/kg	—	—	—	—	—	—	1051	< 26
Chloroform in µg/kg	—	< 1.3	< 1.1	< 1.2	—	< 1.8	129	31
Carbon Tetrachloride in µg/kg	—	0.31	0.14	0.12	—	2.8	6.2	< 0.1
Trichloroethene in µg/kg	—	< 0.66	< 0.53	< 0.59	—	< 0.90	4.2	< 0.5
Tetrachloroethene in µg/kg	—	< 1.9	< 1.5	< 1.7	—	< 2.6	—	—

AT-7e

DOE/RL-91-58
Draft A

Table A-7. Chemical Analysis Results of Z Plant Well Soil Samples. (Sheet 6 of 8)

Well 299-W15-21								
Chemical	Depth in Meters (Feet)							
	1.8 (6)	36.6 (120)	38.1 (125)	42.7 (140)	42.7 (140)	48.5 (159)	67.1 (220)	73.2 (240)
1,1,1-Trichloroethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	10	< 1.0
Benzene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	200	< 2.0
Toluene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	64	< 4.5
1,2-Dichloroethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	~ 26	—
Ethylbenzene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	~ 3	—
1,1-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	~ 300	—
trans-1, 2-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	—	—
cis-1, 2-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	—	—
Chlorobenzene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	—	—
m- and p-Xylene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	—	—
o-Xylene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	—	—
Bromodichloromethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	—	—
1,1,2-Trichloroethane in $\mu\text{g}/\text{kg}$	—	—	< 0.005	—	—	—	—	—
Fluoromethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	—	—

AT-7f

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Draft A

Table A-7. Chemical Analysis Results of Z Plant Well Soil Samples. (Sheet 7 of 8)

Well 299-W15-23						
Chemical	Depth in Meters (Feet)					
	18.3 (60)	47.3 (155)	48.8 (160)	61.0 (200)	67.1 (220)	70.2 (230)
Nitrate in mg/kg	—	—	—	—	—	—
Sulfate in mg/kg	—	—	—	—	—	—
Fluoride in mg/kg	—	—	—	—	—	—
Chloride in mg/kg	—	—	—	—	—	—
Phosphate in mg/kg	—	—	—	—	—	—
Bromide in mg/kg	—	—	—	—	—	—
Nitrite in mg/kg	—	—	—	—	—	—
TOC in mg/kg	—	—	—	—	—	—
Beta in pCi/g	16.7	28.8	17.0	23.1	16.8	18.5
Sigma Beta in pCi/g	3.29	4.65	3.39	4.06	3.41	3.57
Lo-Alpha in pCi/g	2.13	10.1	8.24	1.97	3.45	1.18
Sigma Lo-Alpha in pCi/g	1.91	3.58	3.00	1.81	2.29	1.57
Methylene Chloride in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—
Chloroform in $\mu\text{g}/\text{kg}$	< 3	2	—	< 2	2.4	8.8
Carbon Tetrachloride in $\mu\text{g}/\text{kg}$	0.2	0.5	—	< 0.1	3.8	< 0.1
Trichloroethene in $\mu\text{g}/\text{kg}$	< 1	< 2	—	< 1	< 1	< 1
Tetrachloroethene in $\mu\text{g}/\text{kg}$	0.5	1.8	—	< 0.2	< 0.2	< 1.3

AT-7g

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Draft A

Table A-7. Chemical Analysis Results of Z Plant Well Soil Samples. (Sheet 8 of 8)

Well 299-W15-23						
Chemical	Depth in Meters (Feet)					
	18.3 (60)	47.3 (155)	48.8 (160)	61.0 (200)	67.1 (220)	70.2 (230)
1,1,1-Trichloroethane in $\mu\text{g}/\text{kg}$	1.1	2	—	< 1	< 1	< 1
Benzene in $\mu\text{g}/\text{kg}$	200	< 2.0	—	—	—	—
Toluene in $\mu\text{g}/\text{kg}$	75	~ 107	—	< 4	< 3	< 5
1,2-Dichloroethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—
Ethylbenzene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—
1,1-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—
trans-1, 2-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—
cis-1, 2-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—
Chlorobenzene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—
m- and p-Xylene in $\mu\text{g}/\text{kg}$	< 3	< 5	—	< 2	< 2	< 3
o-Xylene in $\mu\text{g}/\text{kg}$	< 5	< 9	—	< 4	< 3	< 5
Bromodichloromethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—
1,1,2-Trichloroethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—
Fluoromethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—

Data Source: Barton et al. 1990

297828/TABLE A-7

AT-7h

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Draft A

Table A-8. Chemical Analysis Results of Z Plant Well Soil Samples. (Sheet 1 of 10)

Well 299-W7-7												
Chemical	Depth in Meters (Feet)											
	1.5(5)	6.1(20)	12.2(40)	18.3(60)	24.4(80)	30.5(100)	36.6(120)	42.7(140)	48.8(160)	54.8(180)	61.0(200)	67.1(220)
Nitrate in mg/kg	1.6	1.8	4.8	4.5	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Sulfate in mg/kg	24.7	60.7	130	1.1	19.8	28.7	17.3	11.4	18.8	10.2	7.1	8.7
Fluoride in mg/kg	< 1	< 1	< 1	< 1	2.1	2.6	1.3	1.1	1.4	1.0	1.1	1.1
Chloride in mg/kg	1.6	1.1	1.9	1.5	3.3	2.5	2.7	3.0	2.9	3.1	3.4	2.9
Phosphate in mg/kg	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Bromide in mg/kg	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Nitrite in mg/kg	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
TOC in mg/kg	< 20	< 20	< 20	< 20	85	< 20	< 20	< 20	< 20	< 20	< 20	< 20
Beta in pCi/g	12.6	14.1	17.4	18.9	15.3	15.3	18.0	14.1	14.7	12.2	13.5	13.1
Sigma Beta in pCi/g	2.81	3.00	3.39	3.56	3.14	3.15	3.46	2.97	3.04	2.77	2.92	2.39
Lo-Alpha in pCi/g	2.47	3.54	4.70	2.55	3.68	3.53	2.28	1.64	0.171	1.20	2.31	3.33
Sigma Lo-Alpha in pCi/g	1.31	2.55	2.69	1.73	2.05	2.33	1.77	1.92	1.79	1.67	1.94	2.38
Chloroform in µg/kg	< 11	—	—	—	—	< 0.6	< 0.7	—	< 11	< 5.7	—	< 5.6
Carbon tetrachloride in µg/kg	6.5	—	—	—	—	< 0.01	< 0.02	—	0.53	< 0.13	—	< .75
Trichloroethene in µg/kg	< 3.3	—	—	—	—	< 0.2	< 0.3	—	< 3.4	< 1.8	—	< 1.7
Tetrachloroethene in µg/kg	< 3.8	—	—	—	—	< 0.3	< 0.3	—	< 3.9	< 2.0	—	< 2.0
1,1,1-Trichloroethane in µg/kg	< 6.5	—	—	—	—	< 0.4	< 0.5	—	< 6.8	< 3.5	—	< 3.4
Benzene in µg/kg	47	—	—	—	—	< 1.6	18	—	39	< 14	—	41
Toluene in µg/kg	< 49	—	—	—	—	ND	ND	—	< 50	40	—	72

AT-8a

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Draft A

Table A-8. Chemical Analysis Results of Z Plant Well Soil Samples. (Sheet 2 of 10)

Well 299-W7-7												
Chemical	Depth in Meters (Feet)											
	1.5(5)	6.1(20)	12.2(40)	18.3(60)	24.4(80)	30.5(100)	36.6(120)	42.7(140)	48.8(160)	54.8(180)	61.0(200)	67.1(220)
1,2-Dichloroethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	—	—	—	—	—	—
Ethylbenzene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	—	—	—	—	—	—
1,1-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	—	—	—	—	—	—
trans-1,2-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	—	—	—	—	—	—
cis-1,2-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	—	—	—	—	—	—
Chlorobenzene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	—	—	—	—	—	—
m- and p-Xylene in $\mu\text{g}/\text{kg}$	40	—	—	—	—	< 1.8	< 1.8	—	< 30	< 15	—	< 15
o-Xylene in $\mu\text{g}/\text{kg}$	20	—	—	—	—	< 1.1	< 1.2	—	< 19	< 9.7	—	< 9.5
Trichlorofluoromethane in $\mu\text{g}/\text{kg}$	ND	—	—	—	ND	ND	—	—	~ 1,600	~ 90	—	~ 150

AT-8b

DOE/RL-91-58
Draft A

Table A-8. Chemical Analysis Results of Z Plant Well Soil Samples. (Sheet 3 of 10)

Well 299-W7-8																
Chemical	Depth in Meters (Feet)															
	6.3(20.5)	9.3(30.5)	12.5(41)	14.6(48)	15.3(50)	16.8(55)	18.9(62)	23.8(78)	27.3(90)	33.6(110)	39.7(130)	45.8(150)	51.9(170)	58.0(190)	64.1(210)	70.2(230)
Nitrate in mg/kg	8.6	7.1	14.3	25.4	16.7	29.9	11.7	5.4	3.8	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Sulfate in mg/kg	5.2	7.7	41.6	27.6	32.2	24.8	9.3	1.4	5.1	4.8	3.8	5.1	12.5	9.2	6.9	4.9
Fluoride in mg/kg	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Chloride in mg/kg	< 1	< 1	32	25.3	< 9.6	19.7	5.8	< 1	< 1	< 1	< 1	2.5	1.6	1.8	1.8	1.9
Phosphate in mg/kg	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Bromide in mg/kg	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Nitrite in mg/kg	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
TOC in mg/kg	< 20	30	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20
Beta in pCi/g	16.6	29.1	14.6	19.9	14.2	17.9	19.0	19.9	15.1	13.7	16.6	18.3	11.8	17.0	14.4	16.4
Sigma Beta in pCi/g	3.28	4.65	3.03	3.69	3.02	3.41	3.55	3.62	3.10	2.96	3.27	3.47	2.75	3.32	3.04	3.27
Lo-Alpha in pCi/g	-1.52	2.80	1.97	4.07	3.52	5.16	3.87	2.53	3.42	3.16	5.61	1.73	1.86	4.17	4.07	2.73
Sigma Lo-Alpha in pCi/g	0.901	2.02	2.13	2.14	2.36	2.75	2.02	2.00	2.23	2.45	2.55	1.82	1.98	2.63	2.16	2.45
Chloroform in µg/kg	< 2.3	< 3.5	< 2.3	< 3.2	< 3.4	< 4.5	< 3.5	< 3.2	< 2.5	< 2.9	< 2.6	< 2.2	< 3.4	< 5.1	< 3.3	< 4.0
Carbon tetrachloride in µg/kg	< 0.05	< 0.08	< 0.05	< 0.07	0.09	0.09	0.07	< 0.07	< 0.06	< 0.06	< 0.06	< 0.05	< 0.07	< 0.11	0.30	0.36
Trichloroethene in µg/kg	< 0.7	< 1.1	< 0.7	< 1.0	< 1.1	< 1.4	< 1.1	< 1.0	< 0.8	< 0.9	< 0.8	< 0.7	< 1.1	< 1.6	0.9	< 1.2
Tetrachloroethene in µg/kg	< 0.8	< 1.2	< 0.8	< 1.1	< 1.2	< 1.6	< 1.2	< 1.1	< 0.9	< 1.0	< 0.9	< 0.8	< 1.2	< 1.8	< 1.2	< 1.4
1,1,1-Trichloroethane in µg/kg	< 1.4	< 2.1	< 1.4	< 1.9	2.5	3.2	2.5	< 1.9	1.8	< 1.8	1.8	< 1.3	< 2.1	< 3.1	3.0	3.0
Benzene in µg/kg	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Toluene in µg/kg	< 5.4	< 8.3	< 5.5	< 7.6	165	212	169	< 7.6	126	< 7.1	123	< 5.1	< 8.1	< 12	176	514
1,2-Dichloroethane in µg/kg	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ethylbenzene in µg/kg	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1,1-Dichloroethene in µg/kg	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

AT-8c

DOE/RL-91-58
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Table A-8. Chemical Analysis Results of Z Plant Well Soil Samples. (Sheet 4 of 10)

Well 299-W7-8																
Chemical	Depth in Meters (Feet)															
	6.3(20.5)	9.3(30.5)	12.5(41)	14.6(48)	15.3(50)	16.8(55)	18.9(62)	23.8(78)	27.3(90)	33.6(110)	39.7(130)	45.8(150)	51.9(170)	58.0(190)	64.1(210)	70.2(230)
trans-1,2-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
cis-1,2-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Chlorobenzene in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
m- and p-Xylene in $\mu\text{g}/\text{kg}$	< 6.1	< 9.4	< 6.2	< 8.6	< 9.3	< 12	< 9.4	< 8.6	< 6.8	< 7.9	< 7.0	< 5.7	< 9.2	< 14	26	< 11
o-Xylene in $\mu\text{g}/\text{kg}$	< 3.8	< 5.9	< 3.9	< 5.4	< 5.8	< 7.7	< 5.9	< 5.4	< 4.3	< 5.0	< 4.4	< 3.6	< 5.8	< 8.6	6.7	< 6.8
Trichlorofluoromethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—	—	—	210	—	—	—	—	—	—	100	—

AT-8d

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Table A-8. Chemical Analysis Results of Z Plant Well Soil Samples. (Sheet 5 of 10)

Well 299-W18-26					
Chemical	Depth in Meters (Feet)				
	12.2 (40*)	40.7 (130)	54.9 (180**)	67.1 (220)	73.2 (240)
Nitrate in mg/kg	2.2	2.1	11.7	< 1	< 1
Sulfate in mg/kg	7.0	3.7	8.2	24.3	7.6
Fluoride in mg/kg	< 1	< 1	< 1	< 1	< 1
Chloride in mg/kg	4.9	< 1	1.2	4.9	2.8
Phosphate in mg/kg	< 2	< 2	< 2	< 2	< 2
Bromide in mg/kg	< 1	< 1	< 1	< 1	< 1
Nitrite in mg/kg	< 1	< 1	< 1	< 1	< 1
TOC in mg/kg	< 20	< 20	< 20	< 20	< 20
Beta in pCi/g	14.8	21.7	24.9	18.7	14.4
Sigma Beta in pCi/g	3.06	3.84	4.20	3.53	3.02
Lo-Alpha in pCi/g	3.25	6.24	3.32	2.06	5.16
Sigma Lo-Alpha in pCi/g	2.52	2.56	2.26	2.24	2.77
Chloroform in µg/kg	—	< 1.8	91	7.9	71
Carbon Tetrachloride in µg/kg	—	0.12	2.3	2.6	4.3
Trichloroethene in µg/kg	—	< 0.90	3.3	< 0.2	< 2.3
Tetrachloroethene in µg/kg	—	< 2.3	—	—	—
1,1,1-Trichloroethane in µg/kg	—	—	4.8	< 0.4	5.7
Benzene in µg/kg	—	—	~ 125	< 0.7	88
Toluene in µg/kg	—	—	161	23	3.9
1,2-Dichloroethane in µg/kg	—	—	~ 31	—	—

AT-8e

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Table A-8. Chemical Analysis Results of Z Plant Well Soil Samples. (Sheet 6 of 10)

Well 299-W18-26					
Chemical	Depth in Meters (Feet)				
	12.2 (40 ^o)	40.7 (130)	54.9 (180 ^{**})	67.1 (220)	73.2 (240)
Ethylbenzene in $\mu\text{g}/\text{kg}$	—	—	—	—	—
1,1-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	~ 21	—	~ 55
trans-1,2-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	~ 24	—	—
cis-1,2-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	~ 34	—	—
Chlorobenzene in $\mu\text{g}/\text{kg}$	—	—	—	—	—
m- and p-Xylene in $\mu\text{g}/\text{kg}$	—	—	—	—	—
o-Xylene in $\mu\text{g}/\text{kg}$	—	—	—	—	—
Trichlorofluoromethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—

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Table A-8. Chemical Analysis Results of Z Plant Well Soil Samples. (Sheet 7 of 10)

Chemical	Well 299-W15-19				
	Depth in Meters (Feet)				
	12.2 (40)	24.4 (80)	36.6 (120)	67.1 (220)	73.2 (240)
Nitrate in mg/kg	1.2	< 1	2.1	< 1	< 1
Sulfate in mg/kg	2.8	22.3	10.8	7.7	44.5
Fluoride in mg/kg	< 1	< 1	< 1	< 1	1.2
Chloride in mg/kg	1.2	1.6	2.3	1.4	22
Phosphate in mg/kg	< 2	< 2	< 2	< 2	< 2
Bromide in mg/kg	< 1	< 1	< 1	< 1	< 1
Nitrite in mg/kg	< 1	< 1	< 1	< 1	< 1
TOC in mg/kg	< 20	< 20	< 20	< 20	< 20
Beta in pCi/g	16.2	22.7	17.9	16.9	27.7
Sigma Beta in pCi/g	3.22	3.95	3.41	3.30	4.49
Lo-Alpha in pCi/g	1.20	6.67	3.48	2.30	5.12
Sigma Lo-Alpha in pCi/g	1.67	2.67	2.61	2.13	2.69
Chloroform in µg/kg	2.6	4.1	2.8	16	168
Carbon Tetrachloride in µg/kg	0.55	1.4	0.56	5.8	8.1
Trichloroethene in µg/kg	3.0	4.4	1.7	< 0.14	0.37
Tetrachloroethene in µg/kg	2.1	3.4	1.3	< 0.39	< 0.21
1,1,1-Trichloroethane in µg/kg	—	—	—	—	—
Benzene in µg/kg	—	—	—	—	—
Toluene in µg/kg	—	—	—	—	—
1,2-Dichloroethane in µg/kg	—	—	—	—	—

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Table A-8. Chemical Analysis Results of Z Plant Well Soil Samples. (Sheet 8 of 10)

Chemical	Well 299-W15-19				
	Depth in Meters (Feet)				
	12.2 (40)	24.4 (80)	36.6 (120)	67.1 (220)	73.2 (240)
Ethylbenzene in $\mu\text{g}/\text{kg}$	—	—	—	—	—
1,1-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—
trans-1,2-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—
cis-1,2-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	—	—	—
Chlorobenzene in $\mu\text{g}/\text{kg}$	—	—	—	—	—
m- and p-Xylene in $\mu\text{g}/\text{kg}$	—	—	—	—	—
o-Xylene in $\mu\text{g}/\text{kg}$	—	—	—	—	—
Trichlorofluoromethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—

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Table A-8. Chemical Analysis Results of Z Plant Well Soil Samples. (Sheet 9 of 10)

Well 299-W15-20					
Chemicals	Depth in Meters (Feet)				
	6.1 (20)	24.4 (80)	54.9 (180)	67.1 (220)	73.2 (240)
Nitrate in mg/kg	< 1	< 1	< 1	< 1	< 1
Sulfate in mg/kg	2.7	25.7	12.1	16.3	7.0
Fluoride in mg/kg	< 1	< 1	1.4	3.2	< 1
Chloride in mg/kg	< 1	13.2	1.6	2.4	1.2
Phosphate in mg/kg	< 2	< 2	< 2	< 2	< 2
Bromide in mg/kg	< 1	< 1	< 1	< 1	< 1
Nitrite in mg/kg	< 1	< 1	< 1	< 1	< 1
TOC in mg/kg	< 20	< 20	< 20	< 20	< 20
Beta in pCi/g	13.1	25.1	15.6	13.5	18.7
Sigma Beta in pCi/g	2.89	4.24	3.19	2.92	3.56
Lo-Alpha in pCi/g	8.36	12.5	12.0	10.4	15.4
Sigma Lo-Alpha in pCi/g	2.94	3.58	3.81	3.45	4.33
Chloroform in $\mu\text{g}/\text{kg}$	< 10	< 0.9	187	13	7.5
Carbon Tetrachloride in $\mu\text{g}/\text{kg}$	< 0.4	3.2	9.5	0.3	< 0.5
Trichloroethene in $\mu\text{g}/\text{kg}$	< 3.0	< 0.3	7.6	< 0.3	< 0.3
Tetrachloroethene in $\mu\text{g}/\text{kg}$	—	—	1.6	—	—
1,1,1-Trichloroethane in $\mu\text{g}/\text{kg}$	< 6.4	< 0.6	18	< 0.5	< 0.5
Benzene in $\mu\text{g}/\text{kg}$	< 13	< 1.2	~ 380	14	< 1.1
Toluene in $\mu\text{g}/\text{kg}$	< 29	< 2.6	123	< 2.3	< 2.4
1,2-Dichloroethane in $\mu\text{g}/\text{kg}$	—	—	~ 36	—	—

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Table A-8. Chemical Analysis Results of Z Plant Well Soil Samples. (Sheet 10 of 10)

Well 299-W15-20					
Chemicals	Depth in Meters (Feet)				
	6.1 (20)	24.4 (80)	54.9 (180)	67.1 (220)	73.2 (240)
Ethylbenzene in $\mu\text{g}/\text{kg}$	—	—	—	—	—
1,1-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	~ 457	~ 47	—
trans-1,2-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	~ 440	~ 47	—
cis-1,2-Dichloroethene in $\mu\text{g}/\text{kg}$	—	—	~ 78	—	—
Chlorobenzene in $\mu\text{g}/\text{kg}$	—	—	~ 10	~ 2	—
m- and p-Xylene in $\mu\text{g}/\text{kg}$	—	—	—	—	—
o-Xylene in $\mu\text{g}/\text{kg}$	—	—	—	—	—
Trichlorofluoromethane in $\mu\text{g}/\text{kg}$	—	—	—	—	—

- Methanol evaporated or leaked from container during transport to analytical laboratory (VOA analyses).
- VOA values compromised, low volume of methanol caused by evaporation or absorption into large amount of soil gas.

Data Source: Goodwin and Bjornstad 1990

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Table A-9. Summary of Gamma-Radiation Logs Reviewed. (Sheet 1 of 8)

Waste Management Unit	Well Number	Number of Times	
		Logged	Inclusive Dates
Cribs and Drains			
216-Z-1 Crib	299-W18-64	3	8/63 to 9/67
	299-W18-65	1	7/86
216-Z-2 Crib	299-W18-60	1	7/86
	299-W18-61	1	7/86
	299-W18-62	1	7/86
	299-W18-63	1	7/86
	299-W18-172	1	7/86
216-Z-3 Crib	299-W18-67	0	Not logged.
	299-W18-68	0	Not logged.
	299-W18-88	3	04/73 to 09/86
216-Z-5 Crib	299-W15-1	2	12/59 to 5/63
	299-W15-52	0	Not Logged
	299-W15-53	0	Not Logged
	299-W15-54	0	Not Logged
	299-W15-55	0	Not Logged
	299-W15-56	0	Not Logged
	299-W15-57	0	Not Logged
	299-W15-58	0	Not Logged
	299-W15-212	2	3/84 to 6/86
216-Z-7 Crib	299-W15-7	4	4/66 to 5/76
	299-W15-62	3	05/76 to 07/86
	299-W15-63	2	05/76 to 07/86

Table A-9. Summary of Gamma-Radiation Logs Reviewed. (Sheet 3 of 8)

Waste Management Unit	Well Number	Number of Times	
		Logged	Inclusive Dates
	299-W18-155	1	7/86
	299-W18-156	0	Not Logged
	299-W18-157	1	7/86
	299-W18-162	0	Not logged.
	299-W18-179	0	Not logged.
	299-W18-180	0	Not logged.
	299-W18-181	0	Not logged.
	299-W18-182	0	Not logged.
	299-W18-183	0	Not logged.
	299-W18-184	0	Not logged.
	299-W18-185	0	Not logged.
	299-W18-242	0	Not logged.
	299-W18-243	0	Not logged.
	299-W18-244	0	Not logged.
	299-W18-245	0	Not logged.
216-Z-16 Crib	299-W15-10	3	2/68 to 5/76
	299-W15-11	3	3/68 to 5/76
216-Z-18 Crib	299-W18-9	6	12/68 to 07/87
	299-W18-10	4	12/68 to 5/76
	299-W18-11	5	03/70 to 07/87
	299-W18-12	3	3/70 to 5/76
	299-W18-82	4	2/70 to 7/87
	299-W18-83	3	1/70 to 7/87

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Table A-9. Summary of Gamma-Radiation Logs Reviewed. (Sheet 4 of 8)

Waste Management Unit	Well Number	Number of Times	
		Logged	Inclusive Dates
	299-W18-93	3	5/76 to 7/87
	299-W18-94	4	5/73 to 7/87
	299-W18-95	4	5/73 to 7/87
	299-W18-96	4	4/73 to 7/87
	299-W18-97	4	5/73 to 7/87
	299-W18-98	4	5/73 to 7/87
	299-W18-99	3	5/73 to 7/87
216-Z-1A Tile Field	299-W18-6 ^U	3	02/70 to 02/87
	299-W18-7 ^U	9	03/64 to 07/87
	299-W18-56	3	8/63 to 5/73
	299-W18-57	4	8/63 to 1/66
	299-W18-58	4	8/63 to 9/67
	299-W18-59	4	8/63 to 5/73
	299-W18-66	1	7/86
	299-W18-76	1	5/73
	299-W18-77	0	Not logged.
	299-W18-78	1	5/73
	299-W18-79	0	Not Logged
	299-W18-80	0	Not Logged
	299-W18-81	1	5/73
	299-W18-85	4	2/70 to 7/87
	299-W18-86	4	2/70 to 7/87
	299-W18-87 ^U	4	2/70 to 07/87

Table A-9. Summary of Gamma-Radiation Logs Reviewed. (Sheet 5 of 8)

Waste Management Unit	Well Number	Number of Times	
		Logged	Inclusive Dates
	299-W18-89	4	2/70 to 7/87
	299-W18-149	0	Not Logged
	299-W18-150	1	7/86
	299-W18-158	1	7/86
	299-W18-159	1	7/86
	299-W18-163	1	7/86
	299-W18-164	1	7/86
	299-W18-165	1	7/86
	299-W18-166	1	7/86
	299-W18-167	1	7/86
	299-W18-168	1	7/86
	299-W18-169	1	7/86
	299-W18-170	1	7/86
	299-W18-171	2	7/86 to 7/87
	299-W18-173	1	7/86
	299-W18-174	1	7/86
	299-W18-175	1	7/86
Reverse Wells			
216-Z-10 Reverse Well	299-W15-51	0	Not logged.
	299-W15-59	0	Not logged.
	299-W15-60	0	Not logged.
	299-W15-61	0	Not logged.

Table A-9. Summary of Gamma-Radiation Logs Reviewed. (Sheet 6 of 8)

Waste Management Unit	Well Number	Number of Times Logged	Inclusive Dates
Ponds, Ditches, and Trenches			
216-Z-9 Trench	299-W15-6	6	07/59 to 03/87
	299-W15-8	6	10/68 to 03/87
	299-W15-9	7	02/67 to 03/87
	299-W15-82	3	05/63 to 03/87
	299-W15-84	4	05/63 to 03/87
	299-W15-85	4	5/63 to 2/87
	299-W15-86	4	05/63 to 03/87
	299-W15-94	1	5/63
	299-W15-95	6	05/63 to 03/87
	299-W15-101	2	2/67 to 4/73
216-Z-17 Trench	299-W15-204	0	Not logged.
Transfer Facilities, Diversion Boxes, and Pipelines			
241-Z Diversion Box No. 2	299-W15-156	0	Not logged.
Basins			
216-Z-21 Seepage Basin	299-W15-208	0	Not logged.
Burial Sites			
218-W-3A Burial Ground	299-W7-2	1	9/87
	299-W7-3	1	10/87
	299-W10-179	0	Not logged.
218-W-3AE Burial Ground	299-W6-2	1	10/87
	299-W7-4	1	11/87
	299-W7-5	1	11/87

Table A-9. Summary of Gamma-Radiation Logs Reviewed. (Sheet 7 of 8)

Waste Management Unit	Well Number	Number of Times	
		Logged	Inclusive Dates
	299-W7-6	1	10/87
	299-W7-7	1	11/89
	299-W7-8	1	11/89
	299-W7-10	2	1/90
218-W-4B Burial Ground	299-W15-19	2	8/89 to 9/89
	299-W15-20	1	10/89
	299-W15-23	1	01/90
218-W-4C Burial Ground	299-W15-14	0	Not logged.
	299-W15-15	1	8/87
	299-W15-16	1	8/87
	299-W15-17	1	9/87
	299-W15-18	1	07/87
	299-W15-21	1	9/89
	299-W15-24	1	12/89
	299-W18-3	3	7/59 to 4/73
	299-W18-21	1	7/87
	299-W18-22	1	08/87
	299-W18-23	1	06/87
	299-W18-26	1	9/89
	299-W18-84	2	2/70 to 5/73
218-W-5 Burial Ground	299-W7-1	1	7/87
	299-W7-9	2	11/89 to 01/90
	299-W8-1	1	7/87

9 0 1 2 8 3 1 2 1 0

Table A-9. Summary of Gamma-Radiation Logs Reviewed. (Sheet 8 of 8)

Waste Management Unit	Well Number	Number of Times	
		Logged	Inclusive Dates
	299-W9-1	1	10/87
	299-W10-13	1	9/87
	299-W10-14	1	10/87
218-W-6 Burial Ground	299-W6-1	3	4/58 to 4/63
218-W-11 Burial Ground	299-W15-2	4	04/58 to 11/76

^v Also logged by WHC Tank Surveillance Group.

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APPENDIX B

HEALTH AND SAFETY PLAN

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1.0 GENERAL CONSIDERATIONS AND REQUIREMENTS

1.1 INTRODUCTION

The purpose of this Health and Safety Plan (HSP) is to outline standard health and safety procedures for Westinghouse Hanford Company (Westinghouse Hanford) employees and contractors engaged in investigation activities in the Z-Plant Aggregate Area Management Study (AAMS). These activities will include surface investigation, drilling and sampling boreholes, and environmental sampling in areas of known chemical and radiological contamination. Appropriate site-specific safety documents (e.g., Hazardous Waste Operations Permit [HWOP] or Job Safety Analysis [JSA]) will be written for each task or group of tasks. A more complete discussion of Westinghouse Hanford environmental safety procedures is presented in the Westinghouse Hanford manual *Health and Safety for Hazardous Waste Field Operations*, WHC-CM-4-3 vol. 4 (WHC 1992).

All employees of Westinghouse Hanford or any other contractors who are participating in on-site activities in the Z-Plant Aggregate Area shall read the site-specific safety document and attend a pre-job safety or tailgate meeting to review and discuss the task.

1.2 DESIGNATED SAFETY PERSONNEL

The field team leader and site safety officer are responsible for site safety and health. Specific individuals will be assigned on a task-by-task basis by project management, and their names will be properly recorded before the task is initiated.

All activities onsite must be cleared through the field team leader. The field team leader has responsibility for the following:

- Allocating and administering resources to successfully comply with all technical and health and safety requirements
- Verifying that all permits, supporting documentation, and clearances are in place (e.g., electrical outage requests, welding permits, excavation permits, HWOP or JSA, sampling plan, radiation work permits [RWP], and on-site/off-site radiation shipping records)
- Providing technical advice during routine operations and emergencies
- Informing the appropriate site management and safety personnel of the activities to be performed each day

- 1 • Coordinating resolution of any conflicts that may arise between RWPs and the
2 implementation of the HWOP or JSA with health physics
3
4 • Handling emergency response situations as may be required
5
6 • Conducting pre-job and daily tailgate safety meetings
7
8 • Interacting with adjacent building occupants and/or inquisitive public.
9

10 The site safety officer is responsible for implementing the HWOP at the site. The site
11 safety officer shall do the following.
12

- 13 • Monitor chemical, physical, and (in conjunction with the health physics
14 technician) radiation hazards to assess the degree of hazard present; monitoring
15 shall specifically include organic vapor detection, radiation screening, and
16 confined space evaluation where appropriate.
17
18 • Determine protection levels, clothing, and equipment needed to ensure the safety
19 of personnel in conjunction with the health physics department.
20
21 • Monitor the performance of all personnel to ensure that the required safety
22 procedures are followed.
23
24 • Halt operations immediately, if necessary, due to safety or health concerns.
25
26 • Conduct safety briefings as necessary.
27
28 • Assist the field team leader in conducting safety briefings as necessary.
29

30 The health physics technician is responsible for ensuring that all radiological
31 monitoring and protection procedures are being followed as specified in the Radiation
32 Protection Manual and in the appropriate RWP. Westinghouse Hanford Industrial Safety and
33 Fire Protection personnel will provide safety overview during drilling operations consistent
34 with Westinghouse Hanford policy and, as requested, will provide technical advice. Also,
35 downwind sampling for hazardous materials and radiological contaminants and other analyses
36 may be requested from appropriate contractor personnel as required.
37

38 The ultimate responsibility and authority for employee's health and safety lies with the
39 employee and the employee's colleagues. Each employee is responsible for exercising the
40 utmost care and good judgment in protecting his or her personal health and safety and that of
41 fellow employees. Should any employee observe a potentially unsafe condition or situation,
42 it is the responsibility of that employee to immediately bring the observed condition to the
43 attention of the appropriate health and safety personnel, as designated previously. In the
44 event of an immediately dangerous or life-threatening situation, the employee automatically

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1 has temporary "stop work" authority and the responsibility to immediately notify the field
2 team leader or site safety officer. When work is temporarily halted because of a safety or
3 health concern, personnel will exit the exclusion zone and meet at a predetermined place in
4 the support zone. The field team leader, site safety officer, and health physics technician
5 will determine the next course of action.
6
7

8 **1.3 MEDICAL SURVEILLANCE**

9

10 All field team members engaged in operable unit activities at sites governed by an
11 HWOP must have baseline physical examinations and be participants in Westinghouse
12 Hanford (or an equivalent) hazardous waste worker medical surveillance program.
13

14 Medical examinations will be designed to identify any pre-existing conditions that may
15 place an employee at high risk, and will verify that each worker is physically able to perform
16 the work required by this plan without undue risk to personal health. The physician shall
17 determine the existence of conditions that may reduce the effectiveness or prevent the
18 employee's use of respiratory protection. The physician shall also determine the presence of
19 conditions that may pose undue risk to the employee while performing the physical tasks of
20 this work plan using level B personal protection equipment. This would include any
21 condition that increases the employee's susceptibility to heat stress.
22

23 The examining physician's report will not include any nonoccupational diagnoses unless
24 directly applicable to the employee's fitness for the work required.
25

26 **1.4 TRAINING**

27

28
29 Before engaging in any onsite activities, each team member is required to have
30 received 40 hours of health and safety training related to hazardous waste site operations and
31 at least 8 hours of refresher training each year thereafter as specified in 29 Code of Federal
32 Regulations (CFR) 1910.120. In addition, each inexperienced employee (never having
33 performed site characterization) will be directly supervised by a trained/experienced person
34 for a minimum of 24 hours of field experience.
35

36 The field team leader and the site safety officer shall receive an additional 8 hours of
37 training (in addition to the refresher training previously discussed).
38

39 **1.5 TRAINING FOR VISITORS**

40

41
42 For the purposes of this plan, a visitor is defined as any person visiting the Hanford
43 Site, who is not a Westinghouse Hanford employee or a Westinghouse Hanford contractor
44 directly involved in the Resource Conservation and Recovery Act (RCRA)/Comprehensive

1 Environmental Response, Compensation and Liability Act of 1980 (CERCLA) facility
2 investigation activities, including but not limited to those engaged in surveillance, inspection,
3 or observation activities.
4

5 Visitors who must, for whatever reason, enter a controlled (either contamination
6 reduction or exclusion) zone, shall be subject to all of the applicable training, respirator fit
7 testing, and medical surveillance requirements discussed in Westinghouse Hanford
8 Environmental Investigations Instructions (EII) 1.1 and Appendix B to EII 1.1 (WHC 1991).
9

10 All visitors shall be informed of potential hazards and emergency procedures by their
11 escorts and shall conform to EII 1.1 (WHC 1991).
12

13

14 **1.6 RADIATION DOSIMETRY**

15

16 All personnel engaged in onsite activities shall be assigned dosimeters according to the
17 requirements of the RWP applicable to that activity. All visitors shall be assigned basic
18 dosimeters, as a minimum, that will be exchanged annually.
19

20 **1.7 REQUIREMENTS FOR THE USE OF RESPIRATORY** 21 **PROTECTION**

22

23 All employees of Westinghouse Hanford and subcontractors who may be required to
24 use air-purifying or air-supplied respirators must be included in the medical surveillance
25 program and be approved for the use of respiratory protection by the Hanford Environmental
26 Health Foundation (HEHF) or other licensed physician. Each team member must be trained
27 in the selection, limitations, and proper use and maintenance of respiratory protection
28 (existing respiratory protection training may be applicable towards the 40-hour training
29 requirement).
30

31 Before using a negative pressure respirator, each employee must have been fit-tested
32 (within the previous year) for the specific make, model, and size according to Westinghouse
33 Hanford fit-testing procedures. Beards (including a few days' growth), large sideburns, or
34 moustaches that may interfere with a proper respirator seal are not permitted.
35

36 Subcontractors must provide evidence to Westinghouse Hanford that personnel are
37 participants in a medical surveillance and respiratory protection program that complies with
38 29 CFR 1910.120 and 29 CFR 1910.134, respectively.
39
40
41

2.0 GENERAL PROCEDURES

The following personal hygiene and work practice guidelines are intended to prevent injuries and adverse health effects. A hazardous waste site poses a multitude of health and safety concerns because of the variety and number of hazardous substances present. These guidelines represent the minimum standard procedures for reducing potential risks associated with this project and are to be followed by all job-site employees at all times.

2.1 GENERAL WORK SAFETY PRACTICES

2.1.1 Work Practices

The following work practices must be observed.

- Eating, drinking, smoking, taking certain medications, chewing gum, and similar actions are prohibited within the exclusion zone. All sanitation facilities shall be located outside the exclusion zone; decontamination is required before using such facilities.
- Personnel shall avoid direct contact with contaminated materials unless necessary for sample collecting or required observation. Remote handling of such things as casings and auger flights will be practiced whenever practical.
- While operating in the controlled zone, personnel shall use the "buddy system" where appropriate, or be in visual contact with someone outside of the controlled zone.
- The buddy system will be used where appropriate for manual lifting.
- Requirements of Westinghouse Hanford radiation protection and RWP manuals shall be followed for all work involving radioactive materials or conducted within a radiologically controlled area.
- Onsite work operations shall only be carried out during daylight hours, unless the entire control zone is adequately illuminated with artificial lighting. A new tour (shift) will operate the drilling rig after completion of each shift.
- Do not handle soil, waste samples, or any other potentially contaminated items unless wearing the protective equipment specified in the HWOP or JSA.

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- Whenever possible, stand upwind of excavations, boreholes, well casings, drilling spoils, and the like, as indicated by an onsite windsock.
 - Stand clear of trenches during excavation. Always approach an excavation from upwind.
 - Be alert to potentially changing exposure conditions as evidenced by such indications as perceptible odors, unusual appearance of excavated soils, or oily sheen on water.
 - Do not enter any test pit or trench deeper than 1 m (4 ft) unless in accordance with procedures specified in the HWOP.
 - Do not under any circumstances enter or ride in or on any backhoe bucket, materials hoist, or any other similar device not specifically designed for carrying passengers.
 - All drilling team members must make a conscientious effort to remain aware of their own and others' positions in regards to rotating equipment, cat heads, or u-joints. Drilling operations members must be extremely careful when assembling, lifting, and carrying flights or pipe to avoid pinch-point injuries and collisions.
 - Tools and equipment will be kept off the ground whenever possible to avoid tripping hazards and the spread of contamination.
 - Personnel not involved in operation of the drill rig or monitoring activities shall remain a safe distance from the rig as indicated by the field team leader.
 - Follow all provisions of each site-specific hazardous work permit as addressed in the HWOP, including cutting and welding, confined space entry, and excavation.
 - Catalytic converters on the underside of vehicles are sufficiently hot to ignite dry prairie grass. Team members should not drive over dry grass that is higher than the ground clearance of the vehicle and should be aware of the potential fire hazard posed by catalytic converters at all times. Never allow a running or hot vehicle to sit in a stationary location over dry grass or other combustible materials.
 - Follow all provisions of each site-specific RWP.
 - Team members will attempt to minimize truck tire disturbance of all stabilized sites.

2.1.2 Personal Protective Equipment

- Personal protective equipment will be selected specifically for the hazards identified in the HWOP. The site safety officer in conjunction with Westinghouse Hanford Health Physics and Industrial Hygiene and Safety is responsible for choosing the appropriate type and level of protection required for different activities at the job site.
- Levels of protection shall be appropriate to the hazard to avoid either excessive exposure or additional hazards imposed by excessive levels of protection. The HWOP will contain provisions for adjusting the level of protection as necessary. These personal protective equipment specifications must be followed at all times, as directed by the field team leader, health physics technician, and site safety officer.
- Each employee must have a hard hat, safety glasses, and substantial protective footwear available to wear as specified in the HWOP or JSA.
- The exclusion zone around drilling or other noisy operations will be posted "Hearing Protection Required" and team members will have had noise control training.
- Personnel should maintain a high level of awareness of the limitations in mobility, dexterity, and visual impairment inherent in the use of level B and level C personal protective equipment.
- Personnel should be alert to the symptoms of fatigue, heat stress, and cold stress and their effects on the normal caution and judgment of personnel.
- Rescue equipment as required by Occupational Safety and Health Administration (OSHA), Washington Industrial Safety and Health Act (WISHA), or standards for working over water will be available and used.

2.1.3 Personal Decontamination

- The HWOP will describe in detail methods of personnel decontamination, including the use of contamination control corridors and step-off pads when appropriate.
- Thoroughly wash hands and face before eating or putting anything in the mouth to avoid hand-to-mouth contamination.

- 1 • At the end of each work day or each job, disposable clothing shall be removed
2 and placed in (chemical contamination) drums, plastic-lined boxes or other
3 containers as appropriate. Clothing that can be cleaned may be sent to the
4 Hanford Site laundry.
5
6 • Individuals are expected to thoroughly shower before leaving the work site or
7 Hanford Site if directed to do so by the health physics technician, site safety
8 officer, or field team leader.
9

10 11 **2.1.4 Emergency Preparation**

- 12
13 • A multipurpose dry chemical fire extinguisher, a fire shovel, a complete field
14 first-aid kit, and a portable pressurized spray wash unit shall be available at every
15 site where there is potential for personnel contamination.
16
17 • Prearranged hand signals or other means of emergency communication will be
18 established when respiratory protection equipment is to be worn, because this
19 equipment seriously impairs speech.
20
21 • The Hanford Fire Department shall be initially notified before the start of the site
22 investigation project. This notification shall include the location and nature of the
23 various types of field work activities as described in the work plan. A site
24 location map shall be included in this notification.
25
26

27 **2.2 CONFINED SPACE/TEST PIT ENTRY PROCEDURES**

28
29 The following procedures apply to the entry of any confined space, which for the
30 purpose of this document shall be defined as any space having limited egress (access to an
31 exit) and the potential for the presence or accumulation of a toxic or explosive atmosphere.
32 This includes manholes, certain trenches (particularly those through waste disposal areas),
33 and all test pits greater than 1 m (4 ft) deep. If confined spaces are to be entered as part of
34 the work operations, a hazardous work permit (filled out for confined space entry) must be
35 obtained from Industrial Safety and Fire Protection.
36

37 The identified remedial investigation activities on the Z Plant AAMS should not require
38 confined space entry. Nevertheless, the hazards associated with confined spaces are of such
39 severity that all employees should be familiar with the safe work discussed in the following
40 paragraphs.
41

42 No employee shall enter any test pit or trench deeper than 1 m (4 ft) unless the sides
43 are shored or laid back to a stable slope as specified in OSHA 29 CFR 1926.652 or
44 equivalent state occupational health and safety regulations.

4.0 SCOPE OF WORK AND POTENTIAL HAZARDS

While the information presented in Sections 2.0 through 10.0 of the plan are believed to be representative of the constituents and quantities of wastes at the time of discharge, the present chemical nature, location, extent, and ultimate fate of these wastes in and around the liquid disposal facilities are largely unknown. The emphasis of the investigation in the Z Plant Aggregate Area will be to characterize the nature and extent of contamination in the vadose (unsaturated subsurface soil) zone.

4.1 WORK TASKS

Work tasks are described in Section 5.0 of the plan.

4.2 POTENTIAL HAZARDS

On-site tasks will involve non-invasive surface sampling procedures and invasive soil sampling either directly in or immediately adjacent to areas known or suspected to contain potentially hazardous chemical substances, toxic metals, and radioactive materials.

Surface radiological contamination and fugitive dust will be the potential hazards of primary concern during noninvasive mapping and sampling activities.

Existing data indicate that hazardous substances may be encountered during invasive sampling; these include radionuclides, heavy metals, and corrosives. In addition, volatile organics may also be associated with certain facilities such as the solvent storage buildings or underground storage tanks.

Potential hazards include the following:

- External radiation (gamma and to a lesser extent, beta) from radioactive materials in the soil
- Internal radiation resulting from radionuclides present in contaminated soil entering the body by ingestion or through open cuts and scratches
- Internal radiation resulting from inhalation of particulate (dust) contaminated with radioactive materials
- Inhalation of toxic vapors or gases such as volatile organics or ammonia

- 1 • Inhalation or ingestion of particulate (dust) contaminated with inorganic or
2 organic chemicals, and toxic metals
3
4 • Dermal exposure to soil or groundwater contaminated with radionuclides
5
6 • Dermal exposure to soil or groundwater contaminated with inorganic or organic
7 chemicals, and toxic metals
8
9 • Physical hazards such as noise, heat stress, and cold stress
10
11 • Slips, trips, falls, bumps, cuts, pinch points, falling objects, other overhead
12 hazards, crushing injuries, and other hazards typical of a construction-related job
13 site
14
15 • Unknown or unexpected underground utilities
16
17 • Biological hazards; snakes, spiders, etc.
18
19

20 4.3 ASSESSMENT AND MITIGATION OF POTENTIAL 21 HAZARDS

22
23 The likelihood of significant exposure (100 mR/h or greater) to external radiation is
24 remote and can be readily monitored and controlled by limiting exposure time, increasing
25 distance, and employing shielding as required.
26

27 Internal radiation by inhalation or inadvertent ingestion of contaminated dust is a
28 realistic concern and must be continuously evaluated by the health physics technician.
29 Appropriate respiratory protection, protective clothing, and decontamination procedures will
30 be implemented as necessary to reduce potential inhalation, ingestion, and dermal exposure
31 to acceptable levels.
32

33 Dermal exposure to toxic chemical substances is not expected to pose a significant
34 problem for the identified tasks given the use of the designated protective clothing. The
35 appropriate level of personal protective clothing and respiratory protection will vary from
36 work site to work site.
37
38
39

40 5.0 ENVIRONMENTAL AND PERSONAL MONITORING

41
42
43 The site safety officer or authorized delegate shall be present at all times during work
44 activities which require an HWOP, and shall be in charge of all environmental/personal

9 1 2 8 6 7 1 2 2 5

1 monitoring equipment. Industrial Hygiene and Safety shall review all activities involving or
2 potentially involving radiological exposure or contamination control and shall prescribe the
3 appropriate level of technical support and/or monitoring requirements. Other equipment
4 deemed necessary by the site safety officer or Industrial Hygiene and Safety shall be obtained
5 at their direction; work will be initiated or continued until such equipment is in place. These
6 instruments are to be used only by persons who are trained in their usage and who
7 understand their limitations. No work shall be done unless instrumentation is available and
8 in proper working order.
9

10 Air sampling may be required downwind of the referenced waste sites to monitor
11 particulates and vapors before job startup. Siting of such sampling devices will be
12 determined by Health Physics, the site safety officer, and HEHF, if appropriate. Any time
13 personnel exposure monitoring, other than radiological, is required to determine exposure
14 levels, it must be done by HEHF. Discrete sampling of ambient air within the work zone
15 and breathing zones will be conducted using a direct-reading instrument, as specified in the
16 site-specific safety document, and other methods as deemed appropriate (e.g., pumps with
17 tubes, O₂ meters). The following standards will be used in determining critical levels:
18

- 19 • "Radionuclide Concentrations in Air," in Chapter XI, DOE Order 5480.1B (DOE
20 1986)
- 21 • "Air Contaminants - Permissible Exposure Limits," in 29 CFR 1910.1000
- 22 • *Threshold Limit Values and Biological Exposure Indices for 1990-1991* (ACGIH
23 1991)
- 24 • *Occupational Safety and Health Standards*, 29 CFR 1910.1000
- 25 • *Pocket Guide to Chemical Hazards* (NIOSH 1991), which provides National
26 Institute for Occupational Safety and Health (NIOSH)-recommended exposure
27 limits for substances that do not have either a threshold limit value or a
28 permissible exposure limit.
29

30 5.1 AIRBORNE RADIOACTIVE AND RADIATION 31 MONITORING 32

33 An on-site health physics technician will monitor airborne radioactive contamination
34 levels and external radiation levels. Action levels will be consistent with derived air
35 concentrations and applicable guidelines as specified in the radiation protection manual
36 WHC-CM-4-10 (WHC 1988).
37

38 Appropriate respiratory protection shall be required when conditions are such that the
39 airborne contamination levels may exceed an 8-hour derived air concentration (e.g., the
40
41
42
43
44

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1 presence of high levels of uncontained, loose contamination on exposed surfaces or
2 operations that may raise excessive levels of dust contaminated with airborne radioactive
3 materials, such as excavation or drilling under extremely dry conditions).
4

5 Specific conditions requiring the use of respiratory protection because of radioactive
6 materials in air will be incorporated into the RWP. If, in the judgement of the health physics
7 technician, any of these conditions arise, work shall cease until appropriate respiratory
8 protection is provided.
9

10 11 12 **6.0 PERSONAL PROTECTIVE EQUIPMENT**

13
14
15 The level of personal protective equipment required initially at a site will be specified
16 in the site-specific safety document for each task or group of tasks. Personal protective
17 clothing and respiratory protection shall be selected to limit exposure to anticipated chemical
18 and radiological hazards. Work practices and engineering controls may be used to control
19 exposure.
20

21 22 23 **7.0 SITE CONTROL**

24
25
26 The field team leader, site safety officer, and health physics technician are designated
27 to coordinate access control and security on the site. Special site control measures will be
28 necessary to restrict public access. The zones will be clearly marked with rope and/or
29 appropriate signs. The size and shape of the control zone will be dictated by the types of
30 hazards expected, the climatic conditions, and specific operations required.
31

32 Control zone boundaries may be increased or decreased based on results of field moni-
33 toring, environmental changes, or work technique changes. The site RWP and the
34 contractor's standard operating procedures for radiation protection may also dictate the
35 boundary size and shape. All team members must be surveyed for radioactive contamination
36 when leaving the controlled zone if in a radiation zone.
37

38 The onsite command post and staging area will be established near the upwind side of
39 the control zone as determined by an onsite windsock. Exact location for the command post
40 is to be determined just before start of work. Vehicle access, availability of utilities (power
41 and telephone), wind direction, and proximity to sample locations should be considered in
42 establishing a command post location.
43
44

8.0 DECONTAMINATION PROCEDURES

Remedial investigation activities will require entry into areas of known chemical and radiological contamination. Consequently, it is possible that personnel and equipment could be contaminated with hazardous chemical and radiological substances.

During site activities, potential sources of contamination may include airborne vapors, gases, dust, mists, and aerosols; splashes and spills; walking through contaminated areas; and handling contaminated equipment. Personnel who enter the exclusion zone will be required to go through the appropriate decontamination procedures on leaving the zone. Decontamination procedures shall be consistent with EII 5.4, "Field Decontamination of Drilling, Well Development, and Sampling Equipment," and EII 5.5, "Decontamination of Equipment for RCRA/CERCLA Sampling" (WHC 1991), or other approved decontamination procedures.

9.0 CONTINGENCY AND EMERGENCY RESPONSE PLANS

As a general rule, in the event of an unanticipated, potentially hazardous situation indicated by instrument readings, visible contamination, unusual or excessive odors, or other indications, team members shall temporarily cease operations and move upwind to a predesignated safe area as specified in the site-specific safety documentation.

10.0 REFERENCES

- BACGIH, 1991, *Threshold Limit Values and Biological Exposure Indices for 1990-1991*, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.
- DOE, 1986, *Environment, Safety & Health Program for DOE Operations*, DOE Order 5480.1B, U.S. Department of Energy, Washington, D.C.
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- NIOSH, 1991, *Pocket Guide to Chemical Hazards*, National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, Washington, D.C.

- 1 WHC, 1988, *Radiation Protection*, WHC-CM-4-10, Westinghouse Hanford Company,
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- 3
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- 6
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APPENDIX C

PROJECT MANAGEMENT PLAN

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9 1 3 0 3 3 1 0 2

1.0 INTRODUCTION

1
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3
4 This Project Management Plan (PMP) defines the administrative and institutional tasks
5 necessary to support the Z Plant Aggregate Area investigations at the Hanford Site. Also,
6 this PMP defines the responsibilities of the various participants, the organizational structure,
7 and the project tracking and reporting procedures. This PMP is in accordance with the
8 provisions of the Tri-Party Agreement Action Plan dated August 1990. Any revisions to the
9 Tri-Party Agreement Action Plan that would result in changes to the project management
10 requirements would supersede the provisions of this chapter.
11
12
13

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 INTERFACE OF REGULATORY AUTHORITIES AND THE U.S. DEPARTMENT OF ENERGY

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15
16
17
18
19
20 The Z Plant Aggregate Area consists of active and inactive waste management units to
21 be remedied under either RCRA or CERCLA. Ecology has been designated as the lead
22 regulatory agency, as defined in the Tri-Party Agreement. Accordingly, Ecology is
23 responsible for overseeing remedial action activity at this aggregate area and ensuring that
24 the applicable authorities of both EPA and Ecology are applied. The specific responsibilities
25 of EPA, Ecology, and DOE are detailed in the Tri-Party Agreement Action Plan.
26
27

2.2 PROJECT ORGANIZATION AND RESPONSIBILITIES

28
29
30 The project organization for implementing remedial activities at the Z Plant Aggregate
31 Area is shown on Figure C-1. The following sections describe the responsibilities of the
32 individuals shown on Figure C-1.
33
34

2.2.1 Project Managers

35
36
37 The EPA, DOE, and Ecology have each designated one individual as project manager
38 for remedial activities at the Hanford Site. These project managers will serve as the primary
39 point of contact for all activities to be carried out under the Tri-Party Agreement Action
40 Plan. The responsibilities of the project managers are given in Section 4.1 of the Tri-Party
41 Agreement Action Plan.

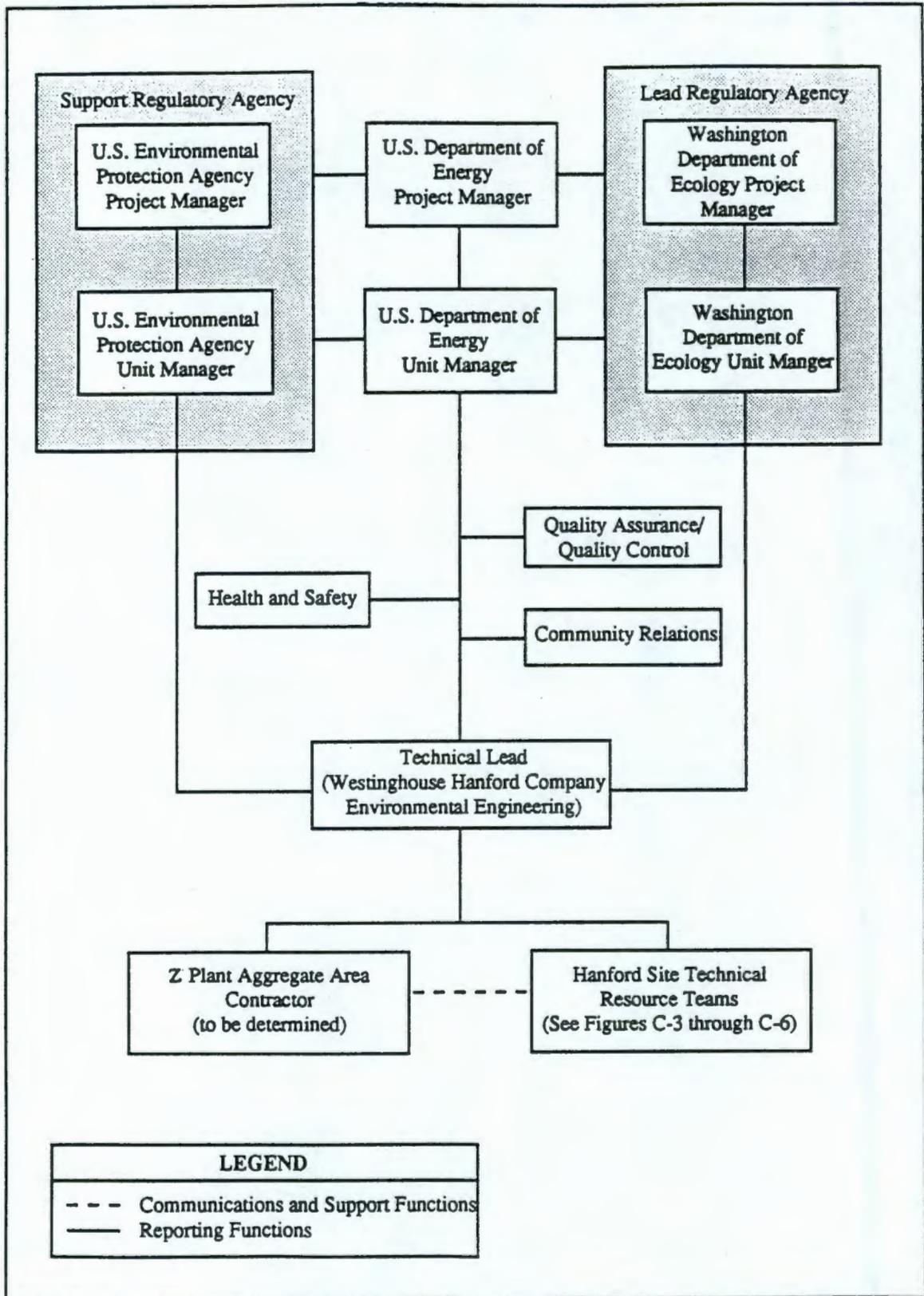


Figure C-1. Project Organization for the Z Plant Aggregate Area Project.

9 3 1 2 8 6 5 1 2 3 4

1
2 **2.2.2 Unit Managers**
3

4 As shown on Figure C-1, EPA, DOE, and Ecology will each designate an individual as
5 a unit manager for the Z Plant Aggregate Area.
6

7 The unit manager from Ecology will serve as the lead unit manager. The Ecology unit
8 manager will be responsible for regulatory oversight of all activities required for the Z Plant
9 Aggregate Area.
10

11 The unit manager from EPA will be responsible for making decisions related to issues
12 for which the supporting regulatory agency maintains authority. All such decisions will be
13 made in consideration of recommendations made by the Ecology unit manager.
14

15 The unit manager from DOE will be responsible for maintaining and controlling the
16 schedule and budget and keeping the EPA and Ecology unit managers informed as to the
17 status of the activities at the Z Plant Aggregate Area, particularly the status of agreements
18 and commitments.
19

20 **2.2.3 Quality Assurance Officer**
21

22 The quality assurance officer is responsible for monitoring overall environmental
23 restoration program activities through establishment of Hanford Site quality assurance
24 auditing program controls that may be appropriately applied to the remedial activities. The
25 quality assurance officer is specifically vested with the organizational independence and
26 authority to identify conditions adverse to quality, and to systematically seek effective
27 corrective action.
28

29 **2.2.4 Quality Coordinator**
30

31 The quality coordinator is responsible for coordinating and monitoring performance of
32 the Quality Assurance Project Plan (QAPP) requirements by means of internal surveillance
33 techniques and by auditing, as directed by the quality assurance officer. The quality
34 coordinator retains the necessary organizational independence and authority to identify
35 conditions adverse to quality, and to inform the technical lead of needed corrective action.
36

37 **2.2.5 Health and Safety Officer (Environmental Division/Environmental Field Services)**
38

39 The health and safety officer is responsible for monitoring all potential health and
40 safety hazards, including those associated with radioactive, volatile, and/or toxic compounds
41 during sample handling and sampling decontamination activities. The health and safety
42 officer has the responsibility and authority to halt field activities resulting from unacceptable
43 health and safety hazards.
44
45

2.2.6 Technical Lead

The technical lead will be a designated person within the Westinghouse Hanford Environmental Engineering Group. The responsibilities of the technical lead will be to plan, authorize, and control work so that it can be completed on schedule and within budget, and to ensure that all planning and work performance activities are technically sound.

2.2.7 Remedial Investigation/Feasibility Study Coordinators

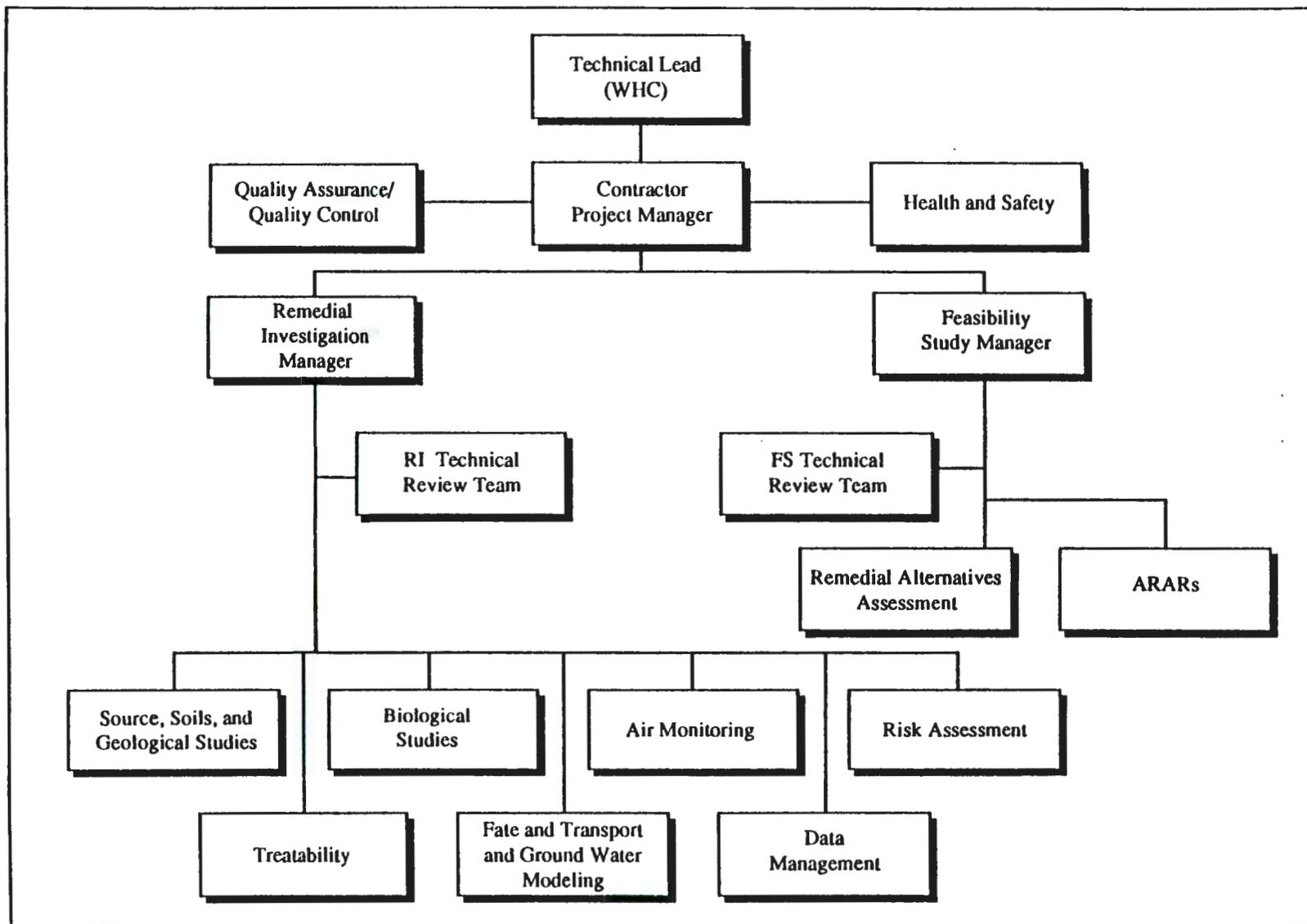
The RI and FS coordinators will be responsible for coordinating all activities related to the RI and FS, respectively, including data collection, analysis, and reporting. The RI and FS coordinators will be responsible for keeping the technical lead informed as to the RI and FS work status and any problems that may arise.

2.2.8 Resource Conservation Recovery Act Facility Investigation/Corrective Measures Study Contractor

Figure C-1 shows the organizational relationship of an offsite contractor. Assuming a contractor is used to perform the RI/FS for the Z Plant Aggregate Area, the contractor would assume responsibilities of the RI and FS coordinators, as described above. In this instance, the contractor will be directly responsible for planning data collection activities and for analyzing and reporting the results of the data-gathering in the RI and FS reports. However, the Westinghouse Hanford coordinator would retain the responsibility for securing and managing the field sampling efforts of the Hanford Site technical resource teams, described below. Figure C-2 shows a sample organizational structure for an RI/FS contractor team.

2.2.9 Hanford Site Technical Resources

The various technical resources available on the Hanford Site for performing the field studies are shown in Table C-1. These resources will be responsible for performing data collection activities and analyses, and for reporting the results of specific technical activities. Figures C-3 through C-6 show the detailed organizational structure of specific technical teams. Internal and external work orders and subcontractor task orders will be written by the Westinghouse Hanford technical lead to use these technical resources, which are under the control of the technical lead. Statements of work will be provided to the technical teams and will include a discussion of authority and responsibility, a schedule with clearly defined milestones, and a task description including specific requirements. Each technical team will keep the coordinator informed of the work status performed by that group and any problems that may arise.



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Figure C-2. Example Project Organization for the Z Plant Aggregate Area

Table C-1. Hanford Site RI/FS Technical Resources.

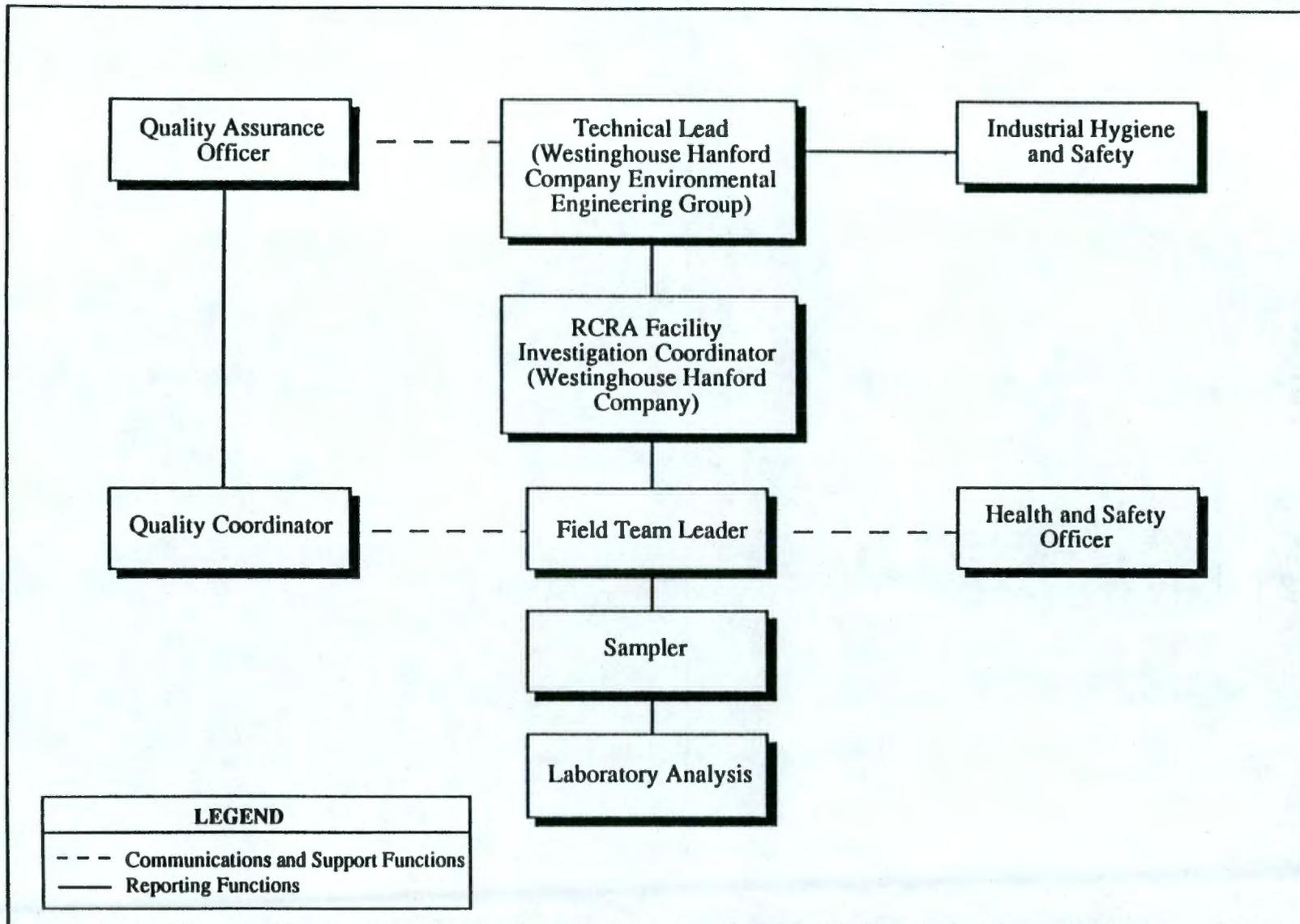
Subject/Activity	Technical Resources	
	RI	FS
Hydrology and geology	Westinghouse Hanford/Geosciences PNL/Earth and Environmental Sciences Center	Westinghouse Hanford/Geosciences
Toxicology and risk/endangerment assessment	Westinghouse Hanford/Environmental Technology PNL/Earth and Environmental Sciences Center PNL/Life Sciences Center	Westinghouse Hanford/ Environmental Technology
Environmental chemistry	Westinghouse Hanford/Geosciences PNL/Earth and Environmental Sciences Center	Westinghouse Hanford/Geosciences
Geotechnical and civil engineering	Westinghouse Hanford/Geosciences (Planning) Environmental Field Services	NA
Geotechnical and civil engineering	NA	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Ground water treatment engineering	NA	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Waste stabilization and treatment	NA	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Surveying	Kaiser Engineers Hanford	NA

Table C-1. Hanford Site RI/FS Technical Resources.

Subject/Activity	Technical Resources	
	RI	FS
Soil and water sampling and analysis	Westinghouse Hanford/Environmental Engineering Westinghouse Office of Sampling Management PNL/Earth and Environmental Sciences Center PNL/Materials and Chemical Sciences Center	NA
Drilling and well installation	Westinghouse Hanford/Geosciences Environmental Field Services Kaiser Engineers	NA
Radiation monitoring	Westinghouse Hanford/Operational Health Physics	NA

NA = Not applicable.

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Figure C-3. The Hanford Site Soil Sampling Team.

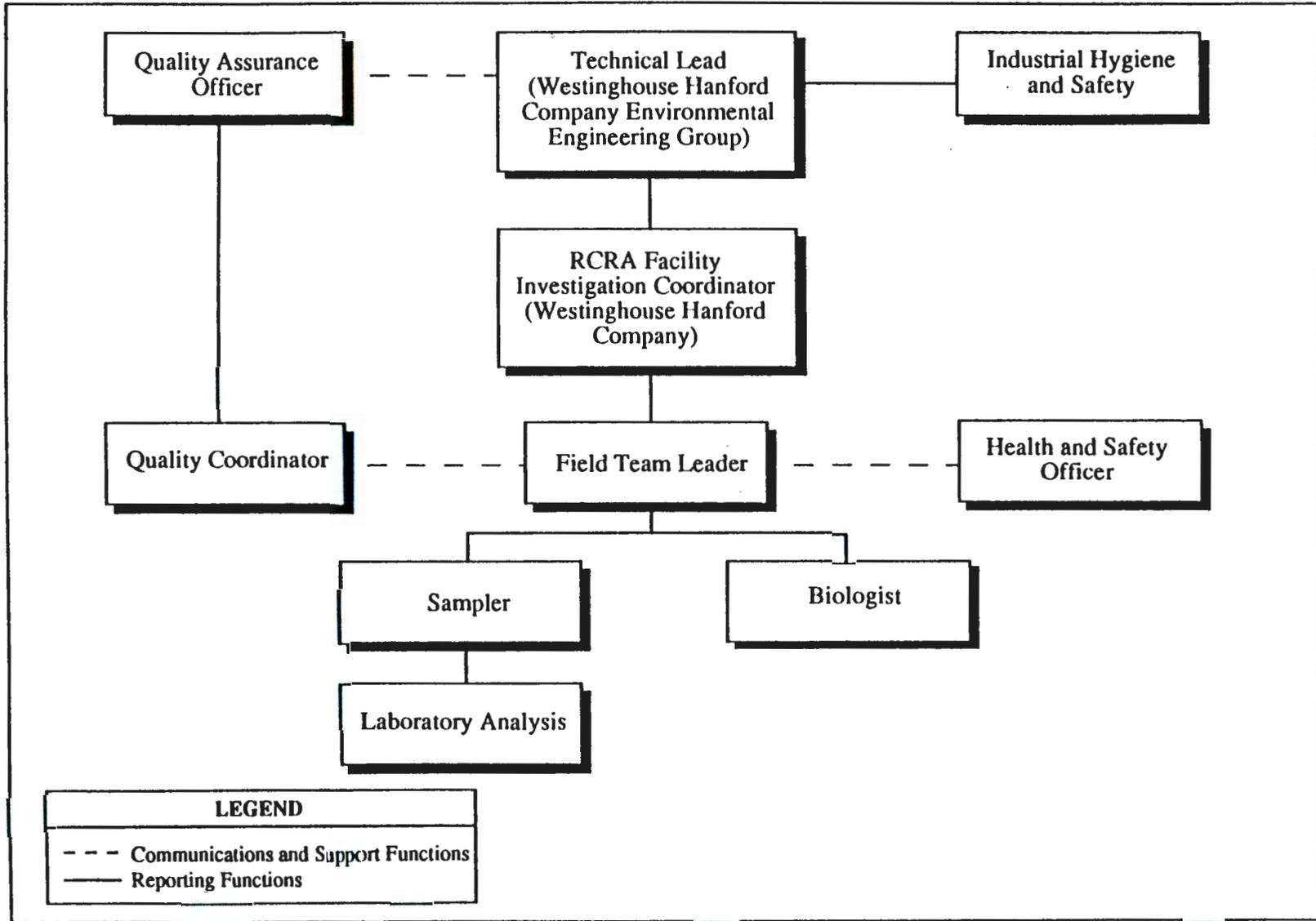


Figure C-4. The Hanford Site Biological Sampling Team.

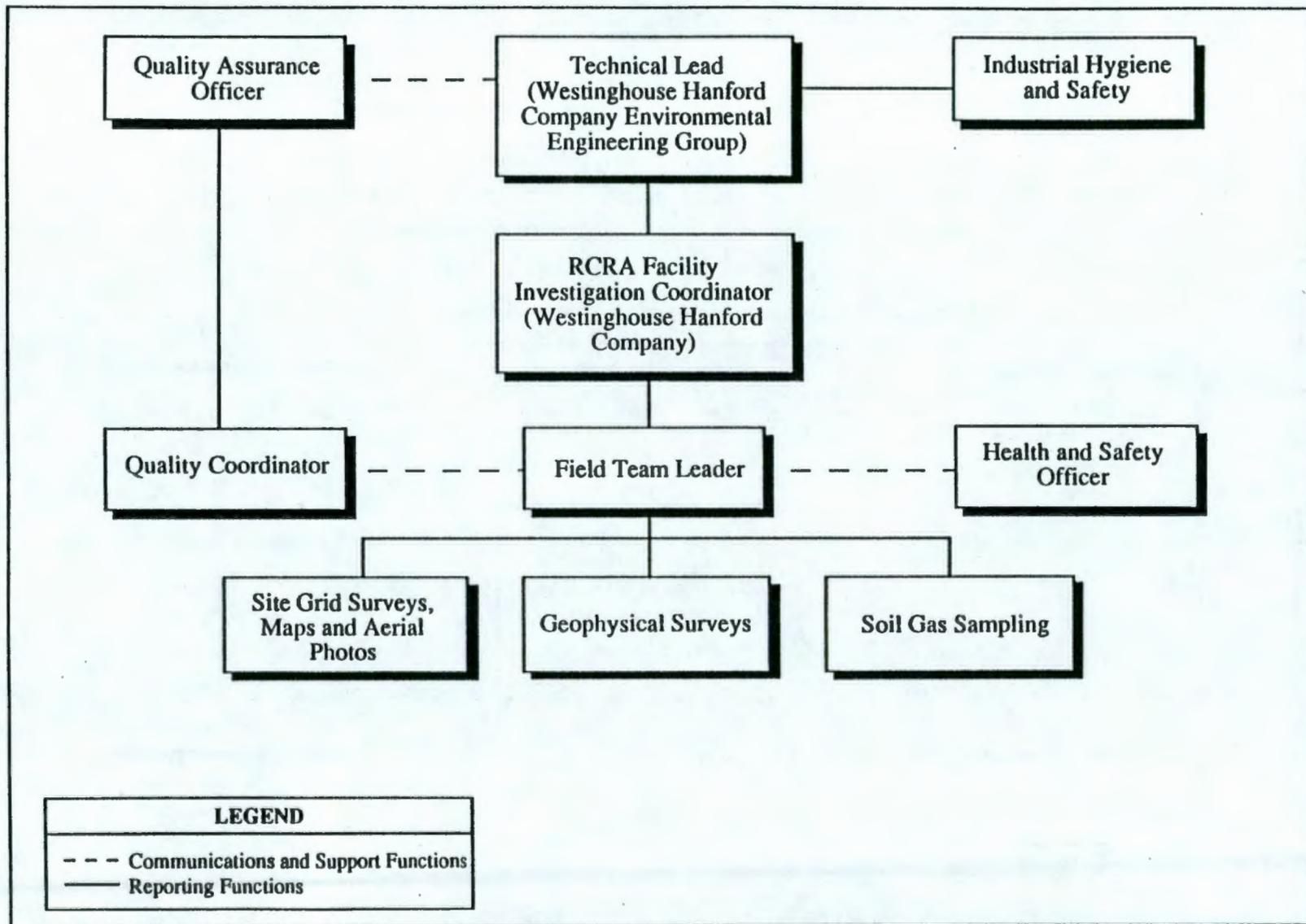
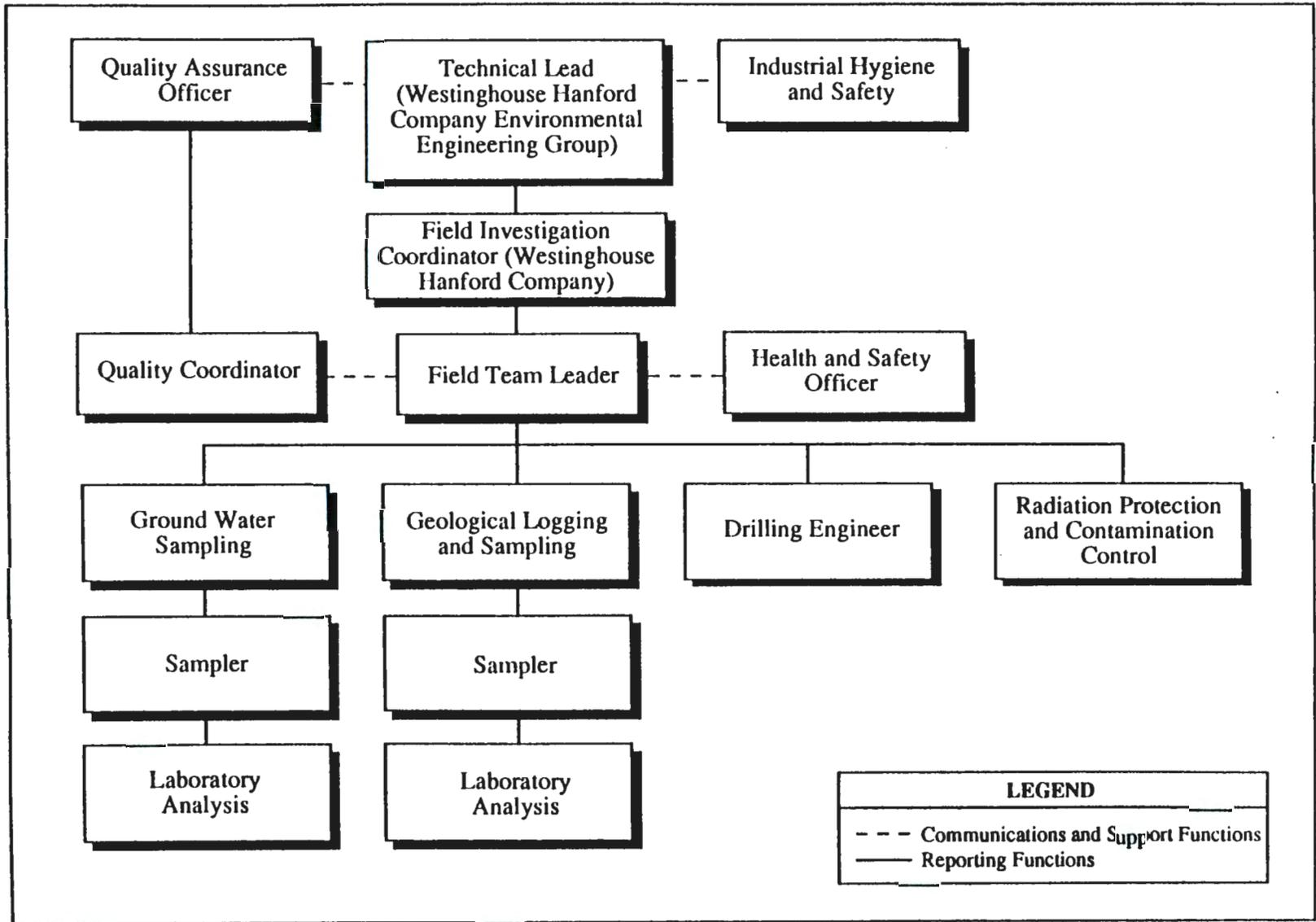


Figure C-5. The Hanford Site Physical and Geophysical Survey Team.

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C-11

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Figure C-6. Drilling, Sampling, and Well-Development Team.

3.0 DOCUMENTATION AND RECORDS

All plans and reports will be categorized as either primary or secondary documents as described by Section 9.1 of the Tri-Party Agreement Action Plan. The process for document review and comment will be as described in Section 9.2 of the Tri-Party Agreement Action Plan. Revisions, should they become necessary after finalization of any document, will be in accordance with Section 9.3 of the Tri-Party Agreement Action Plan. Changes in the work schedule, as well as minor field changes, can be made without having to process a formal revision. The process for making these changes will be as stated in Section 12.0 of the Tri-Party Agreement Action Plan. Administrative records, which must be maintained to support the Hanford Site activities, will be in accordance with Section 9.4 of the Tri-Party Agreement Action Plan.

4.0 FINANCIAL AND PROJECT TRACKING REQUIREMENTS

4.1 MANAGEMENT CONTROL

Westinghouse Hanford will have the overall responsibility for planning and controlling the investigation activities, and providing effective technical, cost, and schedule baseline management. If a contractor is used, the contractor will assume the direct day-to-day responsibilities for these management functions. The management control system used for this project must meet the requirements of DOE Order 4700.1, Project Management System and DOE Order 2250.1C, Cost and Schedule Control Systems Criteria. The Westinghouse Hanford Management Control System (MCS) meets these requirements. The primary goals of the Westinghouse Hanford MCS are to provide methods for planning, authorizing, and controlling work so that it can be completed on schedule and within budget, and to ensure that all planning and work performance activities are technically sound and in conformance with management and quality requirements.

The schedule developed for the Z Plant Aggregate Area will be updated at least annually, to expand the new current fiscal year and the follow-on year. In addition, any approved schedule changes (see Section 12.0 of the Tri-Party Agreement Action Plan for the formal change control system) would be incorporated at this time, if not previously incorporated. This update will be performed in the fourth quarter of the previous fiscal year (e.g., July to September) for the upcoming current fiscal year. The work schedule can be revised at any time during the year if the need arises, but the changes would be restricted to major changes that would not be suitable for the change control process.

4.2 MEETINGS AND PROGRESS REPORTS

Both project and unit managers must meet periodically to discuss progress, review plans, and address any issues that have arisen. The project managers' meeting will take place at least quarterly, and is discussed in Section 8.1 of the Tri-Party Agreement Action Plan.

Unit managers shall meet monthly to discuss progress, address issues, and review near-term plans pertaining to their respective operable units and/or treatment, storage, and disposal groups/units. The meetings shall be technical in nature, with emphasis on technical issues and work progress. The assigned DOE unit manager for the Z Plant Aggregate Area will be responsible for preparing revisions to the aggregate area schedule prior to the meeting. The schedule shall address all ongoing activities associated with the Z Plant Aggregate Area, including actions on specific source units (e.g., sampling). This schedule will be provided to all parties and reviewed at the meeting. Any agreements and commitments (within the unit manager's level of authority) resulting from the meeting will be prepared and signed by all parties as soon as possible after the meeting. Meeting minutes will be issued by the DOE unit manager and will summarize the discussion at the meeting, with information copies given to the project managers. The minutes will be issued within five working days following the meeting. The minutes will include, at a minimum, the following information:

- Status of previous agreements and commitments
- Any new agreements and commitments
- Schedules (with current status noted)
- Any approved changes signed off at the meeting in accordance with Section 12.1 of the Tri-Party Agreement Action Plan.

Project coordinators for each operable unit also will meet on a monthly basis to share information and to discuss progress and problems.

The DOE shall issue a quarterly progress report for the Hanford Site within 45 days following the end of each quarter. Quarters end on March 31, June 30, September 30, and December 31. The quarterly progress reports will be placed in the public information repositories as discussed in Section 10.2 of the Tri-Party Agreement Action Plan. The report shall include the following:

- Highlights of significant progress and problems
- Technical progress with supporting information, as appropriate

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- Problem areas with recommended solutions. This will include any anticipated delays in meeting schedules, the reason(s) for the potential delay, and actions to prevent or minimize the delay
- Significant activities planned for the next quarter
- Work schedules (with current status noted).

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Table C-1. Hanford Site RI/FS Technical Resources.

Subject/Activity	Technical Resources	
	RI	FS
Hydrology and geology	Westinghouse Hanford/Geosciences PNL/Earth and Environmental Sciences Center	Westinghouse Hanford/Geosciences
Toxicology and risk/endangerment assessment	Westinghouse Hanford/Environmental Technology PNL/Earth and Environmental Sciences Center PNL/Life Sciences Center	Westinghouse Hanford/ Environmental Technology
Environmental chemistry	Westinghouse Hanford/Geosciences PNL/Earth and Environmental Sciences Center	Westinghouse Hanford/Geosciences
Geotechnical and civil engineering	Westinghouse Hanford/Geosciences (Planning) Environmental Field Services	NA
Geotechnical and civil engineering	NA	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Ground water treatment engineering	NA	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Waste stabilization and treatment	NA	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Surveying	Kaiser Engineers Hanford	NA

Table C-1. Hanford Site RI/FS Technical Resources.

Subject/Activity	Technical Resources	
	RI	FS
Soil and water sampling and analysis	Westinghouse Hanford/Environmental Engineering Westinghouse Office of Sampling Management PNL/Earth and Environmental Sciences Center PNL/Materials and Chemical Sciences Center	NA
Drilling and well installation	Westinghouse Hanford/Geosciences Environmental Field Services Kaiser Engineers	NA
Radiation monitoring	Westinghouse Hanford/Operational Health Physics	NA

NA = Not applicable.

APPENDIX D

DATA MANAGEMENT PLAN

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ACRONYMS

AR	administrative record
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CMS	Corrective Measures Study
DMP	Data Management Plan
DOE	U.S. Department of Energy
Ecology	Washington Department of Ecology
EDMC	Environmental Data Management Center
EII	environmental investigations instructions
EIMP	Environmental Information Management Plan
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
ERRA	Environmental Restoration Remedial Action
FOMP	Field Office Management Plan
FS	Feasibility Study
GIS	geographic information system
HEHF	Hanford Environmental Health Foundation
HEIS	Hanford Environmental Information System
HLAN	Hanford Local Area Network
HMS	Hanford Meteorological Station
KEH	Kaiser Engineers Hanford
OSM	Office of Sample Management
PNL	Pacific Northwest Laboratory
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RL	Richland Field Office
ROD	record of decision
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
TSD	treatment, storage, and disposal

DEFINITIONS OF TERMS

Action Plan. Action plan for implementation of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1990). A negotiation between the U.S. Environmental Protection (EPA), the U.S. Department of Energy (DOE), and the State of Washington Department of Ecology (Ecology). The Action Plan defines the methods and processes by which hazardous waste permits will be obtained, and by which closure and post-closure actions under the Resource Conservation and Recovery Act of 1976 (RCRA) and by which remedial actions under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) will be conducted on the Hanford Site.

Administrative Record (AR). In CERCLA, the official file that contains all information that was considered or relied on by the regulatory agency in arriving at a final remedial action decision, as well as all documentation of public participation throughout the process. In RCRA, the official file that contains all documents to support a final RCRA permit determination.

Administrative Record File. The assemblage of documents compiled and maintained by an agency pertaining to a proposed project of administrative action and designated as AR or that are candidates for inclusion in the AR once a record of decision (ROD) is attained.

Data Management. The planning and control of activities affecting data.

Data Quality. The totality of features and characteristics of data that bears on its ability to satisfy a given purpose. The characteristics of major importance are accuracy, precision, completeness, representativeness, and comparability.

Data Validation. The process whereby data are accepted or rejected based on a set of criteria. This aspect of quality assurance involves establishing specified criteria for data validation. The quality assurance project plan (QAPP) must indicate the specified criteria that will be used for data validation.

ENCORE. The name given to the combination of hardware, software, and administrative subsystems that serve to integrate the management of the Hanford Site environmental data.

Environmental Data Management Center (EDMC). The central facility and services that provide a files management system for processing environmental information.

Environmental Information. Data related to the protection or improvement of the Hanford Site environment, including data required to satisfy environmental statutes, applicable DOE orders, or the Tri-Party Agreement.

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Field File Custodian. An individual who is responsible for receipt, validation, storage, maintenance, control, and disposition of information or other records generated in support of Environmental Division activities.

Hanford Environmental Information System (HEIS). A computer-based information system under development as a resource for the storage, analysis, and display of investigative data collected for use in site characterization and remediation activities. Subject areas currently being developed include geophysics/soil gas, vadose zone soil (geologic), atmospheric, and biota.

Information System. Collection of components relate to the management of data and reporting of information. Information systems typically include computer hardware, computer software, operating systems, utilities, procedures, and data.

Lead Agency. The regulatory agency (EPA or Ecology) that is assigned the primary administrative and technical responsibility with respect to actions at a particular operable unit.

Nonrecord Material. Copies of material that are maintained for information, reference, and operating convenience and for which another office has primary responsibility.

Operable Unit. An operable unit at the Hanford Site is a group of land disposal and ground water sites placed together for the purposes of doing a remedial investigation/feasibility study. The primary criteria for placement of a site into an operable unit are geographic proximity, similarity of waste characteristics and site types, and the possibility for economies of scale.

Primary Document. A document that contains information on which key decisions are made with respect to the remedial action or permitting process. Primary documents are subject to dispute resolution and are part of the administrative record file.

Project Manager. The individual responsible for implementing the terms and conditions of the Action Plan on behalf of his respective party. The EPA, DOE, and Ecology will each designate one project manager.

Quality Affecting Record. Information contained on any media, including but not limited to, hard copy, sample material, photo copy, and electronic systems, that is complete in terms of appropriate content and that furnishes evidence of the quality of items and/or activities affecting quality.

Quality Assurance. The systematic actions necessary to provide adequate confidence that a material, component, system, process, or facility performs satisfactorily or as planned in service.

Quality Assured Data. Data developed under an integrated program for assurance of the reliability of data.

Raw Data. Unprocessed or unanalyzed information.

Record Validation. A review to determine that records are complete, legible, and meet records requirements. Documents are considered valid records only after the validation process has been completed.

Retention Period. The length of time records must be held before they can be disposed of. The time is usually expressed in years from the date of the record, but may also be expressed as contingent on the occurrence of an event.

Secondary Document. A document providing information that does not, in itself, reflect or support key decisions. A secondary document is subject to review by the regulatory agencies and may be part of the administrative record field. It is not subject to dispute resolution.

Validated Data. Data that meet criteria contained in an approved company procedure.

Verified Data. Data that have been checked for accuracy and consistency following a transfer action (e.g., from manual log to computer, or from distributed database to centralized data repository).

1.0 INTRODUCTION AND OBJECTIVES

1.1 INTRODUCTION

An extensive amount of data will be generated over the next several years in connection with the activities planned for the Z Plant Aggregate Area. The quality of these data are extremely important to the full remediation of the aggregate area as agreed on by the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA) the Washington State Department of Ecology (Ecology), and interested parties.

The Data Management Plan (DMP) provides an overview of the data management activities at the operable unit level. It identifies the type and quantity of data to be collected and references the procedures which control the collection and handling of data. It provides guidance for the data collector, aggregate area investigator, project manager, and reviewer to fulfill their respective roles.

This DMP addresses handling of data generated from activities associated with the aggregate area activities. All data collected will be in accordance with the environmental investigations instructions (EII) contained in the Westinghouse Hanford Company's *Environmental Investigations and Site Characterization Manual* (WHC 1991a).

Development of a comprehensive plan for the management of all environmental data generated at the Hanford Site is under way. The *Environmental Information Management Plan* (EIMP) (Steward et al. 1989), released in March 1989, described activities in the Environmental Data Management Center (EDMC) and long-range goals for management of scientific and technical data. The scientific and technical data part of the EIMP was reviewed, revised, and expanded in fiscal year 1990 (Michael et al. 1990). An *Environmental Restoration Remedial Action Program Records Management Plan* (WHC 1991b) issued in July 1991, enables the program office to identify, control, and maintain the quality assurance (QA), decisional, or regulatory prescribed records generated and used in support of the Environmental Restoration Remedial Action (ERRA) Program.

1.2 OBJECTIVES

This DMP describes the process for the collection and control procedures for validated data, records, documents, correspondence, and other information associated with this aggregate area. This DMP addresses the following:

- Types of data to be collected
- Plans for managing data
- Organizations controlling data
- Databases used to store the data
- EIMP

- Hanford Environmental Information System (HEIS).

2.0 TYPES OF DATA

2.1 TYPES OF DATA

The general types of technical data to be collected and the associated controlling procedures are as follows:

<u>Type of data</u>	<u>Procedure</u>
Historical reports	EII 1.6
Aerial photos	EII 1.6
Chart recordings	EII 1.6
Technical memos	EII 1.6
Validated samples analyses	EII 1.6
Reports	EII 1.6
Logbooks	EII 1.5
Chain-of-custody forms	EII 5.1
Sample quality assurance/ quality control (QA/QC)	Office of Sample Management (OSM)

All such data are submitted to the EDMC for entry into the administrative record (AR).

General types of related administrative data is shown in Table D-1, which is organized in terms of general types of personnel and compliance/regulatory data. Table D-1 references the appropriate procedures and the record custodians. Data associated with aggregate area investigations will be submitted to the EDMC for entry into the AR, as appropriate.

2.2 DATA COLLECTION

Data will be collected according to the aggregate area sampling and analysis plans and the quality assurance project plan (QAPP). Section 2.1 listed the controlling procedures for data collection and handling before turnover to the organization responsible for data storage. All procedures for data collection shall be approved in compliance with the Westinghouse Hanford *Environmental Investigations and Site Characterization Manual* (WHC 1991a).

2.3 DATA STORAGE AND ACCESS

Data will be handled and stored according to procedures approved in compliance with applicable Westinghouse Hanford procedures (WHC 1988). The EDMC is the central files

1 manager and process facility. AH data entering the EDMC will be indexed, recorded, and
2 placed into safe and secure storage. Data designated for placement into the AR will be
3 copied, placed into the Hanford Site AR file, and distributed by the EDMC to the user
4 community. The hard copy files are the primary sources of information; the various
5 electronic data bases are secondary sources.

6
7 Normal access to data is through EDMC which is responsible for the AR. The
8 Administrative Record Pubic Access Room is located in the 345 Hills Street Facility in
9 Richland, Washington. This facility includes AR file documents (including identified
10 guidance documents and technical literature).

11
12 Project participants may access data that are not in the AR by requesting it at the
13 monthly unit managers' meeting for the operable unit of concern. As the project moves to
14 completion, it is expected that all of the relevant data will be contained in the AR and the
15 need to access data will be minimal.

16
17 The following types of data will be accessed from and reside in locations other than the
18 EDMC:

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<u>Data Type</u>	<u>Data location</u>
• QA/QC laboratory data	OSM (Westinghouse Hanford)
• Sample status	OSM (Westinghouse Hanford)
• Archived samples	Laboratory performing analyses
• Training records	Technical Training Support Section (Westinghouse Hanford)
• Meteorological data	Hanford Meteorological Station (HMS) (Pacific Northwest Laboratory [PNL])
• Health and safety records	Hanford Environmental Health Foundation (HEHF)
• Personal protective fitting	Environmental Health and Pesticide Services Section (Westinghouse Hanford)
• Radiological exposure	Pacific Northwest Laboratory.

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2.4 DATA QUANTITY

Data quantities for the investigative activities will be estimated based on the sampling and analysis plans developed for investigation of sites within the aggregate area.

3.0 DATA MANAGEMENT PLAN

3.1 OBJECTIVE

A considerable amount of data will be generated through the implementation of the aggregate area sampling and analysis plans. The QAPP will provide the specific procedural direction and control for obtaining and analyzing samples in conformance with requirements to ensure quality data results. The sampling and analysis plans will provide the basis for selecting the location, depth, frequency of collection, etc., of media to be sampled and methods to be employed to obtain samples of selected media for cataloging, shipment, and analysis. Figure D-1 displays the general DMP outline for data generated through work plan activities.

3.2 ORGANIZATIONS CONTROLLING DATA

This section addresses the organizations that will receive data generated from aggregate area activities.

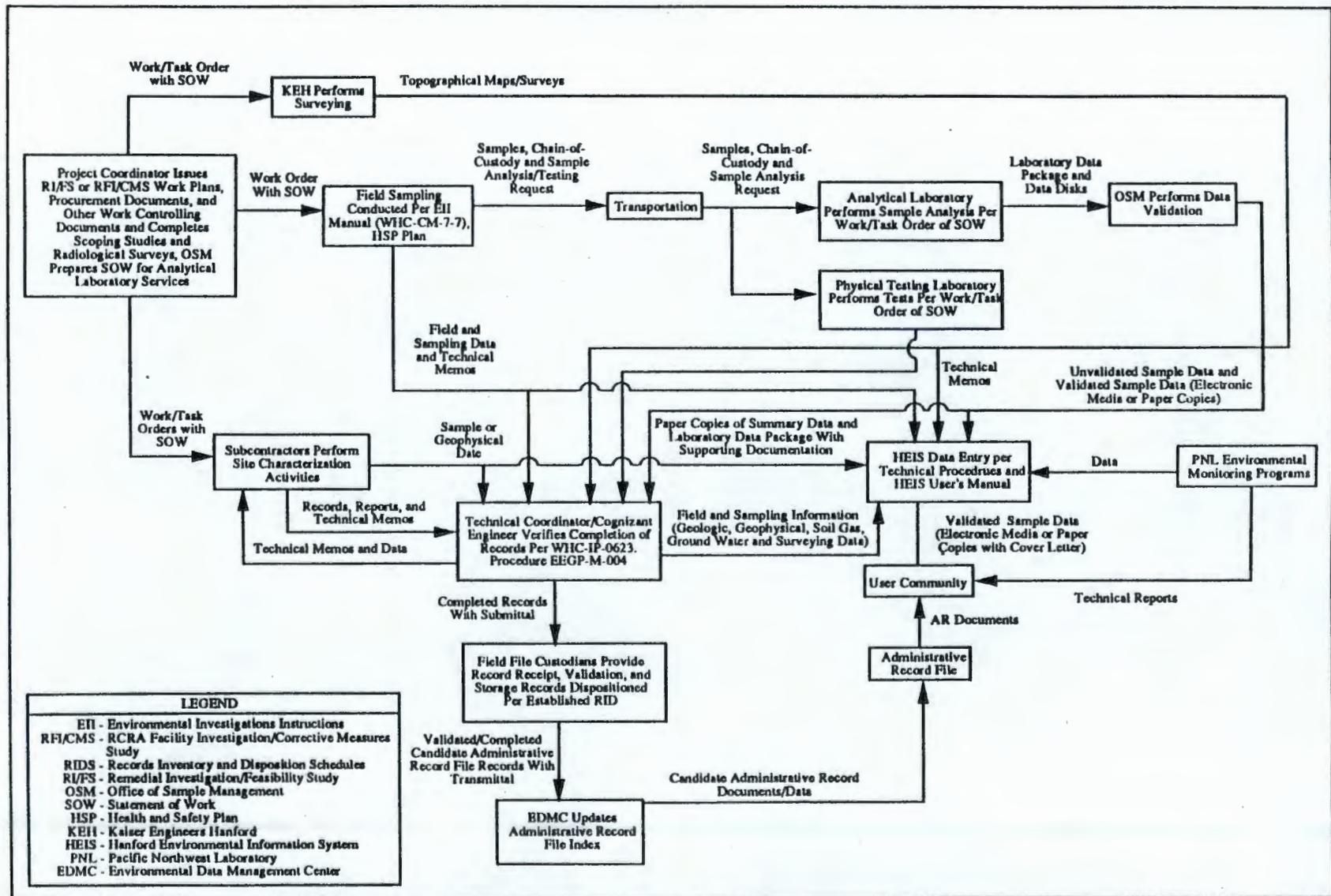
3.2.1 Environmental Engineering Group

The Westinghouse Hanford Environmental Engineering Group provides the operable unit technical coordinator. The technical coordinator is responsible for maintaining and transmitting data to the designated storage facility.

3.2.2 Office of Sample Management

The Westinghouse Hanford OSM will validate all analytical data packages received from the laboratory. Validated summary data (sample results and copies of chain of custody forms) will be forwarded to the technical coordinator. Nonvalidated data will be forwarded to the technical coordinator on request. Preliminary data will be clearly labeled as such. The OSM will maintain raw sample data, QA/QC laboratory data, and the archived sample index.

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Figure D-1. Environmental Engineering, Technology and Permitting Data Management Model.

3.2.3 Environmental Data Management Center

The EDMC is the Westinghouse Hanford Environmental Division's central facility and service that provides a file management system for processing environmental information. The EDMC manages and controls the AR and Administrative Record Public Access Room at the Hanford Site. Part 1 of the EIMP (Michael et al. 1990) describes the central file system and services provided by the EDMC. The following procedures address data transmittal to the EDMC:

- EII 1.6, Records Management (WHC 1991a)
- EII 1.11, Technical Data Management (WHC 1991a)
- TPA-MP-02, Information Transmittals and Receipt Controls (DOE-RL 1990)
- TPA-MP-07, Administrative Record Collection and Management (DOE-RL 1990)

3.2.4 Information Resource Management

Information Resource Management is the designated records custodian (permanent storage) for Westinghouse Hanford. The procedural link from the EDMC to the Information Resource Management is currently under development.

3.2.5 Hanford Environmental Health Foundation

The HEHF performs the analyses on the nonradiological health and exposure data (Section 3.3.2) and forwards summary reports to the Fire and Protection Group and the Environmental Health and Pesticide Services Section within the Westinghouse Hanford Environmental Division. Nonradiological and health exposure data are maintained also for other Hanford Site contractors (PNL and Kaiser Engineers Hanford [KEH]) associated with aggregate area activities. The HEHF provides summary data to the appropriate site contractor. EII 2.1, Preparation of Hazardous Waste Operations Permits, and EII 2.2, Occupational Health Monitoring (WHC 1991a) address the preparation of health and safety plans and occupational health monitoring, respectively.

3.2.6 Environmental Health and Pesticide Services Section

The Westinghouse Hanford Environmental Health and Pesticide Services Section maintains personal protective equipment fitting records and maintains nonradiological health field exposure and exposure summary reports provided by HEHF for Westinghouse Hanford Environmental Division and subcontractor personnel.

3.2.7 Technical Training Records and Scheduling Section

The Westinghouse Hanford Technical Training Records and Scheduling Section provides training and maintains training records (Section 3.3.4).

3.2.8 Pacific Northwest Laboratory

The PNL operates the HMS and collects and maintains meteorological data (Section 3.3.1). Data management is discussed in Andrews (1988).

The PNL collects and maintains radiation exposure data (Section 3.3.3).

3.3 DATABASES

This section addresses databases that will receive data generated from the aggregate area activities. These and other databases are described in the EIMP (Michael et al. 1990). All of these databases exist independently of this aggregate area and serve other site functions. Data pertinent to the operable unit, housed in these databases, will be submitted to the AR.

3.3.1 Meteorological Data

The HMS collects and maintains meteorological data. Their database contains meteorological data from 1943 to the present, and Andrews (1988) is the document containing meteorological data management information.

3.3.2 Nonradiological Exposure and Medical Records

The HEHF collects and maintains data for all nonradiological exposure records and medical records.

3.3.3 Radiological Exposure Records

The PNL collects and maintains data on occupational radiation exposure. This database contains respiratory personal protective equipment fitting records, work restrictions, and radiation exposure information.

3.3.4 Training Records

Training records for Westinghouse Hanford and subcontractor personnel are managed by the Westinghouse Hanford Technical Training Support Section. Other Hanford Site contractors (PNL and KEH) maintain their own personnel training records. Training records for non-Westinghouse personnel are entered into the Westinghouse (soft reporting) database to document compliance.

Training records include:

- Initial 40-hr hazardous waste worker training
- Annual 8-hr hazardous waste worker training update

- 1 • Hazardous waste generator training
- 2 • Hazardous waste site specific training
- 3 • Radiation safety training
- 4 • Cardiopulmonary resuscitation
- 5 • Scott air pack
- 6 • Fire extinguisher
- 7 • Noise control
- 8 • Mask fit.
- 9

10 **3.3.5 Environmental Information/Administrative Record**

11
12 Environmental information and the AR are managed by Westinghouse Hanford EDMC
13 personnel. They provide an index and key information on all data transmitted to the EDMC.
14 This database is used to assist in data retrieval and to produce index lists as required.

15 **3.3.6 Sample Status Tracking**

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17
18 The OSM maintains the sample status tracking database. This database contains
19 information about each sample. Information maintained includes sample number, ship date,
20 receipt date, and laboratory identification.

21 **4.0 ENVIRONMENTAL INFORMATION AND RECORDS MANAGEMENT PLAN**

22
23
24 This section briefly discusses the EIMP (Michael et al. 1990) that was developed to
25 provide an overview of an integrated approach to managing Hanford Site environmental data,
26 and the *Environmental Restoration Remedial Action Program Records Management Plan*
27 (WHC 1991b).

28 **4.1 ENVIRONMENTAL INFORMATION MANAGEMENT PLAN**

29
30
31 The EIMP provides an overview of how information is managed throughout the
32 lifetime of Hanford Site environmental programs.

33
34
35 The Environmental Division of Westinghouse Hanford is responsible for the protection
36 and improvement of the Hanford Site environment. To fulfill responsibility, the
37 Environmental Division has assumed a management role with respect to Hanford Site
38 environmental information. This management role includes (1) establishing standards for how
39 data are validated and controlled, (2) developing and maintaining a supporting
40 computer-based environment, and (3) sustaining a centralized file management system.
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1 Hanford Site environmental information is defined as data related to the protection or
2 improvement of the Hanford Site environment, including data required to satisfy
3 environmental statutes, applicable DOE orders, or the *Hanford Federal Facility Agreement*
4 *and Consent Order* (Ecology et al. 1990), hereinafter referred to as the Tri-Party Agreement.
5

6 Environmental information falls into several overlapping categories, such as
7 administrative versus technical and electronic versus manual or hard copy. A considerable
8 amount of data are recorded in documents, which are governed by company-wide document
9 and records control practices. Other data are collected or generated by computer and,
10 therefore, exist in electronic form. The name ENCORE has been given to the combination of
11 administrative, hardware, and software systems that serve to integrate the management of this
12 electronic data.
13

14 Administrative information (e.g., budgets and schedules) is subject to accounting and
15 other standard business practices. Scientific and technical data are subject to a different set
16 of legal, classification, release, and engineering requirements.
17

18 Superimposed over these categories is the files management system for environmental
19 information. This management system, has been developed to meet a number of
20 Environmental Division needs, including requirements for compilation of AR files. The AR
21 files are compilations of all material related to environmental restoration and remedial action
22 records of decision (ROD) for each operable unit and treatment, storage, and disposal (TSD)
23 group described in the Tri-Party Agreement
24

25 Data in electronic form flows from information systems in the ENCORE realm to both
26 scientific/technical and administrative documents. Environmental documents distributed
27 within the Hanford Site and from regulatory agencies are received by the EDMC for storage
28 and future processing.
29

30 Part I of the EIMP describes the overall Westinghouse Hanford systems that are
31 generally applied to documents and records. Part I also describes, in greater detail, the files
32 management system developed to manage the AR file information. The EDMC compiles the
33 AR files and provides controlled distribution of specified information to the AR files held by
34 DOE, Ecology, and the EPA. The EDMC also provides controlled distribution of specified
35 community relations information to regional information repositories.
36

37 Part II addresses computer-based information, with an emphasis on scientific and
38 technical data. The long-term nature of environmental programs and the complex
39 interrelationships of environmental data require that the data be preserved, retrievable,
40 traceable, and sufficient for future use. To ensure data availability for response to regulatory
41 and agency requirements, the plan is directed toward optimizing the use of automated
42 techniques for managing data. The current processing environment and the proposed
43 ENCORE realm are described, and the plans for implementation of ENCORE are addressed.
44
45

4.2 ENVIRONMENTAL RESTORATION REMEDIAL ACTION PROGRAM RECORDS MANAGEMENT PLAN

The ERRA Program records management plan was developed to fulfill the requirements of the DOE, Richland Field Office (RL) *Environmental Restoration Field Office Management Plan* (FOMP) (DOE-RL 1989). The FOMP describes the plans, organization, and control systems to be used for management of the Hanford Site ERRA Program. The Westinghouse Hanford ERRA Program Office has developed this ERRA Program records management plan to fulfill the requirements of the FOMP. This records management plan will enable the program office to identify, control, and maintain the quality assurance, decisional, or regulatory prescribed records generated and used in support of the ERRA Program.

The ERRA Program records management plan describes how the applicable records management requirements will be implemented for the ERRA Program. The plan also develops the criteria for identifying the appropriate requirements for each individual piece of information related to ERRA work activities.

This records management plan applies to all ERRA Program records and documents generated, used, or maintained in support of ERRA-funded work activities on the Hanford Site. The terms, information, documents, nonrecord material, records, record material, and QA records used throughout the ERRA records management plan are interpreted as ERRA information, ERRA documents, ERRA nonrecord material, ERRA records, ERRA record material, and ERRA QA records.

5.0 HANFORD ENVIRONMENTAL INFORMATION SYSTEM

5.1 OBJECTIVE

The Hanford Environmental Information System (HEIS) has been developed by PNL for Westinghouse Hanford as a primary resource for computerized storage, retrieval, and analysis of quality-assured technical data associated with Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) Remedial Investigation/Feasibility Study (RI/FS) activities and RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) activities being undertaken at the Hanford Site. The HEIS will provide a means of interactive access to data sets extracted from other databases relevant to implementation of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1990). The HEIS will support graphics analysis, including a geographic information system. Implementation of HEIS will serve to ensure that data consistency, quality, traceability, and security are achieved through incorporation of all environmental data within a single controlled database.

1 The following is a list of data subjects proposed to be entered into HEIS:
2

- 3 • Geologic
- 4 • Geophysics
- 5 • Atmospheric
- 6 • Biotic
- 7 • Site characterization
- 8 • Soil gas
- 9 • Waste site information
- 10 • Surface monitoring
- 11 • Ground water.

12
13
14
15 **5.2 STATUS OF THE HANFORD ENVIRONMENTAL**
16 **INFORMATION SYSTEM**

17
18 The HEIS, a computerized database containing technical data and information used to
19 support the Hanford environmental restoration (ER) activities, is operational, the data for the
20 Hanford ground water wells and ground water samples is currently accessible via the
21 Hanford Local Area Network (HLAN) to local users and to offsite users via a modem link to
22 the HEIS database computer. Additional data, including geologic, biota, and other pertinent
23 environmental sample results, are being entered into the HEIS database.
24

25 The *Hanford Environmental Information System (HEIS) User's Manual* (WHC 1990)
26 was issued in October 1990. An operator manual is being prepared and is expected to be
27 issued in 1992.
28

29 The HEIS geographic information system (GIS) will display detailed maps for the
30 Hanford restoration sites including data from the HEIS database. Such spatially related data
31 will be used to support analysis of waste site technical issues and restoration options. The
32 combination of the HEIS for data and the GIS spatial displays offers some powerful tools for
33 many users to analyze and collectively evaluate the environmental data from the ER and
34 site-wide monitoring programs.
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