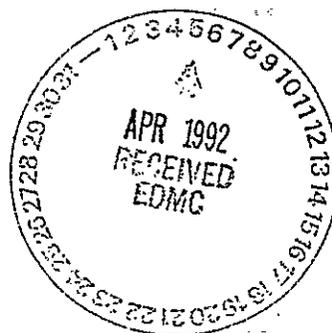


S Plant Aggregate Area Management Study Report

Date Published
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United States
Department of Energy

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- 4 S Plant Aggregate Area Conceptual Model

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LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|------------------|--|
| AAMS | Aggregate Area Management Study |
| AAMSR | Aggregate Area Management Study Reports |
| ANSI | American National Standards Institute |
| ARAR | applicable or relevant and appropriate requirement |
| CaCO | calcium carbonate |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| CMS | corrective measures studies |
| DOE | Department of Energy |
| DQO | data quality objective |
| DST | double-shell tank |
| Ecology | Washington State Department of Ecology |
| EPA | Environmental Protection Agency |
| ERA | expedited response action |
| ES&H | Environment, Safety, and Health |
| FIC | Food Instrument Corporation |
| FS | feasibility study |
| HISS | Hanford Inactive Site Survey |
| HNO ₃ | nitric acid |
| HRS | Hazard Ranking System |
| HSFP | Hanford Surplus Facilities Program |
| HEPA | High efficiency particulate air |
| IRM | interim remedial measure |
| LDR | land disposal restriction |
| LFI | limited field investigation |
| MIBK | methyl isobutyl ketone |
| mHRS | modified Hazard Ranking System |
| NPL | National Priorities List |
| NO | nitrous oxide |
| PARCC | precision, accuracy, representativeness, completeness, and comparability |
| PFP | Plutonium Finishing Plant |
| PNL | Pacific Northwest Laboratory |
| PUREX | Plutonium Uranium Extraction |
| QA | quality assurance |
| RA | risk assessment |
| RAO | remedial action objective |
| RARA | Radiation Area Remedial Action |
| RCRA | Resource Conservation and Recovery Act |
| REDOX | reduction-oxidation |
| RFI | RCRA Facility Investigation |
| RI | remedial investigation |

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| | |
|---------------------|--|
| ROD | Record of Decision |
| SST | single-shell tank |
| Tri-Party Agreement | Hanford Federal Facility Agreement and Consent Order |
| TRAC | Tracks Radioactive Components |
| TRU | transuranic |
| TSD | treatment, storage, or disposal |
| UNH | uranyl nitrate hexahydrate |
| VOC | volatile organic compound |
| WAC | Washington Administrative Code |
| WHC | Westinghouse Hanford Company |
| WIDS | Waste Information Data System |

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1.0 INTRODUCTION

The U.S. Department of Energy (DOE) Hanford Site in Washington State is organized into numerically designated operational areas including the 100, 200, 300, 400, 600, and 1100 Areas (Figure 1-1). 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 S 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 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 encompasses the 200 Areas and selected portions of the 600 Area. 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, location, facility type, and other site characteristics. The 200 NPL site includes a total of 44 operable units including 20 in the 200 East Area, 17 in the 200 West Area, 1 in the 200

1 North Area, and 6 isolated operable units. The intent of defining operable units was to
2 group associated waste management units together, such that they could be effectively
3 characterized and remediated under one work plan.
4

5 The Tri-Party Agreement also defines approximately 25 RCRA TSD groups within the
6 200 Areas which will be closed or permitted (for operation or postclosure care) in
7 accordance with the Washington State Dangerous Waste Regulations (WAC 173-303). The
8 TSD facilities are often associated with an operable unit and are required to be addressed
9 concurrently with past-practice activities under the Tri-Party Agreement.
10

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

19 1.1.1 Tri-Party Agreement

20
21 The Tri-Party Agreement was developed and signed by representatives from the EPA,
22 Ecology, and DOE in May 1989, and revised in 1990 and 1991. The scope of the agreement
23 covers all CERCLA past practice, RCRA past practice, and RCRA TSD activities on the
24 Hanford Site. The purpose of the Tri-Party Agreement is to ensure that the environmental
25 impacts of past and present activities are investigated and appropriately remediated to protect
26 human health and the environment. To accomplish this, the Tri-Party Agreement provides a
27 framework and schedule for developing, prioritizing, implementing and monitoring
28 appropriate response actions.
29

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

1 **1.1.2 Hanford Site Past Practice Strategy**
2

3 The *Hanford Past-Practice Strategy* was developed between Ecology, EPA, and DOE
4 to streamline the existing RI/FS and RFI/CMS processes. A primary objective of this
5 strategy is to develop a process to meet the statutory requirements and integrate CERCLA
6 RI/FS and RCRA Past Practice RFI/CMS guidance into a singular process for the Hanford
7 Site that ensures protection of human health and welfare and the environment. The strategy
8 refines the existing past practice decision-making process as defined in the Tri-Party
9 Agreement. The fundamental principle of the strategy is a bias-for-action by optimizing the
10 use of existing data, integrating past practice with RCRA TSD closure investigations,
11 focusing the RI/FS process, conducting interim remedial actions, and reaching early
12 decisions to initiate and complete cleanup projects on both operable-unit and aggregate-area
13 scale. The ultimate goal being ~~is~~ the comprehensive cleanup or closure of all contaminated
14 areas at the Hanford Site at the earliest possible date in the most effective manner.
15

16 The process under this strategy is a continuum of activities whereby the effort is
17 ~~defined~~ based upon knowledge gained as work progresses. Whereas the strategy is intended
18 to streamline investigations and documentation to promote the use of interim actions to
19 accelerate cleanup, it is consistent with RI/FS and RFI/CMS processes. An important
20 element of this strategy is the application of the observational approach, in which
21 characterization data are collected concurrently with cleanup.
22

23 For the 200 Areas the first step in the strategy is the evaluation of existing information
24 presented in AAMSR. Based on this information, decisions ~~will be~~ ~~are~~ made regarding
25 which strategy path(s) to pursue for further actions in the aggregate area. The strategy
26 includes three paths for interim decision making and a final remedy-selection process that
27 incorporates the three paths and integrates sites not addressed in those paths. As shown on
28 Figure 1-2, the three paths for decision making are the following:
29

- 30 • Expedited response action (ERA) path, where an existing or near-term
31 unacceptable health or environmental risk from a site is determined or suspected,
32 and a rapid response is necessary to mitigate the problem
33
- 34 • Interim remedial measure (IRM) path, where existing data are sufficient to
35 indicate that the site poses a risk through one or more pathways and additional
36 investigations are not needed to screen the likely range of remedial alternatives
37 for interim actions; if a determination is made that an IRM is justified, the
38 process ~~will proceed~~ to select an IRM remedy and ~~may include~~ a focused FS, if
39 needed, to select a remedy
40

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

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

1.2 200 NPL SITE AGGREGATE AREA MANAGEMENT STUDY PROGRAM

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

1.2.1 Overall Approach

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

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

- 1 • U Plant
- 2
- 3 • Z Plant
- 4
- 5 • S Plant
- 6
- 7 • T Plant
- 8
- 9 • PUREX
- 10
- 11 • B Plant
- 12
- 13 • Semi-Works
- 14
- 15 • 200 North.
- 16

17 The groundwater beneath the 200 Areas will be investigated under two groundwater
18 AAMS on an Area-wide scale (i.e., 200 West and 200 East Areas). Groundwater aggregate
19 areas were delineated to encompass the geography necessary to define and understand the
20 local hydrologic regime, and the distribution, migration and interaction of contaminants
21 emanating from source terms. which is The groundwater aggregate areas are considered an
22 appropriate scale for developing conceptual and numerical groundwater models.
23

24 The U.S. Department of Energy, Richland Operations Field Office (DOE-RL) functions
25 as the "lead agency" for the 200 AAMS program. Depending on the specific AAMS, EPA
26 and/or Ecology function as the "Lead Regulatory Agency" (Table 1-1). Through periodic
27 (monthly) meetings information is transferred and regulators are informed of the progress of
28 the AAMS such that decisions established under the *Hanford Past-Practice Strategy* (e.g., is
29 an ERA justified?) (Figure 1-2) can be quickly and collectively made between the three
30 parties. These meetings will continually refine the scope of AAMS as new information is
31 evaluated, decisions are made and actions taken. Completion milestones for AAMS are
32 defined in Ecology et al. (1991) and duplicated in Table 1-1. All AAMSR will be
33 submitted as Secondary Documents which are defined in the Tri-Party Agreement as
34 informational documents.
35

36 1.2.2 Process Overview

37 Each AAMS will be conducted in consists of three steps: 1) the analysis of existing
38 data and formulation of a preliminary conceptual model, 2) identification of data needs and
39
40

1 evaluation of remedial technologies, and 3) conduct of limited field characterization activities
2 and report preparation. Steps 1 and 2 are components of an AAMSR. Step 3 is a parallel
3 effort for which separate reports will be produced.
4

5 The first and primary task of the AAMS investigation process involves the search,
6 compilation and evaluation of existing data. Information that will be collected for these
7 purposes includes the following:
8

- 9 • Facility and process descriptions and operational histories for waste sources
- 10
- 11 • Waste disposal records defining dates of disposal, waste types, and waste
12 quantities
- 13
- 14 • Sampling events of waste effluents and effected media
- 15
- 16 • Site conditions including the site physiography, geology, hydrology, meteorology,
17 ecology, demography, and archaeology
- 18
- 19 • Environmental monitoring data for affected media including air, surface water,
20 sediment, soil, groundwater and biota.
21

22 Collectively this information will be used to identify contaminants of concern,
23 determine the scope of future characterization efforts, and to develop a preliminary
24 conceptual model of the aggregate area. Although data collection objectives are similar, the
25 types of information collected will depend on whether the study is a source or groundwater
26 AAMS. The data collection step serves to avoid duplication of previous efforts and
27 facilitates a more focused investigation by the identification of data gaps.
28

29 Topical reports referred to as Technical Baseline Reports will be initially prepared
30 to summarize facility information. These reports will describe individual waste management
31 units and unplanned releases contained in the aggregate area as identified in the Waste
32 Information Data System (WIDS) (WHC 1991a). The reports are based on review of current
33 and historical Hanford Site reports, engineering drawings and photographs and are
34 supplemented with site inspections and employee interviews. Information contained in the
35 reports will be summarized in the AAMSR. Other topical reports are used as sources of
36 information in the AAMSR. These reports are as follows:
37

- 38 • U Plant Geologic and Geophysics Data Package
- 39
- 40 • Z Plant Geologic and Geophysics Data Package

- 1 • S Plant Geologic and Geophysics Data Package
- 2
- 3 • T Plant Geologic and Geophysics Data Package
- 4
- 5 • PUREX Geologic and Geophysics Data Package
- 6
- 7 • B Plant Geologic and Geophysics Data Package
- 8
- 9 • 200 N Geologic and Geophysics Data Package
- 10
- 11 • Semworks Geologic and Geophysics Data Package
- 12
- 13 • Geologic and Geophysics Data Packages
- 14
- 15 • Hydrologic Model for the 200 West Groundwater Aggregate Area
- 16
- 17 • Hydrologic Model for the 200 East Groundwater Aggregate Area
- 18
- 19 • Unconfined Aquifer Hydrologic Test Data Package for the 200 West
- 20 Groundwater Aggregate Area
- 21
- 22 • Unconfined Aquifer Hydrologic Test Data Package for the 200 East Groundwater
- 23 Aggregate Area
- 24
- 25 • Confined Aquifer Hydrologic Test Data Package for the 200 Groundwater
- 26 Aggregate Area Management Studies
- 27
- 28 • Groundwater Field Characterization Report
- 29
- 30 • 200 West Area Borehole Geophysics Field Characterization
- 31
- 32 • 200 East Area Borehole Geophysics Field Characterization
- 33

34 The general scope of the topical reports related to this AAMSR is described in Section
35 ~~8.0~~ Generally, other topical reports will be generated for environmental monitoring or
36 sampling data which have not been previously compiled or summarized, or when existing
37 reports are outdated or inadequate.

38
39 Information on waste sources, pathways, and receptors will be used to develop a
40 preliminary conceptual model of the aggregate area. In the preliminary conceptual model,

1 ~~the release mechanisms and transport pathways are identified.~~ If the conceptual
2 understanding of the site is considered inadequate, limited field characterization activities can
3 be undertaken as part of the study. Field screening activities ~~planned under~~
4 ~~occurring in parallel with and as part of the AAMS process~~ include the following:
5

- 6 • Expanded groundwater monitoring programs (non Contract Laboratory Program)
7 at approximately 80 select existing wells to identify contaminants of concern and
8 refine groundwater plume maps
9
- 10 • In situ assaying of gamma-emitting radionuclides at approximately 10 selected
11 existing boreholes per aggregate area to develop radioelement concentration
12 profiles in the vadose zone.
13

14 Wells, boreholes, and analytes ~~will be~~ ~~are~~ selected based on a review of existing
15 environmental data which ~~will be~~ ~~is~~ undertaken early in the AAMS process. Field
16 characterization results will be presented ~~later~~ in topical reports.
17

18 After the ~~preliminary~~ conceptual model is developed, ~~health and environmental~~
19 ~~concerns are identified.~~ The purpose of this determination is to provide one basis for
20 ~~determining recommendations and prioritization for subsequent actions at waste management~~
21 ~~units.~~ ~~preliminary~~ Potential applicable or relevant and appropriate requirements (ARARs)
22 and potential remedial technologies ~~will be~~ ~~are~~ identified. In cases where the existing
23 information is sufficient, the *Hanford Past-Practice Strategy* allows for a focused FS or CMS
24 to be initiated prior to the completion of the study.
25

26 Data needs ~~will be~~ ~~are~~ identified by evaluating the sufficiency of existing data and by
27 determining what additional data are necessary to adequately characterize the aggregate area,
28 refine the ~~preliminary~~ conceptual model and ~~potential~~ ARARs, and/or narrow the range of
29 remedial alternatives. Determinations ~~will be~~ ~~are~~ made regarding the level of uncertainty
30 associated with existing data and the need to verify or supplement the data. If additional data
31 are needed, the intended data uses ~~will be~~ ~~are~~ identified, data quality objectives (DQO)
32 established and data priorities set.
33

34 Each AAMS ~~will~~ ~~results~~ in management recommendations for the aggregate area
35 including the following:
36

- 37 • The need for ERA, IRM, and LFI ~~or whether to retain in the final remedy~~
38 ~~selection path~~
- 39 • Definition and prioritization of operable units
40

- 1 • Prioritization of work plan activities
- 2
- 3 • Integration of RCRA TSD closure activities
- 4
- 5 • The conduct of field characterization activities
- 6
- 7 • The need for treatability studies.
- 8
- 9 • Identification of waste management units addressed entirely under other
- 10 operational programs
- 11

12 The waste management units recommended for ERA, IRM, or LFI actions are
13 considered higher priority units that require rapid response. Lower priority waste
14 management units will generally follow the conventional process for RI/FS. In spite of this
15 distinction in the priority of sites, RI/FS activities will be conducted for all the waste
16 management units. In the case of the higher priority waste management units, rapid response
17 operations will be followed by conventional RI/FS activities, although these activities may be
18 modified because of knowledge gained through the remediation activities. In the case of the
19 lower priority waste management units, an area-wide RI/FS will be prepared which
20 encompasses these sites.

21
22 Based on the AAMSR, a decision is made on whether the study has provided sufficient
23 information to forego further field investigations and prepare a FS. If further field
24 investigations are required, a An RI/FS work plan (which may be limited to LFI activities) is
25 will be developed and executed. The scope of future work plans will be largely limited to
26 that of a sampling and analysis plan. The background information normally required to
27 support the preparation of a work plan (e.g., site description, conceptual model, DQO, etc.)
28 is developed in the AAMSR and can be referenced accordingly. The future work plans will
29 reference information from the AAMSR. They will also include the rationale for sampling
30 and analysis, will present detailed, unit-specific DQO, and will further develop physical site
31 models as the data allows. In some cases, there may be insufficient data to support any
32 further analysis than is provided in the AAMSR, so an added level of detail in the work plan
33 may not be feasible.

34
35 All ten AAMS are scheduled to be completed by September 1992. This will facilitate a
36 coordinated approach to prioritizing and implementing future past practice activities for the
37 entire 200 Areas.
38
39
40

1 **1.3 PURPOSE, SCOPE, AND OBJECTIVES**
2

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

10
11 Specific objectives of the AAMS include the following:

- 12 • Assemble and interpret existing data including operational and environmental data
- 13 • Describe site conditions
- 14 • Conduct limited new site characterization work if data or interpretation
15 uncertainty could be reduced by the work
- 16 • Develop a preliminary conceptual model
- 17 • Identify contaminants of concern, and their distribution
- 18 • Identify preliminary potential ARARs
- 19 • Define preliminary remedial action objectives, screen potential remedial
20 technologies, and if possible provide recommendations for focused FS
- 21 • Recommend treatability studies to support the evaluation of remedial action
22 alternatives
- 23 • Define data needs, establish general DQO and set data priorities
- 24 • Provide recommendations for expedited, interim or limited ERA, IRM, LFI or
25 other actions
- 26 • Redefine and prioritize, as data allow, operable unit boundaries
- 27 • Define and prioritize, as data allow, work plan and other past practice activities
28 with emphasis on supporting early cleanup actions and records of decisions
- 29
- 30
- 31
- 32
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- 35
- 36
- 37
- 38
- 39
- 40

- Integrate RCRA TSD closure activities with past practice activities.

Information on single-shell and double-shell tanks is presented in Sections 2.0 and 4.0. The AAMSR is not intended to address remediation related to the tanks. Nonetheless, the tank information is presented because known and suspected releases from the tanks may influence the interpretation of contamination data at nearby waste management units. Information on other facilities and buildings is also presented for this same reason. However because these structures are addressed by other programs, the AAMSR does not include recommendations for further action at these structures.

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

1.4 QUALITY ASSURANCE

A limited amount of field characterization work will be performed as part in parallel with preparation of the AAMS report. To help ensure that data collected are of sufficient quality to support decisions, all work on the Hanford Site is subject to the requirements of DOE Order 5700.1A, Quality Assurance (DOE RL 1983), which establishes broadly applicable QA program requirements in compliance with American National Standards Institute/American Society of Mechanical Engineers QA guidelines (ANSI/ASME 1989); the QA program requirements so defined apply to all types of project activities conducted on the Hanford Site.

To ensure that the objectives of the past practice activities are met in a manner consistent with DOE RL Order 5700.1A (DOE RL 1983), Quality Assurance, all work will be performed in compliance with Westinghouse Hanford's existing QA manual, WHC-CM-4-2 (WHC 1988a) and with procedures outlined in the QA program plan, WHC-EP-0383

1 (WHC 1990a) specific to CERCLA RI/FS activities. This QA program plan describes the
2 various plans, procedures, and instructions that will be used by Westinghouse Hanford to
3 implement the QA requirements of DOE RL Order 5700-1A.
4

5 6 1.5 ORGANIZATION OF REPORT

7
8 In addition to this introduction, the AAMSR will consist of the following nine sections
9 and appendices:

- 10 • Section 2.0, Facility, Process and Operational History Descriptions, describes the
11 major facilities, waste management units and unplanned releases within the
12 aggregate area. A chronology of waste disposal activities is established and waste
13 generating processes are summarized.
- 14 • Section 3.0, Site Conditions, describes the physical, environmental, and
15 sociological setting including, geology, hydrology, ecology, meteorology, and
16 demography.
- 17 • Section 4.0, Preliminary Conceptual Model, summarizes the conceptual
18 understanding of the aggregate area with respect to types and extent of
19 contamination, exposure pathways and receptors.
- 20 • Section 5.0, Health and Environmental Concerns, identifies chemicals used or
21 disposed within the aggregate area that could be of concern regarding public
22 health and/or the environment and describes and applies the screening process for
23 determining the relative priority of follow up action at each waste management
24 unit.
- 25 • Section 6.0, Potentially Applicable or Relevant and Appropriate Requirements,
26 identifies federal and state standards, requirements, criteria, or limitations that
27 may be considered relevant to the aggregate area.
- 28 • Section 7.0, Preliminary Remedial Action Technologies, identifies and screens
29 potential remedial technologies and establishes remedial action objectives for
30 environmental media.
- 31 • Section 8.0, Data Quality Objectives, reviews QA criteria on existing data,
32 identifies data gaps or deficiencies, and identifies broad data needs for field
33
34
35
36
37
38
39

1 characterization and risk assessment. The DQO and data priorities are
2 established.

- 3
4 • Section 9.0, Recommendations, provides guidance for future past practice
5 activities based on the results of the AAMS. Recommendations are provided for
6 ERA at problem sites, IRM, LFI, refining operable unit boundaries, prioritizing
7 work plans, and conducting field investigations and treatability studies.
8
9 • Section 10.0, References, list reports and documents cited in the AAMSR.
10 • Appendix A, Supplemental Data, provides supplemental data supporting the
11 AAMSR.

12
13 The following plans are included and will be used to support past practice activities in
14 the aggregate area:

- 15
16 • Appendix B: Health and Safety Plan
17
18 • Appendix C: Project Management Plan
19
20 • Appendix D: Data Management Plan
21

22 Community relations requirements for the U Plant Aggregate Area can be found in the
23 *Community Relations Plan for the Hanford Federal Facility Agreement and Consent Order*
24 (Ecology et al. 1989).
25

93128451299

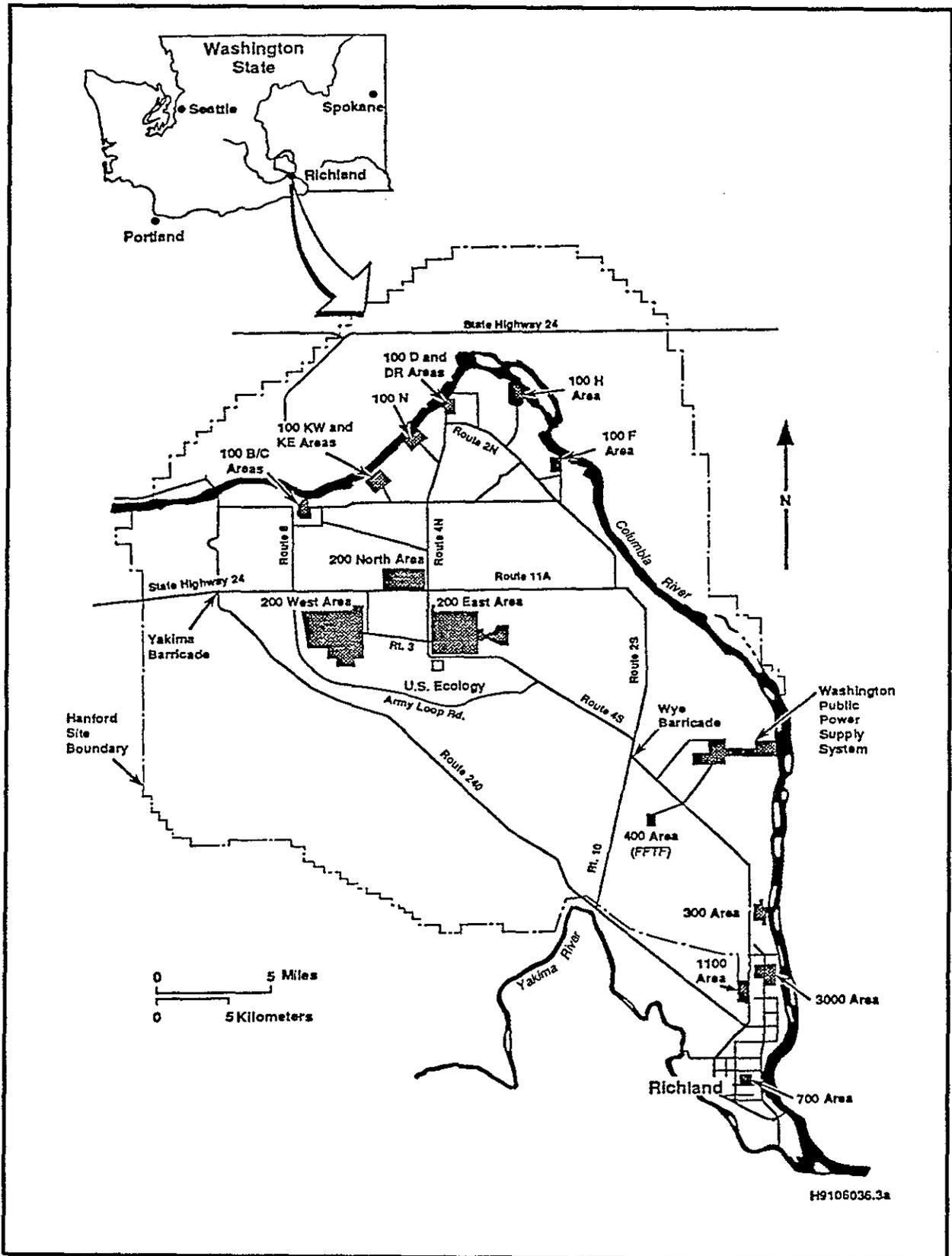
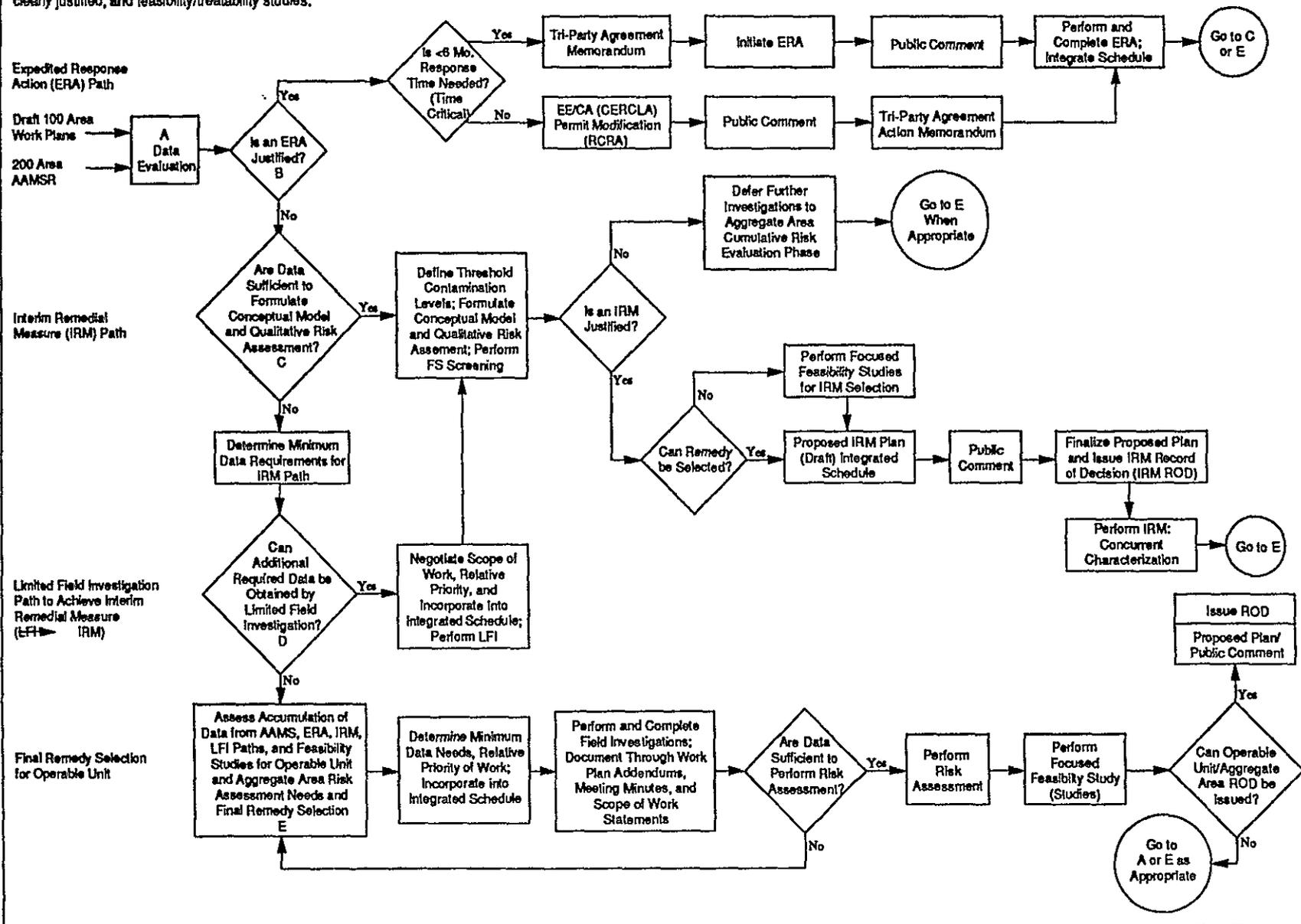


Figure 1-1. Hanford Site Map.
1F-1

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.

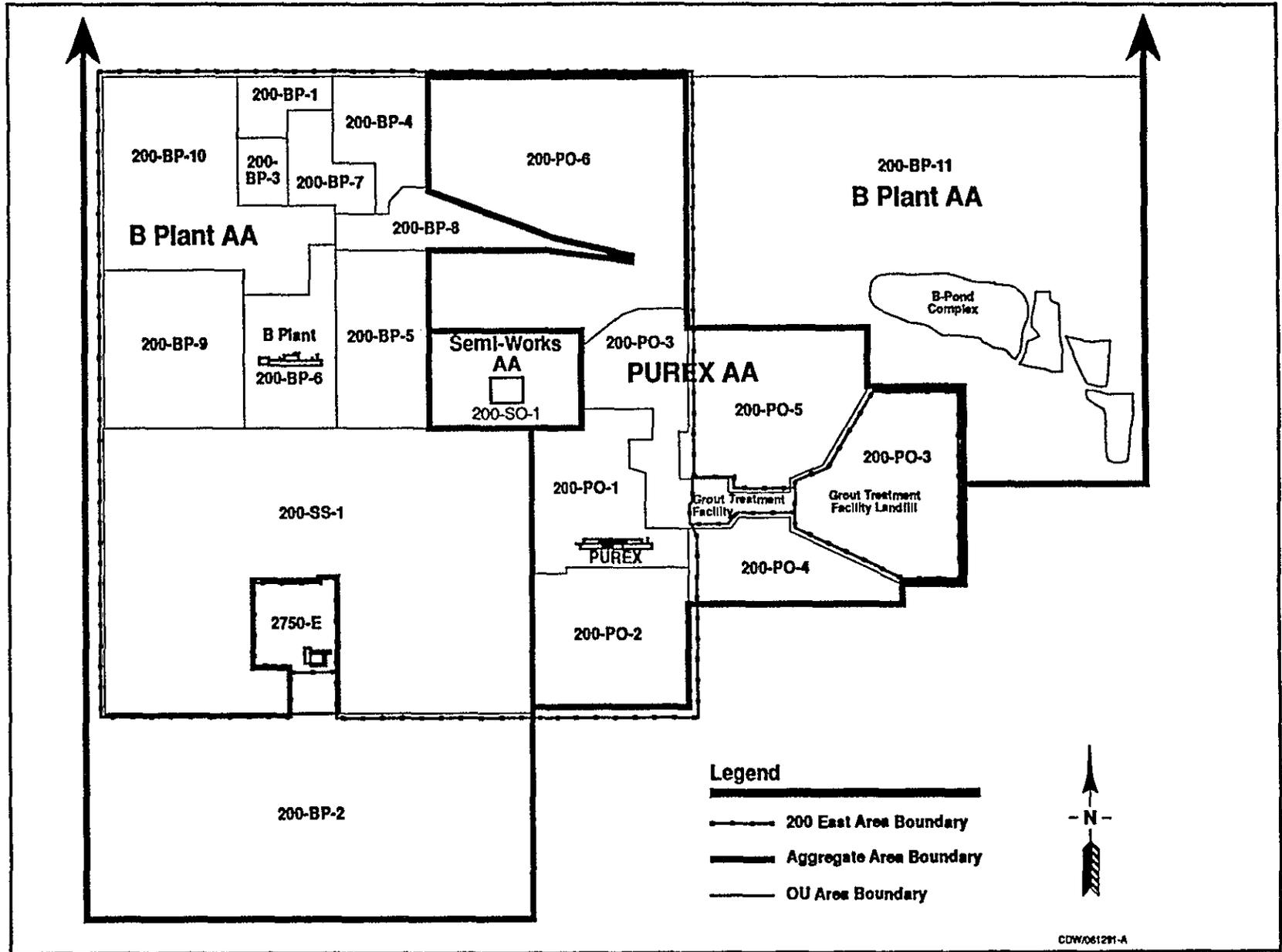


1F-2

DOE/RL-91-60
Draft A

Figure 1-2. Hanford Past Practice Investigation Strategy Flow Chart. (Thompson 1991)

1F-3



DOE/RL-91-60
Draft A

Figure 1-3. 200 East Aggregate Areas.

9 3 1 2 0 5 1 3 0 2

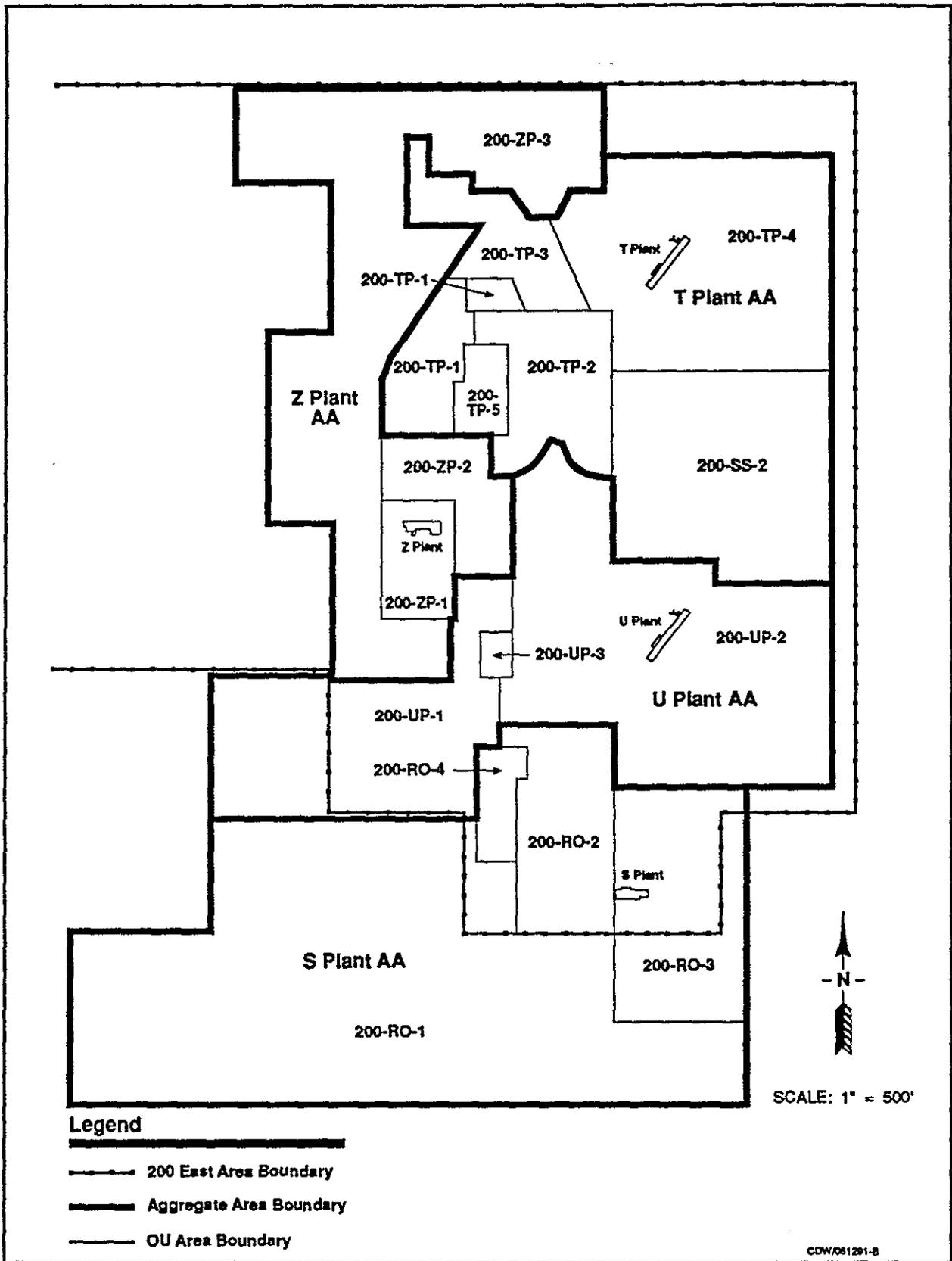


Figure 1-4. 200 West Aggregate Areas.

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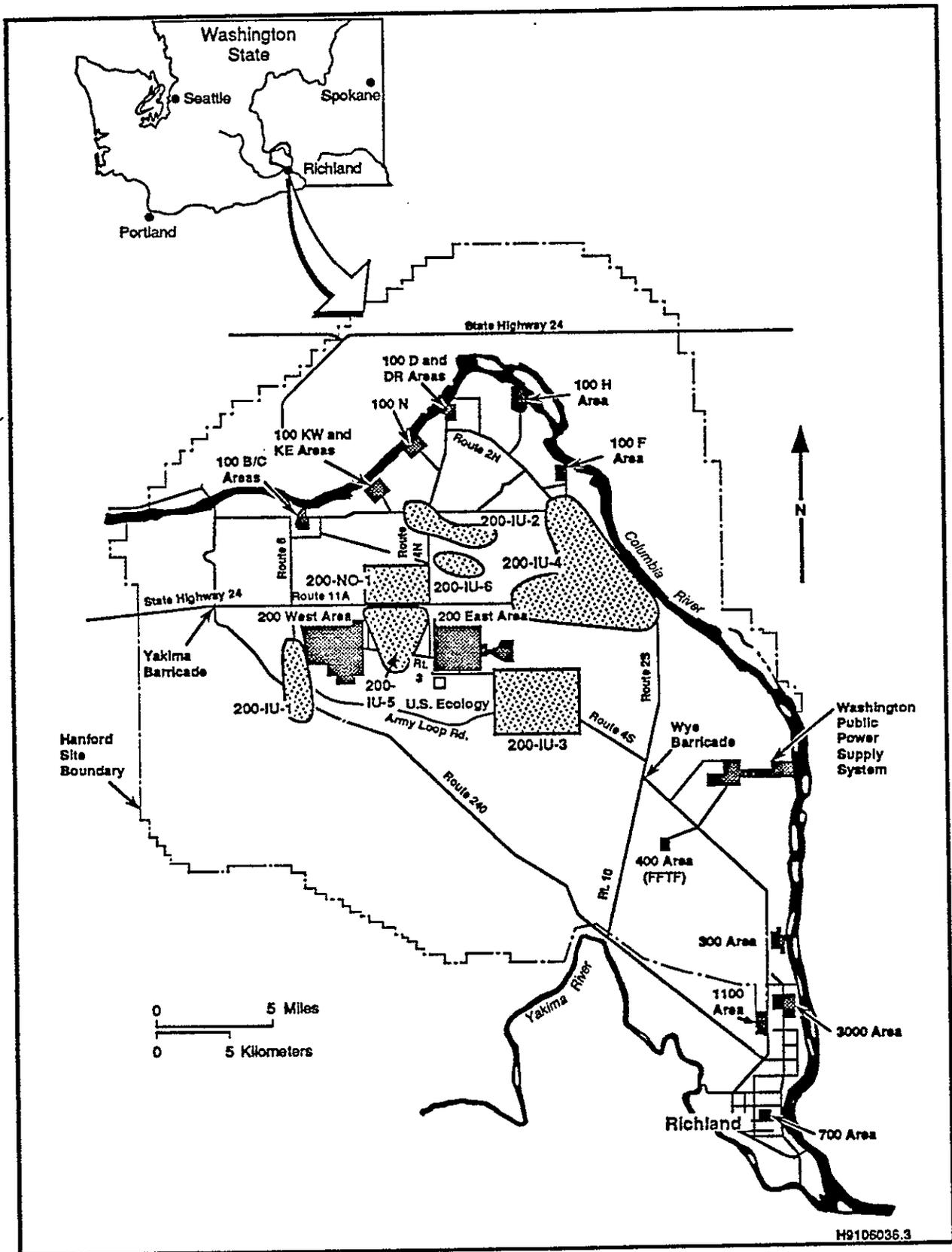


Figure 1-5. 200 NPL Site Isolated Operable Units.
1F-5

H9106035.3

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 Milestone |
|------------|--|--------------|------------------------|---------------------------|
| 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-6 222-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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1 **2.0 FACILITY, PROCESS AND OPERATIONAL HISTORY DESCRIPTIONS**
2
3

4 Section 2.0 of the aggregate area management study (AAMS) presents historical data on
5 the S Plant Aggregate Area and detailed physical descriptions of the individual waste
6 management units and unplanned releases. These descriptions include historical data on waste
7 sources and disposal practices and are based on a review of current and historical Hanford
8 Site reports, engineering drawings, site inspections, and employee interviews. Section 3.0
9 describes the environmental setting of the waste management units. The waste types and
10 volumes are qualitatively and quantitatively assessed at each site in Section 4.0. Data from
11 these three sections are used to identify contaminants of concern (Section 5.0), potential
12 applicable or relevant and appropriate requirements (ARARs) (Section 6.0) and current data
13 gaps (Section 8.0).
14

15 This section describes the location of the S Plant Aggregate Area (Section 2.1),
16 summarizes the history of operations (Section 2.2), describes the facilities, buildings, and
17 structures of the S Plant Aggregate Area (Section 2.3), and describes S Plant Aggregate Area
18 waste generating processes (Section 2.4). Section 2.5 discusses interactions with other
19 aggregate areas or operable units. Sections 2.6 and 2.7 discuss interactions with the Resource
20 Conservation and Recovery Act (RCRA) program and other Hanford programs.
21

22
23 **2.1 LOCATION**
24

25 The Hanford Site, operated by the U.S. Department of Energy (DOE), occupies about
26 1,450 km² (560 mi²) of the southeastern part of Washington State north of the confluence of
27 the Yakima and Columbia Rivers (Figure 1-1). The 200 West Area is a controlled area of
28 approximately 8.3 km² (3.2 mi²) near the middle of the Hanford Site. The 200 West Area is
29 about 8 km (5 mi) from the Columbia River and 11 km (6.8 mi) from the nearest Hanford
30 boundary. There are 17 source operable units and one groundwater operable unit grouped
31 into four aggregate areas in the 200 West Area (Figure 1-4). The S Plant Aggregate Area
32 (consisting of operable units 200-UP-1, 200-UP-2, and 200-UP-3) lies in the southern portion
33 of the 200 West Area (Figure 1-4). The location of the buildings and waste management
34 units are shown on Plate 1. Plate 2 shows the topography of the S Plant Aggregate Area.
35 The media sampling locations are depicted on Plate 3.
36

37
38 **2.2 HISTORY OF OPERATIONS**
39

40 The Hanford Site, established in 1943, was originally designed, built, and operated to
41 produce plutonium for nuclear weapons using production reactors and chemical reprocessing
42 plants. In March 1943, construction began on three reactor facilities and three chemical
43 processing facilities. After World War II, six more reactors were built. Beginning in the
44 1950's, waste management, energy research and development, isotope use, and other activities
45 were added to the Hanford operation. In early 1964, a presidential decision was made to
46 begin shut down of the reactors. Eight of the reactors were shut down by 1971. The N

1 Reactor operated in steam production mode from about 1971 to 1980 for electricity
2 production; in weapons grade material production mode from 1980 to 1987; and was placed
3 on cold standby status in October 1989. Westinghouse Hanford was notified September 20,
4 1991 that they should cease preservation and proceed with activities leading to a decision on
5 ultimate decommissioning of the reactor. These activities are scoped within a N Reactor
6 shutdown program which is scheduled to be completed in 1999.
7

8 Operations in the 200 Areas (West and East) are mainly related to separation of special
9 nuclear materials from nuclear fuel. Spent nuclear fuel is fuel that has been withdrawn from
10 a nuclear reactor following irradiation. The 200 West Area consists of the following four
11 main processing areas (Figure 1-4):
12

- 13 • S Plant and T Plant, where initial processing to separate uranium and plutonium
14 from irradiated fuel rods took place
15
- 16 • U Plant, where uranium recovery operations took place
17
- 18 • Z Plant, where plutonium separation and recovery operations took place.
19

20 The 200 Areas also contain nonradioactive support facilities, including transportation
21 maintenance buildings, service stations, and coal-fired powerhouses for process steam
22 production, steam transmission lines, raw water treatment plants, water-storage tanks,
23 electrical maintenance facilities, and subsurface sewage disposal systems.
24

25 The REDOX (short for reduction-oxidation) process was conducted at the 202-S
26 Building (commonly known as the S Plant Complex). The 202-S Building was constructed
27 between May 1950 and August 1951 and was the first process to recover both plutonium and
28 uranium from fission products. Plant operations continued through 1967 when the plant was
29 shut down. An analytical laboratory (222-S) near the facility is still operating. This
30 laboratory supports B Plant operations and performs research and development to support
31 waste management and environmental control operations. The laboratory also serves as a
32 backup to the Plutonium Uranium Extraction (PUREX) and Z Plant Analytical Laboratory.
33

34 The 241-S, -SX, and -SY Tank Farms contain 30 single- and double-shell tanks
35 constructed in 1943, 1953, and 1974, respectively. The single-shell tanks (SSTs) received
36 high-level waste from the S Plant Aggregate Area and other facilities, and the three double-
37 shell tanks (DSTs) receive waste concentrate and saltwell liquor from the SSTs high-level
38 wastes from all operating facilities in the 200 West Area, and groundwater treatment wastes
39 from 216-U-1 and -2 Cribs area. The transfer from SST to DST is an ongoing process of
40 waste stabilization (DOE 1987).
41
42

1 **2.3 FACILITIES, BUILDINGS, AND STRUCTURES**
2

3 The S Plant Aggregate Area (200-RO-1, -2, -3, and -4) contains a variety of facilities
4 that were involved in waste generation, transfer, treatment, storage, or disposal. Wastes were
5 predominantly generated in the S Plant Complex where plutonium and uranium were
6 separated from their fission products. Wastes were routed through a series of diversion boxes
7 or other control structures in open trenches or ditches or in surface and subsurface piping to
8 their ultimate waste disposal sites. In some cases, the trenches and ditches served as the
9 waste disposal units because of evaporative losses and percolation into the soil column.
10 High-level wastes were stored in underground tanks. Low-level wastes were disposed in
11 underground cribs or open ponds and basins. Radioactive and nonradioactive solid wastes
12 were disposed in appropriate burial sites or burial vaults. Some wastes, most notably
13 ventilation air, were treated prior to release. Numerous unplanned releases also occurred.
14 The waste types are defined in DOE Order 5820.2:
15

- 16 • High-level waste is highly radioactive waste material that results from the
17 reprocessing of spent nuclear fuel, including liquid waste produced directly in
18 reprocessing and any solid waste derived from the liquid, that contains a
19 combination of transuranic (TRU) waste and fission products in concentrations as
20 to require permanent isolation.
21
22 • TRU waste is defined as: without regard to source or form, radioactive waste that
23 at the end of institutional control periods is contaminated with alpha-emitting
24 transuranium radionuclides with half-lives greater than 20 years and concentrations
25 greater than 100 nCi/g. Regarding the Waste Isolation Pilot Plant, high-level
26 waste and spent nuclear fuel as defined by this Order are specifically excluded by
27 this definition.
28
29 • Low-level waste is radioactive waste not classified as high-level waste, TRU
30 waste, spent nuclear fuel, or byproduct material as defined by the Order.
31

32 Based on construction, purpose, or origin, the S Plant Aggregate Area waste
33 management units fall into one of ten subgroups as follows:
34

- 35 • Plants, Buildings, and Storage Areas (Section 2.3.1)
36
37 • Tanks and Vaults (Section 2.3.2)
38
39 • Cribs and Drains (Section 2.3.3)
40
41 • Reverse Wells (Section 2.3.4)
42

- 1 • Ponds, Ditches, and Trenches (Section 2.3.5)
- 2
- 3 • Septic Tanks and Associated Drain Fields (Section 2.3.6)
- 4
- 5 • Transfer Facilities, Diversion Boxes, and Pipelines (Section 2.3.7)
- 6
- 7 • Basins (Section 2.3.8)
- 8
- 9 • Burial Sites (Section 2.3.9)
- 10
- 11 • Unplanned Releases (Section 2.3.10)
- 12

13 Table 2-1 presents a list of the waste management units within the aggregate area. In
14 addition, the aggregate area contains several unplanned release sites. The locations of these
15 waste management units are shown on separate figures for each waste management group and
16 on Plate 1. Figure 2-1 summarizes the operational history of each of the waste management
17 units (WHC 1991a, DOE/RL 1992). Tables 2-2 and 2-3 summarize data available regarding
18 the quantity and types of wastes disposed of to the waste management units. These data have
19 been compiled from the Waste Information Data System (WIDS) inventory sheets (WHC
20 1991a) and from the Hanford Inactive Site Survey (HISS) database (DOE 1986). These
21 inventories include all of the contaminants reported in the databases, but do not necessarily
22 include all of the contaminants disposed at each site. In the following sections, each waste
23 management unit is described within the context of one of the waste management unit types.

24 25 26 **2.3.1 Plants, Buildings, and Storage Areas**

27
28 Plants and buildings are not generally identified as past practice waste management
29 units according to the *Hanford Federal Agreement and Consent Order* (Tri-Party Agreement)
30 and will generally be addressed under the Surplus Facilities program. Because several of the
31 S Plant Aggregate Area plants or buildings were the primary generators of waste disposed
32 within the S Plant Aggregate Area, a description of these is provided in Section 2.3.1.1. The
33 S Plant Aggregate Area plants and buildings that are also waste management units are
34 addressed in Section 2.3.1.1. Some plants and buildings are or contain RCRA treatment,
35 storage, or disposal (TSD) facilities. A description of such facilities is provided in Section
36 2.6. The locations of plants, buildings, and storage areas in the aggregate area are shown in
37 Figure 2-2.

38
39 The 202-S Building and the 222-S Laboratory were the primary locations of waste
40 generation within the S Plant Aggregate Area. These plants and the associated buildings are
41 described in Section 2.3.1.1.

42
43 Most other buildings and structures located within the aggregate area are not addressed
44 in this document because they are not thought to have released contaminants and will be
45 closed through a separate decontamination and decommissioning process. These structures
46 are described in Section 2.3.1.2.

1 **2.3.1.1 Process Facilities.**
2

3 **2.3.1.1.1 202-S Building.** The 202-S Building was the primary waste generating
4 source in the S Plant Aggregate Area and is the dominant physical structure in the area. The
5 202-S Building was constructed between May 1950 and August 1951 to separate plutonium
6 and uranium from their fission products. Plant operations continued through 1967. The
7 building contained all of the equipment for dissolution, separation, and decontamination of
8 uranium and plutonium as well as equipment for waste concentration, waste neutralization,
9 and solvent recovery. Facilities were also provided for the make-up of process chemicals.
10 Some of the office space in the 202-S Building is still in use. In addition, the Canyon area in
11 the 202-S Building is used for storage, and the Silo area in the building is used for research
12 and development activities. The 202-S Building is included in the Hanford Surplus Facilities
13 Program (HSFP).
14

15 Effluent ventilation air from the Canyon Cells and Silo process areas was passed
16 through a graduated gravel and sand filter to capture radioactive particles prior to discharge to
17 the environment through the 291-S Stack Complex. Ventilation air from regulated (i.e.,
18 uncontaminated) areas was discharged to the atmosphere.
19

20 The 202-S Building high-level process wastes were stored in underground tank farms in
21 the 200 West Area, specifically in the 241-S and 241-SX Tank Farms within the S Plant
22 Aggregate Area. Wastes stored in these underground tanks included zirconium and niobium
23 scavenging wastes, ruthenium scrubber wastes, main process wastes (from the extraction
24 columns, organic wash column, organic distillation column bottoms, and condensate
25 evaporator bottoms), coating removal slurry, and dissolver flush. Section 2.4 describes the
26 wastes in greater detail.
27

28 Low-level condensate waste was disposed in the 216-S Crib, and low-level solvent
29 treatment wastes were disposed in the 276-S Crib. Cooling water was discharged to the
30 207-S Retention Basin and ultimately disposed in the 216-S-16 or 216-S-17 Ponds.
31

32 Several unplanned releases occurred in the vicinity of the 202-S Building. These are
33 UN-200-W-57, UPR-200-W-59, UN-200-W-61, and UPR-200-W-96. These unplanned
34 releases involved the spread of radioactive materials as a result of fire or because of process
35 liquid or waste leaks.
36

37 **2.3.1.1.2 222-S Laboratory.** The 222-S Laboratory is the primary ongoing waste
38 source in the S Plant Aggregate Area. It is located immediately south of the 202-S Building.
39 The laboratory was constructed during 1950 and 1951. The laboratory provided chemical and
40 radiological analytical control and product development for the 200 Area plants. This
41 laboratory continues to support Hanford Site operations with emphasis on waste management,
42 off-site shipment certification, chemical processing, and environmental monitoring programs
43 throughout the 200 West and East Areas including B Plant, U Plant, the tank farms, 242-A
44 and 242-S evaporators, waste encapsulation storage facility, PUREX Plant, and Z Plant.
45

1 Low-level wastes from this facility are treated in the 219-S Waste Retention and
2 Treatment Facility and stored in the 222-S Dangerous and Mixed Waste Storage Facility prior
3 to shipment to the 241-SY DSTs. Laboratory waste water (along with waste water from the
4 291-S Stack Complex and 219-S Waste Retention and Treatment Facility) is directed through
5 the 207-SL Retention Basin and ultimately to the 216-S-26 crib.
6

7 The laboratory is a three-level building housing administrative areas and support
8 facilities, a low-level laboratory, and a high-level laboratory. Adjacent to the 222-S
9 Laboratory is the 222-SA Chemical Standards Laboratory, housed in trailers. The 222-S
10 Laboratory is included in the Hanford RCRA Program.
11

12 **2.3.1.2 Waste Management Unit Buildings.**

13
14 **2.3.1.2.1 204-S Pumphouse.** The 203-S and 204-S Tank Farms included six
15 aboveground uranyl nitrate hexahydrate storage tanks in open concrete basins. Adjacent to
16 the south wall of the 204-S Basin was a pumphouse for transfer of uranyl nitrate hexahydrate.
17 Uranyl nitrate hexahydrate solution was transferred by pipeline to the 224-UA Building
18 Calcination Plant. In 1966, the 204-S facility was converted for unloading radioactive waste
19 from rail tank cars and for storage of thorium nitrate solutions. This building was included in
20 the Radiation Area Reduction Action (RARA) Program. The 203-S and 204-S Tank Farms
21 were removed.
22

23 **2.3.1.2.2 205-S Silica Gel House.** The 205-S Silica Gel House included a two-story
24 building that housed two chemical make-up tanks, a uranyl nitrate hexahydrate sampling
25 room, extensive piping, and an underground process vault housing two silica gel adsorption
26 columns (to remove trace fission products [zirconium and niobium] from uranyl nitrate
27 hexahydrate) and a 10,410 L (2,750 gal) waste neutralizer tank. This facility was
28 occasionally used to further remove fission products from decontaminated uranium solutions
29 from the PUREX Plant. This building was included in the RARA Program. The 205-S
30 Building was removed.
31

32 **2.3.1.2.3 211-S Valve House.** The 211-S Valve House (located at the REDOX
33 Reagent Tank Farm) is a wooden valve house adjacent to 11 tanks (used to store S Plant
34 process chemicals).
35

36 **2.3.1.2.4 219-S Waste Retention and Treatment Facility.** The 219-S Waste
37 Retention and Treatment Facility is a concrete building that houses the control room and
38 sample gallery. This facility is currently in use for treatment (with caustic and sodium nitrite)
39 of radioactive wastes discharged from the 222-S Laboratory. Treated waste is shipped to the
40 200 West Area double-shell tank farms. This facility is included in the Hanford RCRA
41 Program.
42

43 **2.3.1.2.5 233-S Plutonium Concentration Facility.** The 233-S Plutonium
44 Concentration Facility is a concrete and metal building used for concentration and load-out of
45 plutonium nitrate product from the REDOX process. The building is included in the Hanford
46 Surplus Facilities Program (HSFP).

1 **2.3.1.2.6 233-SA Exhaust Filter and Stack.** The 233-SA Exhaust Filter and Stack
2 houses high-efficiency particulate air (HEPA) filter banks, fans, and an exhaust stack for the
3 233-S Building. The facility is included in the HSFP.
4

5 **2.3.1.2.7 241-SX-401 Building.** The 241-SX-401 Building is a concrete building that
6 housed condensers, hand & wheel operation, instrumentation, and condensate receiving tanks
7 designated to receive condensate from the 241-sx Tank Farm. A single-story control room is
8 attached at the south end. This facility is included in the HSFP.
9

10 **2.3.1.2.8 241-SX-402 Building.** The 241-SX-402 Building houses condensers, hand
11 wheel valve operators, instrumentation, and condensate receiving tanks designated to receive
12 condensate from the 241-SX Tank Farm. A single-story control room is attached at the south
13 end. This facility is included in the HSFP.
14

15 **2.3.1.2.9 242-S Evaporator Facility.** The 242-S Evaporator Facility houses the steam
16 condensate evaporator that operated from 1973 to 1980. The evaporator served to reduce the
17 volume of wastes stored in the 241-SY DSTs. Building ventilation systems are still active.
18

19 **2.3.1.2.10 276-S Solvent Handling Facility.** The 276-S Solvent Handling Facility,
20 operated from 1952 through 1967, is a concrete and transite building used for storage and
21 treatment of methyl isobutyl ketone (MIBK) used in the 202-S Building. This facility is
22 included in the HSFP.
23

24 **2.3.1.2.11 291-S Stack Complex.** The 291-S Stack Complex includes an in-ground
25 graduated sand and gravel filter that is still in use to provide ventilation for the process area
26 of the 202-S Building, and a concrete building adjacent to the fans (between the sand filter
27 and the stack) that houses the controls for the fans. This facility is included in the HSFP.
28

29 **2.3.1.2.12 292-S Jet Pit House.** The 292-S Jet Pit House is a concrete building that
30 housed the jets used to wash down the inner liner of the 291-S Stack Complex. This facility
31 is included in the HSFP.
32

33 **2.3.1.2.13 293-S Off-Gas Treatment and Recovery Facility.** The 293-S Off-Gas
34 Treatment and Recovery Facility is a concrete and transite building housing adsorption
35 towers, acid recovery equipment, and a pipe valve pit that was used to recover nitrogen
36 oxides and volatile fission products from the off-gas. This facility is included in the HSFP.
37

38 **2.3.1.2.14 2704-S Monitoring House.** The 2704-S Monitoring House is a metal
39 building. No further information was discovered.
40

41 **2.3.1.2.15 2711-S Stack Monitoring Building.** The 2711-S Stack Monitoring Building
42 is a wood structure adjacent to the 291-S Stack Complex that housed instrumentation for
43 sampling exhaust in the ventilation system. This facility is included in the HSFP.
44

45 **2.3.1.2.16 2718-S Sand Filter Sampler.** The 2718-S Sand Filter Sampler is a wood
46 structure adjacent to the 291-S Stack Complex that housed instrumentation for monitoring the

1 pressure drop and radioactivity of effluent air in the ventilation system. This facility is
2 included in the HSFP.

3
4 **2.3.1.2.17 222-S Dangerous and Mixed Waste Storage Facility.** The 222-S
5 Dangerous and Mixed Waste Storage Facility consists of two metal storage sheds on a
6 concrete pad. Drummed mixed wastes are stored in the shed prior to burial. This facility is
7 included in the Hanford RCRA Program.

8
9 **2.3.1.2.18 2727-S Nonradioactive Dangerous Waste Storage Facility.** The 2727-S
10 Nonradioactive Dangerous Waste Storage Facility is a metal building on a concrete pad
11 located in the southeast portion of the 200 West Area. The facility provided container storage
12 for nonradioactive dangerous wastes generated in the research and development laboratories,
13 process operations, and maintenance and transportation function throughout the Hanford Site.
14 This facility operated from March 1983 to December 1986. This facility is included in the
15 Hanford RCRA Program.

16 17 18 **2.3.2 Tanks and Vaults**

19
20 Tanks and vaults were constructed to handle and store liquid wastes generated by
21 plutonium processing activities. Several types of tanks are present in the aggregate area
22 including catch tanks, storage tanks, and receiver tanks. The catch tanks are generally
23 associated with decision boxes and other transfer units and were designed to accept overflow
24 and spills. Storage tanks were used to collect and store large quantities of liquid waste.

25
26 Locations for tanks and vaults are shown in Figure 2-3. A more detailed location map
27 of SSTs and DSTs is provided in Figure 2-4. The SSTs at the Hanford Site were built
28 between 1943 and 1964 to store high-level liquid wastes. Within the S Plant Aggregate Area,
29 the 27 SSTs are located in two tank farms: 241-S Tank Farm (12 SSTs) and 241-SX Tank
30 Farm (15 SSTs) (Refer to Tables 2-4 and 2-5). A detailed drawing of an SST is shown in
31 Figure 2-5. Any pumpable interstitial liquid and supernatant liquid are transferred to DSTs
32 (Borsheim and Kirch 1991) and stored as a concentrate (DOE 1987). There is one DST farm
33 in the S Plant Complex, 241-SY Tank Farm, which houses three DSTs. A detailed drawing
34 of a DST is shown in Figure 2-6. Single-shell tanks are regulated under RCRA Section
35 3005(e) and associated state dangerous waste regulations. The 241-S and -SX Tank Farms
36 are considered active in the regulatory sense because they are "actively" storing
37 RCRA-regulated wastes; however, they have not received additional wastes since 1980. Cribs
38 and trenches that received discharges from cascading tank operations are characterized and
39 remediated under CERCLA or RCRA past practice authority as stated in the Tri-Party
40 Agreement (Ecology et al. 1990).

41
42 All of the tanks within the S Plant Aggregate Area tank farms will be addressed by the
43 RCRA SST closure program. The structures and related contamination in the tank farm will
44 be described in this report, but investigation and remediation strategies will be deferred to the
45 SST closure program.

1 Interim isolation and stabilization have been performed on the tanks to varying degrees,
2 as listed in the individual tank descriptions (Refer to Table 2-4). Interim isolation is the
3 sealing of all accesses to the tank not required for long-term surveillance. The seal provides
4 a barrier against inadvertent addition of liquid. The administrative designation "partially
5 interim isolated" reflects the completion of the effort required for interim isolation with the
6 exception of isolation of risers and piping required for pumping or other methods of
7 stabilization (Hanlon 1991). Interim stabilization is the removal of as much liquid as possible
8 through use of a salt well and a jet pump. A salt well is a slotted riser pipe inserted into the
9 salt cake of a tank and into which a pump is placed. A tank is considered interim stabilized
10 if it contains less than 189,000 L (50,000 gal) of drainable interstitial liquid and less than
11 19,000 L (5,000 gal) of supernatant liquid. In all cases of interim stabilization, interstitial
12 liquids remain with the volume and vary according to waste volume, liquid type, and other
13 factors.
14

15 **2.3.2.1 241-S Tank Farm.** The 241-S Tank Farm is located less than 1.6 km (1 mi)
16 northwest of the 202-S Building. The 241-S Tank Farm was constructed between 1950 and
17 1951 and contains twelve 2,800,000 L (750,000 gal) underground tanks. The tanks are
18 constructed of reinforced concrete with a mild steel liner covering the bottom and side walls
19 (Anderson 1990). Bottoms of most tanks are slightly dished and are below grade with at least
20 1.8 m (6 ft) of soil cover for shielding. Forced ventilation provides cooling for tanks capable
21 of generating heat that could exceed established concrete temperature limits. Single stage
22 HEPA filters allow atmospheric breathing for tanks that do not require cooling (DOE 1987).
23 Each tank is ringed with a series of vadose zone boreholes to monitor the soil for
24 radioactivity and also to act as a leak detection system. Specifications of these boreholes are
25 152 mm (6 in.), open-ended bottom, and sunk approximately 23 m (75 ft) below grade. The
26 wells can accommodate portable gamma and neutron detection devices (Anderson 1990).
27 Tanks in the 241-S Tank Farm were originally arranged in a system of four cascades
28 composed of three tanks each (101-103, 104-106, 105-107, 108-112). Liquid wastes were
29 transferred to the first tank allowing solids to settle and then overflowing to two subsequent
30 tanks in the cascade (Appendix E, Exhibit 1) through piping in the sidewalls; however, as
31 various programs have been initiated, many of the cascade systems between the tanks have
32 either been removed, modified, or sealed (Anderson 1990). It is anticipated that
33 Westinghouse Hanford will empty seven tanks in the 241-S Tank Farm in the near future
34 (Appendix E; Exhibit 2).
35

36 Most of the wastes in the SSTs is in the form of sludge, saltcake, and liquids, and
37 consists primarily of sodium hydroxide; sodium salts of nitrate, nitrite, carbonate, aluminate,
38 and phosphate; and hydrous oxides of iron and manganese. Radiation intensity in these tanks
39 is expected to be very high due to the radioactive decay of elements such as uranium,
40 thorium, plutonium, and neptunium; however, radiation intensities should be lower down the
41 cascade due to the greater number of solids that precipitated out in the previous tank. A
42 discussion of the unplanned releases from the SSTs can be found in Section 2.3.10.
43

44 **2.3.2.1.1 241-S-101 Single-Shell Tank.** Tank 241-S-101 actively received wastes from
45 1953 through 1980. Types of wastes include REDOX process high-level wastes, REDOX
46 process coating waste, and supernatant containing waste from Pacific Northwest Laboratory

1 (PNL) coating waste, PUREX low-level waste, laboratory waste, B Plant high-level waste,
2 terminal liquor and condensate evaporator bottoms, partial neutralization feed, N Reactor
3 waste, ion exchange waste, and waste from 241-U, -S, and -SX Tank Farms. The tank
4 currently contains 318,000 L (84,000 gal) of interstitial liquid, 45,400 L (12,000 gal) of
5 supernatant liquid, and 1,571,800 L (415,000 gal) of solids (Hanlon 1991). There are five
6 active monitoring wells associated with this tank (WHC 1991a).

7
8 **2.3.2.1.2 241-S-102 Single-Shell Tank.** Tank 241-S-102 actively received waste from
9 1953 through 1980. Types of waste include REDOX process high-level wastes; nitric
10 acid/potassium permanganate ($\text{HNO}_3/\text{KMnO}_4$) solution and supernatant containing REDOX
11 process high-level waste, condensate evaporator bottoms, noncomplexed waste, DST slurry
12 feed, and partial neutralization feed from 241-S, -SX, -SY, and -U Tank Farms. The tank
13 currently contains 870,600 L (230,000 gal) of interstitial liquid, no supernatant liquid, and
14 2,078,000 L (549,000 gal) of solids (Hanlon 1991).

15
16 **2.3.2.1.3 241-S-103 Single-Shell Tank.** Tank 241-S-103 actively received wastes from
17 1953 through 1980. Types of wastes include REDOX process high-level waste, REDOX
18 process coating waste, $\text{HNO}_3/\text{KMnO}_4$ solution, and a supernatant containing REDOX process
19 high-level waste, condensate evaporator bottoms, noncomplexed waste, and partial
20 neutralization feed from 241-S, -SX, -SY, and -U Tank Farms. The tank currently contains
21 321,700 L (85,000 gal) interstitial liquid, 64,300 L (17,000 gal) supernatant liquid, and
22 874,300 L (231,000 gal) of solids (Hanlon 1991). There are seven active monitoring wells
23 associated with this tank.

24
25 **2.3.2.1.4 241-S-104 Single-Shell Tank.** Tank 241-S-104 actively received waste from
26 February 1953 to 1968. Types of waste include REDOX process coating waste, REDOX
27 process high-level waste, and supernatant containing REDOX process high-level waste
28 overflow from other tanks in the 241-S Tank Farm. The tank currently contains 106,000 L
29 (28,000 gal) interstitial liquid, 3,800 L (1,000 gal) supernatant liquid, and 1,109,000 L
30 (293,000 gal) of solids (Hanlon 1991).

31
32 This tank was removed from service and categorized "questionable integrity" because of
33 a liquid level decrease, and this tank is now assumed to be a leaker (WHC 1991a). There are
34 four active monitoring wells associated with this tank.

35
36 **2.3.2.1.5 241-S-105 Single-Shell Tank.** Tank 241-S-105 actively received waste from
37 1953 to 1974. Types of waste include REDOX process coating waste and REDOX process
38 high-level waste. The tank currently contains 132,500 L (35,000 gal) interstitial liquid, no
39 supernatant liquid, and 1,726,000 L (456,000 gal) of solids (Hanlon 1991) and has five active
40 monitoring wells associated with it (WHC 1991a).

41
42 **2.3.2.1.6 241-S-106 Single-Shell Tank.** Tank 241-S-106 actively received waste from
43 1953 to 1979. Types of waste include REDOX process high-level waste, supernatant
44 containing REDOX process high-level wastes, and condensate evaporator bottoms. The tank
45 currently contains 435,300 L (115,000 gal) interstitial liquid, no supernatant liquid, and
46 2,055,300 L (543,000 gal) of solids (Hanlon 1991).

1 A jet pump saltwell system was installed and placed in operation during August 1978.
2 The tank has six active monitoring wells associated with it.
3

4 **2.3.2.1.7 241-S-107 Single-Shell Tank.** Tank 241-S-107 actively received wastes from
5 August 1952 until 1980. Types of waste include REDOX process high-level waste, REDOX
6 process coating waste, and supernatant containing REDOX process high-level waste,
7 decontamination waste, B Plant high-level and low-level waste, PNL waste, laboratory waste,
8 N Reactor waste, PUREX low-level waste, ion exchange waste, fractionization waste,
9 condensate evaporator bottoms, double-shell tank slurry feed, partial neutralization feed, and
10 complexed concentrate from 241-BX, -C, -S, -SX, -SY, and -U Tank Farms. The tank
11 currently contains 170,300 L (45,000 gal) interstitial liquid, 22,700 L (6,000 gal) supernatant
12 liquid, and 1,370,200 L (362,000 gal) of solids (Hanlon 1991).
13

14 Intermittent liquid level increases since July 1981 have been attributed to
15 decontamination work or precipitation (accumulating in a valve pit). Although the unit was
16 partially isolated in December 1982, liquid level measurements continue to show a slow
17 increase (WHC 1991a). A slow increase in the surface level has been observed since May
18 1987, but it has not exceeded 5.0 cm (2.0 in.). The surface level measurement increased
19 2.8 cm (1.1 in.) in September 1991 during the installation of a saltwell screen. The reference
20 baseline was adjusted to reflect this planned water addition. This tank will remain under
21 close surveillance for unexplained surface level increases and is reported on the Alert List
22 (Hanlon 1991). The tank has six active monitoring wells associated with it.
23

24 **2.3.2.1.8 241-S-108 Single-Shell Tank.** Tank 241-S-108 actively received waste from
25 1952 to 1979. Types of waste include REDOX process high-level waste, supernatant
26 containing REDOX process high-level waste, and condensate evaporator bottoms. The tank
27 currently contains 389,900 L (103,000 gal) interstitial liquid, no supernatant liquid, and
28 2,286,100 L (604,000 gal) of solids (Hanlon 1991).
29

30 Past liquid level increases are attributed to dry buoyant surface crust. Dry well readings
31 have remained stable during the review period and are the only means of leak detection as the
32 Food Instrument Corporation (FIC) liquid level measurement device, and manual tape
33 plummet are contacting solids (WHC 1991a). The tank has five active monitoring wells
34 associated with it.
35

36 **2.3.2.1.9 241-S-109 Single-Shell Tank.** Tank 241-S-109 actively received waste from
37 1952 until 1979. Types of waste include REDOX process high-level supernatant containing
38 condensate evaporator bottoms from the 241-S-102 Tank. The tank currently contains
39 469,300 L (124,000 gal) interstitial liquid, no supernatant liquid, and 2,149,900 L
40 (568,000 gal) of solids (Hanlon 1991) and has six active monitoring wells associated with it.
41

42 **2.3.2.1.10 241-S-110 Single-Shell Tank.** Tank 241-S-110 actively received waste from
43 1952 until 1979. Types of waste include REDOX process high-level waste, REDOX process
44 coating waste, supernatant containing REDOX process ion exchange waste, 224-U Building
45 waste, coating waste, decontamination waste, B Plant low-level waste, and organic wash
46 waste from 241-B, -S, -SX, -T, -TX, and -U Tank Farms. The tank currently contains

1 227,100 L (60,000 gal) interstitial liquid, no supernatant liquid, and 2,619,200 L (692,000 gal)
2 of solids (Hanlon 1991).
3

4 Past increases of surface level had caused considerable operational problems, and
5 special pumping was necessary in October 1975 to lower levels below maximum operating
6 limits. The increase was attributed to drying of the buoyant crust layer. Dry well readings
7 have remained stable during the review period and are the only means of leak detection since
8 the unit predominantly contains solids (WHC 1991a).
9

10 The only cleanup action taken to date is the installation of a jet pump saltwell system in
11 August 1978. The tank has eight active monitoring wells associated with it.
12

13 **2.3.2.1.11 241-S-111 Single-Shell Tank.** Tank 241-S-111 actively received waste from
14 1952 to 1975. The tank received REDOX process high-level waste and supernatant
15 containing condensate evaporator bottoms. The tank currently contains 726,700 L
16 (192,000 gal) interstitial liquid, 37,800 L (10,000 gal) supernatant liquid, and 2,218,000 L
17 (586,000 gal) of solids (Hanlon 1991).
18

19 The causes of past liquid level increases are not completely known. Dry well readings
20 have remained stable during the review period and are the primary means of leak detection
21 since the unit contains solids. This tank has the potential to generate hydrogen or other
22 flammable gas. Its maximum temperature reading was 35°C (95°F) in February 1991
23 (WHC 1991a). The unit has six active monitoring wells associated with it including the dry
24 wells.
25

26 **2.3.2.1.12 241-S-112 Single-Shell Tank.** Tank 241-S-112 actively received waste from
27 1952 until 1974. Types of waste include REDOX process high-level waste and supernatant
28 containing REDOX process high-level wastes and condensate evaporator bottoms. The tank
29 currently contains 545,000 L (144,000 gal) interstitial liquid, no supernatant liquid, and
30 2,418,700 L (639,000 gal) of solids (Hanlon 1991).
31

32 This unit has a potential to generate hydrogen or flammable gas. Its maximum
33 temperature reading was 34°C (93°F) in February 1988. Past liquid level increases are
34 attributed to drying of buoyant surface crust. Dry wells have remained stable during the
35 review period and are the only means of leak detection as the unit predominantly contains
36 solids (WHC 1991a). This unit has five active monitoring wells associated with it including
37 the dry wells (WHC 1991a).
38

39 **2.3.2.2 241-SX Tank Farm.** The 241-SX Tank Farm is an active site located directly south
40 of the 241-S Tank Farm. The tank farm was constructed between 1953 and 1954 and
41 contains fifteen 3,785,000 L (1,000,000 gal) SSTs as well as two aboveground water tanks.
42 The underground tanks are constructed of reinforced concrete with a mild steel liner covering
43 the bottom and sidewalls. Bottoms of most tanks are slightly dished and below grade with at
44 least 1.8 m (6 ft) of soil cover for shielding. Forced ventilation provides cooling for tanks.
45 Single stage HEPA filters allow atmospheric breathing for tanks that do not require cooling
46 (DOE 1987). Each tank is ringed with a series of dry wells (vadose zone boreholes) to

1 monitor the soil for radioactivity and also to act as a leak detection system. Specifications of
2 these boreholes are 15.2 cm (6 in.) in diameter, an open-ended bottom, and sunk
3 approximately 23 m (75 ft) below grade. The wells can accommodate portable gamma and
4 neutron detection devices (Anderson 1990). The 241-SX Tank Farm, receiving REDOX
5 process salt wastes, was the first tank farm equipped for handling hard boiling waste
6 solutions; however, only Tanks 241-SX-105, -107, and -115 could accommodate these wastes.
7 In these tanks, heat is generated when the fission products decay radioactively and, although
8 most of the heat is dissipated by boiling the supernatant, a small amount is conducted to the
9 ground (Anderson 1990). Vapors from the boiling are routed through headers to condensers
10 that are then vented to the atmosphere through filters. Most of the wastes in these SSTs is in
11 the form of sludge, saltcake, and liquids, consisting primarily of sodium hydroxide; sodium
12 salts of nitrate, nitrite, carbonate, aluminate, and phosphate; and hydrous oxides of iron and
13 manganese. Condensate is either discharged to cribs or returned to the tank to maintain the
14 liquid level. Tanks in the 241-SX Tank Farm were originally arranged in a system of five
15 cascades composed of three tanks each (101-103, 104-106, 105-107, 108-112, 113-115).
16 Liquid wastes were transferred to the first tank allowing solids to settle and then overflowing
17 to two subsequent tanks in the cascade (Appendix E, Exhibit 1) through piping in the
18 sidewalls; however, as various programs have been initiated, many of the cascade systems
19 between the tanks have either been removed, modified, or sealed (Anderson 1990).
20

21 Most of the wastes in the SSTs is in the form of sludge, saltcake, and liquids, and
22 consists primarily of sodium hydroxide; sodium salts of nitrate, nitrite, carbonate, aluminate,
23 and phosphate; and hydrous oxides of iron and manganese. Radiation intensity in these tanks
24 is expected to be very high due to the radioactive decay of elements such as uranium,
25 thorium, plutonium, and neptunium; however, radiation intensities should be lower as wastes
26 moved down the cascade due to the greater number of solids that precipitated out in the
27 previous tank. A discussion of the unplanned releases from the SSTs can be found in
28 Section 2.3.10.
29

30 **2.3.2.2.1 241-SX-101 Single-Shell Tank.** Tank 241-SX-101 actively received waste
31 from May 1954 until 1980. Types of waste include REDOX process high-level waste;
32 supernatant containing REDOX process ion exchange waste, evaporator bottoms, partial
33 neutralization feed; and complexed waste from 241-S, -BX, -SX, and -U Tank Farms. The
34 tank currently contains 548,800 L (145,000 gal) interstitial liquids, 3,800 L (1,000 gal)
35 supernatant liquid, and 1,722,200 L (455,000 gal) of solids (Hanlon 1991).
36

37 The unit was connected to the 241-SX sludge cooler in April 1976. Temperatures in
38 the tank range from 88°C (190°F) in the sludge to 62.8°C (145°F) in the bulk solution.
39 Measurement anomalies were attributed to the FIC plummet contacting surface solids exposed
40 during evaporation. Photographs taken in February 1982 confirm this. This unit has the
41 potential to generate hydrogen or flammable gas (WHC 1991a).
42

43 The unit has eight active monitoring wells associated with it. Monitoring results from
44 dry wells (vadose zone boreholes), the primary means of leak detection, have remained stable
45 during the review period (WHC 1991a).
46

1 **2.3.2.2.2 241-SX-102 Single-Shell Tank.** Tank 241-SX-102 actively received waste
2 from May 1954 until 1980. Types of waste include REDOX process high-level waste,
3 carbonate waste, concrete, supernatant containing REDOX process high-level waste, REDOX
4 process ion exchange waste, evaporator bottoms, and partial neutralization feed from 241-BX,
5 -SX, -TX, and -U Tank Farms. The tank currently contains 692,700 L (145,000 gal)
6 interstitial liquid, no supernatant liquid, and 2,055,300 L (543,000 gal) of solids
7 (Hanlon 1991).
8

9 Future plans include installation of a jet pump saltwell system to remove as much of the
10 remaining interstitial liquid as possible with current technology. The unit is connected to the
11 241-SX sludge cooler facility since temperatures in the bulk waste rise above 90°C (200°F).
12 An apparent liquid level decrease in the tank was attributed to movement of surface solids.
13 The unit has the potential to generate hydrogen or other flammable gas (WHC 1991a).
14

15 This unit has five active monitoring wells associated with it. Monitoring results from
16 dry wells (vadose zone boreholes) have remained stable during the review period. The only
17 cleanup action taken to date is pumping the waste to a minimum supernatant heel
18 (WHC 1991a).
19

20 **2.3.2.2.3 241-SX-103 Single-Shell Tank.** Tank 241-SX-103 actively received waste
21 from May 1954 until 1980. Types of waste include REDOX process high-level waste,
22 concrete, and supernatant containing REDOX process high-level waste, coating waste,
23 evaporator bottoms, organic wash waste, and partial neutralization feed from 241-BX, -SX,
24 and -S Tank Farms. The tank currently contains 916,000 L (242,000 gal) interstitial liquids,
25 3,800 L (1,000 gal) supernatant liquid, and 2,464,000 L (651,000 gal) of solids
26 (Hanlon 1991).
27

28 Future plans include installing a jet pump saltwell system to remove as much of the
29 remaining interstitial liquid as possible with current technology. The unit is connected to the
30 241-SX sludge cooler facility and temperatures in the bulk waste rise above 90°C (200°F). A
31 liquid level decrease following a transfer into the unit was attributed to the FIC plummet
32 measuring an irregular material surface. This unit has the potential to generate hydrogen or
33 flammable gas (WHC 1991a).
34

35 This tank has six active monitoring wells associated with it. Dry well (vadose zone
36 boreholes) radionuclide monitoring results have remained stable during the review period.
37 The only cleanup action initiated at this site is pumping the waste to a minimum supernatant
38 heel (WHC 1991a).
39

40 **2.3.2.2.4 241-SX-104 Single-Shell Tank.** Tank 241-SX-104 actively received waste
41 from 1955 until 1980. Types of waste include REDOX process high-level waste and
42 supernatant containing REDOX process ion exchange waste, and condensate evaporator
43 bottoms. The tank currently contains 522,300 L (138,000 gal) interstitial liquid, no
44 supernatant liquid, and 2,324,000 L (614,000 gal) of solids (Hanlon 1991).
45

1 An apparent liquid level decrease was attributed to a defective liquid level tape and
2 localized slumping of the solids in the vicinity of the FIC plummet. This unit has the
3 potential to generate hydrogen or other flammable gas (WHC 1991a).
4

5 The tank has seven active monitoring wells associated with it. Dry well (vadose zone
6 borehole) radionuclide monitoring results have remained stable during the review periods.
7 Because of the surface solids, the dry wells are the primary means of leak detection. Tank
8 241-SX-104 was declared an assumed leaker in 1989 after 416,350 L (110,000 gal) of liquid
9 had leaked.
10

11 **2.3.2.2.5 241-SX-105 Single-Shell Tank.** Tank 241-SX-105 actively received waste
12 from February 1955 until 1980. Types of waste include REDOX process high-level waste
13 and supernatant containing REDOX process high-level waste, REDOX process ion exchange
14 waste, evaporator bottoms, and partial neutralization feed from 241-BX, -S, -TX, and -U Tank
15 Farms. The tank currently contains 987,900 L (261,000 gal) interstitial liquid, no supernatant
16 liquid, and 2,585,200 L (683,000 gal) of solids (Hanlon 1991).
17

18 Future plans include installing a jet pump saltwell system to remove as much of the
19 remaining interstitial liquid as the current technology allows. The unit is connected to the
20 241-SX sludge cooler facility and temperatures in the bulk waste rise above 90°C (200°F). A
21 liquid level decrease was attributed to the FIC plummet contacting surface solids. The unit
22 has the potential for hydrogen or other flammable gas generation (WHC 1991a).
23

24 The unit has seven active monitoring wells associated with it. Monitoring results from
25 dry wells (vadose zone boreholes) and laterals have remained stable during the review period.
26 Because of surface solids, dry wells and laterals are the primary means of leak detection. The
27 only cleanup action taken to date at this unit is pumping the waste to a *minimum* supernatant
28 heel (WHC 1991a).
29

30 **2.3.2.2.6 241-SX-106 Single-Shell Tank.** Tank 241-SX-106 actively received waste
31 from 1954 until 1980. Types of waste include Hanford Site laboratory waste, PNL waste,
32 nitric acid/potassium permanganate solution, supernatant containing REDOX process waste
33 and fractionization ion exchange waste, evaporator bottoms, B Plant low-level waste, coating
34 waste, REDOX process high-level waste, complexed and noncomplexed waste, and partial
35 neutralization feed from 241-B, -BX, -C, -S, -SX, -SY, -TX, and -U Tank Farms. The tank
36 currently contains 734,300 L (194,000 gal) interstitial liquid, 230,900 L (61,000 gal)
37 supernatant liquid, and 1,805,400 L (477,000 gal) of solids (Hanlon 1991).
38

39 The unit is connected to the 241-SX sludge cooler because temperatures rise to 60°C
40 (140°F) in the bottom solids and 49°C (120°F) in the bulk solution. Test augerings in 1974
41 at locations adjacent to the earlier suspect well (41-06-09) were inconclusive, and no further
42 studies are planned. A liquid level increase in the tank was attributed to a leaking 241-SX
43 sludge cooler steam coil and failure of a steam coil valve. In addition, a surface level
44 increase in the tank was attributed to water vapor condensing in the 241-SX sludge cooler
45 ducting and draining to this unit. This unit has the potential to generate hydrogen or other

1 flammable gases. This unit also contains potentially high concentrations of organic salts
2 (WHC 1991a).
3

4 This tank has six active monitoring wells associated with it. Dry well (vadose zone
5 boreholes) radionuclide monitoring results, the primary means of leak detection, have
6 remained stable during the review period (WHC 1991a).
7

8 **2.3.2.2.7 241-SX-107 Single-Shell Tank.** Tank 241-SX-107 actively received waste
9 from April 1956 until 1964. Types of waste include REDOX process high-level waste,
10 REDOX process coating waste, concrete, and supernatant containing REDOX process high-
11 level waste. The unit contains the contents of 41 bottles of neutralized waste from the 100-F
12 Reactor, each containing less than 1 g (2×10^{-3} lb) ^{239}Pu . The tank currently contains
13 18,900 L (5,000 gal) interstitial liquid, no supernatant liquid, and 393,600 L (104,000 gal) of
14 sludge (Hanlon 1991).
15

16 The only known release is UPR-200-W-140 where approximately 20,000 L (5,000 gal)
17 of waste was spilled (WHC 1991a). Contamination spread laterally in a stratum 17 to 18 m
18 (55 to 60 ft) below grade.
19

20 The unit is connected to the 241-SX sludge cooler. The solid waste is estimated to
21 generate 16,000 J/sec (53,000 Btu/h), and the current average temperature of the bulk solids is
22 66°C (150°F). The maximum temperature recorded by any of the sludge thermocouples is
23 97.8°C (208°F). The unit is considered to have high heat load 12,000 J/sec (42,000 Btu/h)
24 (WHC 1991a).
25

26 The unit was removed from service as a "confirmed leaker." Because of a caked
27 surface, dry wells and laterals are the only means of leak detection. All wells except Well
28 41-07-08 have remained stable during the review period. The level of nearby Well 41-07-08
29 continues to increase slowly, and past directional probe data indicates that the activity is
30 coming from the northeast, which is the direction of this unit.
31

32 **2.3.2.2.8 241-SX-108 Single-Shell Tank.** Tank 241-SX-108 actively received waste
33 from November 1955 until 1962. Types of waste include REDOX process high-level waste,
34 concrete, and supernatant containing REDOX process high-level waste from other tanks in the
35 241-SX Tank Farm. The tank currently contains 22,700 L (6,000 gal) interstitial liquid, no
36 supernatant liquid, and 435,300 L (115,000 gal) of sludge (Hanlon 1991).
37

38 The tank has a known release, UPR-200-W-141, where approximately 9,100 L
39 (2,400 gal) of waste leaked (WHC 1991a).
40

41 This unit is considered to have a high heat load of 13,000 J/sec (45,000 Btu/h).
42 Photographs have indicated no surface liquid. The dry well and lateral radiation radioisotope
43 monitoring results have remained stable during the past review period and are the only means
44 of leak detection since the unit contains primarily solids. Radiation levels in dry
45 Well 41-08-04 were substantially reduced in November 1981 when a caisson located between
46 this unit and dry Well 41-08-04 was filled with dirt (WHC 1991a).

1 The tank has six active monitoring wells associated with it (WHC 1991a).

2
3 **2.3.2.2.9 241-SX-109 Single-Shell Tank.** Tank 241-SX-109 actively received waste
4 from September 1955 through 1965. Types of waste include REDOX process high-level
5 waste and supernatant containing REDOX process high-level waste from other tanks in the
6 241-SX Tank Farm. The tank currently contains 37,900 L (10,000 gal) interstitial liquid, no
7 supernatant liquid, and 946,200 L (250,000 gal) of sludge (Hanlon 1991).

8
9 This unit has a known release associated with it, UPR-200-W-142, where approximately
10 20,000 L (5,000 gal) of waste leaked (WHC 1991a).

11
12 The unit is connected to the 241-SX sludge cooler and was interim stabilized in May
13 1981. The estimated heat generation of the solids is 10,300 J/sec (35,000 Btu/h), and the
14 average temperature of the sludge is 72.8°C (163°F). The unit is considered to have a high
15 heat potential for flammable gas accumulation because other 241-SX tanks vent through it
16 (WHC 1991a).

17
18 The unit was removed from service as a "confirmed leaker." Dry wells and laterals are
19 monitored to track the migration of existing radionuclides in the soil. During the review
20 period, radiation levels in dry wells and laterals remained stable with the exception of dry
21 Well 41-09-09, which continues to show a steady increase at the 23 m (74 ft) level. The unit
22 has eight active monitoring wells associated with it (WHC 1991a).

23
24 **2.3.2.2.10 241-SX-110 Single-Shell Tank.** Tank 241-SX-110 actively received waste
25 from November 1960 until 1976. Types of waste include REDOX process high-level waste,
26 concrete, supernatant containing REDOX process high-level waste, PNL waste, B Plant low-
27 level waste, ion exchange waste, evaporator bottoms, and 244-U Building waste from 241-B,
28 -BX, and -SX Tank Farms. The contents of 16 plastic bottles containing the following were
29 added to this unit: natural uranium, depleted uranium, enriched uranium, and ²³⁹Pu. The tank
30 currently contains no interstitial or supernatant liquids; however, it does contain 235,000 L
31 (62,000 gal) of sludge (Hanlon 1991).

32
33 The unit was classified "questionable integrity" in 1976 due to an unexplained liquid
34 level decrease. The unit was connected to the 241-SX sludge cooler in July 1972. The solids
35 have an estimated heat generation rate of 16,000 J/sec (56,000 Btu/h), and an average bulk
36 temperature of 66°C (150°F) (WHC 1991a).

37
38 This unit has nine active monitoring wells associated with it. The dry well and lateral
39 radiation readings remained stable during the review period and are the only means of leak
40 detection since the unit contains solids (WHC 1991a).

41
42 **2.3.2.2.11 241-SX-111 Single-Shell Tank.** Tank 241-SX-111 actively received waste
43 from 1956 until May 1974. Types of waste include REDOX process high-level waste and
44 supernatant containing REDOX process high-level waste and REDOX process ion exchange
45 waste. The tank currently contains 26,500 L (7,000 gal) interstitial liquid, no supernatant
46 liquid, and 473,100 L (125,000 gal) of sludge (Hanlon 1991).

1 **2.3.2.2.12 241-SX-112 Single-Shell Tank.** Tank 241-SX-112 actively received waste
2 from 1959 until 1969. Types of waste include REDOX process high-level waste and
3 supernatant containing REDOX process high-level waste from other tanks in the 241-SX
4 tanks. The tank currently contains 11,400 L (3,000 gal) interstitial liquid, no supernatant
5 liquid, and 348,200 L (92,000 gal) of sludge (Hanlon 1991).
6

7 There is a known release associated with this unit, UPR-200-W-144, when
8 approximately 100,000 L (30,000 gal) of waste was released (WHC 1991a).
9

10 The unit is connected to the 241-SX sludge cooler. The estimated heat generation rate
11 of the sludge is 18,000 J/sec (61,000 Btu/h), and the average temperature of the material is
12 60°C (140°F) (WHC 1991a).
13

14 The tank was removed from service as a "confirmed leaker." The dry well and lateral
15 leak detection radiation readings appeared to be stable during the review period. The tank has
16 seven active monitoring wells associated with it (WHC 1991a).
17

18 **2.3.2.2.13 241-SX-113 Single-Shell Tank.** Tank 241-SX-113 actively received waste
19 from February 1958 until June 1958. Types of waste include REDOX process high-level
20 waste with diatomaceous earth added in 1962 as a stabilizer. The tank currently contains no
21 interstitial or supernatant liquid; however, it does contain 98,400 L (26,000 gal) of sludge
22 (Hanlon 1991).
23

24 This unit had a known release, UPR-200-W-145, when approximately 57,000 L
25 (15,000 gal) of waste was released (WHC 1991a).
26

27 This unit was removed from service as a "confirmed leaker" in 1962. The dry well
28 readings remained stable during the review period. The unit was equipped with five
29 prototype laterals. They have been disassembled and are not serviceable. The unit was
30 stabilized with diatomaceous earth, and photographs indicate that no liquid is present. The
31 tank has three active monitoring wells associated with it (WHC 1991a).
32

33 **2.3.2.2.14 241-SX-114 Single-Shell Tank.** Tank 241-SX-114 actively received waste
34 from November 1956 until 1972. Types of waste include REDOX process high-level waste
35 and supernatant containing REDOX process high-level waste, REDOX process ion exchange
36 waste, and condensate evaporator bottoms from 241-SX tanks. The tank currently contains
37 53,000 L (14,000 gal) interstitial liquid, no supernatant liquid, and 685,100 L (181,000 gal) of
38 solids (Hanlon 1991).
39

40 The unit is now attached to the sludge cooler. The estimated rate of heat generated by
41 the remaining solids is 25,479 J/sec (86,999 Btu/h) and the average temperature of this
42 material is 87°C (190°F). The unit was categorized "questionable integrity" because of dry
43 well activity. The dry well and lateral radiation readings have remained stable during the
44 review period (WHC 1991a). The tank has seven active monitoring wells associated with it
45 (WHC 1991a).
46

1 **2.3.2.2.15 241-SX-115 Single-Shell Tank.** Tank 241-SX-115 actively received waste
2 from September 1958 until 1965. Types of waste include REDOX process high-level waste
3 and supernatant containing REDOX process high-level waste. The tank currently contains no
4 interstitial or supernatant liquids; however, it does contain 45,400 L (12,000 gal) of sludge
5 (Hanlon 1991).
6

7 There was a known release at this unit, UPR-200-W-146, when approximately
8 200,000 L (50,000 gal) of waste was released (WHC 1991a). The unit was removed from
9 service as a "confirmed leaker." Photographs taken in 1974 indicate that no liquid is present.
10 The dry wells and laterals data indicate no changes during the review period. The tank has
11 seven active monitoring wells associated with it (WHC 1991a).
12

13 **2.3.2.3 241-SY Tank Farm.** The 241-SY Tank Farm, northeast of the 241-S Tank Farm,
14 was built between 1974 and 1977 and houses three DSTs, each capable of storing
15 3,785,000 L (1,000,000 gal) (see Figure 2-6). They are the latest in tank farm design with
16 heat-treated, stress-relieved primary liners and a nonstress-relieved outer steel liner, both
17 inside a reinforced concrete shell to provide double containment and ensure complete
18 containment in case of an inner shell leak (Anderson 1990; DOE 1987) and designed to
19 provide containment of radioactive waste for a minimum of 50 years. The primary or "K1"
20 ventilation system removes vapors from the primary tank and maintains a negative internal
21 tank pressure relative to atmospheric pressure. Aboveground piping connects one primary
22 riser from each tank to the tank farm primary exhaust system. The 241-SY Tank Farm has a
23 moisture separator, heater, filter bank, and fan.
24

25 The annulus or "K2" ventilation system is used to cool tanks, minimize moisture
26 condensation in the annular space, and serve as a sensitive method of detecting leakage of
27 radioactivity from the primary tank. In the early 1970s, it was decided that all liquid wastes
28 from SSTS be transferred to DSTs. Prior to transfer, these wastes were concentrated using
29 crystallizer-evaporators, producing a thick slurry ("double-shell slurry") consisting of NaOH,
30 NaNO₃, NaNO₂, NaAlO₂, dissolved organic complexants, and other salts (Reynolds et. al.,
31 1991). The 241-SY Tank Farm is one of the tank farms placed into service specifically for the
32 storage of Z Plant and REDOX process wastes. Tanks 241-SY-101 and -103 store
33 complexant concentrate, and 241-SY-102 Tank stores dilute waste. These tanks have drain
34 channels in the insulating material installed between the steel and concrete in order to carry
35 any leakage to the annular space between the inner and outer liners. Conductivity probes in
36 the annulus and radioactivity alarms in the exhaust system provide leak detection during
37 operation (Anderson 1990). The DSTs discussed below are regulated under RCRA.
38

39 **2.3.2.3.1 241-SY-101 Double-Shell Tank.** Tank 241-SY-101 currently contains
40 897,000 L (237,000 gal) of interstitial liquid, no supernatant liquid, and 2,119,600 L
41 (560,000 gal) of saltcake. The waste type is complexant concentrate waste that consists of
42 concentrated product from the evaporation of dilute complexed waste (Hanlon 1991). The
43 buildup and release of hydrogen gases beneath the saltcake has caused the surface level to
44 fluctuate since 1981, and an investigation concerning the slurry growth is ongoing.
45

1 **2.3.2.3.2 241-SY-102 Double-Shell Tank.** Tank 241-SY-102 currently contains
2 2,157,400 L (570,000 gal) supernatant liquid, no interstitial liquid, and 268,700 L (71,000 gal)
3 of sludge. The waste type is miscellaneous laboratory waste from 222-S, dilute
4 noncomplexed waste, and plutonium finishing plant TRU solids. These wastes are low
5 activity wastes originating from the T Plant and the S Plant Complex, the 300 and 400 Areas,
6 PUREX facility miscellaneous wastes, 100 N Area sulfate waste, B Plant, saltwells, PFP
7 supernatant, and TRU solids from the West Area operations (Hanlon 1991).
8

9 **2.3.2.3.3 241-SY-103 Double-Shell Tank.** Tank 241-SY-103 currently contains
10 651,000 L (172,000 gal) supernatant liquid, no interstitial liquid, and 15,100 L (4,000 gal) of
11 saltcake. The waste type is dilute complexant similar to that in Tank 241-SY-101
12 (Hanlon 1991).
13

14 **2.3.2.4 Catch Tanks.** There are four catch tanks and one vault within the S Plant Aggregate
15 Area. Catch tanks (Figure 2-7) contain less volume than SSTs and are usually associated
16 with diversion boxes and diverter stations. The catch tanks receive leakage from transfer
17 lines, diversion boxes, or nearby pipe encasements. Wastes accumulated in catch tanks are
18 transferred to storage tanks.
19

20 **2.3.2.4.1 240-S-302 Catch Tank.** This unit consists of a catch tank that received low-
21 level mixed wastes from 1950 through 1987. Wastes consisted of dilute laboratory waste
22 containing 0.021 moles per liter (mol/L) sodium; greater than 0.01 mol/L hydroxide; greater
23 than 0.011 mol/L nitrous oxide (NO), and 0.000078 g/L total plutonium. Approximately
24 200,000 L/yr (50,000 gal/yr) were transferred through the 240-S-151 Diversion Box from the
25 222-S Laboratory. Approximately 2,000 L (600 gal), mostly rainwater, were unintentionally
26 released between June 1985 and January 1986 (WHC 1991a). Catch Tank 240-S-302 is an
27 assumed leaker and currently contains 9,000 L (2,380 gal) of waste as determined by FIC
28 gauge and the computer automated surveillance system.
29

30 **2.3.2.4.2 241-S-302A Catch Tank.** Beginning in 1952, the 241-S-302A Catch Tank
31 collected drainage from secondary containment of liquid mixed waste solution transfer routes
32 from processing and decontamination operations. The tank has been removed from service
33 and replaced with 241-S-304A. It was never officially retired, but it is currently inactive.
34 The tank currently contains 200 L (54 gal) of waste and was partially filled with grout in
35 February 1991; however, after a leak test, it was still assumed to be a leaker (Hanlon 1991).
36 All drainage lines have been cut and routed to 241-S-304A. This tank is included in the
37 Hanford RCRA Program.
38

39 **2.3.2.4.3 241-S-302B Catch Tank.** This tank, located west of the 241-S Tank Farm,
40 was used to transfer waste solutions from processing and decontamination operations and
41 currently holds 12,300 L (3,240 gal) of waste. Leak detection and air monitoring are
42 performed continuously within the 241-S Tank Farm. This unit was activated in 1952 and
43 isolated in 1985 (DOE/RL 1992).
44

45 **2.3.2.4.4 241-SX-302 Catch Tank.** Catch Tank 241-SX-302 is an inactive waste unit
46 located on the east side of the 241-SX Tank Farm. The tank was used to transfer waste

1 solutions from processing and decontamination operations from 1954 through 1983. The
2 volume of waste remaining in this tank is currently unknown, as it is not monitored
3 (Hanlon 1991). The unit was isolated in 1985.
4

5 **2.3.2.5 244-S Receiver Tank.** The 244-S Double-Contained Receiver Tank is an
6 active waste unit located 620 m (2,030 ft) northwest of 202-S Building near the 241-S Tank
7 Farm. The unit receives waste solutions from processing and decontamination operations. It
8 contains approximately 41,465 L (10,954 gal) of waste although it has a design capacity of
9 76,768 L (20,280 gal). The tank is situated vertically within a reinforced concrete, steel-lined
10 vault with 0.3 m (1 ft) thick walls. The bottom of the vault is 15 m (50 ft) below grade.
11

12 **2.3.2.6 Vaults.** The 218-W-7 Burial Site is a vault, but due to the 218 designation and the
13 type of waste received by this unit, it is described under burial sites in Section 2.3.9.1.
14

15 **2.3.3 Cribs and Drains**

16
17 There are two main types of underground liquid disposal facilities in the S Plant
18 Aggregate Area: cribs and french drains (Figure 2-8). The S Plant Aggregate Area includes
19 12 cribs and one french drain. Most of the information describing the design and operation
20 of cribs in this section has been extracted from *Waste Disposal into the Ground at Hanford*,
21 by Beard and Godfrey (1967).
22

23
24 Cribs are and have been used extensively to dispose liquid wastes into the subsurface
25 allowing radionuclides to sorb to the soil without exposing them to the surface. This action
26 uses the specific retention of a soil, which is the ratio of the volume of water a soil can retain
27 against gravity drainage to the total volume of the soil. Cribs are shallow excavations that
28 are either backfilled with gravel material or held open by wood structures. The gravel-filled
29 structures provide liquid reservoir capacity and promote even distribution of the waste
30 solutions as they percolate into the vadose zone soil without exposing the waste solutions to
31 the air. Over time, crib designs evolved into configurations that provided greater capacity at
32 reduced cost.
33

34 Cribs constructed since the 1960s consist of long, narrow trenches about 3 m (10 ft)
35 wide at the bottom, filled with a few meters of graded gravel (Figure 2-9). A plastic
36 membrane is placed over the gravel and the trench is backfilled with earth. A single
37 distributor pipe traverses the length of the crib within the gravel bed about a meter above the
38 bottom of the excavation.
39

40 Waste liquids spread laterally as well as vertically from a crib, thus increasing the liquid
41 handling capacity per cubic meter of excavation. The lateral spread must be considered in the
42 location of other cribs in the same general area. The lateral movement of waste from an
43 active crib into an inactive crib could transport retained radioactivity into the ground water
44 below the abandoned crib, since the soil surrounding the inactive crib could be saturated and
45 may not adsorb more radionuclides.
46

1 Section 2.3.3.12 discusses the history of operation of the french drain. The usual design
2 of a french drain is a large perforated pipe, greater than 30 cm (12 in.) in diameter, and less
3 than 12 m (40 ft) deep with a crushed stone filling in the bottom section of the pipe
4 (Figure 2-10). French drains manage potentially contaminated liquid by promoting
5 percolation into the soil.
6

7 **2.3.3.1 216-S-1 and 216-S-2 Cribs.** The 216-S-1 and -2 Cribs were constructed in 1950 and
8 1951. Design of the crib is illustrated in Figure 2-6. The crib is located approximately
9 430 m (1,400 ft) northwest of 202-S Building (Figure 2-8). The bottom of the excavation is
10 approximately 10 m (34 ft) below grade with bottom dimensions of 12 x 27 m (40 x 90 ft)
11 and 45-degree side slopes. The bottom 3 m (10 ft) were filled with screened, crushed stone
12 greater than 1.3 cm (0.5 in.) in diameter. Two open-bottomed, square, wooden crib boxes,
13 3.7 m (12 ft) on a side and 2.9 m (9.5 ft) high, were placed 1.8 m (5.9 ft) into the gravel
14 layer. The crib boxes were constructed with 15 x 15 cm (6 x 6 in.) timbers and cross braces
15 (DOE/RL 1992). The two crib boxes were connected in series with overflow from the S-1
16 Box flowing into the S-2 Box via a pipe. The crib dimensions are 27 x 12 x 11 m (90 x 40 x
17 35 ft). The radionuclides suspected to have been disposed here include ¹³⁷Cs, ¹⁰⁶Ru, and ⁹⁰Sr.
18 Suspected inorganics of concern include aluminum, nitrate, nitrite, nitric acid, and sodium.
19

20 Before the facility was put into service, three vadose zone (unsaturated) monitoring
21 wells, 299-W22-1, -2, and -3, were drilled to a depth of 45 m (150 ft). The 216-S-1 and -2
22 facility received cell drainage waste from the D-1 Receiver Tank and redistilled condensate
23 from the D-2 Receiver Tank located in 202-S Building. Waste was discharged to the crib in
24 batches of about 19,000 L (5,000 gal) at an average rate of 10 batches per day. The crib was
25 in service from January 1952 to January 1956 and received approximately 160,000 kiloliters
26 (kL) (4.2 x 10⁷ gal) of liquid waste. Radiological monitoring in September 1976 detected up
27 to 60,000 c/min on Russian thistle at these cribs.
28

29 Well 299-W22-3, one of the three original monitoring wells, was deepened from 45 to
30 93 m (150 to 310 ft) and perforated from 63 to 93 m (210 to 310 ft) in January 1955 to
31 provide a ground water monitoring well for the crib. In June 1955, the well was found to
32 contain liquid waste within 15 m (49 ft) of the ground surface. Waste had flowed to the
33 bottom of the well and into the saturated sediments around the well. An examination of
34 driller's logs for this well shows that two welds in the casing are located within 1 m (3 ft)
35 from the bottom of the crib. Either weld could have provided an entry point for wastes to
36 flow into the well, but the acid waste is suspected of corroding through the casing
37 (WHC 1991a). Early in August 1955, Well 299-W22-3 was filled with sand, and in January
38 1956, the crib was removed from service. The pipeline to the crib was capped at the 241-S-
39 151 Diversion Box and the pipeline effluent was rerouted to the 216-S-7 Crib.
40

41 This release is covered under Subsection 2.3.10, UPR-200-W-36 Unplanned Release.
42

43 Drilling of ground water monitoring wells inside the crib did not resume until after the
44 crib was removed from service. Therefore, no monitoring data regarding soil or ground water
45 radionuclide concentrations were obtained for this facility until the deep-well drilling program
46 of 1955 (216-S-2 and 216-S-Z cribs). Core samples taken from wells drilled in the vicinity

1 of the 216-S-1 and -2 cribs in 1966 indicated that greater than 99.9% of the ^{137}Cs and ^{90}Sr
2 discharged there was contained in the 16 x 33 ft. zone below the cribs (Maxfield 1979).
3 Small, but measurable, amounts of these isotopes were detected at greater depths. Soil
4 samples near the water table contained up to 1.2×10^{-3} μCi of $^{90}\text{Sr}/\text{g}$.
5

6 The 216-S-1 and -2 crib site was studied to determine the 1980 radionuclide
7 distributions in the crib sediments. The only gamma-emitting radionuclide widely distributed
8 at levels greater than 10 nCi/g is ^{137}Cs . The ^{137}Cs concentrations were highest at and just
9 below the bottom of the crib and decreased rapidly with depth. The deepest penetration of
10 ^{137}Cs was beneath the S-2 portion of the crib. The ^{137}Cs activity between 1 and 10 nCi/g was
11 detected at approximately 60 in the original monitoring wells, but this was attributed to
12 contamination fixed on the casing and not on the sediments. A zone of contamination
13 exceeding 10 nCi/g was detected in the saturated sediments directly beneath the crib. The
14 source of this contamination was a monitoring well discussed under unplanned release UPR-
15 200-W-36. This contamination was limited to within 20 laterally from the release point. As
16 a result of this release, ^{90}Sr was detected in sediment samples below the unsaturated zone
17 (Van Luik et al. 1982).
18

19 Scintillation profile comparisons indicated that, except for ^{106}Ru decay, there has been
20 little change in the total gamma radiation profiles since 1958. Differences in these profiles
21 since the late 1960s appear to reflect only random and systematic errors and provide no
22 evidence for translocations of the gamma-emitting radionuclides since 1958 (Van Luik et al.
23 1982).
24

25 Examination of scintillation profiles from the deepened wells indicated that some
26 contamination was fixed on the well casing and was moved deeper into the profile before
27 driving the casing deeper. This could produce erroneous interpretation of borehole logging
28 data if not taken into consideration (Van Luik et al. 1982).
29

30 Since gamma spectroscopic results show that the greater part of the gamma activity in
31 this crib comes from ^{137}Cs , the results of the scintillation probe were compared with ^{137}Cs .
32 Note that these two methods do not see the same effective volumes, and differ in sensitivity.
33 This comparison showed that when the scintillation probe is saturated at about 2.4×10^6
34 counts/min, the corresponding ^{137}Cs concentration is approximately 10 nCi/g. Only the
35 10-meter zone directly below the crib was found to be contaminated with ^{137}Cs greater than
36 10 nCi/g, except for a well near the S-Z portion of the crib, where ^{137}Cs at that concentration
37 of 10 nCi/g was found to have penetrated to 20 meters beneath the crib bottom. The reason
38 for the difference is most likely that the bottom of the 216-S-1 and -2 crib excavation was
39 sloped (2 percent) toward and past this well, causing more of the waste solution to percolate
40 in this lower part of the excavated area (Van Luik et al. 1982). The only conclusion that may
41 be drawn from the available data is that beta contamination levels have been stable since
42 1970, and appear to be slowly decreasing, especially over the last several years (Van Luik
43 et al. 1982).
44

45 The presence of contaminated sediments 2 to 4 feet below ground surface presents a
46 potential for plant or animal intrusion. For this reason, herbicides have been applied to the

1 site annually to prevent plants from growing on the site. At this time, there is no evidence of
2 plant or animal penetration into the waste and the near-surface contamination is posing no
3 radiological control problems (Van Luik et al. 1982). A large exclusion zone encompasses
4 Cribs 216-S-1 and -2 and the 216-S-8 trench. A light chain barricade with surface radiation
5 contamination warning signs surround the area. This unit is included in the RARA Program.
6

7 **2.3.3.2 216-S-5 Crib.** The inactive 216-S-5 Crib is located 914 m (3,000 ft) southwest of
8 the 207-S Retention Basin (Figure 2-8). The crib operated from March 1954 to March 1957
9 and was built as a replacement for the contaminated 216-S-17 pond. This crib received
10 4,100,000 kL (1.1×10^9 gal) of acidic process vessel cooling water and steam condensate
11 from 202-S Building via a 61 cm (24 in.) polyvinyl chloride waste supply line. This waste
12 was acidic (DOE/RL 1992). The radionuclides assumed to be present are ^{106}Ru , ^{90}Sr , and 137
13 Cs. However, ^{106}Ru has such a short half life that it may not be present in quantifiable
14 activities beneath this crib and all of the cribs in this section. Nitrate is the only inorganic
15 nonradioactive constituent of concern suspected to have been disposed at this crib (WHC
16 1991a).

17
18 This unit was deactivated because of insufficient capacity and a series of vessel coil
19 failures, which resulted in operational problems and surface contamination. An area just
20 south of this crib between the 216-S-17 pond and 216-S-10D ditch was used as an overflow
21 for effluent volumes exceeding the capacity of the crib. The 216-S-6 crib discharged to this
22 area in May 1956. Samples of the overflow water indicated gross beta emitter concentrations
23 in the 10^{-5} $\mu\text{c}/\text{cc}$ range. After the area dried in June 1956, contamination levels on the
24 surface were recorded up to 50,000 c/min in some areas with general levels of 10,000 c/min.
25 A surface radiological survey of the overflow area, after a September 1956 discharge,
26 detected levels of radioactivity increasing at a rate of 5 to 100 mR/h at the pond edge and
27 averaging 350 mR/h with localized spots up to 17 mR/h at the pond interior (Maxfield 1979).
28

29 The crib was deactivated by valving out and locking the pipeline to the unit when the
30 top of the crib began to cave in. The effluent was rerouted to the 216-S-6 Crib and 216-S-16
31 Pond. Four cave-ins in the 216-S-5 crib zone were filled in 1974. The site dimensions are
32 $64 \times 64 \times 4.6$ m ($210 \times 210 \times 15$ ft). The unit contains approximately $12,488 \text{ m}^3$
33 ($16,333 \text{ yd}^3$) of gravel fill. Approximately $13,000 \text{ m}^3$ ($17,000 \text{ yd}^3$) of contaminated soil and
34 $12,000 \text{ m}^3$ ($16,000 \text{ yd}^3$) of overburden soil are present at this unit. The unit surface was
35 stabilized on August 24, 1990 (WHC 1991a).
36

37 These vadose zone boreholes (299-W26-1, -4 and -5) and one groundwater monitoring
38 well (299-W26-3) are used to monitor this crib (Plate 3). The radionuclides are held high in
39 the sediment beneath the crib; therefore, data in WIDS indicates that breakthrough to ground
40 water is unlikely to have occurred in this area (WHC 1991a).
41

42 This unit has no barricade, but there are concrete marker posts surrounding it with metal
43 plates labeling the site. The surface is sand with no vegetation. The unit does have
44 underground radiation contamination warning signs. This unit is included in the RARA
45 Program.
46

1 2.3.3.3 216-S-6 Crib. The inactive 216-S-6 Crib is located 1,112 m (3,648 ft) southwest of
2 202-S Building (Figure 2-8) (Maxfield 1979). The crib started receiving waste in November
3 1954 and stopped receiving waste in July 1972. The crib has received a total of 4,470,000 kL
4 (1.18×10^9 gal) of low salt, neutral/basic liquid waste (DOE/RL 1992). Up to June 1967, the
5 site received the process vessel cooling water and steam condensate from 202-S Building.
6 From June 1967 to July 1967, production operations were shut down and S Plant was put on
7 standby. After July 1967, the crib received the steam condensate from the D-12 and D-14
8 waste concentrators in S Plant Complex. In a March 1980 radiological survey, levels from
9 400 to 1500 c/min were detected on rabbitbrush plants and levels of 3,000 c/min were
10 detected in a depression at the northeast corner of the crib. The highest level of contamination
11 detected on rabbitbrush plants was 4,000 c/min. The radionuclides suspected include ^{137}Cs ,
12 ^{90}Sr , and ^{106}Ru . Nitrate is the only inorganic radioactive constituent of concern suspected to
13 have been disposed at this crib (WHC 1991a).
14

15 In September 1955, the 216-S-6 cribs operated at greater than capacity most of the
16 month, and some grade level seepage was observed. Temporary relief was provided by
17 blading a small corner from the 216-S-6 crib and providing a run-off ditch area, rather than
18 allow the cavern water to seep through the roof and damage the roof seal. No water
19 overflowed to this area and no contamination was detected (Maxfield 1979).
20

21 This unit was constructed as part of the Segregation Project to segregate high-level from
22 low-level radioactive contaminated condensates and cooling water. The high potential
23 condensate was sent to this unit, and the low potential condensate was sent to the 216-S-5
24 Crib (WHC 1991a).
25

26 The site is 64 x 64 x 4.6 m (210 x 210 x 15 ft). The unit is filled with approximately
27 89,000 m³ (120,000 yd³) of gravel fill. Approximately 13,000 m³ (17,000 yd³) of
28 contaminated soil and 12,000 m³ (16,000 yd³) of overburden soil are also contained at this
29 site. Waste distribution lines are 2 m (7 ft) below the surface. The risers are 0.6 m (2 ft)
30 below the surface. The unit surface was stabilized in September 14, 1990 (WHC 1991a).
31

32 The site has no barricade, but there are concrete monuments surrounding the site with
33 metal plates marking it as the 216-S-6 Crib. The unit is labeled with underground radiation
34 contamination warning signs. There is no vegetation and the surface is sand and gravel at
35 grade. The 2904-S-171 Control Structure is adjacent at the north boundary of the site. This
36 unit is included in the RARA Program.
37

38 2.3.3.4 216-S-7 Crib. The inactive 216-S-7 Crib is located northwest of S Plant
39 (Figure 2-8). The crib became operable in January 1956 and was retired in July 1965. Until
40 April 1959, the crib received cell drainage from the D-1 Receiver Tank, process condensate
41 from the D-2 Receiver Tank, and condensate from the H-6 condenser in the 202-S Building.
42 After April 1959, the H-6 condenser condensate was rerouted to underground storage
43 (DOE/RL 1992). The crib received a total of 390,000 kL (1.0×10^8 gal) of waste
44 (WHC 1991a). The site dimensions are 30 x 15 x 7 m (100 x 50 x 22 ft) and consist of two
45 4.9 x 4.9 x 1.5 m (16 x 16 x 5 ft) wooden structures 10 m (34 ft) apart in one excavation.
46 The wooden structures are suspended in gravel fill and covered with 4.6 m (15 ft) of dirt.

1 Results of a surface radiological survey conducted in September 1976 indicated a general
2 background radiation level of 300 c/min (Morton 1980). The same study also noted that
3 1,000 c/min was detected on a Russian thistle. Suspected radionuclides include ¹³⁷Cs, ⁹⁰Sr,
4 and ¹⁰⁶Ru, and suspected inorganics of concern include nitrate, nitric acid, sodium, and
5 aluminum nitrate (WHC 1991a).
6

7 When the crib was retired, the D-1 waste was rerouted to REDOX process concentrators
8 for boil-down and discharge to underground storage. D-2 waste went to the 216-S-9 Crib.
9 This crib was deactivated by sealing the pipeline to the unit at the northwest corner of S Plant
10 Complex perimeter fence. Surveillance indicates that the wooden structure may collapse and
11 prompt remedial action will be required to prevent the spread of contamination and to correct
12 other hazards (WHC 1991a).
13

14 Monitoring wells W22-13A and W22-14A were installed 8 m (25 ft) southeast and
15 southwest of the crib, respectively, and were drilled to a depth of 65 m (212 ft) in 1966
16 (Maxfield 1979). Radiochemical analyses of core samples collected during well installation
17 showed ¹³⁷Cs and ⁹⁰Sr detections at maximum values of 13 µCi/g and 6.1 µCi/g, respectively.
18 The maximum ¹³⁷Cs value was recorded at 6 m (21 ft), while the maximum ⁹⁰Sr value was
19 detected at 15 m (50 ft) (Maxfield 1979). Groundwater was at a depth of 62 m (202 ft) at
20 the time the wells were installed and a sample collected from well W22-14A showed ⁹⁰Sr at a
21 level of 7.8×10^{-7} µCi/ml (Maxfield 1979).
22

23 Groundwater monitoring Wells 299-W22-12, -13, -14, and -32 monitor this unit. No
24 measurable migration of radionuclides has been detected beneath the crib since waste disposal
25 was terminated; however, discharge of radionuclides to the ground water could have occurred
26 at this unit (WHC 1991a).
27

28 A double light chain barricade encircles the unit; the outer chain surrounds the entire
29 area with underground radiation contamination signs, and the inner chain, with underground
30 radiation and potential cave-in warning signs, surrounds each of two riser vents. There is also
31 a concrete marker post at the unit. The vent risers appear to have cooling fins on them. In
32 1991, the surface was stabilized with sand and gravel approximately 61 cm (24 in.) above
33 grade. This unit is included in the RARA Program.
34

35 **2.3.3.5 216-S-9 Crib.** The inactive 216-S-9 Crib is located east of the 241-S and 241-SY
36 Tank Farms (Figure 2-8). The crib came into operation in July 1965 and was retired in
37 January 1969. The unit dimensions are 91 x 9.1 x 9.1 m (300 x 30 x 30 ft) with a 1:1.5
38 slope, and the entire distribution system is 6.4 m (21 ft) below grade. Waste flowed into the
39 unit through the distribution system, which consists of 177 m (581 ft) of 15 cm (6 in.)
40 diameter vitrified clay perforated pipe in a U shape, 4.6 m (15 ft) by 90 m (295 ft) and
41 connected by 7.3 m (24 ft) of 7.6 cm (3 in.) schedule 10 pipe in a Y shape (DOE/RL 1992).
42 The crib received 50,300 kL (1.33×10^7 gal) of process condensate from the D-2 Receiver
43 Tank in the 202-S Building. The waste was acidic and composed mainly of nitric acid. A
44 September 1976 surface radiological survey indicated no contamination above 200 c/min
45 (Morton 1980). The radionuclide constituents known included ³H, ⁹⁰Sr, ⁶⁰Co, ¹⁰⁶Ru, ¹³⁷Cs,

1 ²³⁹Pu, ²⁴⁰Pu, and ²³⁸U (WHC 1991a). Unplanned release UPR-200-W-108 is associated with
2 this unit and is discussed separately.
3

4 The crib was retired when it reached prescribed radionuclide limits. The waste was
5 rerouted to the 216-S-13 Crib. The crib was deactivated by sealing the pipeline at the south
6 end of the unit (WHC 1991a).
7

8 Groundwater monitoring Wells 299-W-22-26A and -27A were drilled to depths of 66 m
9 (215 ft) next to this unit in 1966 to determine the radionuclide distribution below the unit.
10 Only low-levels of ⁹⁰Sr (about 10⁻⁵ µCi/g) were detected in a perched water zone at 43 m
11 (140 ft) in Well 299-W-22-26A (Maxfield 1979). Wells 299-W-22-25, -26, -34, and -35
12 presently monitor this unit. Data indicates that breakthrough to ground water could have
13 occurred at this unit (WHC 1991a).
14

15 The unit is surrounded by a light chain barricade with both surface and underground
16 radiation contamination warning signs. There are three steel risers at the crib but there are no
17 permanent concrete markers. The unit dimensions are 12 x 12 x 10 m (40 x 40 x 34 ft) with
18 one 3.7 x 3.7 x 2.7 m (12 x 12 x 9 ft) wooden structure that is gravel filled. The top of the
19 structure is 6 m (20 ft) below grade. The surface is sand and gravel with heavy vegetation.
20 This unit is included in the RARA Program.
21

22 **2.3.3.6 216-S-13 Crib.** The inactive 216-S-13 Crib is located directly west of
23 202-S Building (Figure 2-8). The crib was built in January 1952 and closed in July 1972.
24 Until June 1967, the crib received liquid waste from the 203-S Decontaminated Metal Storage
25 Facility and 204-S Uranyl Nitrate Hexahydrate Facility, and the 276-S Organic Solvent Make-
26 up Facility (DOE/RL 1992). After June 1967, the crib received occasional sump waste from
27 the 204-S Uranyl Nitrate Hexahydrate Facility. The unit is a 3.6 x 3.6 x 2.7 m (12 x 12 x
28 9 ft) wooden structure, approximately 366 m (1,200 ft) of 15 x 20 cm (6 x 8 in.) lumber
29 enclosed on four sides by 2.5 cm (1 in.) sheathing with an open bottom and 1:1 side slope.
30 The top of the structure is located 6 m (20 ft) below grade (DOE/RL 1992). The unit
31 received a total of 5,000 kL (1.3 x 10⁶ gal) of waste. The waste is low-salt, neutral/basic,
32 and mainly composed of nitrate, sodium, and sodium dichromate. A surface survey
33 conducted in September 1976 indicated no contamination above 200 c/min (Morton, 1980).
34 The radionuclides suspected in the waste included ⁶⁰Co, ¹⁰⁶Ru, ⁹⁰Sr, and ¹³⁷Cs. Inorganics
35 suspected at this unit include nitrate, sodium, and sodium dichromate. The only organic
36 believed to be present is MIBK (WHC 1991a).
37

38 The 216-S-13 Crib has been stabilized and posted as underground radioactive material
39 (Huckfeldt 1991). The surface is sand and gravel at grade. The crib has a wooden structure
40 that may collapse (Maxfield 1979). An encasement leads to the crib from 296-S-12.
41 Groundwater monitoring Well 299-W22-12 is east of this crib. This unit is included in the
42 RARA Program.
43

44 **2.3.3.7 216-S-20 Crib.** The inactive 216-S-20 Crib is located 93 m (300 ft) southeast of the
45 222-S Laboratory (Figure 2-8). The crib was placed in operation in January 1952 and retired
46 in May 1973. The unit contains two 3.7 x 3.7 x 2.7 m (12 x 12 x 9 ft) wooden structures,

1 15 m (50 ft) apart, with the top of each being 5.2 m (17 ft) below grade and has a side slope
2 of 1:1. The bottom of each wooden structure is suspended in a gravel fill 1.2 m (4 ft) above
3 the bottom of the unit (DOE/RL 1992). The unit received 135,000 kL (3.57×10^9 gal) of
4 waste. Until July 1953, the crib received miscellaneous waste from laboratory hoods and
5 decontamination sinks in S Plant via a 219-S retention building. From July 1953 to
6 September 1963, the crib received the above effluent via pipelines from the 207-SL Retention
7 Basin and 219-S Retention Building and 300 Area laboratory waste via a tanker truck by
8 mode of a manhole located south of the unit. From September 1963 to January 1969, the crib
9 received miscellaneous waste from laboratory hoods and decontamination sinks in the 222-S
10 Laboratory via the 219-S Retention Building. After January 1969, 300 Area laboratory
11 wastes were rerouted to the 216-T-28 Crib. From January 1969 to November 1972, the unit
12 was inactive due to the ground caving in above the unit. The pipelines were valved out from
13 the unit in 219-S and at the 207-SL Retention Basin and the 222-S Laboratory effluent
14 rerouted to 202-S Building concentrators for boildown and discharge to the underground
15 storage. After November 1972, the ground was filled in.

16
17 The unit has had a history of subsidence. Since the completion of stabilization
18 December 13, 1974, the sink holes have been filled on three different occasions with several
19 cubic yards of fill dirt. It is doubtful that any cavities remain below the ground surface
20 (Maxfield 1979).

21
22 The unit is monitored by nearby groundwater Well 299-W22-20. Data indicate that
23 radionuclide breakthrough to groundwater has not occurred. Levels up to 5000 c/min were
24 detected on vegetation during a September 1976 radiological survey at this unit. The isotopes
25 suspected to be present include ^{137}Cs , ^{106}Ru , and ^{90}Sr . The only inorganic constituent in the
26 received waste was nitrate (WHC 1991a).

27
28 The outer area of the crib is barricaded with a light chain with surface contamination
29 warning signs and a concrete post marker. The surface is sand and gravel with a slight
30 depression around the riser vents. Within the outer barricade are two inner barricades around
31 each of the crib metal riser vents. These inner chains have underground radiation
32 contamination and cave-in potential warning signs. The area has very little vegetation. This
33 unit is included in the RARA Program.

34
35 **2.3.3.8 216-S-22 Crib.** The inactive 216-S-22 Crib is located approximately 200 m (500 ft)
36 east of 202-S Building (Figure 2-8). The unit became operable in October 1957 and was
37 closed in June 1967. The crib dimensions are 30 x 1.1 x 3 m (100 x 3.5 x 10 ft) and the unit
38 is 2 m (7 ft) below grade. The crib is a gravel filled structure with a side slope of 1:1:5. A
39 10 cm (4 in.) vitrified clay pipe enters the unit 2.1 m (7 ft) below grade, branches out at right
40 angles downwards to the bottom, and runs along the bottom for the length of the unit. The
41 pipe has open joints along the entire section of the bottom (DOE/RL 1992). The crib
42 received 98,000 L (26,000 gal) of liquid waste containing nitrate and sodium from the acid
43 recovery facility in the 293-S Building. The unit was retired when production operations
44 were shut down at the S Plant Complex. The inlet piping in the 293-S Building was blanked
45 (WHC 1991a).

1 The crib is monitored by Well 299-W22-19. Data indicate that breakthrough to ground
2 water has not occurred at the unit. A September 1976 surface radiological survey indicated
3 no contamination above 200 c/min. The isotopes suspected include ¹³⁷Cs, ¹⁰⁶Ru, and ⁹⁰Sr.
4 Suspected inorganics include nitrate and nitric acid (WHC 1991a).
5

6 The unit is surrounded by a single light weight chain with signs warning of
7 underground radiation contamination. Inside the chain are two riser vents; one is capped.
8 The surface is composed of sand and gravel with no obvious signs of subsidence. This unit is
9 included in the RARA Program.
10

11 **2.3.3.9 216-S-23 Crib.** The inactive 216-S-23 Crib is located northeast of the 241-SY Tank
12 Farm and north of 216-S-9 Crib (Figure 2-8). The crib became operable in January 1969 and
13 was closed in July 1972. The crib dimensions are 110 x 3 x 8.2 m (360 x 10 x 27 ft) with a
14 side slope of 1:1 and approximately 122 m³ (4300 ft³) of gravel fill. A 15 cm (6 in.) inside
15 diameter perforated pipe runs the length of the unit 0.3 m (1 ft) from its base (DOE/RL
16 1992). The crib received 34,100 kL (9.0 x 10⁶ gal) of process condensate from the D-2
17 Receiver Tank in 202-S Building. The waste was low salt and neutral/basic (DOE/RL 1992).
18 A September 1976 surface radiological survey indicated no contamination above 200 c/min.
19 The radionuclides suspected in the waste included ⁶⁰Co, ⁹⁰Sr, ¹⁰⁶Ru, and ¹³⁷Cs. The only
20 inorganic suspected at this site is nitric acid (WHC 1991a). Ground water monitoring wells
21 299-W19-5, -W19-6, -W22-37, and -W22-38 monitor this site. Data indicate that
22 radionuclide breakthrough to groundwater has not occurred at this unit (WHC 1991a).
23

24 There is a light chain barricade surrounding the area with surface and underground
25 contamination warning signs. The unit has two metal risers, and a stubbed pipe from the
26 216-S-9 Crib. The surface is sand and gravel at grade and has little vegetation. The
27 barricade for the UPR-216-W-30 unplanned release is adjacent to this unit. This unit is
28 included in the RARA Program.
29

30 **2.3.3.10 216-S-25 Crib.** The active 216-S-25 Crib is located 850 m (2,800 ft) northwest of
31 the 202-S Building (Figure 2-8). The unit began operation in November 1973 and received
32 242-S evaporator process steam condensate through November 1980. Since November 1980,
33 the 242-S evaporator has been in standby mode, and the crib has only received 241-SX Tank
34 Farm cooling water. The crib has received approximately 300,000 kL (8.0 x 10⁷ gal) of
35 liquid waste. Results of a radiological survey conducted in March 1980 noted activity levels
36 of from 400 to 1200 c/min on Russian thistle that had blown onto this unit (Morton 1980).
37 The radionuclides assumed to be present are ¹³⁷Cs, ⁹⁰Sr, ³H, and ¹⁰⁶Ru. Nitrate is the only
38 other inorganic constituent of concern known to be present (WHC 1991a).
39

40 The unit dimensions are 175 x 3 x 3 m (575 x 10 x 10 ft). A distribution pipe is
41 approximately 2 m (7 ft) below grade. The site contains 1,200 m³ (41,000 ft³) of gravel,
42 1,100 m³ (1,400 yd³) of contaminated soil, and 2,600 m³ (3,400 yd³) of overburden soil. The
43 unit has three monitoring ground water wells associated with it: 299-W23-9, 299-W23-10,
44 299-W23-11 (WHC 1991a).
45

1 The crib has a light chain barricade posted with underground radiation contamination
2 warning signs. A metal sign on a fence post is labelled "216-25 -S" [sic]. There are three
3 metal vents rising from the crib. There is abundant vegetation growing on the sandy gravel
4 surface. The surface is about 30 cm (12 in.) above grade.
5

6 **2.3.3.11 216-S-26 Crib.** The active 216-S-26 Crib is located 150 m (500 ft) southeast of the
7 222-S Laboratory, and was activated in October 1984 (Figure 2-8) (WHC 1991a). The
8 dimensions are 128 x 3 x 3.7 m (420 x 10 x 12 ft) and a 15 cm (6 in) vitrified clay,
9 perforated distribution pipe runs the length of the unit, 0.5 m (1.5 ft) above the bottom of the
10 unit. Gravel lining the bottom measures 0.8 x 0.5 x 7.6 m and is covered with a membrane
11 barrier and 2.9 m (9.5 ft) of soil (DOE/RL 1992). Facility inspections performed on April 27,
12 1990 showed little deep rooted vegetation and more short rooted grasses on the 216-S-26 crib.
13 Between October 1984 and December 1988, the crib received 151,000 kL (4.02 x 10⁷ gal) of
14 steam condensate, equipment cooling water and sink wastes, which are byproduct radioactive
15 wastes from the 222-S Laboratory, 222-SA Chemical Standards Laboratory, and 291-S Stack
16 Complex via the 207-SL Retention Basin and an addition of 2,340 kL/month between October
17 1989 and March 1990 (WHC 1990). The wastes contain a variety of chemicals, including
18 acetone, nitrate, nitric acid, and lesser amounts of sulfuric and hydrofluoric acids
19 (WHC 1991a). The crib also received three or more 4,200 L (1,100 gal) tanker discharges of
20 Z Plant caustic flushwater with pH of 12.5. After receiving these wastes percolation
21 decreased and has been a problem since that time.
22

23 The 222-S Laboratory has been forced to temporarily divert wastes to the 216-S-10D
24 Ditch in lieu of shutting down due to procedural and operating specification liquid level
25 exceedances. During the 1988 shutdown remedial measures were discussed to improve
26 infiltration.
27

28 During the week of October 20, 1984, an unnamed spill occurred at the 222-S
29 Laboratory resulting in the release of water contaminated with ⁹⁰Sr to the 207-SL Retention
30 Basin. Concentrations averaged two to three times the ⁹⁰Sr guide, but did not exceed the
31 DOE Administrative Control Limit standards. The water was released to the 216-S-26 Crib
32 (WHC 1991a).
33

34 Data from the nearby 299-W27-01 ground water monitoring well indicates alpha
35 radiation and total uranium remain above the ²³⁸U concentration limit (WHC 1991a). The
36 radionuclides suspected at the crib are ²³⁸U, ²⁴¹Am, ¹³⁷Cs, ²³⁹Pu, and ⁹⁰Sr (WHC 1991a).
37

38 There are two steel pipes rising about 61 cm (24 in.) above grade. One riser is a vent
39 at the downstream end of the crib and the other riser is a liquid level riser approximately
40 one-third of the way from the headend of the crib. There is a manhole at the west end of
41 216-S-26 Crib that appears to be astride the waste line that runs south to the 216-S-19 Pond.
42 The unit is posted "underground radioactive material" and the manhole is posted "surface
43 contamination."
44

45 The RCRA, RARA and HSFP program and the Tri-Party Agreement have been
46 reviewed and this unit is not included under these programs.

1 **2.3.3.12 216-S-3 French Drain.** The inactive 216-S-3 French Drain is located east of the
2 241-S Tank Farm (Figure 2-8). The drain began operation in September 1953 and was closed
3 in August 1956. The unit consists of two structures, each with 3 x 3 m (10 x 10 ft) bottom
4 surface dimensions, spaced 15 m (50 ft) apart and 1.8 m (6 ft) deep. The french drain
5 received 4,000 kL (1.06 x 10⁶ gal) of condensate from condensers on the 241-S-101 and
6 241-S-104 Tanks in the 241-S Tank Farm (DOE/RL 1992). The waste is low salt and
7 neutral/basic. Suspected inorganics at the drain are nitrate, sodium, sodium aluminate, sodium
8 dichromate, and sodium hydroxide. Suspected radionuclides are ¹³⁷Cs and ⁹⁰Sr (WHC 1991a).
9 Analytical results of condensate samples taken in 1953 indicated that 95% of the radioactivity
10 present was due to Zr and Nb (Maxfield 1979). It was postdated that decay of these two
11 elements would have been nearly complete at the time the referenced report was written
12 (Maxfield 1979). A September 1976 survey did not detect any beta/gamma contamination
13 above 200 c/min.
14

15 The unit was deactivated by removing the aboveground piping in the tank farm to the
16 crib when the tank air condensers were reactivated (WHC 1991a).
17

18 The unit is not directly accessible due to a lightweight chain barricade surrounding the
19 area at some distance. This barricade is the zone around the UPR-216-W-30 Unplanned
20 Release, which is discussed separately. There are surface and underground radiation
21 contamination warning signs marking the area. This unit is included in the RARA Program.
22 A diagram of a typical french drain is depicted in Figure 2-10.
23

24 **2.3.4 Reverse Wells**

25 A reverse well (dry well) is a buried or covered, encased, drilled hole with a perforated
26 or open lower end of the pipe to allow seepage of liquid to the ground. Reverse wells were
27 used in various areas on the Hanford Site, but none exist in the S Plant Aggregate Area.
28
29
30
31

32 **2.3.5 Ponds, Ditches, and Trenches**

33 Locations of ponds, ditches, and trenches are depicted in Figure 2-11. There are three
34 ditches, four trenches, and six ponds discussed in this section.
35
36

37 **2.3.5.1 Ponds.** Ponds were used to manage large quantities of water (i.e., cooling water and
38 steam condensate) associated with chemical processing operations. These liquid effluents
39 normally consisted of low-level mixed waste (<5 x 10⁻⁵ μCi/ml of mixed radioactivity of a
40 spectrum typical of that in irradiated fuels 100-200 days after reactor discharge), and the
41 pond's function was to promote percolation of the liquid effluent into the subsurface (Beard
42 and Godfrey 1967). All of the ponds are inactive and have been backfilled with soil. Ponds
43 were used to manage liquids from the process facilities.
44

45 **2.3.5.1.1 216-S-10P Pond.** The inactive 216-S-10P Pond is located approximately
46 1,300 m (4,300 ft) southwest of the 202-S Building and covers approximately 20,300 m²

1 (218,000 ft²) (Figure 2-11). The pond started operation in February 1954 and closed in
2 October 1984 (WHC 1991a). Until 1965, the pond received the chemical sewer waste from
3 S Plant Complex and overflow from the high water tower via the 216-S-10D Ditch. In the
4 1960s, the pond received bearing cooling water from the S Plant Complex. The pond has
5 received a total of approximately 7,100,000 L (1,900,000 gal) of liquid waste (WHC 1991a).
6 Very little, if any, radioactivity remains in the pond although a few locations of surface
7 contamination may exist as a result of windblown Russian thistles from the 216-S-17 Pond.
8 An area between the 216-S-10D Ditch and 216-S-17 Pond and south of the 216-S-5 Crib
9 overflow area, is posted "surface contamination." The contamination in the posted area was
10 also transported by Russian thistles. The unit has been backfilled and was stabilized in
11 October 1984.

12
13 This unit has a light chain barricade and has regularly spaced concrete monuments with
14 brass plates that state that 216-S-10, -11, and -17 Ponds are all contained within the barricade.
15 Underground radiation contamination warning signs surround the entire area. The present
16 surface is 31 to 61 cm (12 to 24 in.) above grade and has been seeded with grass. The
17 marker post does not distinguish between the 216-S-10D Ditch and 216-S-10P Pond. This
18 unit is included in the Hanford RCRA Program.

19
20 **2.3.5.1.2 216-S-11 Pond.** The inactive 216-S-11 Pond is located approximately 940 m
21 (3,100 ft) southwest of the 202-S Building and covers approximately 6,040 m² (65,000 ft²)
22 (Figure 2-11). There are actually two ponds, and one overflows into the other. The pond
23 began operation in May 1954 and closed in August 1965. The pond received waste from air
24 conditioning drains and chemical sewer waste from 202-S Building via the 216-S-10D Ditch.
25 In August 1965, the 216-S-10D Ditch to this unit was dammed, diverting all building effluent
26 to the 216-S-10P Pond. A total of 2,230,000 kL (5.89 x 10⁸ gal) of liquid waste were
27 discharged to this unit. Radionuclides suspected in the waste water included ¹³⁷Cs, ⁹⁰Sr, and
28 ¹⁰⁶Ru (WHC 1991a).

29
30 The two small ponds were dug to provide additional leaching surface to dispose water
31 from the 216-S-10D Ditch. The pond inlets from the ditch were cut somewhat above the
32 level of the 216-S-10D Ditch bottom so that the ponds would dry whenever the water in the
33 216-S-10D Ditch receded and would fill again when the 216-S-10D Ditch water level became
34 high enough to overflow the ponds. The south pond was covered in the summer of 1975 and
35 is now being used as a root depth penetration study area. This area of the pond is free from
36 radioactive contamination (WHC 1991a).

37
38 A 1954 survey of the chemical sewer south of 200 West Area showed the trench to be
39 contaminated up to 800 mrad/hr and 500 MR/h in spots, with lower contamination levels up
40 to 80,000 c/min an overflow area approximately one acre in area, resulting from a
41 breakthrough on the southeast dike of the south 216-S-11 Pond. The contaminated areas were
42 subsequently decontaminated (Maxfield 1979).

43
44 In May 1982, the north pond was released from "Radiation Zone" status after a
45 radiological survey of the pond surface and a number of 0.9 m (3 ft) borings indicated levels
46 equal to or less than natural background.

1 The unit contains 2,100 m³ (2,700 yd³) of contaminated soil and 5,700 m³ (7,500 yd³) of
2 overburden soil. The total site area is 6,070 m² (65,300 ft²) (WHC 1991a).
3

4 This unit has a lightweight chain barricade and regularly spaced concrete monuments
5 with brass plates stating that 216-S-10, -11, and -17 Ponds are all contained within the
6 barricade. Underground radiation contamination warning signs surround the entire area. The
7 ponds have been stabilized. The present surface is 31 to 61 cm (12 to 24 in.) above grade
8 and has been seeded with grass.
9

10 **2.3.5.1.3 216-S-15 Pond.** The inactive 216-S-15 Pond is located directly east of the
11 241-S Tank Farm and has dimensions of 11 x 1.5 x 1.5 m (35 x 5 x 5 ft) (Figure 2-11). The
12 pond was built in December 1951 and retired in October 1952. The pond received 10,000 L
13 (2,600 gal) of condenser spray cooling water from the 241-S-110 Tank. The waste was low
14 salt, neutral/basic, and was mainly composed of nitrate and MIBK. A summer of 1952
15 survey detected dose rates of up to 10.5 R/h including a reading of 1 R/h at the edge of the
16 216-S-15 Pond (Maxfield 1979).
17

18 The pond was removed from service when condensed tank vapors were mixed with the
19 normal waste discharged to this unit. The aboveground piping was removed and the pond
20 was backfilled with 0.6 m (2 ft) of clean soil (WHC 1991a). These actions were taken after
21 an estimated 1 Ci of fission products had accumulated in the pond.
22

23 The unit is not directly accessible due to the lightweight chain barricade that surrounds
24 the area at a considerable distance (UPR-216-W-30). There are surface and underground
25 radiation contamination warning signs marking the area. This unit is included in the RARA
26 Program.
27

28 **2.3.5.1.4 216-S-16P Pond.** The inactive 216-S-16P Pond is located approximately
29 2,100 m (7,000 ft) southwest of 202-S Building (Figure 2-11). This unit includes four smaller
30 ponds separated by dikes and a leach trench, 3 m (10 ft) deep and 330 m (1,100 ft) long,
31 extending east from the pond. One of the ponds (No. 4 Pond) was never used and is free
32 from radioactive contamination (Maxfield 1979). The total unit area is approximately
33 125,400 m² (1,350,000 ft²), and the ponds have an average depth of 0.9 m (3 ft). The pond
34 began operations in January 1957 and closed in February 1975. Approximately 40,700,000
35 kL (1.08 x 10¹⁰ gal) of liquid waste was discharged to this unit including 3.7 x 10² g of Pu
36 (Meinhardt). Until June 1967, the pond received process cooling water and steam condensate
37 from S Plant Complex. From June 1967 to July 1967, production operations were shut down
38 and S Plant Complex was put on standby. After July 1967, the pond received condenser and
39 vessel cooling water from the concentrator boil-down operations in 202-S Building. A
40 surface survey on exposed contamination, conducted in 1969, indicated levels of radioactivity
41 from 300 to 8000 c/min beta-gamma. Radionuclides suspected in the waste water included
42 ¹³⁷Cs, ⁹⁰Sr, and ¹⁰⁶Ru.
43

44 Three unplanned releases have occurred at this pond that are not covered by the Tri-
45 Party Agreement. These are UPR-200-W-47, UPR-200-W-59, and UPR-200-W-124.
46

1 UPR-200-W-47 refers to releases in June 1958 and April 1959. A dike broke spreading
2 contamination approximately 140 m (150 yd) to the west of the 216-S-16P Pond and 270 m
3 (300 yd) from north to south. The ground was contaminated to a maximum of 750 mR/h. In
4 1959, the contaminated ground was bladed under and the area posted as a radiation zone
5 (WHC 1991a).
6

7 Unplanned Release 200-W-59 occurred on September 26, 1965, when the F-1 process
8 vessel coil in the 202-S Building failed allowing process effluent to mix with the cooling
9 water. An unknown beta/gamma source was released to the pond with a maximum dose rate
10 of 160 μ R/h measured at the No. 1 Pond inlet. Analysis of samples shows that the wastes in
11 the three ponds is at or below 5×10^5 μ Ci/cc fission products. The radioisotopes present are
12 mostly ZrNb⁹⁵ and Ru^{103,106}. Ducks removed from the pond had no external contamination
13 (Maxfield 1979). The release was promptly detected (WHC 1991a).
14

15 During the October 2, 1967 weekend, the west bank of the REDOX No. 1 swamp broke
16 under the pounding of water from high winds. An 8 m (25 ft) wide gap had allowed water
17 from the higher No. 1 swamp to drain into the lower No. 3 swamp. Three-fourths of the
18 bottom of the No. 1 swamp was left exposed and drying. The No. 2 swamp, left without a
19 water supply, receded to one-fifth of its former size (Maxfield 1979).
20

21 Contamination to the three ponds as a result of the overflows are as follows:
22 Pond No. 1 contamination levels measured from 4,000 to 20,000 c/min, and one area to
23 80,000 c/min. A small area in the ditch entrance to the swamp measured 95,000 c/min. Very
24 little radioactivity was found on new algae in the bottom of the pond.
25

26 Pond No. 2 contamination levels ranged from 2,000 c/min to 6,000 c/min with a few
27 spotty areas ranging to 15,000 c/min. Tumbleweeds taken from areas of soil averaging
28 6,000 c/min were found to contain less than detectable radioactivity with a GM survey meter.
29 A gamma scan, however, showed traces of ¹³⁷Cs and ¹⁰⁶Ru.
30

31 Exposed ground surfaces in Pond No. 3 were less than 1,000 c/min radioactivity.
32

33 Unplanned Release 200-W-124 occurred prior to 1959. A dike break allowed
34 contamination to be spread over an area 9 m (30 ft) wide and extending approximately 300 m
35 (1,000 ft) to the southwest. The contaminated area was remediated by turning the ground
36 over with a bulldozer (WHC 1991a).
37

38 There is approximately 43,000 m³ (56,000 yd³) of contaminated soil and 77,000 m³
39 (101,000 yd³) of overburden at the pond (WHC 1991a). Previous to backfilling the ditch and
40 Ponds No. 1 and No. 3, the surface contamination levels were 3,000 c/min in Pond No. 1 and
41 the ditch and 1,000 c/min in Pond No. 3. The upper 15 cm (6 in.) of Pond No. 2 was
42 removed to a 2.7 m (8 ft) deep borrow trench along the inside base of the south dike. The
43 trench was covered with 0.9 m (3 ft) of soil and 0.3 m (1 ft) of gravel. In addition, 0.3 m
44 (1 ft) of gravel was placed over Pond No. 1 and 15 cm (6 in.) over Pond No. 2 and a number
45 of test plots were asphalted. In 1975, after the 216-S-16 pond complex was backfilled with

1 0.3 m (1 ft) of soil along the edges and 0.9 m (3 ft) in the center, no surface contamination
2 existed.
3

4 In 1980 and 1981, the surface was contaminated by decomposing Russian thistle,
5 growing over the original dike areas with radioactivity levels from 300 to 1,000 cpm beta-
6 gamma.
7

8 A root toxin was applied to a number of test plots and they were then sealed with
9 asphalt. Associated with this area are six 15 cm (6 in.) radionuclide monitoring wells and
10 two 5 cm (2 in.) moisture wells (WHC 1991a).
11

12 This pond has a light chain barricade and regularly spaced concrete monuments with
13 brass plates labeled 216-S-16. Underground radiation contamination warning signs surround
14 the entire area. The site has been stabilized. The present surface is 31 to 61 cm (12 to
15 24 in.) above grade and has been seeded with grass. The marker post does not distinguish
16 between the 216-S-16D Ditch and 216-S-16P Pond. This unit is included in the RARA
17 Program.
18

19 **2.3.5.1.5 216-S-17 Pond.** The inactive 216-S-17 Pond is located approximately
20 1,100 m (3,700 ft) southwest of 202-S Building. The pond dimensions are approximately
21 290 x 290 x 3 m (960 x 960 x 10 ft) (Figure 2-11) with a total area of approximately
22 85,000 m² (920,000 ft²). The pond operation began in October 1951 and was closed in April
23 1954. Approximately 6,440,000 kL (1.7 x 10⁹ gal) of liquid waste were discharged to this
24 pond. A series of process vessel coil failures beginning in October 1952 resulted in high
25 levels of radioactivity released to the 207-S Basin and subsequently to the 216-S-17 pond.
26 Until January 1953, it received the process cooling water and steam condensate from S Plant
27 Complex. After January 1953, the pond received 202-S Building effluent and the overflow
28 from 216-U-10 Pond via the 216-U-9 Ditch. Suspected radionuclides in the waste water
29 included ¹³⁷Cs, ⁹⁰Sr, and ¹⁰⁶Ru. The only suspected inorganic is nitrate.
30

31 The following sequence of historical events give a more complete account of operations
32 related to the 216-S-17 Pond.
33

34 October 1952
35

36 Followup investigation of an above normal reading on the 207-S Retention Basin HM
37 chamber led to the discovery that gross amounts of contamination were sent to the 216-S-17
38 Pond via the process cooling water. Surveys of the 216-S-17 Pond revealed general
39 contamination with a maximum dose rate of 2 R/h including 35 mR/h at 2.5 cm (1 in.) from
40 ground surface. Dose rates up to 50 mR/h including 18 mR/h both measured at 1.5 m (5 ft)
41 from the surface of the water at the 207-S Pond were observed. Vegetation removed from the
42 pond gave dose rates to 2.2 R/h including 80 mR/h at 5 cm (2 in.). Analytical results of this
43 vegetation revealed approximately 42 uCi of beta activity per gram of sample.
44 Approximately 75% of the activity was due to rare earths, with only a few percent of the
45 activity due to Ru, Zr, or I.
46

1 Investigation of possible sources within the building revealed that the D-12 waste
2 concentrator had a steam coil leak (Maxfield 1979).

3
4 November 1952

5
6 Although the activity of the process cooling water dropped considerably following
7 replacement of the D-12 cooling coil, sporadic increases were detected by the 207-S Retention
8 Basin monitoring chamber. Investigation showed that a similar leak in the H-4 coil existed.
9 An attempt was made to prevent contamination of the cooling water by keeping pressure on
10 the coil at all times pending its replacement at the next scheduled shutdown. As the coil
11 rupture became worse, this failed, and gross amounts of contamination were again being
12 discharged to the Redox swamp. During a 3-day period, dose rates increased from 20 to
13 200 mR/h at 5 cm (2 in.) from the process cooling water header, from 80 mR/h including
14 40 mR/h to 250 mR/h, including 70 mR/h approximately 1.5 m (5 ft) above the water at
15 207-S Retention Basin, and from approximately 6 mR/h to 700 mR/h including 30 mR/h
16 15 cm (6 in.) above the water at the 216-S-17 Pond inlet (Maxfield 1979).

17
18 December 1952

19
20 Following replacement of the H-4 pot, the activity of the process cooling water dropped
21 to 10^{-5} $\mu\text{C}/\text{cc}$. Positive activity was still evident, but was probably due to flushing of the
22 contaminated line. A serious problem was discovered, however, when wild fowl were
23 observed feeding on the grossly contaminated 216-S-17 Pond. A duck was killed on the
24 swamp showing a dose rate of 100 mR/h on its surface. In an effort to keep fowl off the
25 216-S-17 Pond colored balloons were anchored around the swamp and a continuous
26 noisemaker was installed. This was apparently successful, since no further birds were seen.
27 High dose rates were observed on a particular form of unidentified vegetation at the 216-S-17
28 Pond. A dose rate of 5 R/h including 300 mR/h was measured at 7.5 cm (3 in.) from one
29 mass of this material. In some cases, the vegetation was entangled in tumbleweeds, which
30 could easily be spread outside the swamp area by windstorms (Maxfield 1979).

31
32 February 1953

33
34 Replacement of the D-12 pot eliminated this source of contamination of the 216-S-17
35 Pond, but a leak in the D-4 coil continued to allow low-level contamination to be discharged
36 to the pond (Maxfield 1979).

37
38 April 1953

39
40 Solvent naphtha was introduced into the 216-S-17 Pond late in an effort to kill
41 vegetation and thus make the area less attractive to wild fowl. The result of the experiment
42 could not yet be evaluated (Maxfield 1979).

43
44 May 1953

1 Solvent naphtha into the 216-S-17 Pond was discontinued when no evidence of
2 vegetation kill could be found (Maxfield 1979).

3
4 July 1953

5
6 The Biology Section recommended the following methods to eliminate vegetation at the
7 216-S-17 Pond and thus discourage use of the Pond by wild fowl: copper sulfate added to
8 the water; 2, 4-D sprayed over the Pond, and sodium chlorate broadcast by hand at the
9 periphery of the Pond. These steps were taken as soon as possible and were continued during
10 the fall migratory period. Surveys downwind of the Pond indicated that no detectable
11 contamination had been spread by the wind (Maxfield 1979).

12
13 August 1953

14
15 A leaking coil in the H-4 pot was detected near the end of the month. Since the spare
16 was not yet completed, operations in H-4 continued, attempting to minimize leakage into the
17 coil by maintaining pressure on the coil at all times. This was not completely successful,
18 however, as dose rates rose from 25 to 180 mR/h at 1.5 cm (2 in.) from the utility outlet
19 header and from 30 to 350 mR/h approximately 1.5 m (5 ft) above the water at 207-S
20 Retention Basin (Maxfield 1979).

21
22 September 1953

23
24 The leak in the H-4 pot coil became worse rapidly. Before the coil was blanked off,
25 dose rates rose to 2 R/h over the 207-S Retention Basin and to 1 R/h at 5 cm (2 in.) from the
26 utility outlet header. Replacement of the H-4 pot eliminated this as a source of further
27 contamination going to the 216-S-17 pond, but another leak in the D-12 pot coil was
28 discovered late in the month (Maxfield 1979).

29
30 February 1954

31
32 Contamination surveys around the 216-S-17 Pond indicate the contamination remains
33 reasonably fixed. Dose rates at the Pond edge were as high as 1,500 mrad/h surface, which
34 is comparable to previous survey results. No contamination was detected at the temporary
35 fence isolating the new underground swamp project (Maxfield 1979).

36
37 March 1954

38
39 The 216-S-17 Pond was bypassed on the 15th of the month and minor construction
40 forces filled the original Pond. The 207-S Retention Basin was bypassed and backfilled
41 during current scheduled shutdown (Maxfield 1979).

42
43 The pond was retired when the radionuclide inventory in the sediments exceeded
44 prescribed limits. The pond was deactivated by plugging the pipeline to the unit north of the
45 216-S-5 Crib and covering the unit with 0.17 to 1.2 m (0.5 to 4 ft) of sterile, coarse black
46 sand. The vegetation layer beneath the fill trapped 90% of the radioactivity (Maxfield 1979).

1 In April 1982, areas where backfill measured 0.17 m^L (0.5 ft), contaminated Russian thistle
2 containing levels up to 4,000 c/min beta-gamma existed. The southeastern portion of the
3 pond where fill was 1.2 m (4 ft) had radioactivity levels up to 1,500 c/min beta-gamma from
4 windblown Russian thistle. The effluent was rerouted to the 216-S-5 Crib. The unit has been
5 stabilized and has approximately 24,000 m³ (31,000 yd³) of contaminated soil and 85,000 m³
6 (110,000 yd³) of overburden soil. In the early 1970s when contaminated weeds were
7 observed in the area, the unit was seeded with Siberian wheatgrass to compete with the
8 Russian thistle. The Russian thistle was removed and buried in a 4.6 x 23 m (15 x 75 ft)
9 trench located within the radiation zone. This unit has a light chain barricade and has spaced
10 concrete monuments with brass plates that state that 216-S-10, -11, and -17 Ponds are all
11 contained within the barricade. Underground radiation contamination warning signs surround
12 the entire area. The present surface is 31 to 61 cm (12 to 24 in.) above the original ground
13 level. This unit is included in the RARA Program.
14

15 **2.3.5.1.6 216-S-19 Pond.** The inactive 216-S-19 Pond is located approximately
16 2,400 ft southwest of 202-S Building (Figure 2-11). The pond was opened in February 1952
17 and closed in October 1984. A total of 1,330,000 kL (3.51 10⁸ gal) of liquid waste were
18 discharged to the pond. Until December 1954, the pond received effluent from the 222-S/SA
19 Laboratory ventilation cooling water and miscellaneous wastes from laboratory hoods and
20 decontamination pond via the 207-SL Retention Basin. From December 1954 to October
21 1955, the pond was inactive because the radionuclide concentration in the 207-SL Retention
22 Basin liquid waste was above the prescribed disposal guidelines. The building effluent was
23 rerouted to the 216-S-20 Crib. After October 1984, the pond received ventilation cooling
24 water and miscellaneous wastes from laboratory hoods and decontamination sinks in the
25 222-S Laboratory via the 207-SL Retention Basin. The potential existed for the disposal of
26 hazardous chemicals; however, no documentation exists to substantiate that this ever occurred.
27 Suspected disposed radionuclides include ¹³⁷Cs, ⁹⁰Sr, ¹⁰⁶Ru, and ³H (WHC 1991a).
28

29 At one time, an area one-fifth the size of the pond trending southeast from the discharge
30 pipe headwall was wet enough to produce aquatic vegetation. Birds and other animals used
31 the area as a feeding area and habitat (Meinhardt 1979).
32

33 In December 1953, surface dose rates up to 200 mR/h were detected at the edge of the
34 pond. Mud samples taken in July 1977 contained 38 x 10⁻⁹ Ci/g ²⁴¹Am. In March 1980, a
35 surface radiological survey detected levels of contamination up to 3,000 cpm beta-gamma.
36

37 The unit area is 14,200 m² (152,000 ft²) with 5,000 m³ of contaminated soil. The pond
38 was stabilized and seeded with grass in October 1984, and the wastes are rerouted to the
39 216-S-26 Crib (WHC 1991a). The unit has metal posts surrounding it but no barricade chain.
40 There is a permanent concrete marker with a metal plate labeling it as a crib; however, it is
41 actually a pond. The unit is marked with underground radiation contamination warning signs.
42 The surface is sandy gravel and is 46 to 61 cm (18 to 24 in.) above grade. This unit is
43 included in the RARA Program.
44

1 **2.3.5.2 Ditches.** A ditch is a long, open, unlined excavation used to transfer low-level liquid
2 wastes from process facilities to ponds (Figure 2-12). Three ditches exist in the S Plant
3 Aggregate Area.
4

5 **2.3.5.2.1 216-S-10D Ditch.** The recently deactivated 216-S-10D Ditch is located
6 approximately 430 m (1,400 ft) southwest of 202-S Building, which is the source of the liquid
7 wastes (Figure 2-12). The ditch is 685 m (2,250 ft) long and 1.83 m (6 ft) wide and has a
8 flow rate of 0.38 m³/min (13 ft³/min) (Meinhardt 1979 and WHC 1990). The ditch began
9 transferring wastes in August 1951. In the past, 420 L (112 gal) of hazardous waste salts in
10 solution (sodium nitrite, sodium hydroxide) were discharged to the unit. Discharges were
11 received from the 202-S Building drains, funnels, process vessel cooling water, and chemical
12 sewer lines and also the 241-S Tank Farm, 211-S station and 276-S drains. Until 1965, the
13 unit received discharges from chemical sewer lines, floor drains, funnels, process vessel
14 cooling water, air compressor cooling water from 202-S Building, overflow from the
15 2901-S-901 Water Tower, drains from the 241-S Tank Farm, station drains in 211-S, and
16 floor drains from the 276-S Solvent Handling Facility, and transferred this discharge to the
17 216-S-10 and 216-S-11 Ponds (WHC 1990). Since October 1984, the unit has been used as a
18 trench because the 216-S-10P Pond was stabilized. No dangerous wastes have been
19 discharged to this unit since February 1987. The 216-S-10D Ditch stopped receiving waste
20 on October 1, 1991 (Appendix E; Exhibit 3). Well 299-W26-11 has perched water at
21 approximately 38 m (125 ft) below the ground surface near the ditch. Radionuclides
22 suspected to have been discharged to the ditch include ¹³⁷Cs, ⁹⁰Sr, ²⁴¹Am, ²³⁹Pu, ²⁴⁰Pu, and
23 ¹⁰⁶Ru. A total of 8,580,000 kL (2.28 x 10⁹ gal) of waste were discharged into this unit from
24 February 1954 to December 1988 with additions of 4.03 x 10⁷ L/mo from October 1989 to
25 March 1990 (WHC 1990).
26

27 Inadvertent dumping of ANN solution to the chemical sewer seriously plugged soil at
28 the terminus of this stream, and the liquid level increased significantly. During the summer
29 of 1955, 0.6 m (2 ft) of "muck" was dredged from the bottom of the 216-S-10D Ditch to
30 improve water percolation in the ditch. The contaminated "muck" was buried in scooped out
31 holes along the sides of the ditch. The depth and location of each burial site is unknown
32 (Maxfield 1979). A number of excavations by backhoe across the 216-S-10D Ditch in 1971
33 showed it to be free of contamination (Maxfield 1979).
34

35 The only radioactivity found in the ditch and ponds during the March 1, 1979 inspection
36 was associated with Russian thistle that had blown into the ditch and ponds from the nearby
37 216-S-17 covered pond. The radioactivity ranged to a maximum of 2,000 c/min beta-gamma
38 activity (Maxfield 1979).
39

40 The ditch is unlined and a portion remains uncovered. This unit has been partially
41 stabilized. It contains approximately 2,200 m³ (2,900 yd³) of contaminated soil
42 (WHC 1991a). Radiological surveys are still scheduled for the covered section of the ditch.
43 Soil and vegetation samples will also continue to be sampled (WHC 1988c).
44

45 This unit has a lightweight chain barricade and has regularly spaced concrete
46 monuments with brass plates that state that waste sites 216-S-10, -11, and -17 are all

1 contained within the barricade. Underground radiation contamination warning signs surround
2 the entire area. Waste sites 216-S-10P, -11, -17, and part of 216-S-10D have been stabilized.
3 The present surface is 31 to 61 cm (12 to 24 in.) above grade and has been seeded with grass.
4 The marker post does not distinguish between the 216-S-10D Ditch and 216-S-10P Pond.
5 Part of the 216-S-10D Ditch has not been stabilized. In the portion of the unit that has not
6 been stabilized, there is approximately 0.3 m (1 ft) of standing water with cattails growing in
7 it. There is a stairway at the northeastern end of the ditch leading to the ditch floor. The
8 active part of ditch has its own barricade, separate from the rest, and has surface radiation
9 contamination warning signs and danger signs surrounding it. This unit is included in the
10 Hanford RCRA Program and in the RARA Program.

11
12 **2.3.5.2.2 216-S-16D Ditch.** The inactive 216-S-16D Ditch is located 1,670 m
13 (5,470 ft) southwest of the 202-S Building (Figure 2-11). The ditch was constructed in
14 January 1957 and was not used after February 1975. The ditch dimensions are 914 x 1.2 x
15 0.9 m (3,000 x 4 x 3 ft) with a 2:1 side slope. A total of 400,000 kL (1.1×10^8 gal) of liquid
16 waste was discharged to this unit. Until June 1967, the ditch received process cooling water
17 and steam condensate from S Plant and transferred it to the 216-S-16 and 216-S-17 Ponds and
18 the 216-S-5 and 216-S-6 Cribs. From June 1967 to July 1967, production operations were
19 shut down, and S Plant Complex was put on standby. After July 1967, the ditch received
20 condenser and vessel cooling water from concentrator boil-down operations in the S Plant
21 Complex. Nitrate is suspected to be present at this unit (WHC 1991a). Removal of the 216-
22 S-16 Pond and ditch system from active service began in May 1969. This work was
23 prompted by several releases over the years including 3.7×10^2 g of plutonium.

24
25 The ditch has been stabilized and backfilled and contains 2,000 m³ (2,700 yd³) of
26 contaminated soil and 770 m³ (1,000 yd³) of overburden soil (WHC 1991a). A light chain
27 barricade and regularly spaced concrete monuments with brass plates labeled 216-S-16
28 encircle the ditch. Underground radiation contamination warning signs surround the entire
29 area. The present surface is 31 to 61 cm (12 to 24 in.) above grade and has been seeded with
30 grass. This unit is included in the RARA Program.

31
32 **2.3.5.2.3 216-U-9 Ditch/UPR-200-W-139.** The inactive 216-U-9 Ditch is located
33 approximately 600 m (2,000 ft) west of the 241-S Tank Farm (Figure 2-11). The ditch is
34 Y-shaped with an eastern fork and western fork (Plate 1). The eastern fork began receiving
35 the U Pond overflow in December 1952 (Maxfield 1979). The ditch dimensions are 1,100 x
36 2 x 2 m (3,500 x 6 x 6 ft) with a 1:2 slope. The unit originally connected the 216-U-10 Pond
37 and the 216-S-17 Pond. In 1973, four trenches approximately 1.2 m (4 ft) deep were dug at
38 intervals across the original ditch to assess the levels of radiation contamination. No
39 radioactivity was found (Maxfield 1979). A new ditch was dug later incorporating the first
40 152 m (500 ft) of the original 216-U-9 Ditch and then running somewhat west of the original
41 route (WHC 1991a). No contamination was found in the first 152 m (500 ft) of the ditch
42 during this construction (Maxfield 1979). The west branch was never used. The ditch is now
43 cut into the side of the 216-S-16 Ditch, which went to the 216-S-16 Pond.

44
45 This ditch (what is now the east branch) became contaminated in September 1953 and
46 was covered in spring 1954 with 0.6 m (2 ft) of clean soil. The contamination was

1 designated UPR-200-W-139. No documented source for the contamination has been found
2 regarding the level of contamination. The unit has been released from radiation zone status.
3

4 The eastern fork of the ditch has no chain barricades or radiation warning signs and is
5 partially backfilled. There is mature sage brush growing in the ditch. The western fork
6 similarly has no chain barricades or radiation warning signs. There has been no obvious
7 backfilling. The ditch is 2 to 3 m (8 to 10 ft) deep with sparse vegetation.
8

9 The wastes that flowed through the 216-U-9 Ditch originated from the 216-U-10 Pond.
10 The 216-U-10 Pond is physically within the U Plant Aggregate Area and is addressed in the
11 U Plant AAMSR.
12

13 **2.3.5.3 Trenches.** Trenches are unlined excavations used for disposing material from the
14 process facilities by infiltration into the subsurface. Quantities are usually limited as
15 compared to cribs or ponds (Figure 2-12). All of the trenches are inactive and are backfilled.
16 Normally, trenches are backfilled following use.
17

18 **2.3.5.3.1 216-S-8 Trench.** The inactive 216-S-8 Trench is located adjacent to the east
19 side of the 241-SX Tank Farm and has dimensions of 31 x 18 x 7.6 m (100 x 60 x 25 ft).
20 The trench was built in November 1951 and retired in February 1952. The trench received
21 10,000 kL (2.6 x 10⁶ gal) of unirradiated startup waste from 202-S Building. The only
22 inorganic waste constituent suspected in the waste was nitrate. The radionuclides suspected
23 included ⁹⁰Sr, ¹³⁷Cs, and ¹⁰⁶Ru (WHC 1991a).
24

25 The trench was retired when the discharge of startup waste to the unit was completed.
26 The trench was deactivated by removing the aboveground piping and backfilling the unit
27 (WHC 1991a).
28

29 The unit is surrounded by a light chain barricade that also encompasses the 216-S-1 and
30 -2 Cribs as well as UPR-200-W-114, allowing no close inspections of the actual area. There
31 are also surface radiation contamination warning signs surrounding the area. This unit is
32 included in the RARA Program.
33

34 **2.3.5.3.2 216-S-12 Trench.** The inactive 216-S-12 Trench is northeast of 202-S
35 Building (Figure 2-11). The unit was constructed in July 1954 to receive approximately
36 76,000 L (20,000 gal) of flush water containing ammonium nitrate from the 291-S Stack
37 Complex. The trench was retired when the flush of the 291-S-1 Stack was complete, also in
38 July 1954 (WHC 1991a).
39

40 This trench was deactivated by removing the aboveground piping and then backfilling.
41 The suspected discharged isotopes are ¹³⁷Cs, ¹⁰⁶Ru, and ⁹⁰Sr. The only inorganic assumed to
42 have been discharged is ammonium nitrate. In all probability this unit can be removed from
43 the status of a radiation zone (WHC 1991a).
44

9 3 1 2 8 1 3 4 5

1 The trench is barricaded with a light chain with underground radiation contamination
2 signs and a concrete marker post. The surface is sand and gravel with no vents or evidence
3 of subsidence.
4

5 Slightly west of the 216-S-12 Trench is a light chain barricade containing two wooden
6 structures approximately 2.4 x 2.4 x 1.5 m (8 x 8 x 5 ft). One of the boxes contains 6.4 cm
7 (2.5 in.) diameter rubber hose. The area has radiation warning signs indicating surface
8 radiation contamination. The contamination is limited to the boxes and is approximately
9 600 c/min.
10

11 The UPR-200-W-30 is a duplicate of this trench history (WHC 1991a). This trench is
12 included in the RARA Program.
13

14 **2.3.5.3.3 216-S-14 Trench.** The inactive 216-S-14 Trench is located approximately
15 390 m (1,300 ft) south of 202-S Building and has dimensions of 31 x 2.4 x 1.8 m (100 x 8 x
16 6 ft) (Figure 2-11). The trench was started in December 1951 and closed in January 1952
17 (WHC 1991a). The trench received 76,000 L (20,000 gal) of contaminated (unirradiated
18 uranium) MIBK from the initial test runs in the 202-S Building. The unit was retired when
19 discharge of MIBK was completed, and it was deactivated by removing the aboveground
20 piping and backfilling the area (WHC 1991a).
21

22 The unit was investigated with core drilling in February 1971. There was a strong odor
23 of MIBK from the samples taken, but no radioactivity was found (WHC 1991a).
24

25 This trench had a cave-in leaving a 3 x 2 m (10 x 10 ft) pit. This pit is marked by a
26 weathered rope suspended by four corner posts. The other portion of the trench is unfenced
27 and there are no radiation warning signs posted in the area. Just south of and in line with the
28 trench, there is a row of roughly ten clay tile pipes that rise above grade running in an east-
29 west line. These pipes appear to be 1.2 to 1.8 m (4 to 6 ft) and may be vents. This trench is
30 included in the RARA Program.
31

32 **2.3.5.3.4 216-S-18 Trench.** The inactive 216-S-18 Trench is located northeast of the
33 241-SX Tank Farm (Figure 2-11). The trench dimensions are 38 x 4.6 x 3 m (12 x 15 x
34 10 ft). The trench was built and retired in October 1954. This trench was a steam cleaning
35 pit for radioactively contaminated equipment and received vehicle decontamination waste.
36 Research strongly suggests that solvents, and in particular chlorinated solvents, were used in
37 the cleaning process. The trench, which was deactivated by backfilling, was retired in the
38 same month that vehicle decontamination was complete (WHC 1991a).
39

40 In October 1972, this trench was excavated and the radioactive objects found in the
41 trench were taken to the 200 West Dry Burial Ground for burial. The objects included some
42 2 cm (3/4 in.) piping, one lab sink, and approximately 1.5 m³ (12 yd³) of soil. The unit was
43 then released from radiation zone status.
44

45 There are no barricades, warning signs, or permanent markers. Some concrete debris is
46 present and the area is moderately vegetated. The unit is L-shaped, the surface is composed

1 of sand and gravel, and is 1.2 to 1.8 m (4 to 6 ft) below grade. This unit is included in the
2 RARA Program.
3
4

5 2.3.6 Septic Tanks and Associated Drain Fields 6

7 Septic tanks are used to treat sanitary waste water; however, some of these tanks may
8 be contaminated. There are two septic tanks discussed in this report, and only one of the
9 units has an associated drain field. A sanitary crib is also discussed in this section.
10

11 **2.3.6.1 2607-W6 Septic Tank and Tile Field.** The 2607-W6 Septic Tank began receiving
12 nonhazardous, nonradioactive sanitary waste water and sewage in 1951. The tank is currently
13 receiving waste at a rate of 34.8 m³/day (1,228 ft³/day) and has an associated tile field
14 (DOE/RL 1992). A tile field is usually a herringbone arrangement of pipe used for
15 distributing waste. Refer to Figure 2-13 for the location of this waste management unit.
16

17 **2.3.6.2 2607-WZ Septic Tank.** The 2607-WZ Septic Tank began receiving nonhazardous
18 and nonradioactive waste liquid such as sanitary wastewater and sewage in 1944 and is
19 currently active. The unit receives an estimated volume of 22.6 m³/day (797 ft³) of waste and
20 has an associated drain field. Refer to Figure 2-13 for the location of this waste management
21 unit.
22

23 **2.3.6.3 Sanitary Crib.** The sanitary crib was constructed in 1944 and is active and receiving
24 nonhazardous and nonradioactive sanitary waste water from the 241-SX-701 Compressor
25 House (WHC 1991a). The sanitary crib is approximately 24 m (80 ft) west of the southwest
26 corner of the 241-SX Tank Farm (Figure 2-8). The crib is about 23 x 7.6 m (75 x 25 ft) and
27 is oriented north-south (Plate 1). It lies under the entrance to a gravel parking area that has
28 two vents from the crib rising through it. The unit includes a drain field. The estimated rate
29 of waste generation sent to the crib is 22.6 m³/day (798 yd³/day) of liquid (WHC 1991a).
30 There are no barricades or warning signs.
31

32 2.3.7 Transfer Facilities, Diversion Boxes, and Pipelines 33

34
35 Wastes were transferred at the S Plant Complex through a system of control structures,
36 diversion boxes, pipelines, and valve pits (Figures 2-14, 2-15, 2-16, and 2-17). Refer to
37 Figure 2-14 for the location of each unit. These structures are either an underground or
38 in-plant enclosure containing jumpers or valved manifolds, which enable solution transfers via
39 pipelines between various processes and storage facilities. Diversion boxes and receiving
40 vaults were designed to contain leaks from transfers and drainage from operations within the
41 unit. Transfer facilities included the following:
42

- 43 • Valve pits, which are concrete structure usually located within a tank farm area
44 housing the valves associated with transfers between tanks
45

- 1 • Diversion boxes, which are concrete structures containing several pipes to divert
2 waste from waste generating and storage facilities to treatment, storage, or
3 disposal facilities
- 4
- 5 • Control structures, which are concrete encasements with a manhole cover housing
6 a large Y- or T-valve or weir used to divert or regulate waste flow to various
7 disposal sites.
- 8

9 Pipelines include all process lines and encasements. Process lines pass through the
10 aggregate area and have been essential to the operation of the S Plant Complex, the 241-S
11 and 241-SX Tank Farms, and related waste management units. The pipelines are not waste
12 management units according to the Tri-Party Agreement. They will be addressed in detail
13 under the HSFP. Radiation emissions from an encasement (UN-216-W-25) is the only piping
14 discussed as a specific facility in the S Plant AAMSR. Process lines (transfer lines or process
15 sewer lines) connect the major process facilities and vary from 3.8 to 76 cm (1-1/2 to 30 in.)
16 in diameter. The pipe composition varies from stainless steel, to steel, corrugated metal, and
17 vitrified or unvitrified clay, with a majority of the pipe encased by vitrified clay. Nearly all
18 pipe is located underground, although some elevated aboveground piping was used.

19
20 Encasements are concrete enclosures designed to protect buried process lines. The
21 encasements vary in width depending on the number of lines contained. The base portion is
22 made of steel reinforced concrete that was formed and poured in place. Separate channels are
23 sometimes provided for each process line, and the lines are raised from the encasement
24 bottom by steel spacers. Steel plate of various design was sealed in place over the process
25 line channels to form a water tight seal. A steel reinforced concrete upper portion, or
26 encasement lid, was then sealed in place to form a second water tight seal and further protect
27 the process lines. Riser pipes were provided to allow sampling of the encasement interior for
28 contamination that might result from process line leakage.

29
30 Encasements protect multiple process lines running between S, T, and U Plants and the
31 241-S, -T, and -U Tank Farms. Both aboveground and belowground piping has been
32 removed, as described in the applicable waste management units.

33
34 There are four control structures, six diversion boxes, eight valve pits, and one pipeline
35 encasement in the S Plant Aggregate Area. Refer to Figures 2-15 through 2-17 for examples
36 of a typical control structure, diversion box, and valve pit.

37
38 **2.3.7.1 216-S-172 Control Structure.** The inactive 216-S-172 Control Structure is located
39 southwest of the 241-SX Tank Farm (Figure 2-14). The unit operated from 1956 to 1976.
40 The control box was built to divert the S Plant Complex process vessel cooling water and
41 steam condensate to the 216-S-16 Ditch. The unit includes a weir box. The structure is a
42 reinforced concrete box 4 x 2 x 2 m (13 x 7 x 8 ft) with 25 cm (10 in.) thick walls and a
43 31 cm (12 in.) thick bottom. Float wells consisting of 41 cm (16 in.) in diameter pipe
44 centered in 71 cm (28 in.) columns are attached vertically to the north and south outside walls
45 of the structure. Piping includes one 25 cm (10 in.) inlet pipe and three 30 cm (12 in.) outlet
46 pipes, and a 61 cm (24 in.) vitrified clay inlet pipe that enters from the floor (DOE/RL 1992).

1 The structure extends 15 cm (6 in.) above grade and 2 m (7 ft) below grade. Radiation
2 surveys, airborne radionuclide monitoring, and visual inspections are routinely performed.
3 The unit contains unquantified amounts of low-level radioactive solid waste. The maximum
4 radiation reading is 25 mR/h (WHC 1991a).
5

6 Control Structure 216-S-172 is stabilized and has a lightweight chain outer barricade
7 with underground radiation warning signs and an inner chain barricade around the area. The
8 inner barricade has underground radiation contamination and cave-in potential warning signs.
9 The unit was interim stabilized in 1991. The surface is approximately 61 cm (24 in.) above
10 grade and has no vegetation. This unit is included in the HSFP.
11

12 **2.3.7.2 2904-S-160 Control Structure.** The inactive 2904-S-160 Control Structure is
13 located southwest of the 241-SX Tank Farm (Figure 2-14). The structure operated from 1954
14 until its closure in 1976. The unit was built to divert process vessel cooling water and steam
15 condensate from the S Plant Complex to 216-S-17, 216-S-6, or 216-S-16 Ponds
16 (WHC 1991a).
17

18 The 2904-S-160 weir is a below-grade pentagonal structure consisting of 0.3 m (1 ft)
19 thick reinforced concrete walls, roof, and floor. The structure is 3 m (9 ft) high with walls
20 about 1.5 m (5 ft) long and extends 15 cm (6 in.) above grade. Piping includes two 61 cm
21 (24 in.) diameter vitrified clay outlet pipes and one 61 cm (24 in.) diameter vitrified clay inlet
22 pipe (DOE/RL 1992).
23

24 The structure contains low-level contaminated concrete and piping. The quantity of
25 contaminated waste has not been determined. There are 5,000 c/min beta/gamma in the soil
26 and up to 300 c/min smearable on the surface of the box (WHC 1991a).
27

28 The 2904-S-160 Control Structure has a light chain outer barricade with underground
29 radiation warning signs surrounding it, and an inner chain barricade around the unit. The
30 inner barricade has underground radiation contamination and cave-in potential warning signs.
31 The area was interim stabilized in 1991. The surface is approximately 61 cm (24 in.) above
32 grade and has no vegetation. The control structure is included in the HSFP.
33

34 **2.3.7.3 2904-S-170 Control Structure.** The inactive 2904-S-170 Control Structure is located
35 southwest of the 241-SX Tank Farm (Figure 2-14). The unit was operated from 1954 until
36 1976 and was built to regulate and measure the process waste flow from the S Plant Complex
37 prior to routing liquid to waste disposal sites (WHC 1991a). The structure is underground
38 and made of reinforced concrete. The walls, floor, and roof are 25 cm (10 in.) thick. It is
39 approximately 4.9 x 1.5 x 3.3 m (16 x 5 x 11 ft). The structure extends 15 cm (6 in.) above
40 grade and 2.9 m (9.5 ft) below grade. One meter (3 ft) of the weir's south end is covered by
41 the 2904-SA Sample Building. Piping includes one inlet and one outlet pipe, both 76 cm
42 (30 in.) diameter vitrified clay pipe (DOE/RL 1992).
43

44 This structure contains low-level contaminated concrete and piping. The quantity of
45 contaminated waste has not been determined. There is less than 200 c/min beta/gamma

1 smearable contamination and less than 7 mR/h total penetrating and nonpenetrating radiation
2 present (WHC 1991a).

3
4 The area is protected by four metal posts. It has no chain barricade, warning signs,
5 monument or other identifying label, but is stabilized. The surface is a sandy soil and is
6 approximately 61 cm (24 in.) above grade. There is no vegetation at the unit, which
7 measures approximately 1.2 x 1.2 m (4 x 4 ft) site. The control structure is included in the
8 HSFP.

9
10 **2.3.7.4 2904-S-171 Control Structure.** The inactive 2904-S-171 Control Structure is located
11 southwest of the 241-SX Tank Farm (Figure 2-14). The unit was operated from 1954 and
12 closed in 1976 and was built to measure and regulate flow of process waste routed to the
13 216-S-6 Crib (WHC 1991a). It is a belowgrade reinforced concrete structure roughly 2.6 x
14 4.0 x 3 m (8.4 x 13 x 10 ft). The walls and roof are 25 cm (10 in.) thick and the floor is
15 30 cm (12 in.) thick. The unit extends 15 cm (6 in.) above grade and 2.9 m (9.5 ft) below
16 grade. Float wells are attached vertically to the north and south outside walls. The float
17 wells are 41 cm (16 in.) diameter metal pipes centered in 71 cm (28 in.) square concrete
18 columns. Piping includes a 46 cm (18 in.) diameter vitrified clay inlet pipe and a 46 cm
19 (18 in.) diameter galvanized corrugated metal outlet pipe (DOE/RL 1992).

20
21 Radiation surveys, airborne radionuclide monitoring, and visual inspections are routinely
22 performed. The unit contains low-level contaminated concrete and piping. The quantity of
23 contaminated waste has not been determined. There is less than 100 c/min beta/gamma
24 smearable contamination and 20 mR/h reading at contact with an open or closed window
25 cutie pie (WHC 1991a).

26
27 The area is encircled by a light chain barricade, and is marked with both surface and
28 underground radiation contamination warning signs, but no permanent monuments. This
29 control structure is included in the HSFP.

30
31 **2.3.7.5 240-S-151 Diversion Box.** The inactive 240-S-151 Diversion Box is located north of
32 the 202-S Building (Figure 2-14). The unit was started in 1950 and closed in March 1987.
33 This diversion box was used for transfer of low- and high-level mixed waste solution from
34 processing and decontamination operations. Volumes were variable according to specific
35 plant operations (WHC 1991a). The unit has been isolated and weather covered (DOE/RL
36 1992).

37
38 The 240-S-151 Diversion Box was the main diversion box for the S Plant Complex.
39 Wastes were transferred to the 216-S-172 Control Structure that diverted wastes to the 216-
40 S-16 Ditch, the 216-S-16 and 216-S-17 Ponds, and the 216-S-5 and 216-S-6 Crib. The 240-
41 S-151 Diversion Box also transferred low- and high-level mixed waste to the 216-S-7, 216-
42 S-9, and 216-S-23 Crib, and the 240-S-152 and 241-S-151 Diversion Boxes, and interacted
43 with the 241-U-153 Diversion Box. This structure drained to the 240-S-302 Catch Tank.

44
45 **2.3.7.6 240-S-152 Diversion Box.** The inactive 240-S-152 Diversion Box is located north of
46 the 202-S Building and the 240-S-151 Diversion Box (Figure 2-14). The box was activated

1 in 1977 and closed in 1980. This unit was used for the transfer of high-level waste solution
2 from processing and decontamination operations. It also received uranyl nitrate hexahydrate
3 from the 240-S-151 Diversion Box and transferred it to the 205-S Chemical Makeup Building.
4 Volumes were variable according to specific plant operations. This unit has been isolated and
5 covered (WHC 1991a). This unit is included in the Hanford RCRA Program.
6

7 **2.3.7.7 241-S-151 Diversion Box.** The active 241-S-151 Diversion Box is located northeast
8 of the 241-SX Tank Farm (Figure 2-14). It is a reinforced concrete structure with dimensions
9 of 17 x 3 x 5 m (56 x 10 x 17 ft). The diversion box transfers low- and high-level mixed
10 waste solutions from processing and decontamination operations. Quantities are variable
11 depending on specific plant operations. The unit interconnects the 240-S-151 and 241-SX-
12 151 Diversion Boxes, and the 241-S Tank Farm (WHC 1991a).
13

14 The 241-S-151 Diversion Box received low- and high-level mixed waste from the 240-
15 S-151 Diversion Box. The waste was transferred to the 216-S-1 and -2 Cribs, the 241-SX-
16 151 and -152 Diversion Boxes, the 241-S Tank Farm, and the 244-S Receiver Tank and
17 interacts with the 241-U-151 and 241-UX-154 Diversion Boxes. This unit was drained to the
18 241-S-302A and 241-S-302B Catch Tanks.
19

20 There are three known releases at this unit: UPR-200-W-20, UPR-200-W-51,
21 UPR-200-W-82 (WHC 1991a) and possibly one unnamed release (Historical Unplanned
22 Release File). These releases are described in Section 2.3.10 and are summarized below.
23

24 The UPR-200-W-20 occurred during January and February 1953. Leakage from the
25 diversion box contaminated about 90 m² (1,000 ft²) around the box. The nature of the
26 contamination was unidentified but the area was covered with gravel (WHC 1991a).
27

28 The UPR-200-W-51 occurred on September 12, 1958, and involved leakage from the
29 diversion box. The leakage covered a narrow strip of ground south of the diversion box,
30 across 10th Street and about 90 m (300 ft) beyond the area fence. There were unknown
31 sources of beta and gamma radiation measured at a maximum of 50 mR/h within 30 m
32 (100 ft) of the box. The contaminated soil, saturated with water, was turned over with a
33 bulldozer (WHC 1991a). The unnamed unplanned release has an almost identical description,
34 but is dated September 15, 1958. It is likely that this was the same incident.
35

36 The UN-200-W-82 involved spots of contamination resulting from routine surveillance
37 traffic. This was detected on January 15, 1980. The spots of contamination were removed to
38 the 218-W-9 Burial Ground (WHC 1991a).
39

40 **2.3.7.8 241-S-152 Diversion Box.** The inactive 241-S-152 Diversion Box is located 30 m
41 (90 ft) northwest of the 241-SY-102 Tank and east of 242-S Evaporator (Figure 2-14). The
42 box was placed in service in 1977 and taken out of service in November 1980. This unit was
43 used for transfer of high-level mixed waste solutions from processing and decontamination
44 operations. The 241-S-152 Diversion Box received high-level mixed waste from the 241-S
45 and 241-SX Tank Farms and transferred it to the 242-S Evaporator for separation. Volumes

1 were variable according to specific plant operations (WHC 1991a). This unit has been
2 isolated and covered and is included in the Hanford RCRA Program.
3

4 **2.3.7.9 241-SX-151 Diversion Box.** The inactive 241-SX-151 Diversion Box is located east
5 of the 241-SX Tank Farm (Figure 2-14). This unit interconnects with the 241-S-151 and
6 241-SX-152 Diversion Boxes, and the 241-SX Tank Farm. The box was placed in service in
7 1954 and closed in October 1983. The unit was used for transfer of high-level mixed waste
8 solutions from processing and decontamination operations. Volumes were variable according
9 to specific plant operations. The 241-SX-151 Diversion Box received high-level mixed waste
10 from the 241-S-151 Diversion Box and transferred it to the 241-SX Tank Farm. This
11 structure drained to the 241-SX-302 Catch Tank. This unit has been isolated and covered
12 (WHC 1991a).
13

14 Although no radionuclides are currently identified as being present at this unit, this
15 diversion box is suspected to have been used to transfer high-level waste. This unit is
16 included in the Hanford RCRA Program.
17

18 **2.3.7.10 241-SX-152 Diversion Box.** The inactive 241-SX-152 Diversion Box is located
19 northeast of the 241-SX Tank Farm (Figure 2-14). This unit interconnects with the
20 241-SX-151 and 241-U-151 Diversion Boxes, and the 241-SX Tank Farm. This unit was
21 placed in service in 1954 and retired in May 1981 and was used to transfer high-level mixed
22 waste solutions from processing and decontamination operations. Volumes were variable
23 according to specific plant operations. The 241-SX-152 Diversion Box received high-level
24 mixed waste from the 241-S-151 Diversion Box, transferred it to the 241-SX Tank Farm and
25 244-S Receiver Tank and interacted with the 241-U-151 and 241-UX-154 Diversion Boxes.
26 This unit drained to the 241-SX-302 Catch Tank.
27

28 The unit has been covered and isolated. Although no radionuclides are currently
29 identified as being present at this unit, this diversion box was used to transfer high-level
30 waste. This unit is included in the Hanford RCRA Program.
31

32 **2.3.7.11 241-S-A Valve Pit.** The 241-S-A Valve Pit is an active facility started in 1952 and
33 located between 241-S-101 and 241-S-102 Tanks (Figure 2-14). The unit housed valve
34 controls for transfers of waste solutions from processing and decontamination operations.
35 Quantities are variable according to specific plant operations. This unit can drain to either a
36 DST or SST (WHC 1991a).
37

38 Leak detection and air monitoring are performed continuously with the 241-S Tank
39 Farm in which this unit is located (WHC 1991a).
40

41 **2.3.7.12 241-S-B Valve Pit.** The 241-S-B Valve Pit is an active facility started in 1952, and
42 located between the 241-S-101 and 241-S-102 Tanks (Figure 2-14). The unit housed valve
43 controls for transfers of waste solutions from processing and decontamination operations.
44 Quantities are variable according to specific plant operations. This valve pit can drain to
45 either a DST or SST (WHC 1991a).
46

1 Leak detection and air monitoring are performed continuously within the 241-S Tank
2 Farm in which this unit is located (WHC 1991a).
3

4 **2.3.7.13 241-S-C Valve Pit.** The 241-S-C Valve Pit is an active waste unit located between
5 241-S-107 and 241-S-108 Tanks (Figure 2-14). This pit was placed in service in 1952. This
6 unit housed valve controls for transfers of waste solutions from processing and
7 decontamination operations. Quantities are variable depending on plant operations. This unit
8 can drain to either a DST or SST (WHC 1991a).
9

10 Leak detection and air monitoring are performed continuously within the 241-S Tank
11 Farm in which this unit is located (WHC 1991a).
12

13 **2.3.7.14 241-S-D Valve Pit.** The 241-S-D Valve Pit is an active waste unit located between
14 241-S-107 and 241-S-108 Tanks (Figure 2-14). This pit became active in 1952. The unit
15 housed valve controls for transfers of waste solutions from processing and decontamination
16 operations. The pit can drain to either a DST or SST (WHC 1991a).
17

18 Leak detection and air monitoring are performed continuously within the 241-S Tank
19 Farm in which this unit is located (WHC 1991a).
20

21 **2.3.7.15 241-SX-A Valve Pit.** The 241-SX-A Valve Pit is an active waste unit located
22 between the 241-SX-105 and -104 Tanks of the 241-SX Tank Farm (Figure 2-14). This unit
23 is assumed to have been activated in 1954 and deactivated in 1980, but is considered active as
24 defined by RCRA. This unit housed valve controls for transfers of waste solutions from
25 processing and decontamination operations.
26

27 Leak detection and air monitoring are performed continuously within the 241-SX Tank
28 Farm in which this unit is located (WHC 1991a).
29

30 **2.3.7.16 241-SX-B Valve Pit.** The 241-SX-B Valve Pit is an active it located between the
31 241-SX-105 and -104 Tanks of the 241-SX Tank Farm (Figure 2-14). This unit is assumed to
32 have been activated in 1954 and deactivated in 1980, but is considered active as defined by
33 RCRA. This unit housed valve controls for transfers of waste solutions from processing and
34 decontamination operations.
35

36 Leak detection and air monitoring are performed continuously within the 241-SX Tank
37 Farm in which this unit is located (WHC 1991a).
38

39 **2.3.7.17 241-SY-A Valve Pit.** The 241-SY-A Valve Pit is an active waste unit located south
40 of and between the 241-SY-101 and 241-SY-102 Tanks in the 241-SY Tank Farm
41 (Figure 2-14). This pit became active in 1977. This unit housed valve controls for transfers
42 of waste solutions from processing and decontamination operations.
43

44 Leak detection and air monitoring are performed continuously within the 241-SY Tank
45 Farm in which this unit is located (WHC 1991a).
46

1 **2.3.7.18 241-SY-B Valve Pit.** The 241-SY-B Valve Pit is an active waste unit located south
2 of and in between Tanks 241-SY-101 and 241-SY-102 in the 241-SY Tank Farm
3 (Figure 2-14). This pit became active in 1977. The unit housed valve controls for transfers
4 of waste solutions from processing and decontamination operations.
5

6 Leak detection and air monitoring are performed continuously within the 241-SY Tank
7 Farm in which this unit is located (WHC 1991a).
8
9

10 **2.3.8 Basins**

11
12 Retention basins were used for intermittent storage of liquid waste before it was
13 transferred to ponds, ditches, or cribs. There are two retention basins discussed in this
14 section. Refer to Figure 2-18 for basin locations and to Figure 2-19 for a diagram of a
15 typical retention basin.
16

17 **2.3.8.1 207-S Retention Basin.** The 207-S Retention Basin, also referred to as the 202-S
18 Building Retention Basin, is a concrete structure with a volume of 3.20×10^6 L (850,000 gal)
19 and a surface area of approximately 430 m² (4,600 ft²). The basin dimensions are 40 x 40 x
20 2 m (130 x 130 x 8 ft). The walls of the concrete structure are approximately 25 cm (10 in.)
21 thick and the floor is 20 cm (8 in.) thick. The system includes approximately 610 m
22 (2,000 ft) of 61 cm (24 in.) diameter vitrified clay pipe that is used to convey wastewater to
23 and from the basin. The basin received liquid low-level wastes such as process cooling water
24 and steam condensate from the 202-S Building from October 1951 through April 1954. The
25 wastes were then discharged to the 216-S-17 or 216-S-16 Ponds. There are three unplanned
26 releases associated with the unit due to leaks in process vessel coils in the 202-S Building.
27 These leaks released radioactivity into the basin from late 1952 until spring 1954 and are
28 discussed in Section 2.3.10. The site unit is included in the HSFP.
29

30 The concrete walls and floors of the basin were filled with dirt to prevent contamination
31 spread. In June 1975, the soil was treated with herbicides and covered with 23 cm (9 in.) of
32 gravel to stop radioactive weed growth (DOE/RL 1992).
33

34 **2.3.8.2 207-SL Retention Basin.** The 207-SL Retention Basin, located approximately 61 m
35 (200 ft) east of the 222-S Laboratory, is also referred to as 222-S Laboratory Retention Basin.
36 The basin is currently operational and has received wastes since February 1952. Until 1954,
37 the unit received low-level wastes such as ventilation cooling water and miscellaneous wastes
38 from laboratory hoods and sinks in the 222-S Laboratory. These wastes were then discharged
39 to the 216-S-19 Pond. The basin was inactive from December 1954 to October 1955 due to
40 exceedances in radioactivity levels. The basin now receives similar wastes as it had
41 originally; however, it now discharges to 216-S-26 Crib. Liquid effluent sampling and
42 analysis is performed weekly and results are composited monthly. The unit dimensions are
43 15 x 15 x 3.7 m (50 x 50 x 12 ft). The unit has reinforced concrete walls 30 to 41 cm thick
44 (12 to 16 in.) and the floor is 38 cm thick (15 in.). A 2 m (7 ft) chain link fence on top of
45 the walls lines the perimeter of the unit (DOE/RL 1992).
46

2.3.9 Burial Sites

Solid wastes generated by the operating facilities at the Hanford Site have routinely been disposed in designated shallow-land burial trenches. These burial trenches have been constructed in groups referred to as solid waste burial sites (Last et al. 1988). Solid wastes were packaged in cardboard boxes, wood boxes, steel drums, concrete burial vaults, or other containers. Initially no attempt was made to segregate these wastes as to type or level of radioactivity.

Waste placed into these trenches are covered with a minimum of 2 m (8 ft) of soil backfill as needed. Wide-bottom or industrial trenches may be as deep as 15 m (50 ft) and from 4.9 m (16 ft) to more than 30 m (100 ft) wide at the bottom. Trench slopes are usually 1:1.5 to avoid sloughing. If vehicular activity is required in the trench, the bottom of the trench is covered with several layers of crushed gravel. This layer also provides a base for stacking waste. All waste is either boxed, drummed, or self-contained (i.e., equipment). A wide-bottom trench is backfilled when dirt-moving equipment is available, usually when less than 100 linear ft of stacked waste is in the trench (Last et al. 1988).

There are two solid waste burial units in the S Plant Aggregate Area.

2.3.9.1 218-W-7 Burial Ground. The inactive 218-W-7 Burial Ground is located near the 222-S Laboratory (Figure 2-21). The unit was started in 1952 and closed in 1960, and is made of carbon steel with one coat of hot coal tar enamel, is 4.3 m (14 ft) deep, and rests on a 0.3 m (1 ft) concrete foundation. The unit has a dome and vent structure that extends 3.2 m (11 ft) to the surface. It received a volume of approximately 160 m³ (210 yd³) consisting of dry, packaged laboratory and sample waste from the 222-S Laboratory. The isotopes thought to be present are ¹³⁷Cs, ¹⁰⁶Ru, ⁹⁰Sr (WHC 1991a).

The unit is barricaded by a lightweight chain and four concrete posts with posted signs warning of underground radiation contamination. The surface of this unit is sand and gravel at grade.

2.3.9.2 218-W-9 Burial Ground. The inactive 218-W-9 Burial Ground is located directly east of the 241-SX Tank Farm (Figure 2-20). The burial ground was used and deactivated during September 1954. The unit contains an unknown amount of metal scrap including the 211-S Tank taken from the S Plant Complex. The burial ground is designated by four corner posts encompassing an area of 41.8 x 297 m (137 x 975 ft) and received 490 m³ (640 yd³) of waste. There is no available information on the actual size of the burial ground (DOE/RL 1992). The waste contained less than 0.1 Ci total beta activity. The radionuclides suspected in the waste included ¹³⁷Cs, ¹⁰⁶Ru, and ⁹⁰Sr. The area is barricaded with a light chain and a concrete marker post. Signs warning of underground radiation contamination also surround the area. The unit was interim stabilized in 1991 with sand and gravel. The surface is approximately 0.46 m (1.5 ft) above grade. There are no vents or vegetation in this area. Unplanned release 200-W-109 did occur directly above the 218-W-9 Burial Ground in 1969.

1 **2.3.10 Unplanned Releases**
2

3 Forty-five unplanned releases are included in the S Plant Aggregate Area. The locations
4 of these unplanned releases are shown in Figure 2-22. Many of the releases are not included
5 as independent units in the Tri-Party Agreement because they are closely associated with
6 existing waste management units; these unplanned releases and their associated waste
7 management units are addressed together in this study. Table 2-6 summarizes the known
8 information for each unplanned release and, where applicable, lists the waste management
9 unit to which it is related. Most of the information available for the unplanned releases is
10 derived from the WIDS sheets (WHC 1991a).
11
12

13 **2.3.11 Potential Waste Sites**
14

15 No new potential waste management units have been identified in the S Plant Aggregate
16 Area. Discharges of steam condensate to the soil column do occur at several locations along
17 the steam transfer line; however, no contaminants are associated with this discharge. These
18 discharges may provide a means to mobilize contaminants in adjacent waste management
19 units.
20
21

22 **2.4 WASTE GENERATING PROCESSES**
23

24 This section describes the feed preparation, solvent extraction, solvent recovery, and
25 waste treatment and disposal process that occurred at the S Plant Complex from 1951 to
26 1967. Table 2-7 summarizes the available information concerning the waste streams produced
27 within the aggregate area. The chemicals or radionuclides that are known or suspected to be
28 present in the S Plant Aggregate Area waste streams are listed in Table 2-8; Table 2-9 lists
29 the chemicals used in the 222-S Laboratory; and Table 2-10 lists radionuclides, organic and
30 inorganic chemicals disposed at S Plant Aggregate Area waste management units. These lists
31 have been compiled from inventory data, sampling data, and process descriptions.
32
33

34 **2.4.1 REDOX Process Overview**
35

36 As part of the mission at the Hanford Site, several processes were developed to separate
37 uranium, plutonium, and their fission products from irradiated uranium slugs. In 1951, the
38 REDOX process replaced the existing bismuth phosphate process because of lower costs,
39 improved throughput, and enhanced recovery of uranium and plutonium. The REDOX
40 process, used between 1951 and 1967, was a solvent-extraction process that extracted
41 plutonium and uranium from dissolved fuel into a MIBK solvent (DOE 1987). This process
42 was carried out in the 202-S Building where irradiated uranium slugs from the 100 Area were
43 treated, resulting in numerous waste streams and relatively pure product streams. The slightly
44 acidic waste streams contained fission products and large quantities of aluminum nitrate that
45 were used to promote the extraction of plutonium and uranium (DOE 1987) in the REDOX
46 process. The wastes were neutralized and stored in tanks, or disposed in cribs, trenches,

1 ditches, or ponds that leached wastes directly into the soil column. Product streams were
2 directed to other processing facilities. The REDOX process was designed to recover at least
3 98% of the uranium and plutonium from the irradiated slugs. With the exception of the feed
4 preparation and dissolution processes, which operated in batch, the REDOX process was
5 continuous.
6

7 The solvent-extraction process was based on the preferential distribution of uranyl
8 nitrate and the nitrates of plutonium between an aqueous phase and an immiscible organic
9 phase. This process is described in greater detail below; however, the descriptions generally
10 exclude mention of water or water vapor that was present in many of the process streams.
11

12 13 2.4.2 Feed Preparation

14
15 The first step in the REDOX process involved preparing the uranium slugs (brought
16 from the 100 Area reactor by rail) for processing. Products resulting from the fission of
17 uranium and plutonium were a function of the time of disintegration and subsequent
18 "cooling." The "cooling" period ranged from 40 to 90 days and allowed the short-lived (half-
19 life less than 1 day) radioactive isotopes in the uranium slugs to decay to negligible
20 radioactivity levels. Approximately 100 short-lived radioactive isotopes, or fission products,
21 were present in irradiated uranium during "cooling." About 20 of the short-lived fission
22 products had yields above 1%. Longer-lived fission products that may have been present in
23 the process streams (in approximate order of abundance) included various isotopes of
24 americium, curium, neptunium, ruthenium, rhodium, zirconium, niobium, cerium,
25 praseodymium, krypton, strontium, yttrium, cesium, tellurium, barium, lanthanum,
26 neodymium, and promethium. Impurities found in the uranium metal that may have been
27 present in small quantities throughout the separation process included carbon, nitrogen, iron,
28 silicon, and trace quantities of cobalt, zinc, potassium, copper, aluminum, cadmium, and
29 boron.
30

31 The irradiated uranium slugs were removed from their aluminum alloy jackets
32 (aluminum, silicon, tin, iron, copper and trace magnesium, manganese, and titanium) by
33 immersion in a solution of NaOH and sodium nitrate (NaNO_3). This process produced an
34 aqueous coating waste stream, containing sodium aluminate (NaAlO_2), NaNO_2 , NaNO_3 ,
35 NaOH, sodium metasilicate (Na_2SiO_3), and small amounts of uranium, plutonium, and fission
36 products. This stream was directed to the 241-S Tank Farm. Aluminum oxide (Al_2O_3) may
37 have precipitated if the ratio of NaOH to aluminum was low. Ammonia (NH_3) and hydrogen
38 (H_2) gases were also emitted.
39

40 After the uranium slugs were removed from their jackets, they were rinsed in HNO_3 to
41 remove residual alkalinity. The rinse water, containing small amounts of uranium and
42 plutonium, was also directed to 241-S Tank Farm. The uranium slugs were then dissolved in
43 HNO_3 , creating a metal solution containing primarily uranyl nitrate ($\text{UO}_2(\text{NO}_3)_2$) and oxidized
44 plutonium (III or IV) as soluble nitrates. Uranyl nitrate crystallizes as $\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ or
45 uranyl nitrate hexahydrate, so the dissolved metal may occasionally be referenced as uranyl
46 nitrate hexahydrate solution. The off-gases, primarily nitrogen dioxide (NO_2) and nitrous

1 oxide (NO) with lesser amounts of HNO₃ and water, were put through a condenser, where the
2 HNO₃ and water were condensed and returned to the dissolver tank. The returning
3 condensate served to scrub NO₂ and NO from the exiting gaseous phase. The remaining
4 gaseous effluent that was not condensed or scrubbed was passed through a "silver reactor" to
5 capture the toxic volatile radioisotope of iodine (¹³¹I) by reaction with silver nitrate (AgNO₃)
6 forming silver iodide (AgI). Off-gas from the "silver reactor" was passed through fiberglass
7 filters to remove radioactive particulate and was then discharged to the atmosphere through
8 the 291-S Stack Complex.

9
10 The metal remaining in the dissolver tank solution was next treated with sodium
11 dichromate (Na₂Cr₂O₇) to oxidize the plutonium to the VI valence state (the uranium already
12 existed in this state as uranyl nitrate). Concurrently, the fission product of ruthenium was
13 oxidized with potassium permanganate (KMnO₄) to form the volatile, ruthenium tetroxide
14 (RuO₄), that was removed by sparging with air. The off-gas was scrubbed with caustic,
15 resulting in the formation of Na₂RuO₄. The scrubber bottoms were disposed with other
16 wastes in the 241-S Tank Farm. The ruthenium was removed because it was the primary
17 contaminant in purified plutonium and uranium streams.

18
19 The manganese dioxide (MnO₂), precipitated from the reduction of KMnO₄ with
20 chromic nitrate (Cr(NO₃)₃), and a filter aid known as Super Fitrol (an activated clay
21 containing mostly silicon dioxide [SiO₂] and Al₂O₃), carried away the adsorbed fission
22 products of zirconium and niobium and was separated from solution by centrifugation. The
23 centrifugation cake was dissolved with a ferrous sulfamate (Fe(NH₂SO₃)₂)/HNO₃ solution and
24 was slurried and pumped to the 241-S Tank Farm. This dissolved cake contained inorganic
25 ions (NH₂SO₃, NO₃, Fe⁺⁺⁺, Mn⁺⁺) and small quantities of uranium and plutonium.

26
27 The metal solution (containing uranium, plutonium, Na₂Cr₂O₇, HNO₃, and potassium
28 dichromate [K₂Cr₂O₇]) was adjusted to an acid-deficient state by addition of NaOH; this
29 ensured neutralization of the solution when it contacted acidified methyl isobutyl ketone
30 (commonly referred to as MIBK) in the subsequent process.

31
32 The metal solution then went through several solvent-extraction cycles, as necessary, to
33 achieve the desired uranium and plutonium purity. These solvent-extraction cycles resulted in
34 three aqueous phases containing essentially all the plutonium, all the uranium, and the bulk of
35 the fission products.

36
37 Waste streams generated by the feed preparation process include both gaseous and
38 liquid/solid wastes. An off-gas stream containing radioactive iodine (¹³¹I) was generated by
39 the dissolvers, treated in the "silver reactor" to remove the radioactive iodine, filtered through
40 fiberglass filters (Filters A-4, B-4, and C-4) to remove particulate, and discharged to the
41 atmosphere through the 291-S Stack Complex. Off-gases were also produced at the oxidizer.
42 These gases, which contained radioactive ruthenium, were put through a ruthenium scrubber
43 to remove the ruthenium, filtered through the J-1 Fiberglass Filter to remove particulate, and
44 discharged to the atmosphere through the 291-S Stack Complex. The gaseous wastes
45 discharged to the atmosphere contained essentially no radioactive particulate matter or

1 ruthenium and little radioiodine. Volatile radioisotopes of xenon and krypton may also have
2 been present.
3

4 Liquid and slurry wastes generated by the feed preparation process included the coating
5 removal solution, the acid flush from the dissolvers, the dissolved or slurried centrifuge cake,
6 and the ruthenium scrubber solution. All of these waste streams were considered to be high-
7 level radioactive wastes and, with the exception of the ruthenium scrubber solution, all were
8 sent to the 241-S Tank Farm via the 240-S and 241-S Diversion Boxes. The ruthenium
9 scrubber solution was sent to the neutralizer one or two times a week, where it was used to
10 help adjust the acid deficiency of the metals solution.
11

12 Waste management units that received process wastes included:

- 13 • 241-S Tank Farm
- 14 • 291-S Stack Complex
- 15 • A-4, B-4, C-4, and J-1 Fiberglass Filters.

21 2.4.3 First Extraction Cycle

22
23 In the first extraction cycle, the metal solution was contacted with acidified MIBK and
24 aqueous aluminum nitrate ($\text{Al}(\text{NO}_3)_3$); the uranium and plutonium were extracted into the
25 organic phase while the fission products remained in the aqueous phase. The $\text{Al}(\text{NO}_3)_3$, a
26 salting agent, reduced the aqueous solubility of the uranium and plutonium nitrates by
27 increasing the nitrate concentration in the aqueous phase. Less than 0.2% of the plutonium,
28 and more than 99% of the fission products, remained in the aqueous stream. This aqueous
29 stream contained the wastes from the extraction cycle, and was subjected to further processing
30 before disposal (see Section 2.4.7).
31

32 The organic phase was then directed to a column where the stream was contacted with
33 ferrous sulfamate reducing the plutonium to the III valence state; the plutonium (III)
34 partitioned into the aqueous phase containing $\text{Al}(\text{NO}_3)_3$ while the uranium remained in the
35 organic phase. The aqueous phase was scrubbed with additional acidified MIBK to remove
36 residual uranium. The aqueous plutonium solution was directed to the Second and Third
37 Plutonium Cycles, as necessary.
38

39 In a third column, the remaining organic phase was contacted with a new aqueous phase
40 (not containing the $\text{Al}(\text{NO}_3)_3$) where the uranium partitioned into the aqueous phase. The
41 aqueous product stream was stripped to remove any dissolved MIBK and adjusted to be acid
42 deficient. The aqueous uranium solution was directed to the Second and Third Uranium
43 Cycles, as necessary.
44

45 The primary waste stream generated by the first extraction cycle was an aqueous stream
46 containing fission products from the dissolved uranium slug stream. This stream was sent to

1 the waste concentrator (discussed in Section 2.4.7) for further treatment prior to disposal.
2 Spent solvent from the separation process contained small amounts of uranium, plutonium,
3 and fission products and was routed to the solvent treatment system (discussed in
4 Section 2.4.6) for purification prior to being recycled into the extraction process.
5

6 The aqueous uranium stream produced by the first extraction cycle was steam stripped,
7 resulting in a gaseous stream with traces of MIBK; and then concentrated, resulting in an
8 air/water vapor stream with (potentially) small amounts of uranium.
9

10 Both of these streams were routed to the condensate stripper, as described in
11 Section 2.4.7.
12
13

14 **2.4.4 Second and Third Plutonium Cycles**

15

16 If needed, the aqueous plutonium-rich stream from the first extraction was passed
17 through additional cycles (similar to those described above) to achieve the desired purity.
18 Prior to any additional plutonium purification cycles, the aqueous plutonium (III) was again
19 oxidized with $\text{Na}_2\text{Cr}_2\text{O}_7$ to the IV or VI valence states to permit the solvent extraction process
20 to proceed. The purified plutonium stream was then directed to a final isolation process in
21 231-S or 234-S Buildings. The plutonium production rate is still classified. The final
22 plutonium product was a plutonium nitrate solution containing approximately 10 grams of
23 plutonium and 400 to 600 grams of free nitric acid per liter. The uranium impurity in the
24 plutonium product stream was estimated at 0.1 weight percent of the plutonium metal. Other
25 impurities in the plutonium stream were expected to be aluminum and iron at 30,000 and
26 10,000 parts per million parts of plutonium, respectively.
27

28 The primary waste streams generated by the second and third plutonium cycles were an
29 aqueous stream containing impurities from the plutonium stream produced in the first
30 extraction cycle and spent solvent, also containing trace impurities from the plutonium stream.
31 The aqueous stream was directed to the waste concentrator (described in Section 2.4.7) and
32 the spent solvent was directed to the solvent recovery system (described in Section 2.4.6). In
33 addition, the plutonium product stream is concentrated prior to shipping. Water vapor
34 produced during this process is sent to the condensate stripper (described in Section 2.4.7).
35

36 All of the waste streams generated during the second and third plutonium cycles
37 received further treatment prior to disposal; therefore, no waste management units received
38 wastes directly from this process.
39
40

41 **2.4.5 Second and Third Uranium Cycles**

42

43 If needed, the aqueous uranium-rich stream from the first extraction was passed through
44 additional cycles (similar to those described above) to achieve the desired purity. The
45 purified uranium stream was then directed to the Uranium Conversion Plant (224-U Building)
46 where the uranyl nitrate was calcinated to uranium trioxide (UO_3) for shipment off site. The

1 uranium production was designed for approximately 2,300 kg (2.5 short tons) per day,
2 assuming an 80% operating efficiency. The uranium product stream was a solution
3 containing approximately 1,004 grams of uranyl nitrate hexahydrate per liter; the plutonium
4 impurity in the uranium stream was expected to be approximately 10 parts per billion parts of
5 uranium. Other impurities in the uranium stream were expected to be HNO₃, sodium,
6 aluminum, and iron at 10,000, 400, 600, and 150 parts per million parts of uranium,
7 respectively.
8

9 Waste streams generated by the second and third uranium cycles are very similar to
10 those produced by the second and third plutonium cycles. Aqueous wastes were directed to
11 the waste concentrator (described in Section 2.4.7) and spent solvent was directed to the
12 solvent recovery system (described in Section 2.4.7). In addition, the aqueous uranium
13 product stream was steam stripped prior to final shipment. This produced a gaseous stream
14 containing water vapor and MIBK, which was routed to the condensate stripper (described in
15 Section 2.4.7).
16

17 All of the waste streams generated during the second and third uranium cycles received
18 further treatment prior to disposal; therefore, no waste management units received wastes
19 directly from this process.
20

21 2.4.6 Solvent Recovery

22 Spent MIBK from the extraction cycles was directed to a scrubber where a sodium
23 carbonate (Na₂CO₃) solution was used to remove the bulk of the fission products and residual
24 plutonium and uranium present in the solvent. The MIBK was then fed to a column where,
25 by distillation and contact with caustic, further removal of plutonium, uranium, and fission
26 products was achieved and any organic impurities such as methyl isopropyl diketone or
27 organic acids (from decomposition of MIBK) were removed. Additional treatments may have
28 been used as necessary to remove solvent impurities such as methyl isobutyl carbinol.
29 Make-up MIBK and acid were added to the purified recycle stream for further use in the
30 extractions.
31
32
33

34 Waste streams generated by the solvent treatment process included an aqueous stream
35 containing plutonium, uranium, and fission product impurities from the spent MIBK and an
36 aqueous stream with trace impurities from the distillation of the cleaned MIBK. The first of
37 these streams had higher concentrations of radioactive elements than the second stream and
38 was directed to the waste concentrator (described in Section 2.4.7) for further treatment prior
39 to disposal. The second stream was very dilute and was disposed in the 276-S Crib.
40

41 The waste management unit that received wastes from the solvent recovery was:

- 42 • 276-S Crib.
- 43
44
45

1 **2.4.7 Waste Treatment and Disposal**
2

3 Generally, waste treatment was intended to treat and segregate aqueous wastes
4 according to their radioactivities and to recover MIBK. Liquid wastes that contained
5 appreciable quantities of radioactive materials (such as aqueous fission product wastes from
6 the extraction, zirconium and niobium scavenging, aluminum jacket removal, and solvent
7 recovery cycles) were concentrated to the highest practicable $\text{Al}(\text{NO}_3)_3$ content in a waste
8 concentrator, blended with wastes from the ruthenium scrubber and from the laboratory
9 (222-S), neutralized with caustic to convert the $\text{Al}(\text{NO}_3)_3$ to NaAlO_2 to minimize corrosion
10 problems, and stored in the 241-S Tank Farm. Wastes were routed to the tanks via the 240-S
11 and 241-S Diversion Boxes. The underground storage tanks operated as a cascade system
12 with successive overflow tanks containing less contaminated wastes than upstream tanks.
13

14 Condensate from the waste concentrator and condensate from the uranium and
15 plutonium concentrators contained very low levels of radioactive wastes. These streams were
16 combined and put through a condensate stripper to remove residual MIBK, which was
17 returned to the solvent recovery process. The aqueous product stream was evaporated to the
18 extent possible and disposed as low-radioactive waste in the 216-S Cribs. Residuals from the
19 condensate stripper were returned to the waste concentrator. Other liquid wastes that
20 contained only trace quantities of radioactive materials such as floor drain wastes were also
21 disposed in cribs.
22

23 Off-specification products were recycled to the process or to parallel columns designed
24 specifically for purifying off-specification products. The 222-S Laboratory generated
25 relatively small quantities of waste, most of which was directed to underground storage tanks.
26 Sanitary wastes were directed to septic tanks with tile fields.
27

28 In addition to the gaseous wastes generated by the feed preparation process (as
29 discussed in Section 2.4.2), gaseous waste streams were also generated from the 202-S
30 Building ventilating system and the 202-S Building equipment vent headers. The ventilating
31 system air was passed through sand and gravel filter to remove particulate material and then
32 was discharged to the atmosphere through the 291-S Stack Complex. Air or inert gas from
33 the equipment vent headers was passed through fiberglass filters (Filters J-3, J-4, and/or J-5)
34 before it was also discharged to the 291-S Stack Complex. The stack gases may have
35 included small quantities of xenon and krypton.
36

37 Chemical sewers drained all nonregulated portions of the buildings (such as operating
38 galleries, service areas, and aqueous make-up) and flowed directly to a pond 1,070 m
39 (3,500 ft) southwest of 202-S Building. Process sewers received water and steam condensate
40 from process equipment jackets and coils. This water should not have been contaminated and
41 was directed to the 207-S Retention Basin prior to discharge to the pond to ensure any
42 leakage of radionuclides from process equipment was within acceptable limits ($1.4 \times$
43 10^{-4} mg/L plutonium and 0.5 millicuries per liter [mCi/L] beta emitters). The water in the
44 pond was disposed through evaporation and seepage into the soil column.
45

1 Organic wastes from the laboratory or other buildings were decontaminated and treated
2 with aqueous solutions in the laboratory where they were produced. The organic liquids were
3 transported to a designated site for burial.
4

5 Dry laboratory wastes (absorbent tissues, wood, metal parts, etc.) with low radioactivity
6 were placed in quart cardboard containers which in turn were placed in larger cardboard
7 cartons. When the radioactivity of the carton reached tolerance, the carton was sealed and
8 transported to the 200 West Area burial ground. Highly contaminated dry wastes were placed
9 in containers and disposed in the 218-W-7 Burial Ground adjacent to 222-S Laboratory.
10

11 Waste management units that received wastes from the waste treatment and disposal
12 processes include the following:
13

- 14 • 241-S Tank Farm
- 15
- 16 • 216-S Cribs
- 17
- 18 • 291-S Stack Complex
- 19
- 20 • J-3, J-4, J-5 Fiberglass Filters
- 21
- 22 • 207-S Retention Basin
- 23
- 24 • Pond 1,070 m (3,500 ft) southwest of 202-S Building
- 25
- 26 • 200 West Area burial ground
- 27
- 28 • 218-W-7 dry waste disposal vault.
- 29

30 2.5 INTERACTIONS WITH OTHER AGGREGATE AREAS OR OPERABLE UNITS

31
32 The 200 Area has two distinct operational areas, 200 East and 200 West (Figures 1-3
33 and 1-4). These areas are used for chemical separations and waste management. Supernatant
34 from the 241-SY-102 Tank is transferred to the 200 East Area tank farms. The complexant in
35 the 241-SY-101 and 241-SY-102 Tanks comes from the 200 East Area. Interaction of the S
36 Plant Complex facilities with 200 East facilities is described below.
37

- 38 • The B Plant, one of the original fuel separation facilities, was in operation from
39 1945 to 1952. The bismuth phosphate process was used to separate plutonium
40 from irradiated uranium fuel. The plutonium was precipitated on a bismuth-
41 phosphate carrier in B Plant and later converted to plutonium nitrate. The 222-S
42 Laboratory continues to provide analytical support for current B Plant operations.
43
- 44 • The PUREX facility separated uranium, plutonium, and neptunium from their
45 fission products similar to the REDOX process except the PUREX process used
46 an organic phase of tributyl phosphate in kerosene instead of MIBK a salting

1 agent of nitric acid instead of aluminum nitrate, and a pulse column instead of
2 continuous packed columns. The final plutonium nitrate stream was concentrated
3 and sent to the Plutonium Finishing Plant (Z Plant) to be converted to metal form.
4 The facility was in operation from 1956 to 1972 and was placed on standby until
5 1983 when operations were resumed. The silica gel adsorption columns in 205-S
6 Building were occasionally used to further remove fission products from
7 decontaminated uranium solutions from the PUREX Plant. Building 205-S is no
8 longer present. The 222-S Laboratory serves as a backup to the PUREX Plant
9 analytical laboratory.

10
11 The 200 West Area Plants consists of the U Plant, S Plant, T Plant, and Z Plant. The
12 interaction of the U Plant, T Plant, and Z Plant with the S Plant is as follows:

- 13
14 • The U Plant was designed as a bismuth phosphate plant but was later converted to
15 a solvent-extraction plant for the recovery of uranium from bismuth phosphate
16 process wastes. This operation used a series of tanks located in the 241-U Tank
17 Farm. The tank farm has both SSTs and DSTs used to store radioactive waste
18 from the U Plant and other plants. Decontaminated uranyl nitrate hexahydrate
19 solution was transferred from the 203-S and 204-S Tank Farms to U Plant for
20 calcination in the 224-U (and 224-UA) Uranium Oxide Plant. The 203-S and
21 204-S Tank Farms are no longer present. The 203-U uranyl nitrate hexahydrate
22 Storage Tanks were used to receive and store the uranyl nitrate hexahydrate
23 solution from the S Plant Complex and other plants. From January 1953 to April
24 1954, the 216-S-17 Pond received overflow from the 216-U-10 Pond via the 216-
25 U-9 Ditch. The 222-S Laboratory provides analytical support services for the U
26 Plant. The 216-S-4 French Drain and the 216-S-21 Crib are physically located in
27 the U Plant Aggregate Area, but received waste from the S Plant; these two units
28 are described in the U Plant AAMSR.
- 29
30 • The T Plant was one of the original bismuth phosphate fuels separation facilities
31 (similar to the B Plant) and was in operation from 1944 to 1956. Some T Plant
32 wastes were disposed in the S Plant Complex SSTs.
- 33
34 • Plutonium finishing operations were conducted at Z Plant. Solid wastes from the
35 202-S Building and other areas were routed to the Z Plant for separation. The
36 222-S Laboratory serves as a backup to the Z Plant analytical laboratory. Some
37 Z Plant wastes were disposed in the 202-S Building SST.

38
39 The 204-S Waste Load-In received contaminated liquid waste from the 100 and 300
40 Area laboratories but has been removed.

41
42 In addition to 202-S Building wastes, wastes from a variety of sources outside the
43 202-S Building were discharged to 202-S Building tanks. Although a specific tank is
44 identified as having received waste from outside sources, any of the tanks within the
45 associated cascade system may have received the same wastes. Wastes from non-202-S
46 Building sources associated with specific tanks are identified below:

- 1 • 241-S-101: Supernatant containing Battelle Pacific Northwest Laboratory (PNL)
- 2 waste, PUREX low-level radioactive waste, B Plant high-level radioactive waste,
- 3 and double-shell slurry feed from 241-U Tank Farms.
- 4
- 5 • 241-S-107: B Plant low-level radioactive wastes, Battelle (PNL) waste, N Reactor
- 6 waste, and complexed concentrate from 241-BX, -C, and -U Tank Farms.
- 7
- 8 • 241-S-110: 224-U wastes, B Plant low-level radioactive waste, and organic wash
- 9 waste from 241-BX, -T, -TX, and -U Tanks.
- 10
- 11 • 241-SX-101: Complexed wastes from 241-BX and -U Tank Farms.
- 12
- 13 • 241-SX-102: Partial neutralization feed from the 241-BX and -TX Tank Farms.
- 14
- 15 • 241-SX-103: Partial neutralization feed from the 241-BX Tank Farm.
- 16
- 17 • 241-SX-105: Partial neutralization feed from the 241-BX and -U Tank Farm.
- 18
- 19 • 241-SX-106: Hanford laboratory waste, PNL waste, B Plant low-level radioactive
- 20 waste, PUREX low-level radioactive waste, and partial neutralization feed from
- 21 241-B, -BX, -C, -TX, and -U Tank Farms.
- 22
- 23 • 241-SX-110: PNL waste, B Plant low-level radioactive waste, and 224-U waste
- 24 from 241-B and -BX Tank Farms.
- 25
- 26 • 241-SY-101: Evaporator condensate from the 241-SY-102 Tank, and transfers
- 27 from the 241-SX-106 and 111-U Tanks.
- 28
- 29 • 241-SY-102: Decontamination wastes from T Plant operations and radioactive
- 30 wastes from the laboratory facility, the Remote Mechanical "C" Line, the
- 31 Plutonium Reclamation Facility, and the Plutonium Finishing Plant.
- 32
- 33

34 2.6 INTERACTION WITH RCRA PROGRAM

35 Appendices B and C of the Tri-Party Agreement list RCRA TSD facilities on the

36 Hanford Site that have entered interim status and, thus, will require final permitting or

37 closure. Within the geographical extent of the S Plant Aggregate Area there are 13 facilities

38 which fall into this category:

39

- 40
- 41 • 276-S-141 and 276-S-142 Hexone Tanks
- 42
- 43 • 216-S-10P Pond and 216-S-10D Ditch
- 44
- 45 • 219-S Waste Handling Facility (including Tanks 219-S-102 and -103)
- 46

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- 1 • 222-S Dangerous and Mixed Waste Facility
- 2
- 3 • 222-S Laboratory (including the Standards Laboratory [222-SA])
- 4
- 5 • 240-S-152, 241-S-152, 241-SX-151, and 241-SX-152 Diversion Boxes
- 6
- 7 • 241-S-101 through 241-S-112 Single-Shell Tanks (12 total)
- 8
- 9 • 241-SX-101 through 241-SX-115 Single-Shell Tanks (15 total)
- 10
- 11 • 241-SY-101 through 241-SY-103 Double-Shell Tank (3 total)
- 12
- 13 • 241-S-302A Catch Tank
- 14
- 15 • 244-S Double Contained Receiver Tank
- 16
- 17 • 296-S-16 and 296-S-23 Stacks
- 18
- 19 • 2727-S Nonradioactive Dangerous Waste Storage Facility.
- 20

21 The 276-S-141 and 276-S-142 Hexone Tanks were identified as RCRA treatment,
22 storage, or disposal (TSD) facilities because they contained F003 spent solvent. The waste
23 consisted of hexone, tributyl phosphate, normal paraffin hydrocarbon, and water. Both tanks
24 are contaminated with radioactive fission products. The tanks are currently under closure
25 activities. A clean closure plan is currently being prepared, and will be submitted to Ecology
26 and EPA by November 1992.

27
28 The 216-S-10P Pond and 216-S-10D Ditch are identified as RCRA TSD facilities
29 because of the disposal of wastes with the characteristics of ignitability, corrosivity, and EP
30 toxicity. They also contain radioactive fission products. A closure plan is scheduled for
31 submission to Ecology and EPA by May 1996.

32
33 The 219-S Waste Handling Facility was identified as a RCRA TSD facility because it
34 contained mixed wastes with the characteristics of corrosivity, toxicity, spent nonhalogenated
35 solvents (F003 and F005), and state-only wastes (WT01). The 222-S Dangerous and Mixed
36 Waste Facility was identified as a RCRA TSD facility because it contained mixed and
37 nonradioactive dangerous wastes of the following types: corrosive, ignitable, reactive, toxic,
38 spent halogenated and nonhalogenated (F002, F002, F003, F005, and F027), and state-only
39 (WC01, WC02, WP01, WT01, and WT02). A clean closure plan for these facilities was
40 submitted to Ecology and EPA in December 1991.

41
42 The SSTs and their associated facilities will be closed under RCRA rather than seeking
43 a RCRA operating permit. The preferred closure option will be resolved through the
44 preparation and completion of a supplemental environmental impact statement. The waste
45 management units in this category include: the 240-S-152, 241-S-152, 241-SX-151, and 241-

1 SX-152 Diversion Boxes; the 241-S-101 through 241-S-112 SSTs (12 total); the 241-SX-101
2 through 241-SX-115 SSTs (15 total); and the 241-S-302A Catch Tank.

3
4 The 241-SY-101 through 241-SY-103 DSTs (3 total) and the 244-S Double-Contained
5 Received Tank are active facilities under the control of the Defense Waste Management
6 Program. These units have a current RCRA operating permit.

7
8 The 2727-S Nonradioactive Dangerous Waste Storage Facility has been identified as a
9 RCRA facility under interim status. It is currently not operating, but received a variety of
10 wastes including heavy metals; chlorinated solvents; and corrosive, ignitable, and reactive
11 wastes. A clean closure plan for this facility was submitted to Ecology and EPA in January
12 1992.

13
14 Many of these units are part of the single-shell tanks and will be closed under RCRA
15 rather than seeking a RCRA operating permit. The preferred closure option will be resolved
16 through the preparation and completion of a supplemental environmental impact statement.

17 18 2.7 INTERACTIONS WITH OTHER HANFORD PROGRAMS

19
20 Other ongoing Hanford programs include the single-shell tank closure program (part of
21 RCRA) the HSFP, the RARA Program, and the Defense Waste Management Program.

22
23 The HSFP is responsible for the safe and cost-effective surveillance, maintenance, and
24 decommissioning of surplus facilities at the Hanford Site. These facilities have been retired
25 from programmatic use and, with the exception of a number of ancillary buildings, are
26 contaminated with radioactive material. Facilities included in this program include shutdown
27 production reactors, chemical separation and processing plants, waste handling facilities, and
28 various support structures. The management of these facilities requires a surveillance and
29 maintenance program to keep them in a safe condition, and the development of a plan for
30 ultimate disposition. The S Plant Complex facilities identified as part of the HSFP (Hughes
31 1990) include the following:

- 32
- 33 • 202-S Building (S Plant)
- 34
- 35 • 207-S Retention Basin
- 36
- 37 • 216-S-172 Control Structure
- 38
- 39 • 233-S Plutonium Concentration Facility
- 40
- 41 • 233-SA Exhaust Air Filter Building
- 42
- 43 • 241-SX-401 and 241-SX-402 Condenser Loadout Facilities
- 44
- 45 • 276-S Solvent Handling Facility
- 46

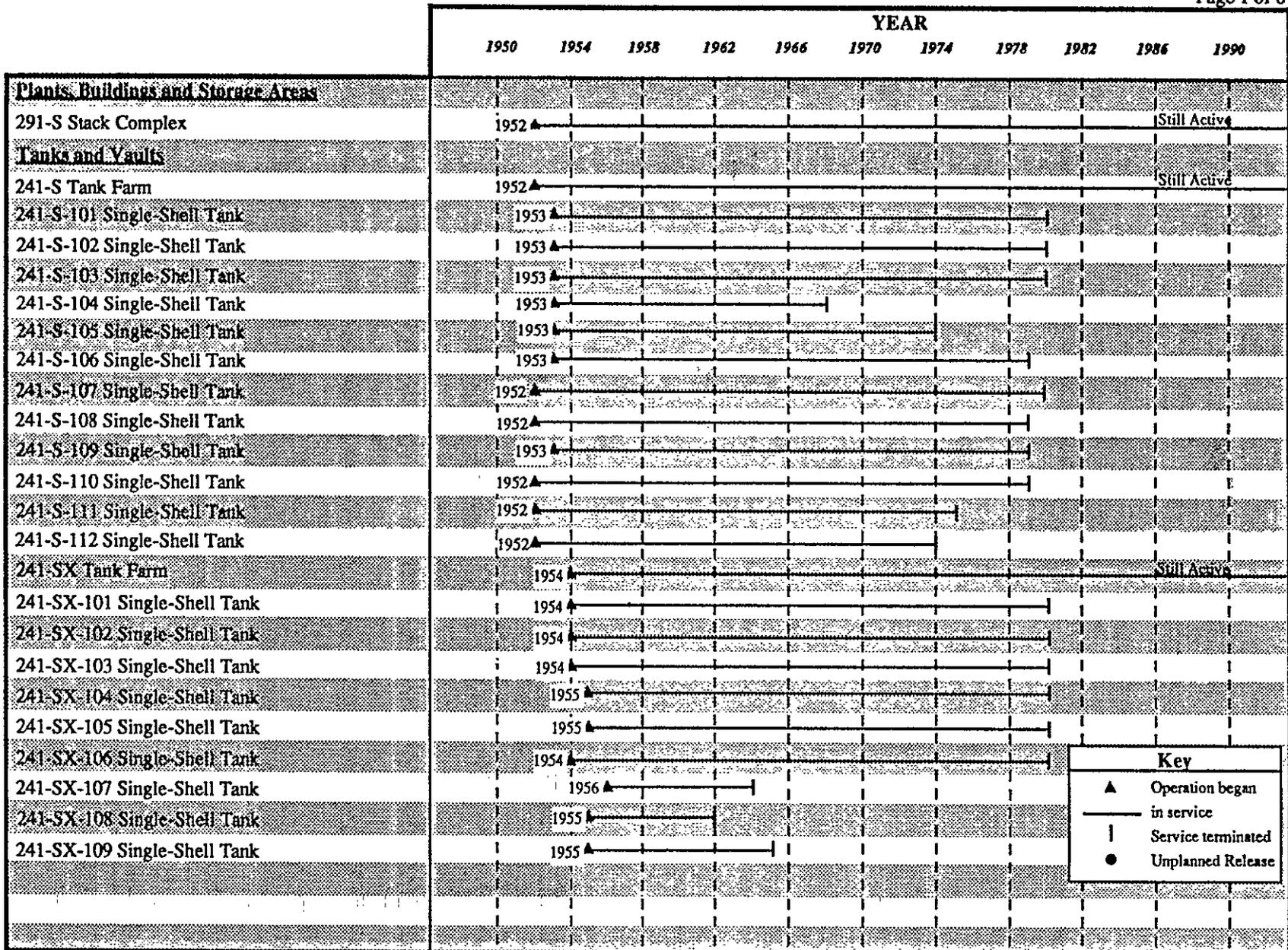
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- 1 • 276-S-141 and 276-S-142 MIBK Storage Tanks
- 2
- 3 • 291-S Fan House and Filter
- 4
- 5 • 291-S-1 Stack
- 6
- 7 • 292-S Jet Pit House
- 8
- 9 • 293-S Off-Gas Treatment Facility
- 10
- 11 • 296-S-1, -2, -4, -6, -7, -12 Stacks
- 12
- 13 • 2711-S Stack Monitoring Building
- 14
- 15 • 2718-S Sand Filter Sampler
- 16
- 17 • 2904-S-160 Control Structure
- 18
- 19 • 2904-S-170 and 2904-S-171 Weir Box
- 20
- 21 • 2904-SA Sampler Building.
- 22

23 The RARA Program is responsible for the surveillance, maintenance, decontamination,
24 and/or interim stabilization of inactive burial grounds, cribs, ponds, trenches, and unplanned
25 releases. A RARA unit is defined as any inactive ground site that has no identified
26 programmatic use, is contaminated with radioactivity and/or chemicals to levels that require
27 controlled access, is outside the jurisdictional land and administrative boundaries of an
28 operating plant, and has been specifically assigned to the RARA Program in accordance with
29 documented transfer procedures. The S Plant Complex facilities identified as part of the
30 RARA Program (Winship and Hughes 1991) include the following:

- 31
- 32 • 203-S through 205-S Underground Zones (no longer present)
- 33
- 34 • 207-S Retention Basin (also in the HSFP)
- 35
- 36 • 216-S-1 through 216-S-7, -9, -13, and -20 through -23 Cribs
- 37
- 38 • 216-S-8 and 216-S-19 Trenches
- 39
- 40 • 216-S-10, -16, -17, -19 Borrow Pits
- 41
- 42 • 216-S-10 and 216-S-16 Ditches (216-S-10 Ditch also in RCRA Program)
- 43
- 44 • 216-S-15 through 216-S-17, and -19 Ponds
- 45
- 46 • 2904-S-160 Control Structure

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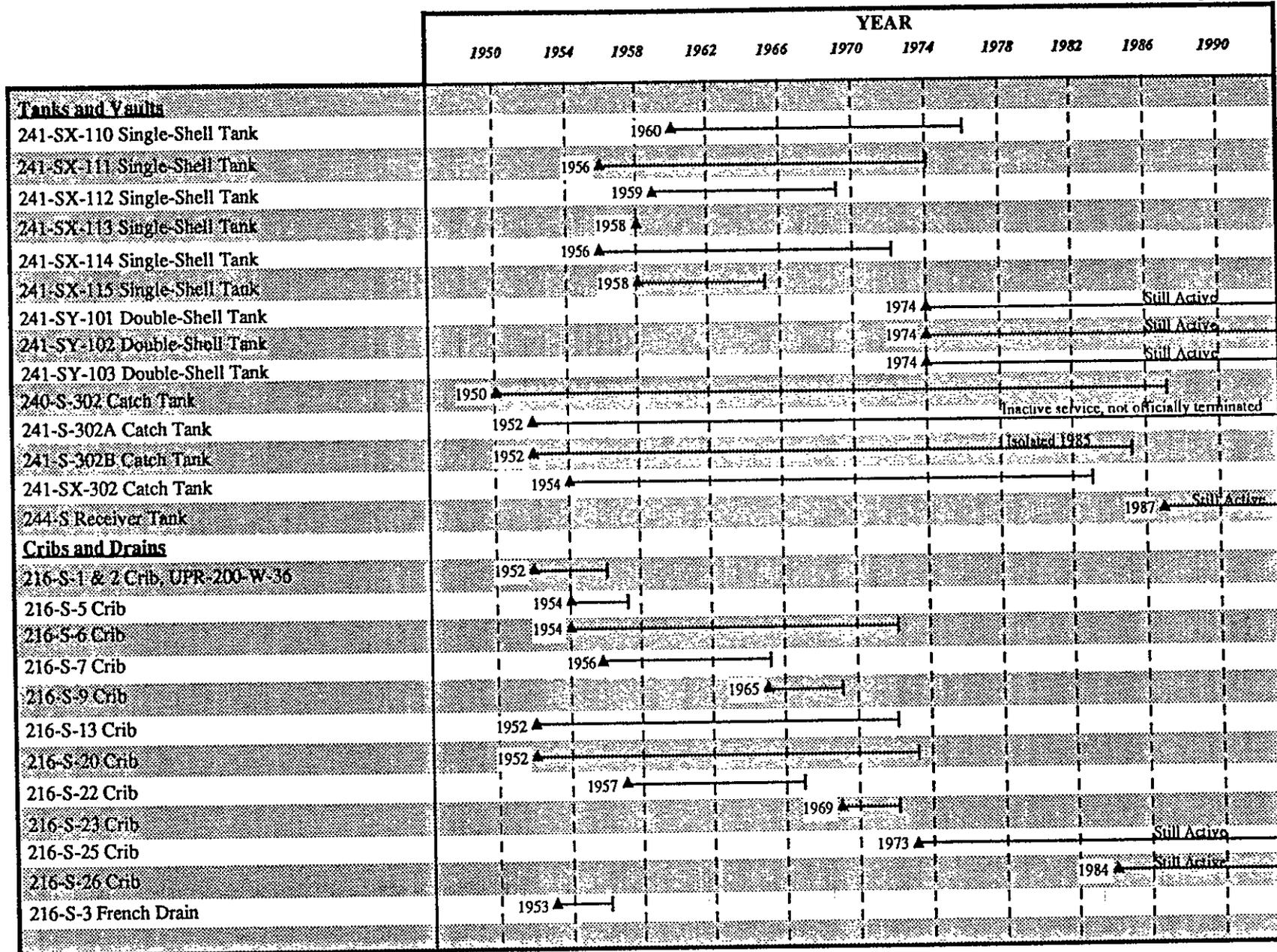


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Figure 2-1. S Plant Aggregate Area Timeline.

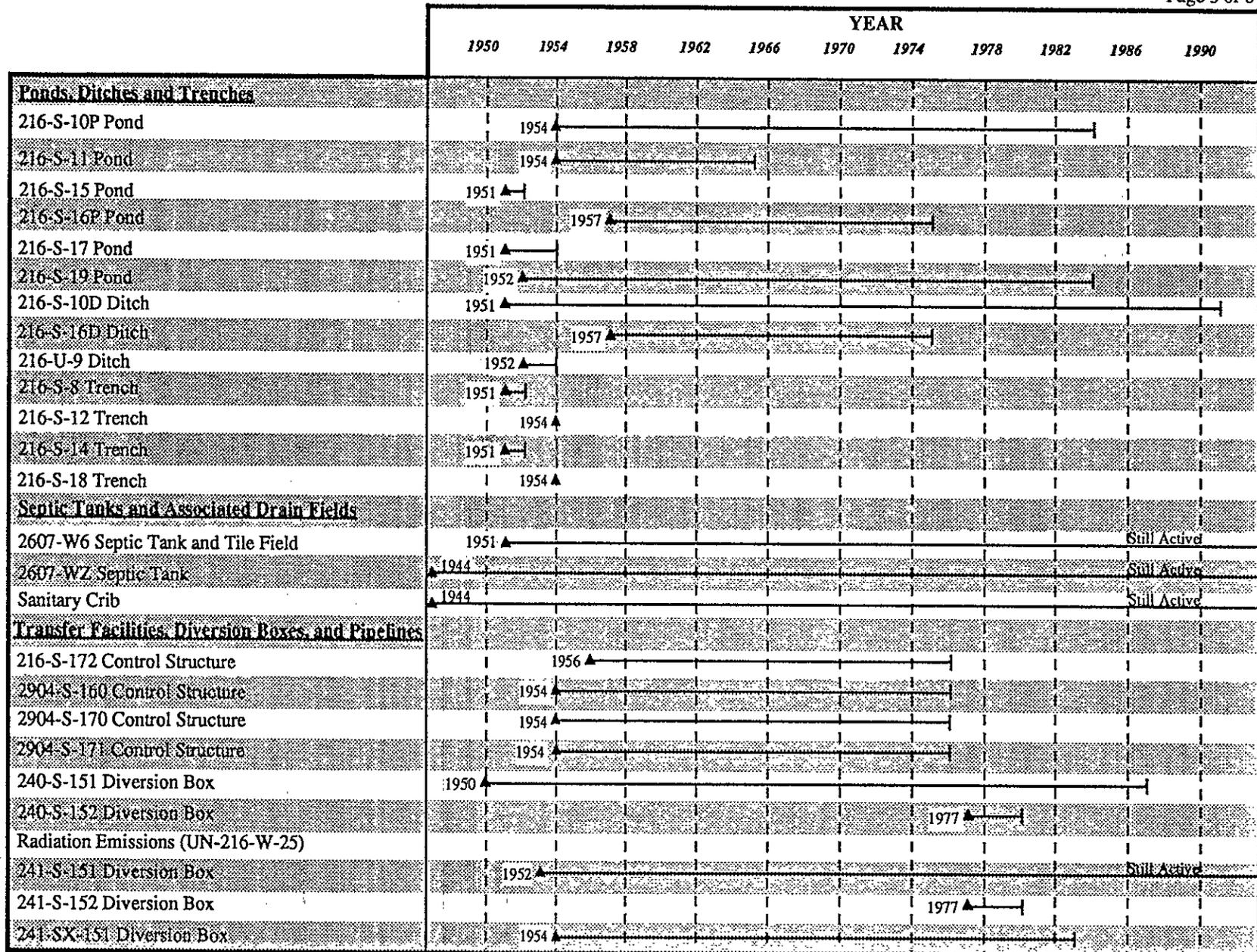
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Figure 2-1. S Plant Aggregate Area Timeline.



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Figure 2-1. S Plant Aggregate Area Timeline.

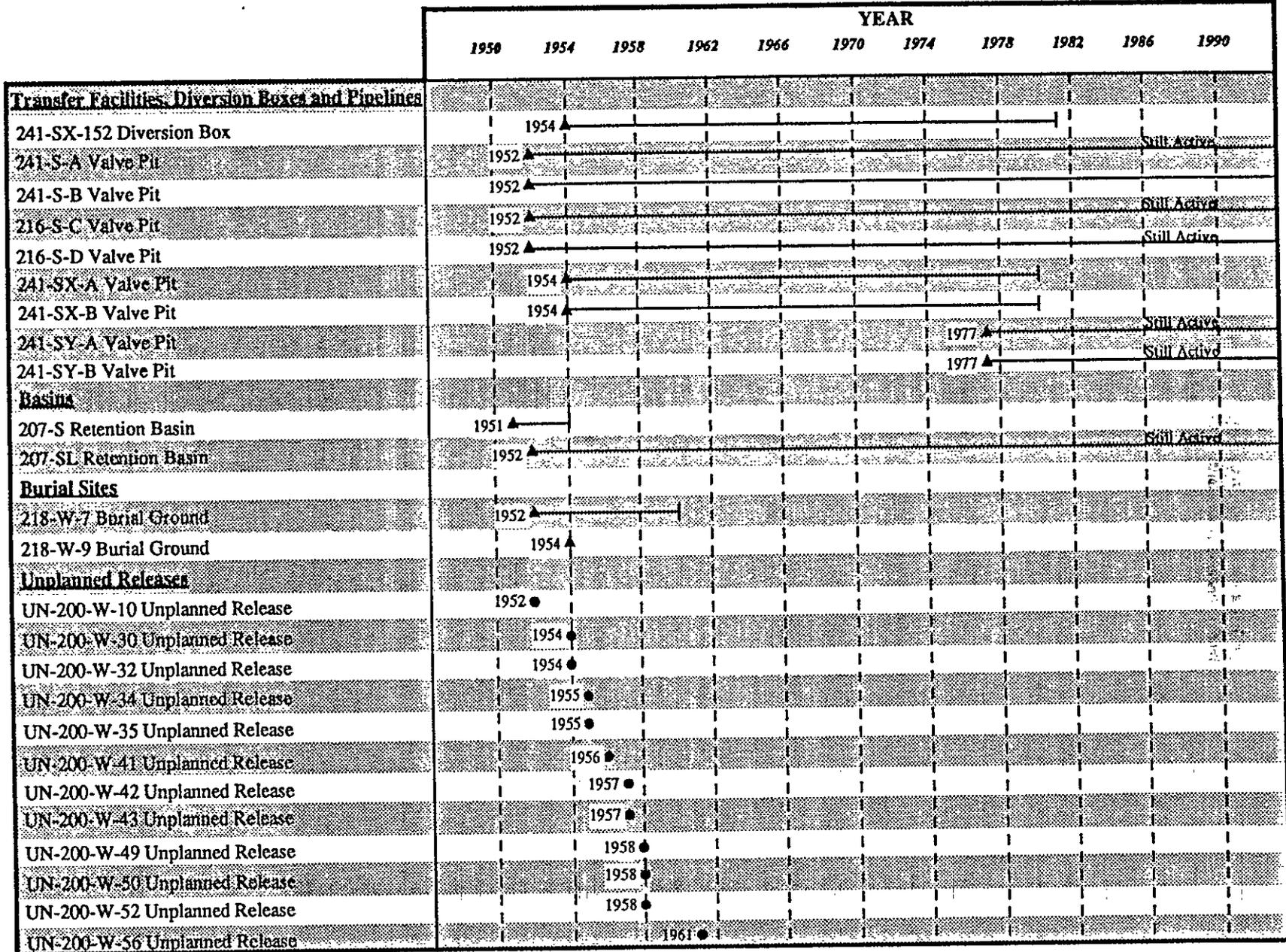


Figure 2-1. S Plant Aggregate Area Timeline.

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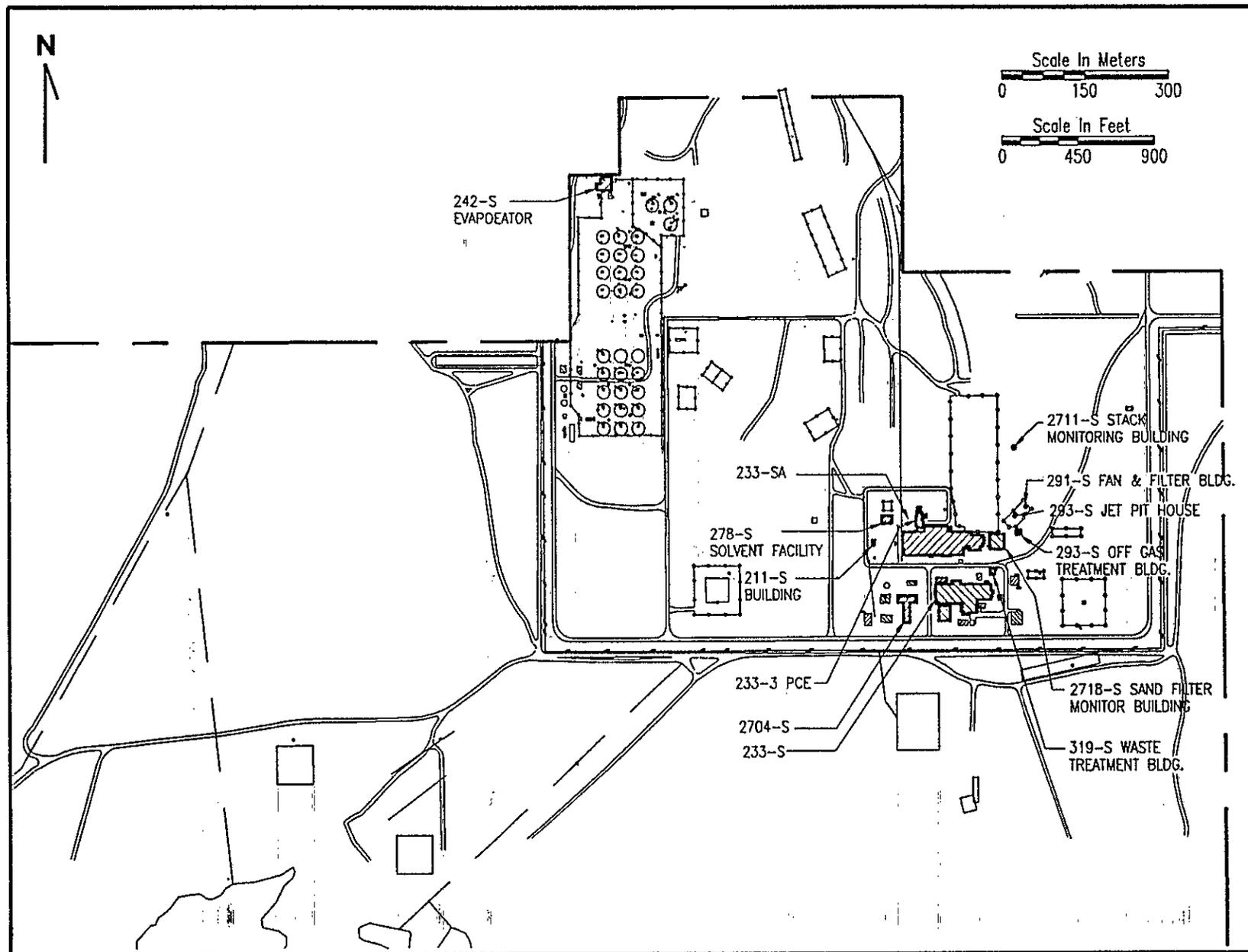
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| | YEAR | | | | | | | | | | | |
|-----------------------------------|--------|--------|--------|--------|--------|---------|------|--------|--------|--------|------|--|
| | 1950 | 1954 | 1958 | 1962 | 1966 | 1970 | 1974 | 1978 | 1982 | 1986 | 1990 | |
| Unplanned Releases | | | | | | | | | | | | |
| UN-200-W-61 Unplanned Release | | | | | 1966 ● | | | | | | | |
| UN-200-W-69 Unplanned Release | | | | | | 1973 ● | | | | | | |
| UN-200-W-80 Unplanned Release | | | | | | | | 1978 ● | | | | |
| UN-200-W-81 Unplanned Release | | | | | | | | 1979 ● | | | | |
| UN-200-W-82 Unplanned Release | | | | | | | | 1980 ● | | | | |
| UN-200-W-83 Unplanned Release | | | | | | | | 1981 ● | | | | |
| UN-200-W-108 Unplanned Release | | | | | 1969 ● | | | | | | | |
| UN-200-W-109 Unplanned Release | | | | | 1969 ● | | | | | | | |
| UN-200-W-114 Unplanned Release | | | | | | | | 1980 ● | | | | |
| UN-200-W-116 Unplanned Release | | | | | 1968 ● | | | | | | | |
| UN-200-W-123 Unplanned Release | | | | | | | | 1979 ● | | | | |
| UN-200-W-127 Unplanned Release | | | | | | | | 1980 ● | | | | |
| Radiation Emissions (UN-216-W-25) | | | | | | UNKNOWN | | | | | | |
| UN-216-W-30 Unplanned Release | | | | | | | | | | 1985 ● | | |
| UPR-200-W-13 Unplanned Release | 1952 ● | | | | | | | | | | | |
| UPR-200-W-15 Unplanned Release | 1952 ● | | | | | | | | | | | |
| UPR-200-W-20 Unplanned Release | 1953 ● | | | | | | | | | | | |
| UPR-200-W-36 Unplanned Release | | 1955 ● | | | | | | | | | | |
| UPR-200-W-47 Unplanned Release | | | 1958 ● | | | | | | | | | |
| UPR-200-W-51 Unplanned Release | | | 1958 ● | | | | | | | | | |
| UPR-200-W-57 Unplanned Release | | | | 1963 ● | | | | | | | | |
| UPR-200-W-59 Unplanned Release | | | | 1965 ● | | | | | | | | |
| UPR-200-W-87 Unplanned Release | | | | | | | | | 1982 ● | | | |
| UPR-200-W-95 Unplanned Release | 1952 ● | | | | | | | | | | | |
| UPR-200-W-96 Unplanned Release | | | | | | 1969 ● | | | | | | |
| UPR-200-W-124 Unplanned Release | | | | | | UNKNOWN | | | | | | |
| UPR-200-W-139 Unplanned Release | 1953 ● | | | | | | | | | | | |
| UPR-200-W-140 Unplanned Release | | | | | 1964 ● | | | | | | | |

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Figure 2-1. S Plant Aggregate Area Timeline.

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

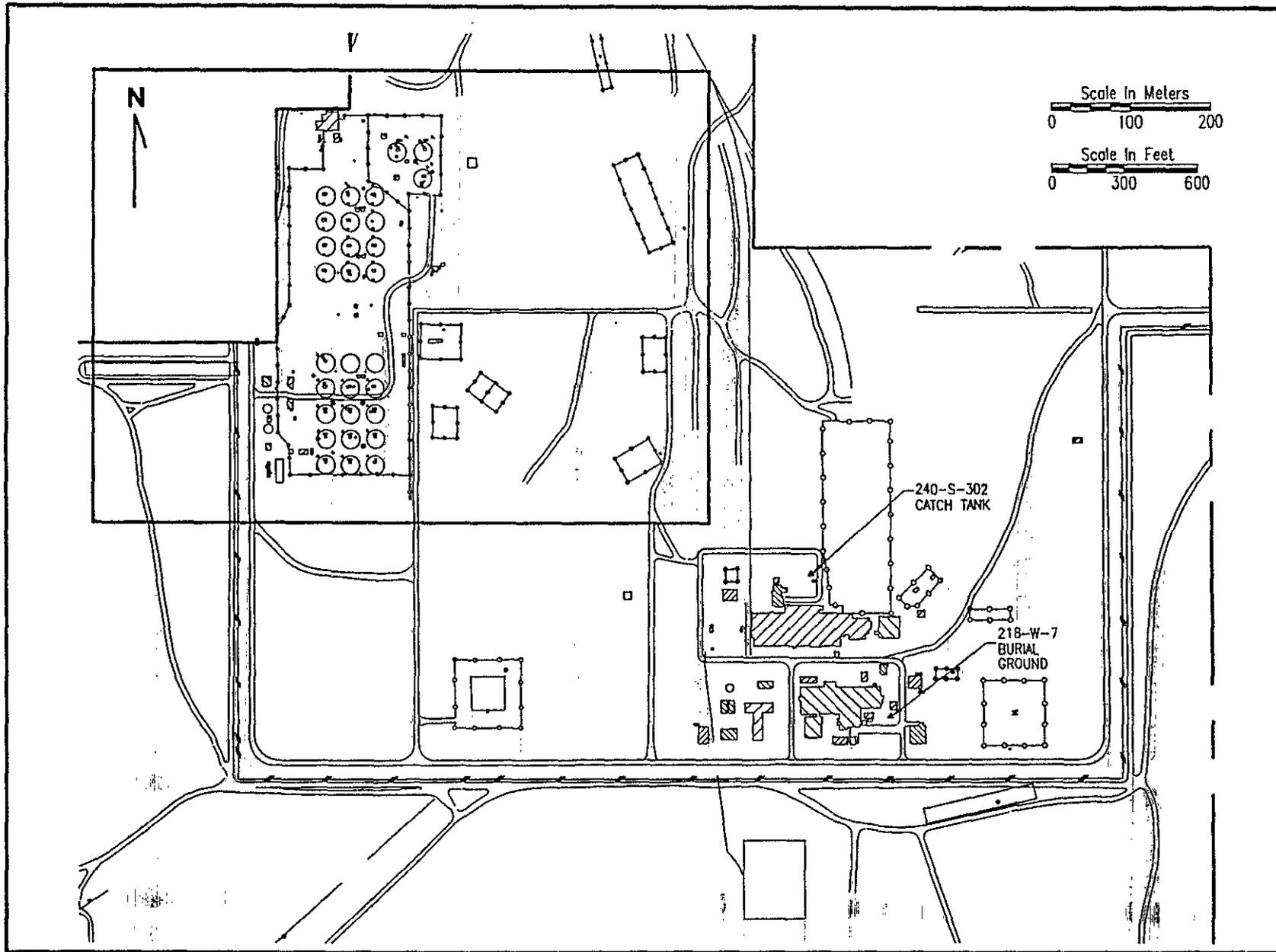
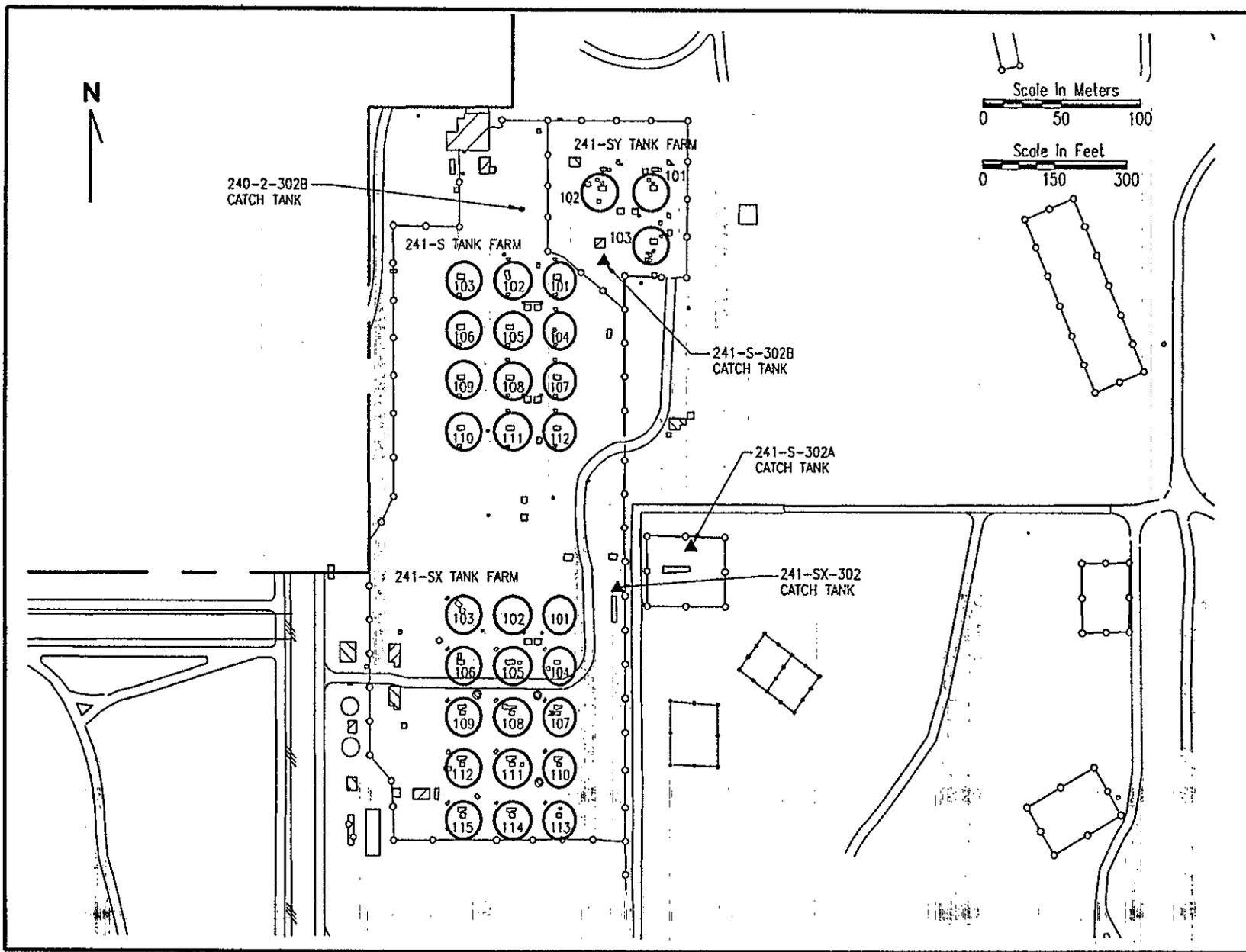


Figure 2-3. Location of Tanks and Vaults.

2F-3

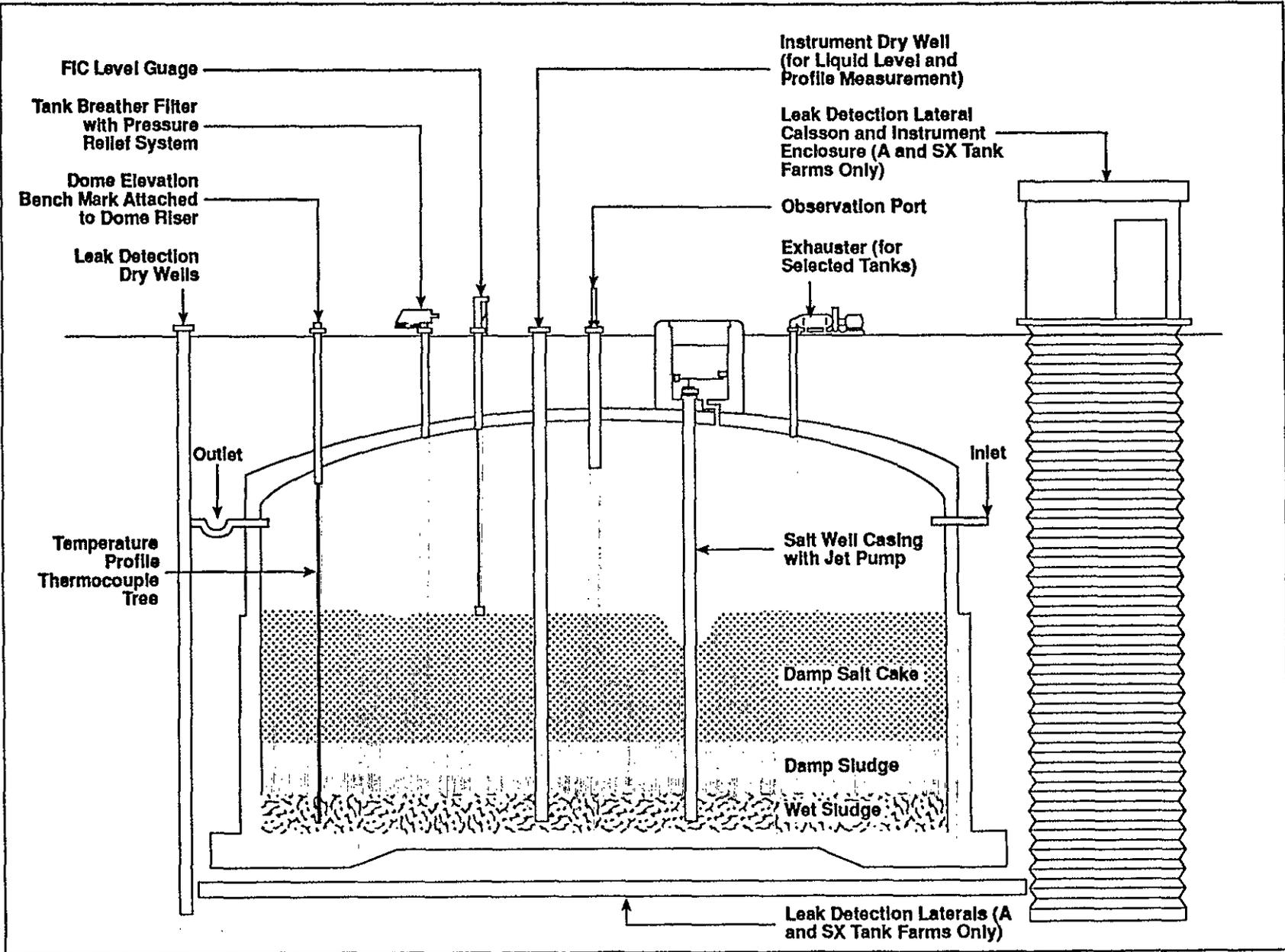
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Figure 2-4. Tank Farm Detail.



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Figure 2-5. Typical Single-Shell Tank.

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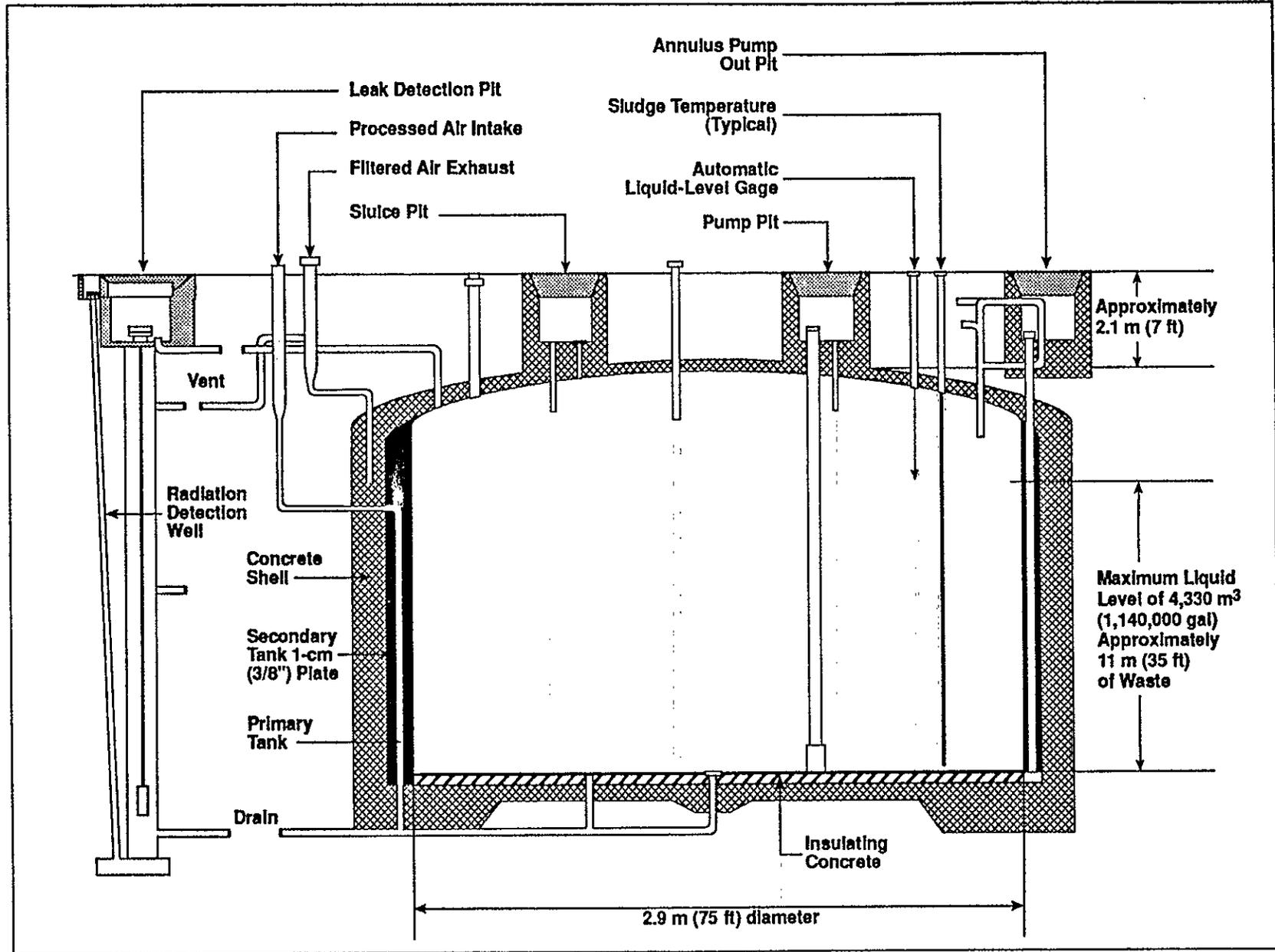
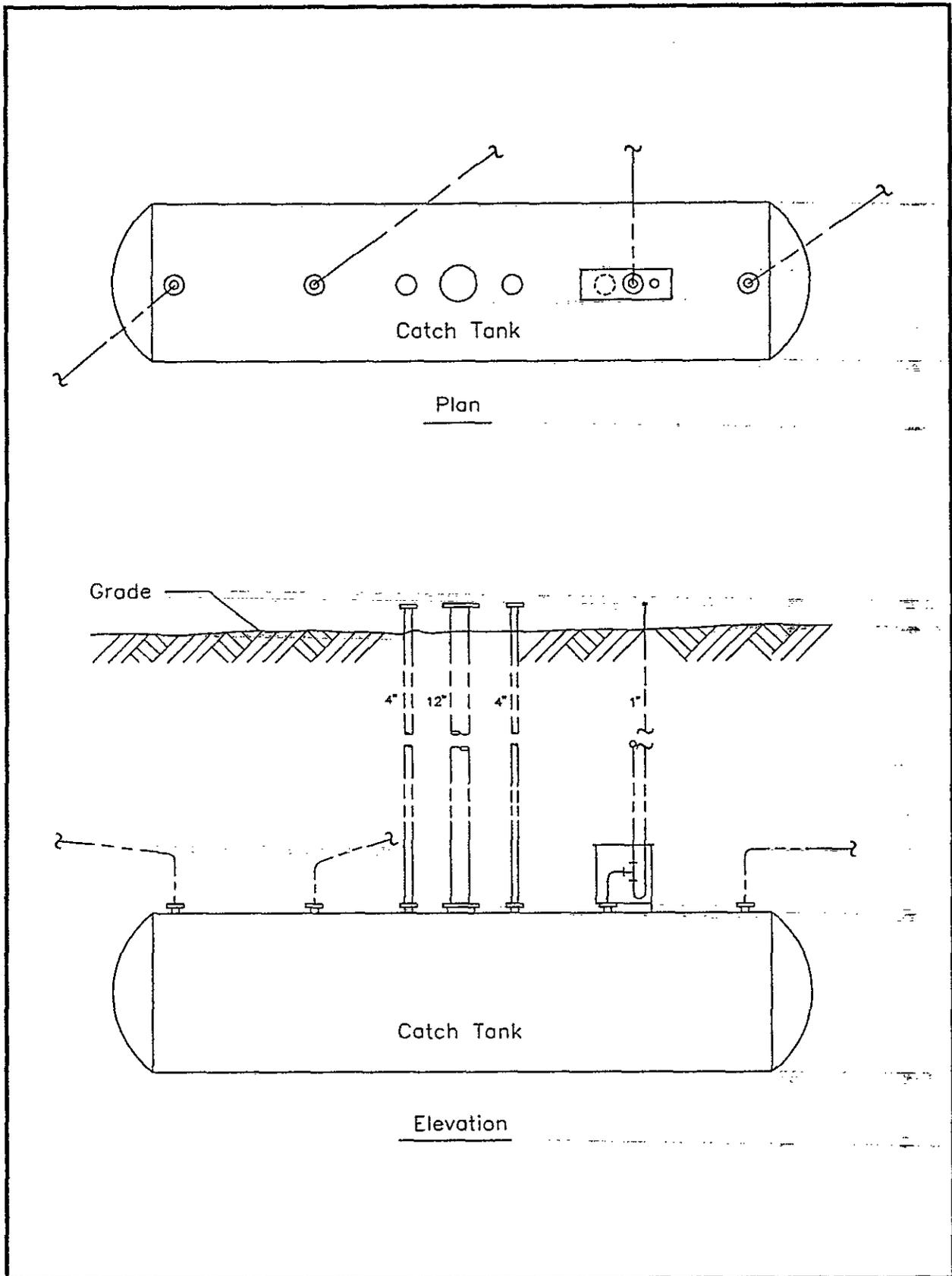
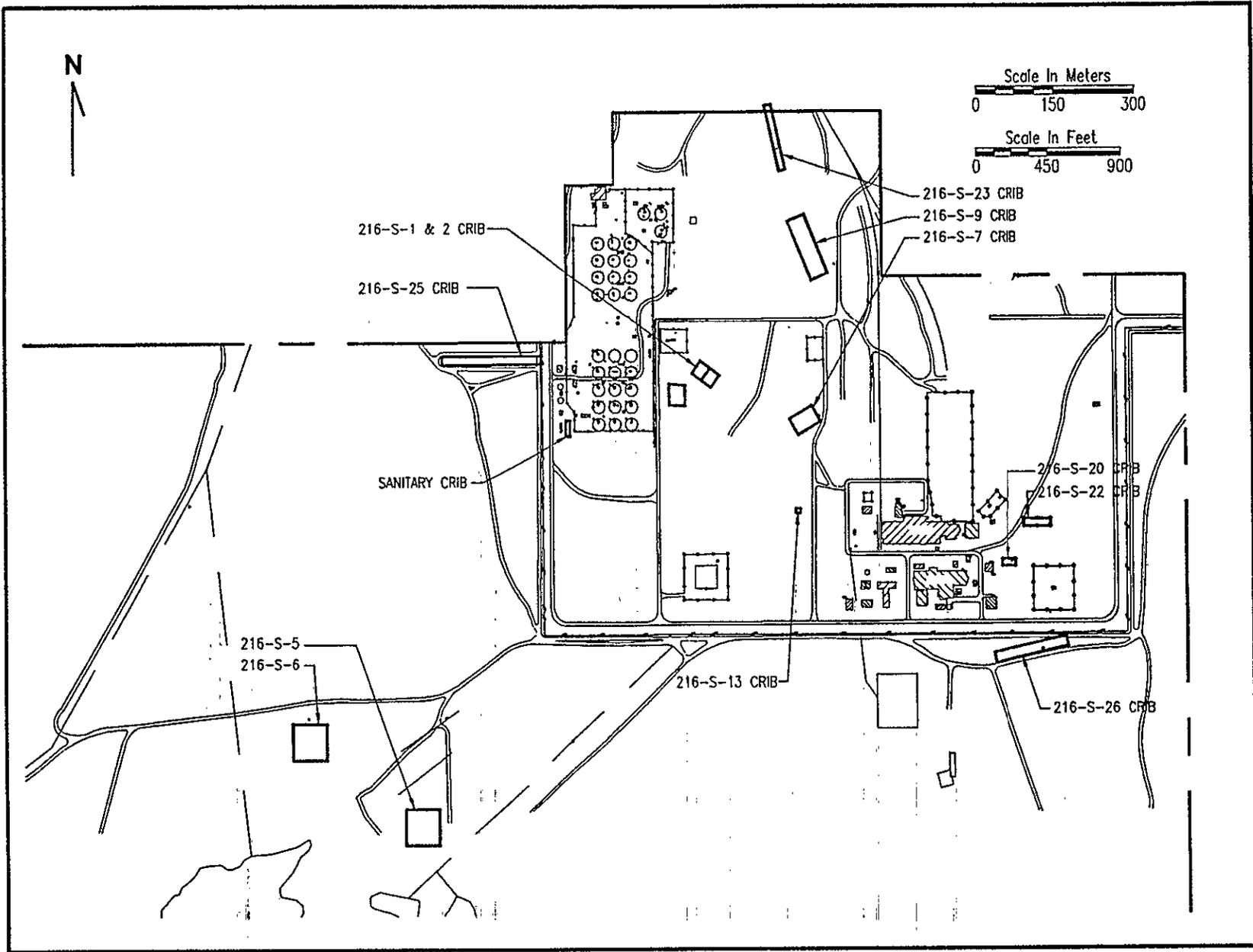


Figure 2-6. Double-Shell Storage Tank (Type V).



9 3 1 2 4 5 1 3 8 1

Figure 2-7. Typical Catch Tank.
2F-7



2F-8

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Figure 2-8. Location of Cribs and Drains.

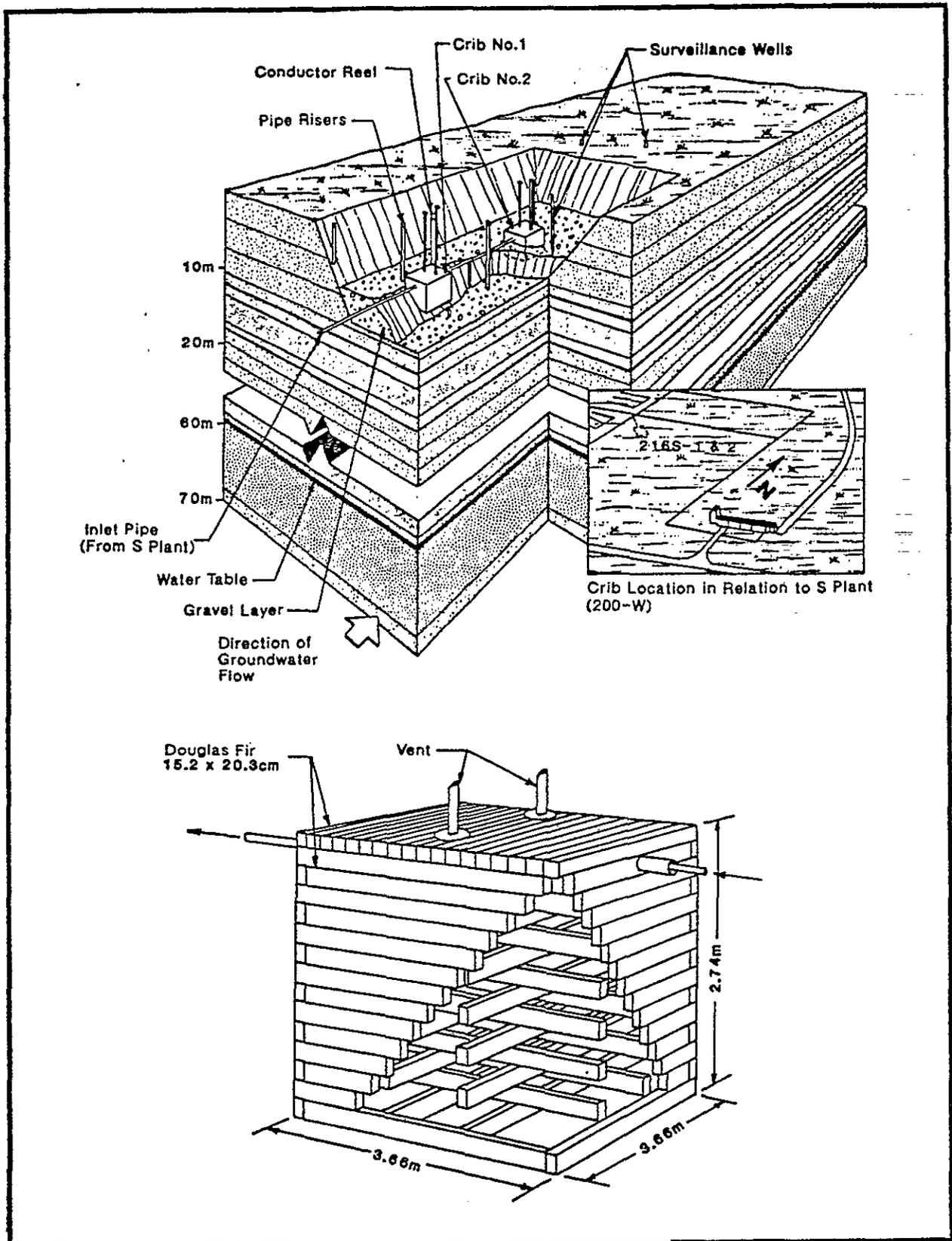


Figure 2-9. Typical Crib.
2f-9

9 3 1 2 9 5 1 3 3 4

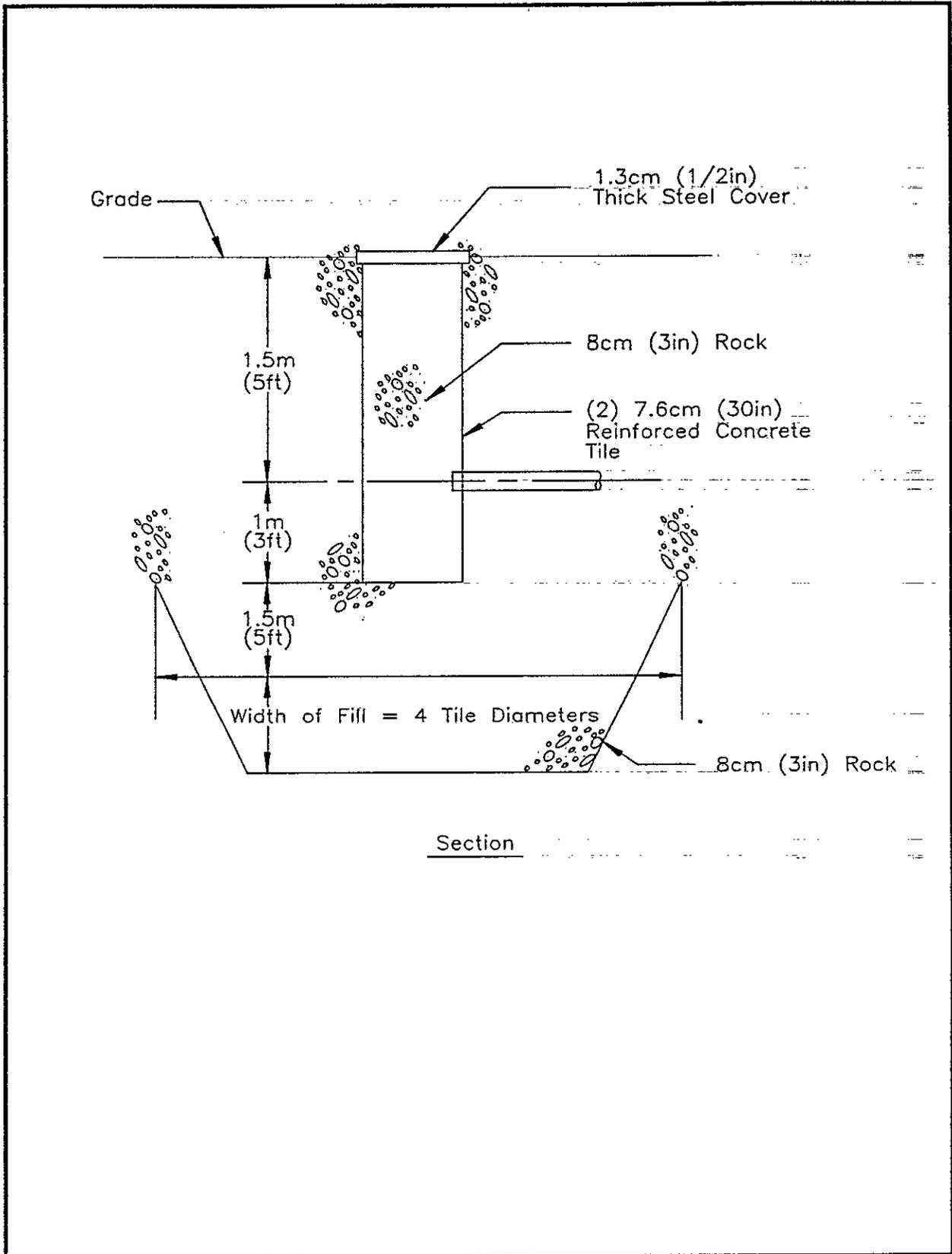
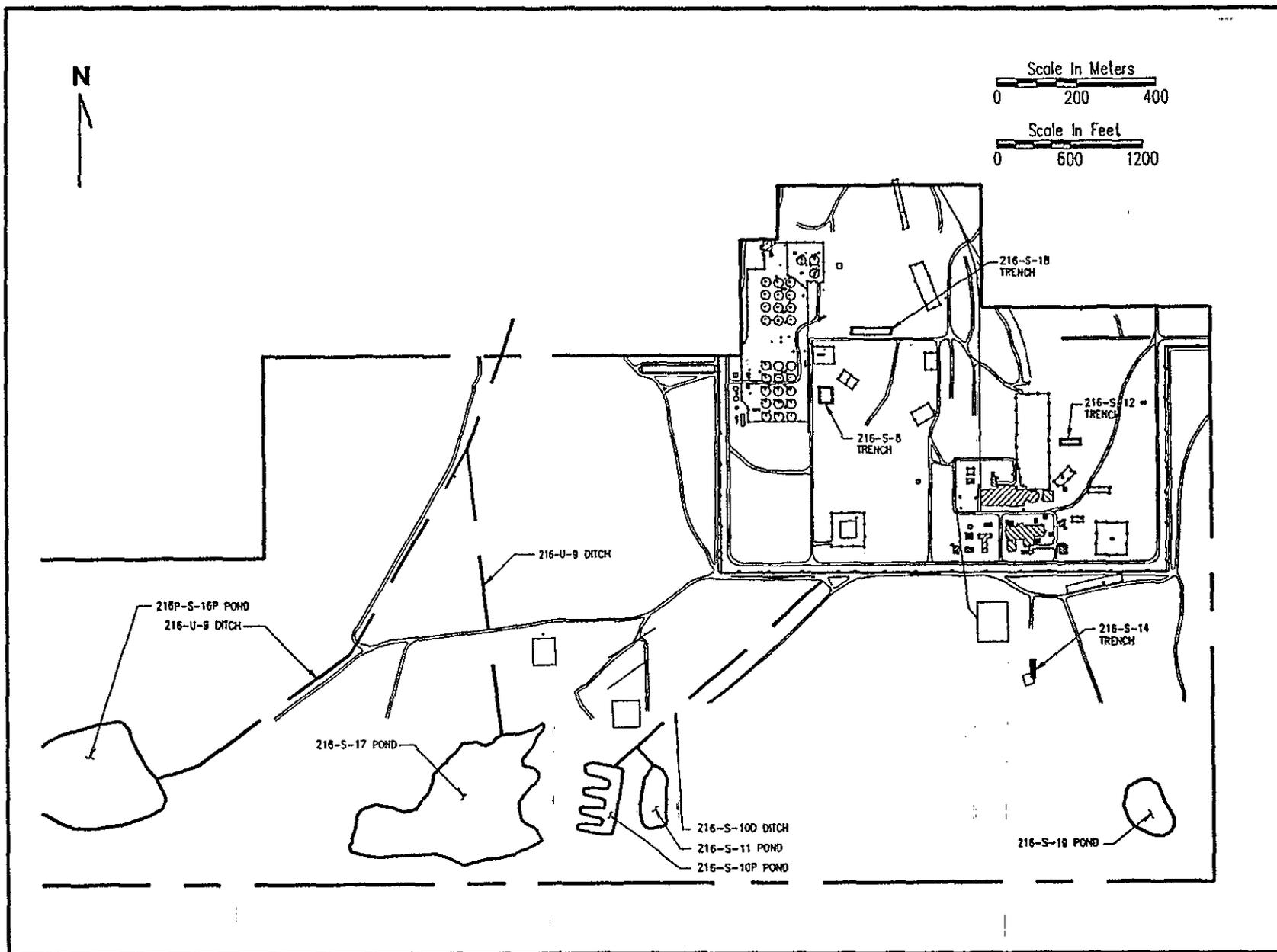


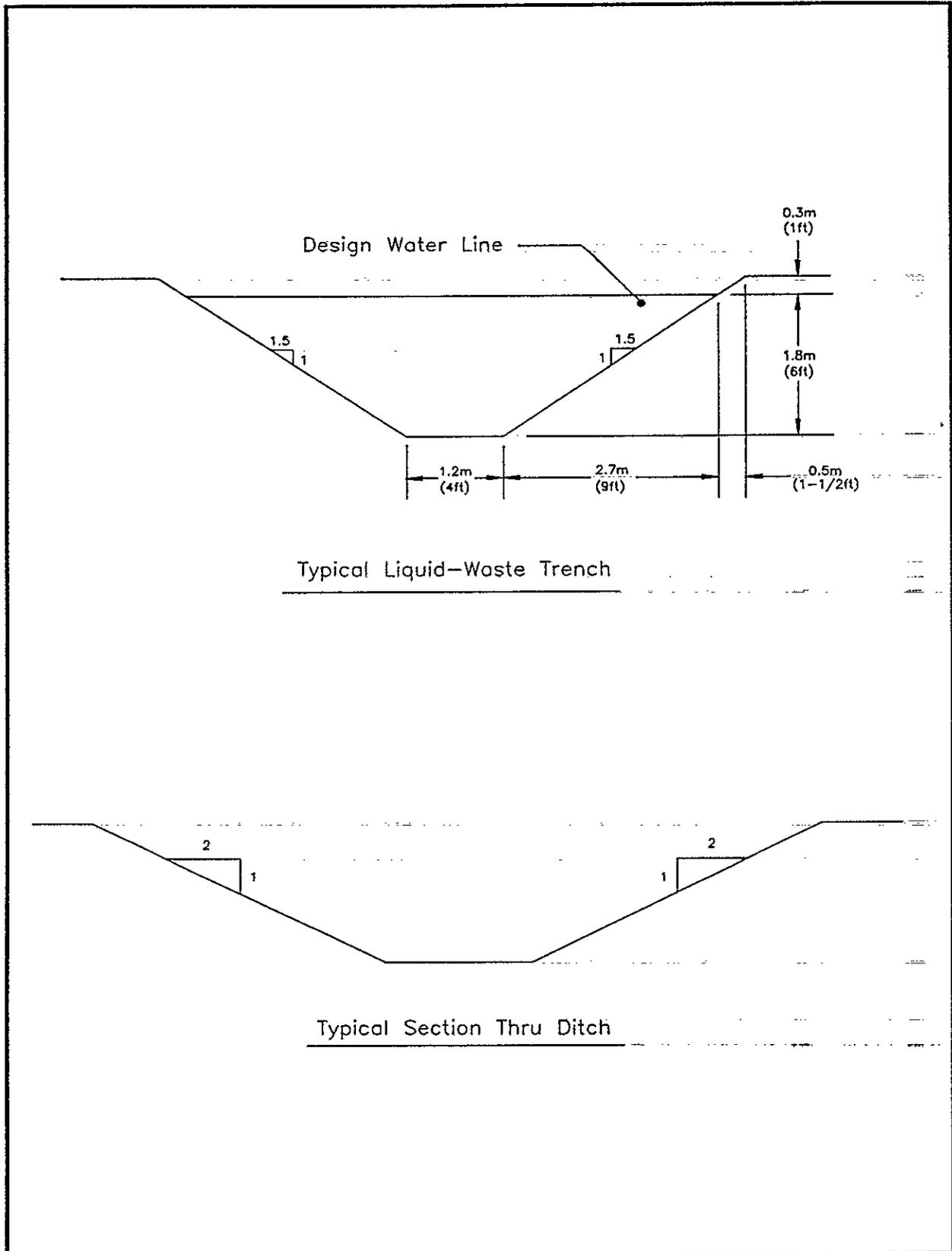
Figure 2-10. Typical French Drain.
2F-10

2F-11



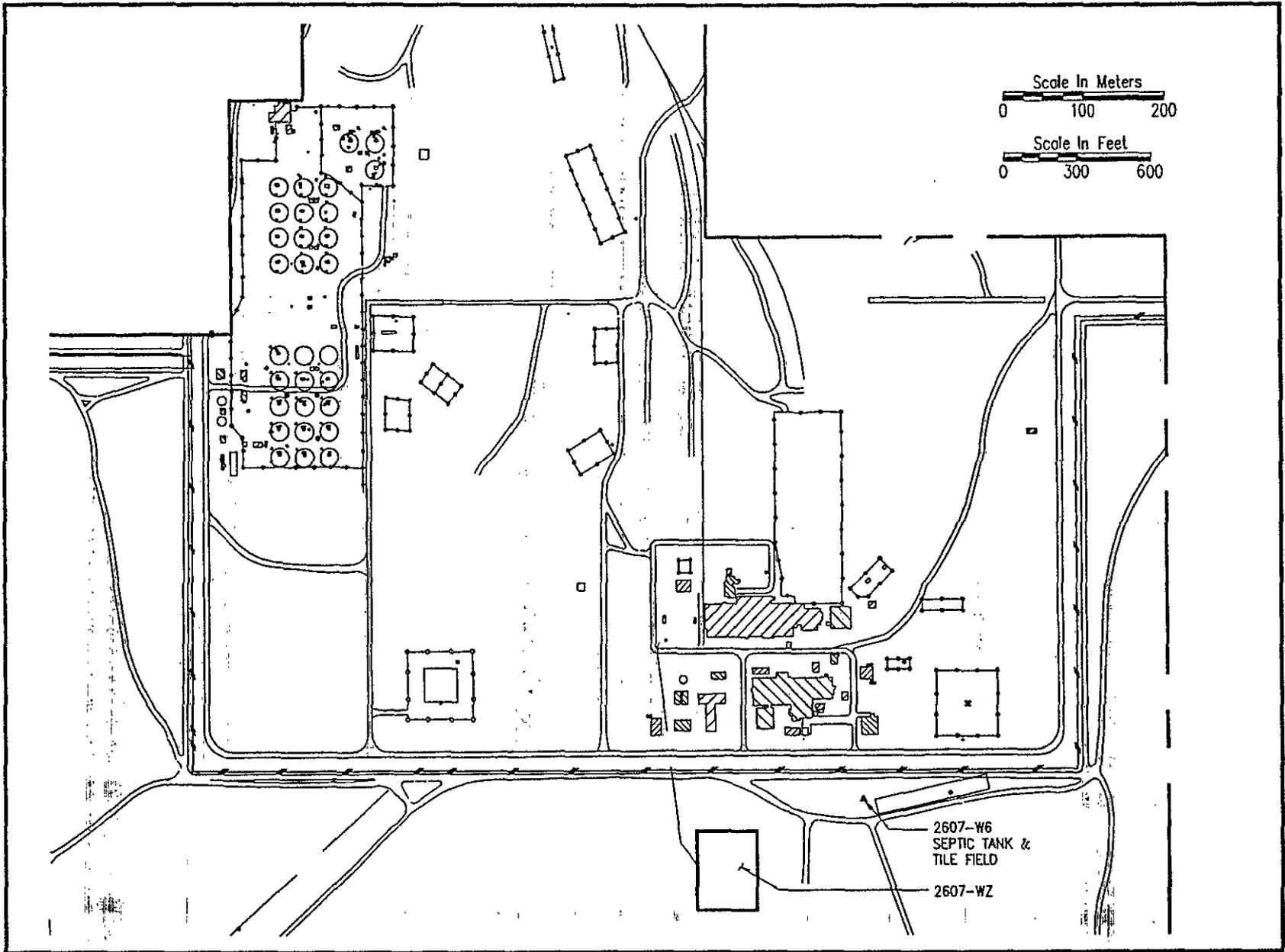
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Figure 2-11. Location of Ponds, Ditches, and Trenches.



9 8 2 1 5 . 8 2 1 3 6

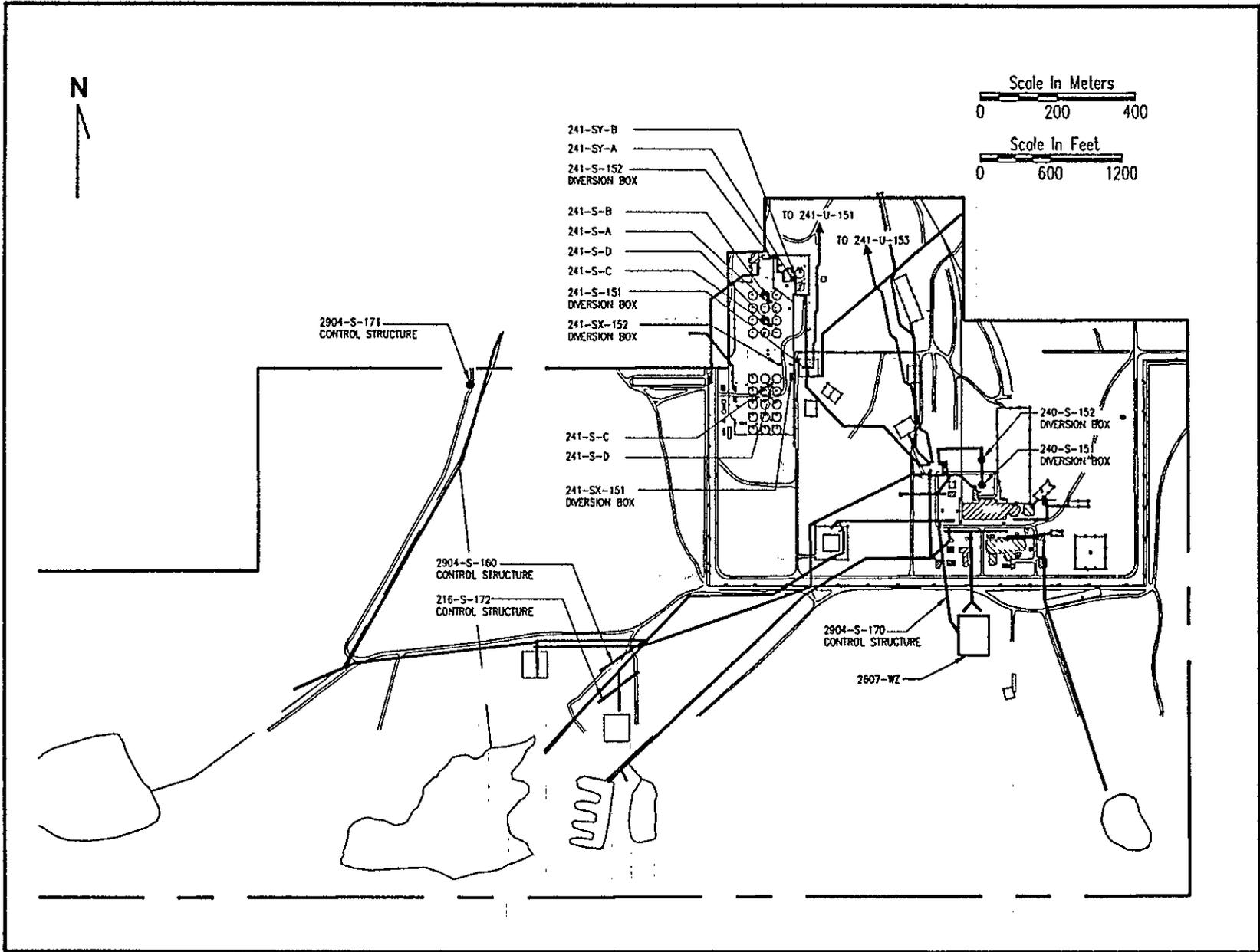
Figure 2-12. Trench and Ditch.
2F-12



2F-13

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Figure 2-13. Location of Septic Tanks and Associated Drain Fields.



2F-14

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Figure 2-14. Location of Transfer Facilities, Diversion Boxes, and Pipelines.

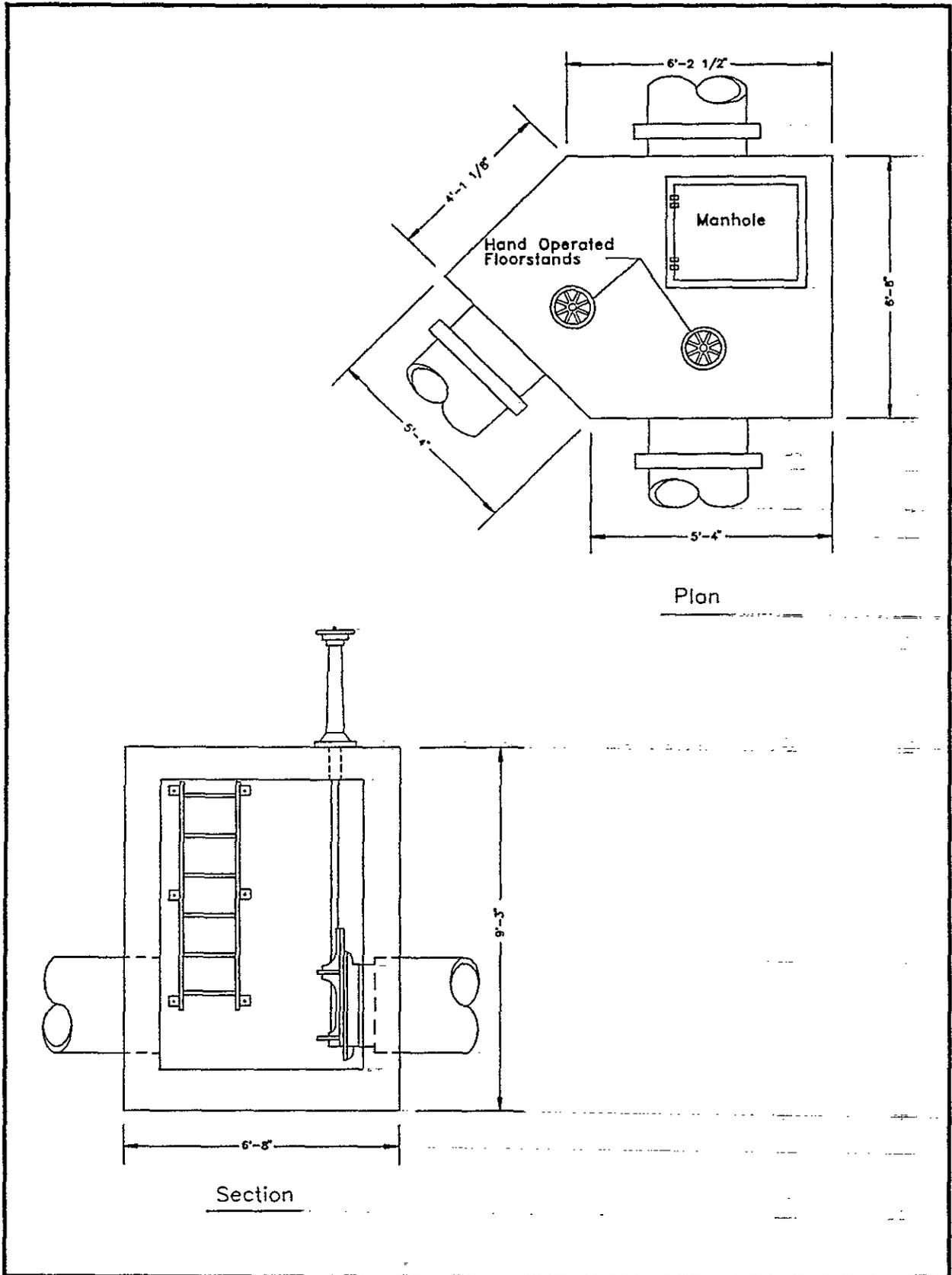


Figure 2-15. Typical Control Structure.
2F-15

9 5 1 2 8 5 1 3 9

9 3 1 2 8 5 1 3 9 0

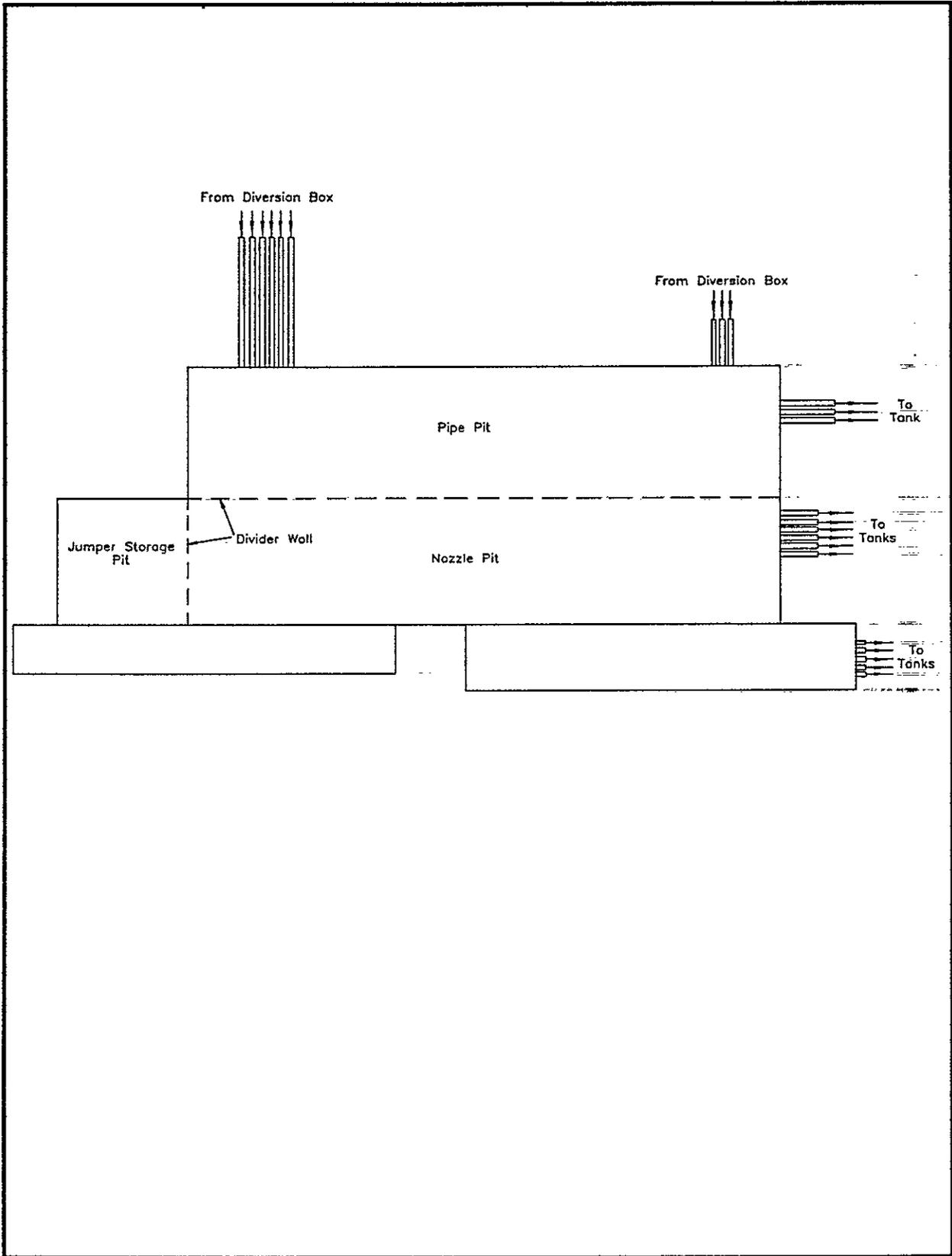


Figure 2-16. Typical Diversion Box.
2F-16

9 3 1 2 3 5 1 3 9 1

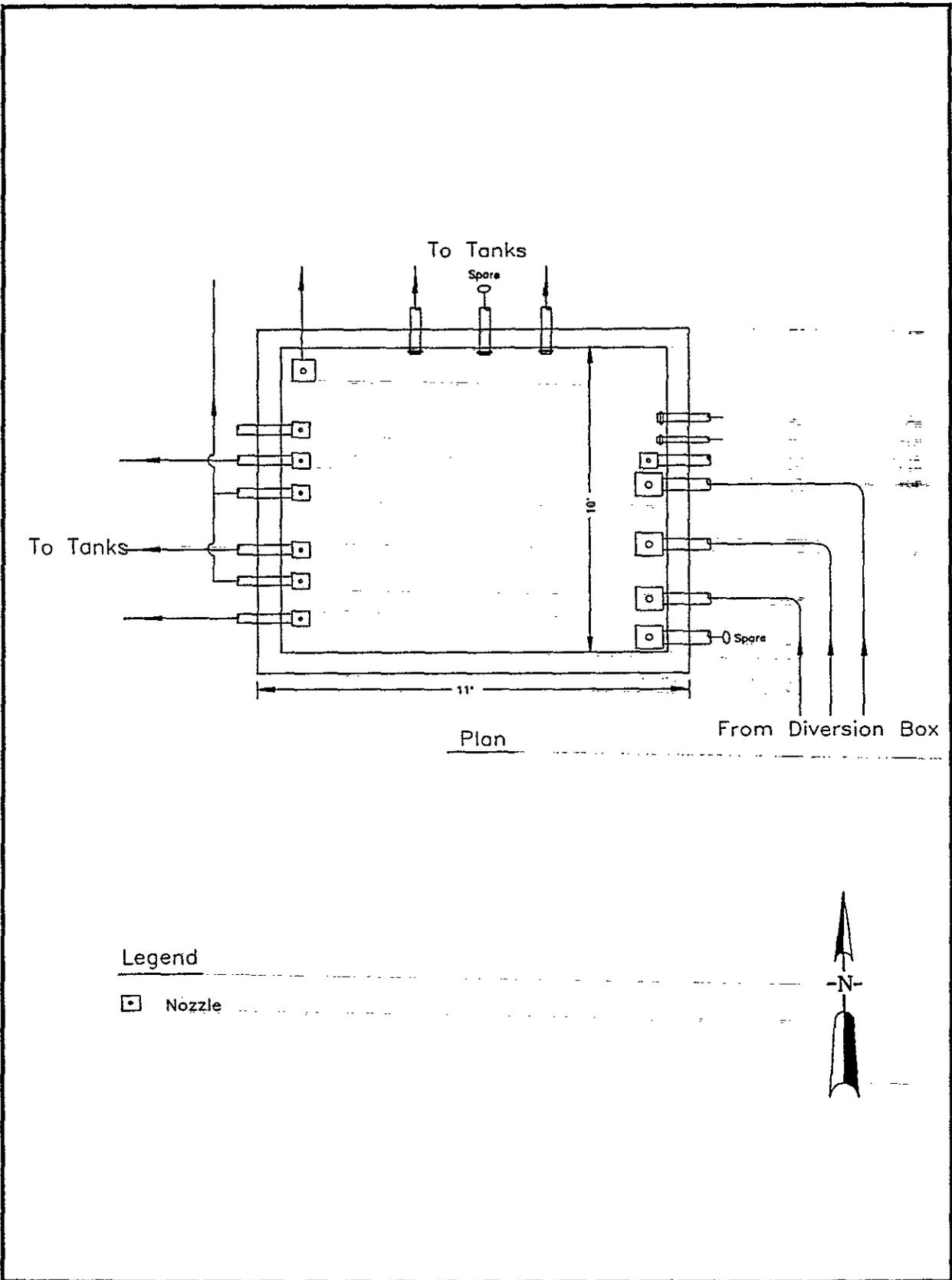
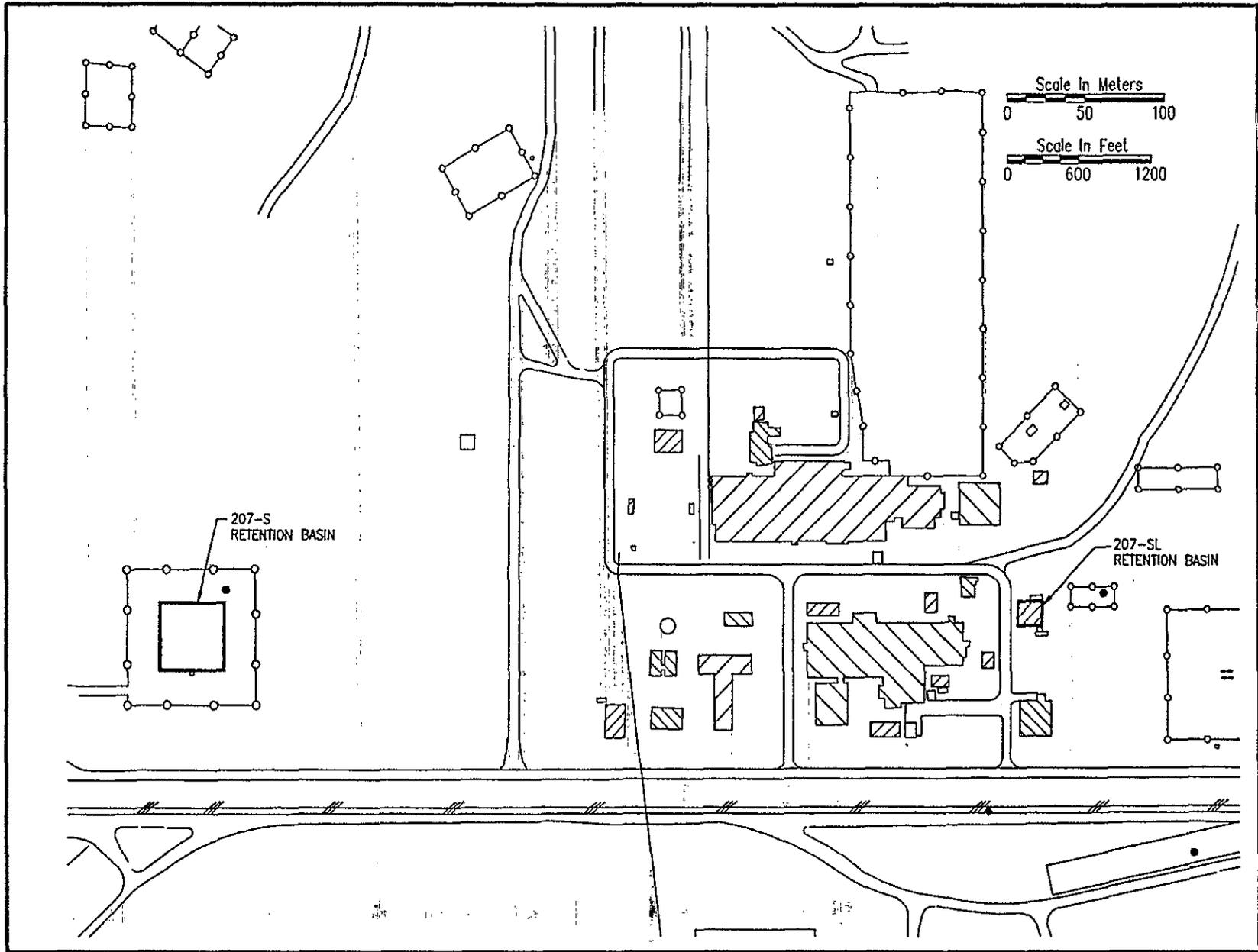


Figure 2-17. Typical Valve Pit.
2F-17

2F-18



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Figure 2-18. Location of Basins.

9 5 1 2 0 5 1 7 9 3

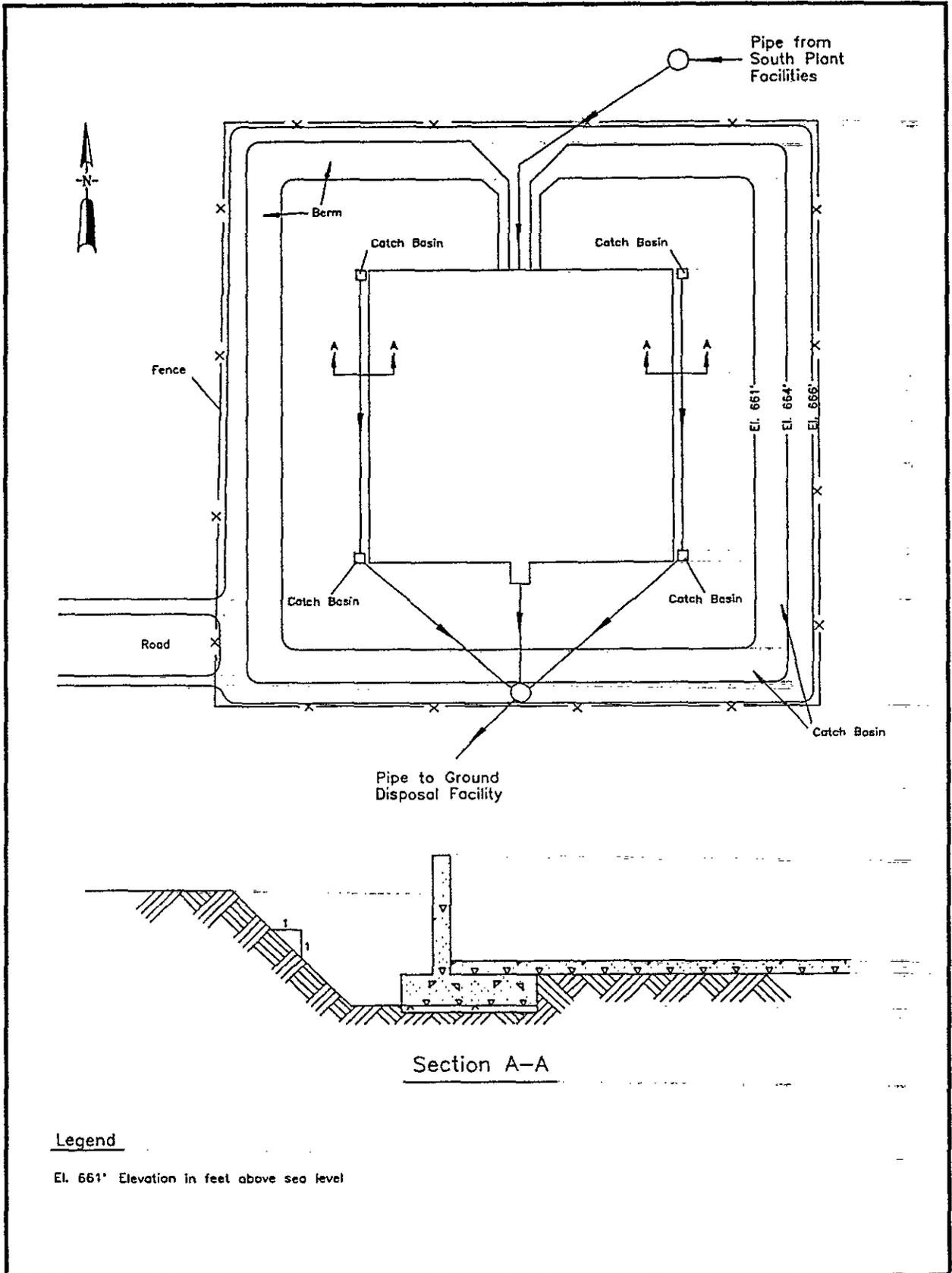
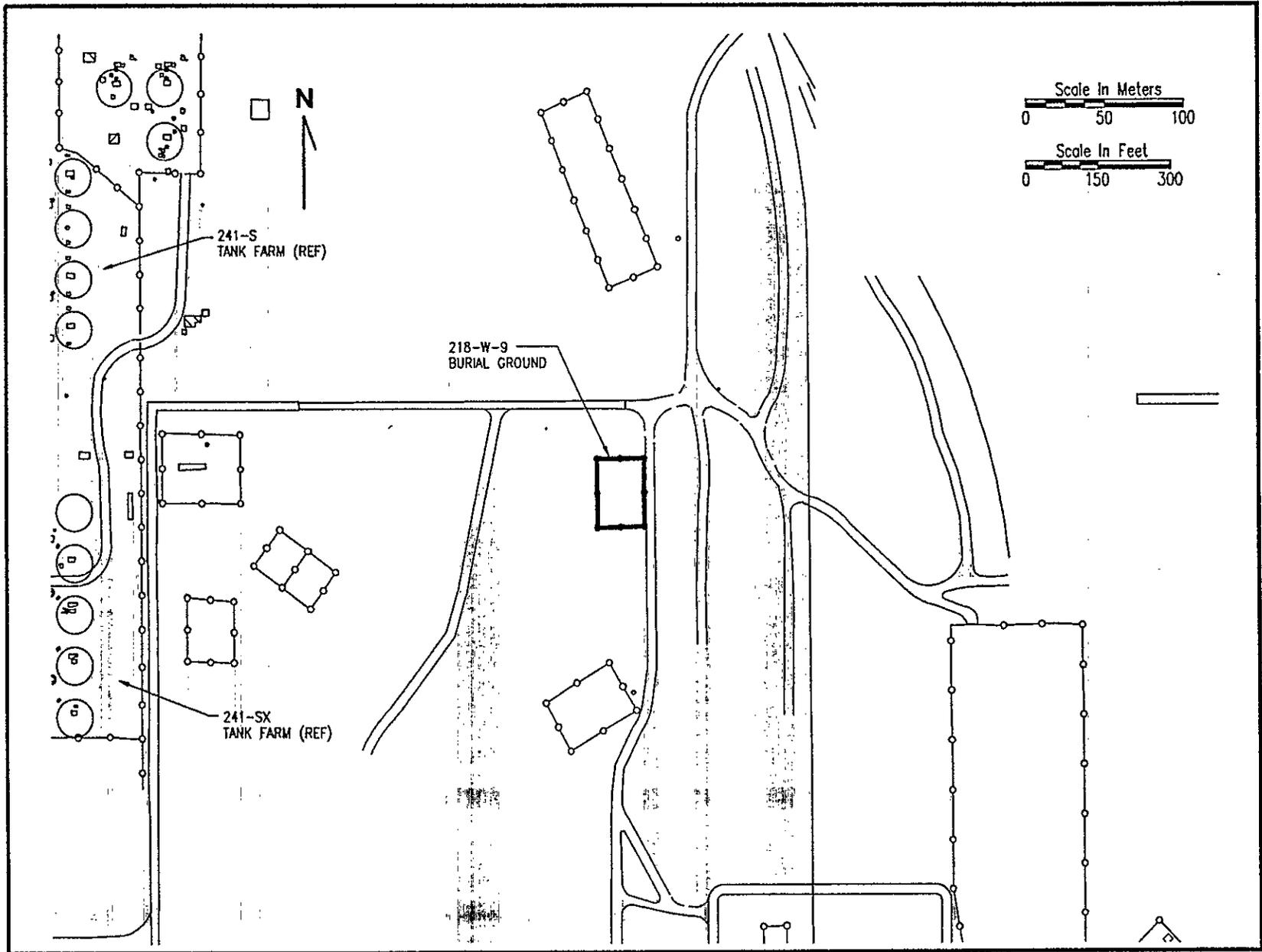


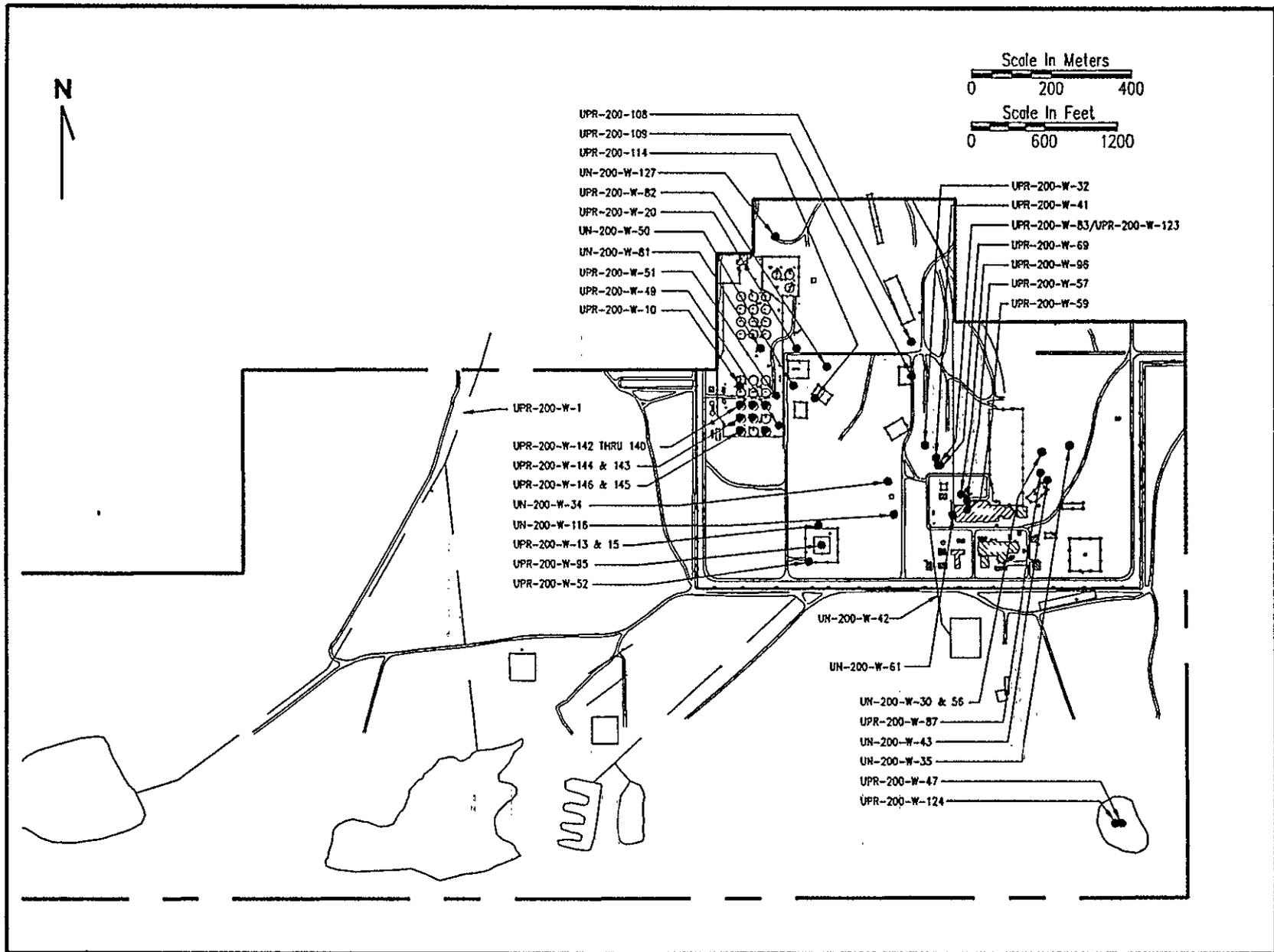
Figure 2-19. Retention Basin 207-S.
2F-19



2F-20

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Figure 2-20. Location of the Burial Site.



2F-22

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Figure 2-22. Location of Unplanned Releases.

Table 2-1. Summary of S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Years in Service Status | Source Description | Waste Volume Received | Operable Unit |
|---|---------------------------------|---|------------------------------|---------------|
| Plants, Buildings, and Storage Areas | | | | |
| 291-S Stack Complex | 1952 - present <i>Active</i> | Received exhaust air from the 202-S Process Building | N/A | 200-RO-3 |
| Tanks and Vaults | | | | |
| 241-S Tank Farm | 1953 - present <i>Active</i> | Temporary storage area for drums/boxes assumed full of monitoring well installation waste generated within the tank farm. | N/A | 200-RO-4 |
| 241-S-101 Single-Shell Tank | 1953 - 1980 <i>Inactive</i> | REDOX process high-level waste, REDOX process coating waste, and supernatant containing Pacific Northwest Laboratory, coating waste, laboratory waste, Purex low-level waste, B Plant high-level waste, terminal liquor and evaporator bottoms, partial neutralization feed, N Reactor waste, ion exchange waste, and double-shell tank slurry feed from 241-U, -S, and -SX Tank Farms. | 1,935,000 L (511,000 gal) | 200-RO-4 |
| 241-S-102 Single-Shell Tank | 1953 - 1980 <i>Inactive</i> | REDOX process high-level waste, nitric acid/potassium permanganate ($\text{HNO}_3/\text{KMnO}_4$) solution, and supernatant containing REDOX process high-level waste, evaporator bottoms, noncomplexed waste, double-shell tank slurry feed, and partial neutralization feed from 241-S, -SX, -SY, and -U Tank Farms. | 2,949,000 L (779,000 gal) | 200-RO-4 |
| 241-S-103 Single-Shell Tank | 1953 - 1980 <i>Inactive</i> | REDOX process high-level waste, REDOX process coating waste, $\text{HNO}_3/\text{KMnO}_4$ solution, and supernatant containing REDOX process high-level waste, evaporator bottoms, noncomplexed wastes, partial neutralization feed, and double-shell tank slurry feed from 241-S, -SX, -SY, and -U Tank Farms. | 1,260,000 L (333,000 gal) | 200-RO-4 |
| 241-S-104 Single-Shell Tank | 1953 - 1968 <i>Inactive</i> | REDOX process coating waste, REDOX process high-level waste, and supernatant containing REDOX process high-level waste from 241-S Tank Farm. | 1,219,000 L (322,000 gal) | 200-RO-4 |
| 241-S-105 Single-Shell Tank | 1953 - 1974 <i>Inactive</i> | 202-S Building coating waste and 202-S Building high-level waste. | 1,859,000 L (491,000 gal) | 200-RO-4 |

2T-1a

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Table 2-1. Summary of S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Years in Service Status | Source Description | Waste Volume Received | Operable Unit |
|-----------------------------|--------------------------------|---|------------------------------|---------------|
| 241-S-106 Single-Shell Tank | 1953 - 1979 <i>Inactive</i> | REDOX process high-level waste, supernatant containing REDOX process high-level wastes and evaporator bottoms. | 2,491,000 L (658,000 gal) | 200-RO-4 |
| 241-S-107 Single-Shell Tank | 1953 - 1980 <i>Inactive</i> | REDOX process high-level waste, REDOX process coating waste, supernatant containing decontamination waste, B Plant high- and low-level waste, REDOX process high-level waste, Pacific Northwest Laboratory waste, N Reactor waste, PUREX low-level waste, ion exchange waste, fractionization waste, evaporator bottoms, double-shell tank slurry feed, partial neutralization feed and complexed concentrate from 241-BX, -C, -S, -SX, -SY, and -U Tank Farms. | 1,563,000 L (413,000 gal) | 200-RO-4 |
| 241-S-108 Single-Shell Tank | 1953 - 1979 <i>Inactive</i> | REDOX process high-level waste, and supernatant containing REDOX process high-level waste and evaporator bottoms from the 241-S and -SX Tank Farms. | 2,676,000 L (707,000 gal) | 200-RO-4 |
| 241-S-109 Single-Shell Tank | 1953 - 1979 <i>Inactive</i> | REDOX process high-level supernatant containing evaporator bottoms from the 241-S-102 Tank. | 2,619,000 L (692,000 gal) | 200-RO-4 |
| 241-S-110 Single-Shell Tank | 1953 - 1979 <i>Inactive</i> | REDOX process high-level waste, REDOX process coating waste, supernatant containing REDOX process ion exchange waste, 224-U Building waste, coating waste, decontamination waste, B Plant low-level waste, and organic wash waste from 241-B, -S, -SX, -T, -TX, and -U Tank Farms. | 2,846,000 L (752,000 gal) | 200-RO-4 |
| 241-S-111 Single-Shell Tank | 1952 - 1975 <i>Inactive</i> | REDOX process high-level waste and supernatant containing evaporator bottoms. | 2,983,000 L (788,000 gal) | 200-RO-4 |
| 241-S-112 Single-Shell Tank | 1953 - 1974 <i>Inactive</i> | REDOX process high-level waste and supernatant containing REDOX process high-level wastes and evaporator bottoms. | 2,964,000 L (783,000 gal) | 200-RO-4 |

2T-1b

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Table 2-1. Summary of S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Years in Service Status | Source Description | Waste Volume Received | Operable Unit |
|------------------------------|---------------------------------|--|-----------------------------------|---------------|
| 241-SX Tank Farm | 1954 - present <i>Active</i> | REDOX process salt wastes. Most of the wastes in the tanks is in the form of sludge, saltcakes, and liquids consisting primarily of sodium hydroxide, sodium salts of nitrate, nitrite, carbonate, aluminate, and phosphate, and hydrous oxides of iron and manganese. | N/A | 200-RO-4 |
| 241-SX-101 Single-Shell Tank | 1954 - 1980 <i>Inactive</i> | REDOX process high-level waste, supernatant containing REDOX process ion exchange waste, evaporator bottoms, partial neutralization feed, and complexed waste from 241-S, -BX, -SX, and -U Tank Farms. | 2,275,000 L 0 (601,000 gal) | 200-RO-4 |
| 241-SX-102 Single-Shell Tank | 1954 - 1980 <i>Inactive</i> | REDOX process high-level waste, REDOX process ion exchange waste, evaporator bottoms, and partial neutralization feed from 241-BX, -SX, -TX, and -U Tank Farms. | 2,748,000 L (688,000 gal) | 200-RO-4 |
| 241-SX-103 Single-Shell Tank | 1954 - 1980 <i>Inactive</i> | REDOX process high-level waste, concrete, and supernatant containing REDOX process high-level waste, coating waste, evaporator bottoms, organic wash waste, and partial neutralization feed from 241-BX, -SX, and -S Tank Farms. | 3,384,000 L (894,000 gal) | 200-RO-4 |
| 241-SX-104 Single-Shell Tank | 1955 - 1980 <i>Inactive</i> | REDOX process high-level waste, and supernatant containing REDOX process ion exchange waste, and evaporator bottoms. | 2,846,000 L (752,000 gal) | 200-RO-4 |
| 241-SX-105 Single-Shell Tank | 1955 - 1980 <i>Inactive</i> | REDOX process high-level waste and supernatant containing REDOX process high-level waste, REDOX process ion exchange waste, evaporator bottoms, and partial neutralization feed from 241-BX, -S, -TX, and -U Tank Farms. | 3,573,000 L (944,000 gal) | 200-RO-4 |
| 241-SX-106 Single-Shell Tank | 1954 - 1980 <i>Inactive</i> | Hanford Site Laboratory waste, Pacific Northwest Laboratory waste, $\text{HNO}_3/\text{KMnO}_4$ solution, supernatant containing REDOX process and fractionization ion exchange waste, evaporator bottoms, B Plant low-level waste, coating waste, REDOX process high-level waste, and complexed and noncomplexed waste and partial neutralization feed from 241-B, -BX, -C, -S, -SX, -SY, -TX, and -U Tank Farms. | 2,771,000 L (732,000 gal) | 200-RO-4 |

2T-1c

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Table 2-1. Summary of S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Years in Service <i>Status</i> | Source Description | Waste Volume Received | Operable Unit |
|---------------------------------|-----------------------------------|--|----------------------------|------------------|
| 241-SX-107 Single-Shell Tank | 1956 - 1964 <i>Inactive</i> | REDOX process high-level waste, REDOX process coating waste, concrete, and supernatant containing REDOX process high-level waste. Also contains neutralized waste from the 100-F Reactor site. | 413,000 L (109,000 gal) | 200-RO-4 |
| 241-SX-108 Single-Shell Tank | 1955 - 1962 <i>Inactive</i> | REDOX process high-level waste, concrete, and supernatant containing REDOX process high-level waste from 241-SX Tank Farm. | 458,000 L (121,000 gal) | 200-RO-4 |
| 241-SX-109 Single-Shell Tank | 1955 - 1965 <i>Inactive</i> | REDOX process high-level waste and supernatant containing REDOX process high-level waste from the 241-SX Tank Farm. | 984,000 L (260,000 gal) | 200-RO-4 |
| 241-SX-110 Single-Shell Tank | 1960 - 1976 <i>Inactive</i> | REDOX process high-level waste, concrete, supernatant containing REDOX process high-level waste, Pacific Northwest Laboratory waste, B Plant low-level waste, ion exchange waste, evaporator bottoms, and 244-U Building waste from 241-B, -BX, and -SX Tank Farms. Also added to this unit: natural uranium, depleted uranium, enriched uranium, and ²³⁹ PU. | 235,000 L (62,000 gal) | 200-RO-4 |
| 241-SX-111 Single-Shell Tank | 1956 - 1974 <i>Inactive</i> | REDOX process high-level waste and supernatant containing REDOX process high-level waste and REDOX process ion exchange waste. | 500,000 L (132,000 gal) | 200-RO-4 |
| 241-SX-112 Single-Shell Tank | 1959 - 1969 <i>Inactive</i> | REDOX process high-level waste and supernatant containing REDOX process high-level waste from the 241-SX tanks. | 360,000 L (95,000 gal) | 200-RO-4 |
| 241-SX-113 Single-Shell Tank | 1958 <i>Inactive</i> | REDOX process high-level waste with added diatomaceous earth. | 98,000 L (26,000 gal) | 200-RO-4 |
| 241-SX-114 Single-Shell Tank | 1956 - 1972 <i>Inactive</i> | REDOX process high-level waste and supernatant containing REDOX process high-level waste, REDOX process ion exchange waste, and evaporator bottoms from 241-SX tanks. | 738,000 L (195,000 gal) | 200-RO-4 |

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Table 2-1. Summary of S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Years in Service Status | Source Description | Waste Volume Received | Operable Unit |
|------------------------------|-----------------------------------|---|--|---------------|
| 241-SX-115 Single-Shell Tank | 1958 - 1965 <i>Inactive</i> | REDOX process high-level waste and supernatant containing REDOX process high-level waste. | 45,000 L (12,000 gal) | 200-RO-4 |
| 241-SY Tank Farm | 1977 - present <i>Active</i> | Receives complexant concentrate and dilute waste in the three tanks. | N/A | 200-RO-4 |
| 241-SY-101 Double-Shell Tank | 1977 - present <i>Active</i> | Receives complexant waste which consists of concentrated product from the evaporation of dilute complexed waste. | 3,017,000 L (797,000 gal) | 200-RO-4 |
| 241-SY-102 Double-Shell Tank | 1977 - present <i>Active</i> | Receives dilute noncomplexed waste and plutonium finishing plant REDOX process transuranic solids originating from T Plant and S Plant Complex, the 300 and 400 Areas, PUREX facility miscellaneous wastes, 100 North Area sulfate waste, B Plant, saltwells, PFP supernatant, and transuranic solids from the West Area. | 2,427,000 L (641,000 gal) | 200-RO-4 |
| 241-SY-103 Double-Shell Tank | 1977 - present <i>Active</i> | Receives complexant waste which consists of concentrated product from the evaporation of dilute complexed waste. | 666,000 L (176,000 gal) | 200-RO-4 |
| 240-S-302 Catch Tank | 1950 - 1987 <i>Inactive</i> | Low level mixed wastes, including dilute laboratory waste containing 0.021 mole/L sodium; greater than 0.01 mole/L sodium hydroxide; greater than 0.011 mole/L nitrous oxide; and 0.000078 g/L total plutonium. | Received approximately 50,000 gal/yr (200,000 L/yr) transferred through 240-S-151 Diversion Box. Currently contains approximately 2,380 gal (9,000 L) waste. | 200-RO-3 |
| 241-S-302A Catch Tank | 1952 - present <i>Inactive</i> | Received drainage from secondary containment of transfer routes of liquid mixed waste, solutions from processing and decontamination operations. | Volume received was variable according to specific plant operation. Currently contains 1,544 gal (200 L) of waste. | 200-RO-2 |

2T-1e

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Table 2-1. Summary of S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Years in Service Status | Source Description | Waste Volume Received | Operable Unit |
|-------------------------|---------------------------------|--|---|---------------|
| 241-S-302B Catch Tank | 1952 - 1985 <i>Inactive</i> | Received waste solutions from processing and decontamination operations for transfer. | Volume received was variable according to specific plant operation. Presently holds 3,240 gal (12,300 L) waste. | 200-RO-4 |
| 241-SX-302 Catch Tank | 1954 - 1983 <i>Inactive</i> | Received waste from processing and decontamination operations for transfer. | Volumes received were variable according to specific plant operations. | 200-RO-2 |
| 244-S Receiver Tank | 1987 - present <i>Active</i> | Transports waste solutions from processing and decontaminant operations. | Quantities are variable. (10,954 gal) | 200-RO-2 |
| Cribs and Drains | | | | |
| 216-S-1 & 2 Cribs | 1952 - 1956 <i>Inactive</i> | Received cell drainage from D-1 Receiver Tank and redistilled condensate from D-2 Receiver Tank in 202-S Building. | 160,000,000 L (42,000,000 gal) | 200-RO-2 |
| 216-S-5 Crib | 1954 - 1957 <i>Inactive</i> | Radioactive, acidic process vessel cooling water and steam condensate from the 202-S Building. | 4,100,000,000 L (1,100,000,000 gal) | 200-RO-1 |
| 216-S-6 Crib | 1954 - 1972 <i>Inactive</i> | Received process vessel cooling water and steam condensate from 202-S Building and steam condensate from the D-12 and D-14 waste concentrators in the S Plant Complex. | 4,470,000,000 L (1,180,000,000 gal) | 200-RO-1 |
| 216-S-7 Crib | 1956 - 1965 <i>Inactive</i> | Received cell drainage from the D-1 Receiver Tank, process condensate from the D-2 Receiver Tank, and condensate from the H-6 Condenser in the 202-S Building. | 390,000,000 L (100,000,000 gal) | 200-RO-2 |
| 216-S-9 Crib | 1965 - 1969 <i>Inactive</i> | Received process condensate from the D-2 Receiver Tank in the 202-S Building. Waste is radioactive and acidic, mainly composed of nitric acid. | 50,300,000 L (13,300,000 gal) | 200-RO-2 |

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Table 2-1. Summary of S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Years in Service <i>Status</i> | Source Description | Waste Volume Received | Operable Unit |
|-----------------------|-----------------------------------|--|--------------------------------------|---------------|
| 216-S-13 Crib | 1952 - 1972 <i>Inactive</i> | Received liquid waste from the 203-S Decontaminated Metal Storage Facility, the 204-S Uranyl Nitrate Hexahydrate Lag Storage Facility, and the 276-S Organic Solvent Make-up Facility. Also received occasional waste from the 204-S Uranyl Nitrate Hexahydrate Facility. Waste is low-salt and neutral/basic. | 5,000,000 L (1,300,000 gal) | 200-RO-2 |
| 216-S-20 Crib | 1952 - 1973 <i>Inactive</i> | Received miscellaneous waste from laboratory hoods and decontamination sinks in the 222-S Building via the 219-S Retention Building. Also received above waste via the 207-SL Retention Basin and 219-S Retention Building and 300 Area laboratory waste via the manhole. Received miscellaneous waste from laboratory hoods and decontamination sinks in 222-S Laboratory via 219-S Retention Building. | 135,000,000 L (3,570,000,000 gal) | 200-RO-3 |
| 216-S-22 Crib | 1957 - 1967 <i>Inactive</i> | Received liquid waste containing nitrate and sodium from the acid recovery facility in the 293-S Building. | 98,000 L (26,000 gal) | 200-RO-3 |
| 216-S-23 Crib | 1969 - 1972 <i>Inactive</i> | Received S Plant Complex process condensate from the D-2 Receiver Tank in the 202-S Building. Waste is low salt and neutral/basic. | 34,100,000 L (9,000,000 gal) | 200-RO-2 |
| 216-S-25 Crib | 1973 - present <i>Active</i> | Received 242-S evaporator process steam condensate, and 241-SX Tank Farm cooling water. | 300,000,000 L (80,000,000 gal) | 200-RO-1 |
| 216-S-26 Crib | 1984 - present <i>Active</i> | Receives steam condensate and sink wastes, which are byproduct radioactive wastes from the 222-S/SA Laboratories via the 207-SL Retention Basin. Wastes contain a variety of chemicals, including acetone, nitric acid, and lesser amounts of sulfuric and hydrofluoric acids. | 164,000,000 L (43,300,000 gal) | 200-RO-3 |
| 216-S-3 French Drain | 1953 - 1956 <i>Inactive</i> | Received condensate from condensers on the 241-S-101 and -104 Single-Shell Tanks in the 241-S Tank Farm. | 4,000,000 L (1,060,000 gal) | 200-RO-2 |

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Table 2-1. Summary of S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Years in Service Status | Source Description | Waste Volume Received | Operable Unit |
|-------------------------------------|---------------------------------|---|--|---------------|
| Ponds, Ditches, and Trenches | | | | |
| 216-S-10P Pond | 1954 - 1984 <i>Inactive</i> | Received chemical sewer waste from S Plant Complex and overflow from the high water tower via the 216-S-10 Ditch. Also received bearing cooling water from S Plant Complex. | 7,100,000 L (1,900,000 gal) | 200-RO-1 |
| 216-S-11 Pond | 1954 - 1965 <i>Inactive</i> | Received waste from air conditioning drains and chemical sewer waste from 202-S Building via the 216-S-10 Ditch. | 2,230,000,000 L (589,000,000 gal) | 200-RO-1 |
| 216-S-15 Pond | 1951 - 1952 <i>Inactive</i> | Received condenser spray cooling water from the 241-S-110 Single-Shell Tank in the 241-S Tank Farm. | 10,000 L (2,600 gal) | 200-RO-2 |
| 216-S-16P Pond | 1957 - 1975 <i>Inactive</i> | Received process cooling water and steam condensate from the S Plant Complex. Also received condenser and vessel cooling water from the concentrator boil-down operations in the 202-S Building. | 40,700,000,000 L (10,800,000,000 gal) | 200-RO-1 |
| 216-S-17 Pond | 1951 - 1954 <i>Inactive</i> | Received process cooling water and steam condensate from the 202-S Building, also received the 202-S Building effluent and overflow from the 216-U-10 Pond via the 216-U-9 Ditch. | 6,440,000,000 L (1,700,000,000 gal) | 200-RO-1 |
| 216-S-19 Pond | 1952 - 1984 <i>Inactive</i> | Received effluent from the 222-S/SA Laboratories, laboratory ventilation cooling water, and miscellaneous wastes from laboratory hoods and decontamination sinks via the 207-SL Retention Basin. | 1,330,000,000 L (351,000,000 gal) | 200-RO-1 |
| 216-S-10D Ditch | 1951 - present <i>Active</i> | Received hazardous waste salts and received chemical sewer waste from 202-S Building, 241-S Tank Farm, 211-S Station, 276-S Solvent-Handling Facility drains, and overflow from the high water tower. | 8,604,000,000 L (2,280,000,000 gal) | 200-RO-1 |
| 216-S-16D Ditch | 1957 - 1975 <i>Inactive</i> | Received process cooling water and steam condensate from S Plant Complex. Also received condenser and vessel cooling water from concentrator boil-down operations in the 202-S Building. | 400,000,000 L (110,000,000 gal) | 200-RO-1 |
| 216-U-9 Ditch | 1952 - 1954 <i>Inactive</i> | Received overflow from the 216-U-10 Pond. | N/A | 200-RO-1 |

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Table 2-1. Summary of S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Years in Service Status | Source Description | Waste Volume Received | Operable Unit |
|--|---------------------------------|---|--|---------------|
| 216-S-8 Trench | 1951 - 1952 <i>Inactive</i> | Received unirradiated start-up waste from the 202-S Building. | 10,000,000 L (2,600,000 gal) | 200-RO-2 |
| 216-S-12 Trench | 1954 - 1975 <i>Inactive</i> | Received flush water containing ammonium nitrate from the 291-S Stack Complex. | 76,000 L (20,000 gal) | 200-RO-3 |
| 216-S-14 Trench | 1951 - 1952 <i>Inactive</i> | Received contaminated (unirradiated uranium) MIBK from the initial test runs in the 202-S Building. | 76,000 L (20,000 gal) | 200-RO-3 |
| 216-S-18 Trench | 1954 <i>Inactive</i> | Received vehicle decontamination waste. | N/A | 200-RO-2 |
| Septic Tanks and Associated Drain Fields | | | | |
| 2607-W6 Septic Tank and Tile Field | 1951 - present <i>Active</i> | Receives sanitary nonhazardous/nonradioactive wastewater and sewage. | Receives estimated 35,000 L/day (9,300 gal/day) | 200-RO-3 |
| 2607-WZ Septic Tank | 1944 - present <i>Active</i> | Receives sanitary nonhazardous/nonradioactive wastewater and sewage. | Receives estimated 23,000 L/day (6,100 gal/day) | 200-RO-1 |
| Sanitary Crib | 1944 - present <i>Active</i> | Receives nonhazardous/nonradioactive sanitary wastewater from the 241-SX-701 Compressor House. | 23,000 L/day (6,100 gal/day) | 200-RO-4 |
| Transfer Facilities, Diversion Boxes, and Pipelines | | | | |
| 216-S-172 Control Structure | 1956 - 1976 <i>Inactive</i> | Diverted low-level radioactive S Plant Complex process vessel cooling water and steam condensate to the 216-S-16 Ditch. | N/A | 200-RO-1 |
| 2904-S-160 Control Structure | 1954 - 1976 <i>Inactive</i> | Diverted process vessel cooling water and steam condensate from S Plant Complex to Ponds 216-S-17, 216-S-6, or 216-S-16 Ponds. Contains low-level contaminated concrete and piping. | N/A | 200-RO-1 |

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Table 2-1. Summary of S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Years in Service <i>Status</i> | Source Description | Waste Volume Received | Operable Unit |
|---------------------------------|-----------------------------------|---|---|---------------|
| 2904-S-170 Control Structure | 1954 - 1976 <i>Inactive</i> | Regulated and measured process waste flow from S Plant Complex prior to routing liquid to waste disposal sites. Contains low-level contaminated concrete and piping. | N/A | 200-RO-1 |
| 2904-S-171 Control Structure | 1954 - 1976 <i>Inactive</i> | Regulated and measured process waste being routed to the 216-S-6 Crib. Contains low-level contaminated concrete and piping. | N/A | 200-RO-1 |
| 240-S-151 Diversion Box | 1950 - 1987 <i>Inactive</i> | Received low- and high-level mixed waste solutions from processing and decontamination operations for transfer to the 216-S-16 Ditch, the 216-S-16 and 216-S-17 Ponds, and the 216-S-5 and 216-S-6 Cribs. Waste was also transferred to the 216-S-7, 216-S-9, and 216-S-23 Cribs and the 240-S-152 and 241-S-151 Diversion Boxes, and interacted with the 241-U-153 Diversion Box. The structure drained to the 240-S-302 Catch Tank. | Volumes variable according to specific plant operation. | 200-RO-3 |
| 240-S-152 Diversion Box | 1977 - 1980 <i>Inactive</i> | Received high-level waste solutions from processing and decontamination operations for transfer. It also received uranyl nitrate hexahydrate from the 240-S-151 Diversion Box and transferred it to the 205-S Chemical Makeup Building. | Volumes variable according to specific plant operation. | 200-RO-3 |
| 241-S-151 Diversion Box | 1952 - present <i>Active</i> | Receives low- and high-level waste solutions from process and decontamination operations for transfer from the 240-S-151 Diversion Box to the 216-S-1 and -2 Cribs, the 241-SX-151 and -152 Diversion Boxes, the 241-S Tank Farm, and the 244-S Receiver Tank. The unit interacts with the 241-U-151 and 241-UX-154 Diversion Boxes. The unit drains to the 241-S-302A and -302B Catch Tanks. | Volumes variable according to specific plant operation. | 200-RO-4 |
| 241-S-152 Diversion Box | 1977 - 1980 <i>Inactive</i> | Received high-level mixed waste solutions from processing and decontamination operations from the 241-S and 241-SX Tank Farms and transferred it to the 242-S evaporator for separation. | Volumes variable according to specific plant operation. | 200-RO-2 |
| 241-SX-151 Diversion Box | 1954 - 1983 <i>Inactive</i> | Received high-level mixed waste solutions from processing and decontamination operations for transfer from the 241-S-151 Diversion Box to the 241-SX Tank Farm. The structure drained to the 241-SX-302 Catch Tank. | Volumes variable according to specific plant operation. | 200-RO-4 |

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Table 2-1. Summary of S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Years in Service Status | Source Description | Waste Volume Received | Operable Unit |
|--------------------------|---------------------------------|--|---|---------------|
| 241-SX-152 Diversion Box | 1954 - 1981 <i>Inactive</i> | Received high-level mixed waste solutions from processing and decontamination operations for transfer from the 241-S-151 Diversion Box to the 241-SX Tank Farm and 244-S Receiver Tank and interacted with the 241-U-151 and 241-UX-154 Diversion Boxes. The unit drained to the 241-SX-302 Catch Tank | Volumes variable according to specific plant operation. | 200-RO-4 |
| 241-S-A Valve Pit | 1952 - present <i>Active</i> | Receives waste solutions from processing and decontamination operations for transfer. | Volumes variable according to specific plant operation. | 200-RO-4 |
| 241-S-B Valve Pit | 1952 - present <i>Active</i> | Receives waste solutions from processing and decontamination operations for transfer. | Volumes variable according to specific plant operation. | 200-RO-4 |
| 241-S-C Valve Pit | 1952 - present <i>Active</i> | Receives waste solutions from processing and decontamination operations for transfer. | Volumes variable according to specific plant operation. | 200-RO-4 |
| 241-S-D Valve Pit | 1952 - present <i>Active</i> | Receives waste solutions from processing and decontamination operations for transfer. | Volumes variable according to specific plant operation. | 200-RO-4 |
| 241-SX-A Valve Pit | 1954 - 1980 <i>Inactive</i> | Receives waste solutions from processing and decontamination operations for transfer. | Volumes variable according to specific plant operation. | 200-RO-4 |
| 241-SX-B Valve Pit | 1954 - 1980 <i>Inactive</i> | Receives waste solutions from processing and decontamination operations for transfer. | Volumes variable according to specific plant operation. | 200-RO-4 |
| 241-SY-A Valve Pit | 1977- present <i>Active</i> | Receives waste solutions from processing and decontamination operations for transfer. | Volumes variable according to specific plant operation. | 200-RO-4 |
| 241-SY-B Valve Pit | 1977- present <i>Active</i> | Receives waste solutions from processing and decontamination operations for transfer. | Volumes variable according to specific plant operation. | 200-RO-4 |

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Table 2-1. Summary of S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Years in Service <i>Status</i> | Source Description | Waste Volume Received | Operable Unit |
|---------------------------|-----------------------------------|---|---|---------------|
| Basins | | | | |
| 207-S Retention Basin | 1951 - 1954 <i>Inactive</i> | Received liquid low-level wastes such as process cooling water and steam condensate from the 202-S Building. | N/A | 200-RO-2 |
| 207-SL Retention Basin | 1952 - present <i>Active</i> | Received low-level wastes including ventilation cooling water and miscellaneous wastes from laboratory hoods and sinks in the 222-S Laboratory. Before 1954 wastes were discharged to the 216-S-19 Pond. Currently discharges to the 216-S-26 Crib. | N/A | 200-RO-3 |
| Burial Sites | | | | |
| 218-W-7 Burial Ground | 1952 - 1960 <i>Inactive</i> | Received dry, packaged laboratory and sample waste from the 222-S Laboratory. | 159 cubic meters (210 cubic yards) | 200-RO-3 |
| 218-W-9 Burial Ground | 1954 <i>Inactive</i> | Contains metal scrap including the 211-S Tank taken from the 202-S Building. | 490 m ³ /d 640 yd ³ /d | 200-RO-2 |
| Unplanned Releases | | | | |
| UN-200-W-10 | 1952 <i>Inactive</i> | Uranium contamination from an unknown source. | N/A | 200-RO-4 |
| UN-200-W-30 | 1954 <i>Inactive</i> | This designation is to be deleted as it is a duplicate of the 216-S-12 unit. | N/A | 200-RO-3 |
| UN-200-W-32 | 1954 <i>Inactive</i> | Uranyl nitrate hexahydrate solution from broken transfer line enroute to 224-U facility from the 202-S Building. | N/A | 200-RO-2 |
| UN-200-W-34 | 1955 <i>Inactive</i> | Overflow from open ditch to the 202-S Building chemical sewer trenches. | N/A | 200-RO-2 |
| UN-200-W-35 | 1955 <i>Inactive</i> | Uranyl nitrate hexahydrate solution from leak in uranyl nitrate hexahydrate process line from 202-S Building to U Plant. | N/A | 200-RO-3 |
| UN-200-W-41 | 1956 <i>Inactive</i> | Beta/gamma contamination from a burial box in transit. | N/A | 200-RO-2 |

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Table 2-1. Summary of S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Years in Service Status | Source Description | Waste Volume Received | Operable Unit |
|-----------------------|----------------------------|--|-----------------------|---------------|
| UN-20-W-42 | 1957 <i>Inactive</i> | Beta/gamma contamination from unknown source. | N/A | 200-RO-2 |
| UN-200-W-43 | 1957 <i>Inactive</i> | Windblown alpha contamination from a nearby radiation zone. | N/A | 200-RO-3 |
| UN-200-W-49 | 1958 <i>Inactive</i> | Beta/gamma contamination from the 241-SX Tank Farm. | N/A | 200-RO-2 |
| UN-200-W-50 | 1958 <i>Inactive</i> | Beta/gamma contamination from 241-SX Tank Farm. | N/A | 200-RO-2 |
| UN-200-W-52 | 1958 <i>Inactive</i> | Ground contamination due to leakage from the 241-S-151 Diversion Box. | N/A | 200-RO-2 |
| UN-200-W-56 | 1961 <i>Inactive</i> | Beta/gamma contamination from radiation zone washed by heavy rainfall. | N/A | 200-RO-3 |
| UN-200-W-61 | 1966 <i>Inactive</i> | Beta/gamma contamination caused by ruptured fire hose while flushing the H-10 to the 241-SX transfer line. | N/A | 200-RO-3 |
| UN-200-W-69 | 1973 <i>Inactive</i> | Beta/gamma contamination from unknown source. | N/A | 200-RO-2 |
| UN-200-W-80 | 1978 <i>Inactive</i> | ⁹⁰ Sr and ¹³⁷ Cs contamination from the 241-S and 241-SX Tank Farms. | N/A | 200-RO-4 |
| UN-200-W-81 | 1979 <i>Inactive</i> | Beta/gamma contamination by air borne migration of contamination from the 241-S and -SX Tank Farms. | N/A | 200-RO-4 |
| UN-200-W-82 | 1980 <i>Inactive</i> | Beta/gamma contamination occurring during daily routine surveillance procedures. | N/A | 200-RO-2 |
| UN-200-W-83 | 1981 <i>Inactive</i> | Radioactive contamination caused by unknown spill to ground. | N/A | 200-RO-2 |
| UN-200-W-108 | 1969 <i>Inactive</i> | Break in crib line caused by contamination by 202-S Building process condensate from the 202-S Building. | N/A | 200-RO-2 |

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Table 2-1. Summary of S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Years in Service Status | Source Description | Waste Volume Received | Operable Unit |
|-----------------------|--------------------------------|---|-----------------------|---------------|
| UN-200-W-109 | 1969 <i>Inactive</i> | Break in crib line caused contamination by 202-S Building process condensate from the D-2 Receiver Tank in the 202-S Building. | N/A | 200-RO-2 |
| UN-200-W-114 | 1980 <i>Inactive</i> | Radioactive particulate matter from the 241-SX Tank Farm, the 241-SX-151 Diversion Box, and the 241-S-151 Diversion Box. | N/A | 200-RO-2 |
| UN-200-W-116 | 1968 - 1981 <i>Inactive</i> | Radioactive particulate matter windblown from the 204-S Waste Storage Tank exhaust and the related railroad tanker waste unloading station. | N/A | 200-RO-3 |
| UN-200-W-123 | 1979 <i>Inactive</i> | Radioactive liquid waste from frozen discharge line. | 2 L (.5 gal) | 200-RO-2 |
| UN-200-W-127 | 1980 <i>Inactive</i> | A pool of unknown liquid was found at east side of 242-S Building. | N/A | 200-RO-2 |
| UN-216-W-25 | Dates unknown <i>Active</i> | Radiation emitted from encasement containing transfer lines that run from the 242-S Evaporator Building to the 241-U Tank Farm. | N/A | 200-RO-3 |
| UN-216-W-30 | 1985 <i>Inactive</i> | Unknown contamination from an unknown source. | N/A | 200-RO-2 |
| UPR-200-W-13 | 1952 <i>Inactive</i> | Beta/gamma contamination from failure of H-4 oxidizer coil at the 202-S Building. | N/A | 200-RO-2 |
| UPR-200-W-15 | 1952 <i>Inactive</i> | Beta/gamma contamination from steam coil failure in the S Plant D-12 Waste Concentrator. | N/A | 200-RO-2 |
| UPR-200-W-20 | 1953 <i>Inactive</i> | Beta/gamma contamination due to leakage from the 241-S-151 Diversion Box. | N/A | 200-RO-2 |
| UPR-200-W-36 | 1955 <i>Inactive</i> | Process waste liquid contamination from 216-S-1 and -2 via a ruptured test well. | N/A | 200-RO-2 |
| UPR-200-W-47 | 1958 <i>Inactive</i> | Radioactive contamination from dike break of 202-S Building pond. | N/A | 200-RO-1 |

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Table 2-1. Summary of S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Years in Service Status | Source Description | Waste Volume Received | Operable Unit |
|-----------------------|--------------------------------|--|-------------------------|---------------|
| UPR-200-S-51 | 1958 <i>Inactive</i> | Beta/gamma contamination due to leakage from the 241-S-151 Diversion Box. | N/A | 200-RO-2 |
| UPR-200-W-57 | 1963 <i>Inactive</i> | Plutonium contamination caused by fire in the plutonium extraction column near the 233-S Building. | N/A | 200-RO-3 |
| UPR-200-W-59 | 1965 <i>Inactive</i> | Beta/gamma contamination caused by failure of the F-1 process vessel coil in the 202-S Building. | N/A | 200-RO-1 |
| UPR-200-W-87 | 1982 <i>Inactive</i> | Beta/gamma contamination caused by spill of contaminated water from the 291-S HEPA filter housing. | N/A | 200-RO-3 |
| UPR-200-W-95 | 1952 - 1954 <i>Inactive</i> | Low-level contamination from a number of process vessel coil leaks from the 202-S Building. | N/A | 200-RO-2 |
| UPR-200-W-96 | 1969 <i>Inactive</i> | Plutonium contaminated water from 233-SA Filter House Drain overflow. | N/A | 200-RO-3 |
| UPR-200-W-124 | Unknown <i>Inactive</i> | A dike break caused contamination of an area near the 202-S Building pond. | N/A | 200-RO-1 |
| UPR-200-W-139 | 1953 <i>Inactive</i> | Contamination of unknown source found in the 216-U-9 Ditch. | N/A | 200-RO-1 |
| UPR-200-W-140 | 1964 <i>Inactive</i> | Waste containing 202-S Building high-level wastes, 202-S Building coating wastes, concrete and supernatant containing 202-S Building high-level wastes leaked from 241-SX-107 Single-Shell Tank within the SX Tank Farm. | 20,000 L (5,000 gal) | 200-RO-4 |
| UPR-200-W-141 | 1962 <i>Inactive</i> | Supernatant containing 202-S Building high-level waste and concrete leaked from 241-SX-108 Single-Shell Tank within the SX Tank Farm. | 9,000 L (2,400 gal) | 200-RO-4 |
| UPR-200-W-142 | 1965 <i>Inactive</i> | 202-S Building high-level waste leaked from 241-SX-109 Single-Shell Tank within the SX Tank Farm. | 20,000 L (5,000 gal) | 200-RO-4 |

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Table 2-1. Summary of S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Years in Service Status | Source Description | Waste Volume Received | Operable Unit |
|-----------------------|-------------------------|---|---------------------------|---------------|
| UPR-200-W-143 | 1974 <i>Inactive</i> | Supernatant containing 202-S Building high-level liquid waste and ion-exchange liquid waste leaked from 241-SX Tanks. | 9,000 L (2,000 gal) | 200-RO-4 |
| UPR-200-W-144 | 1969 <i>Inactive</i> | 202-S Building high-level waste leaked from 241-SX-112 Single-Shell Tank within the SX Tank Farm. | 100,000 L (30,000 gal) | 200-RO-4 |
| UPR-200-W-145 | 1962 <i>Inactive</i> | 202-S Building high-level waste leaked from 241-SX-113 Single-Shell Tank within the SX Tank Farm. | 57,000 L (15,000 gal) | 200-RO-4 |
| UPR-200-W-146 | 1965 <i>Inactive</i> | 202-S Building high-level waste leaked from 241-SX-115 Single-Shell Tank within the SX Tank Farm. | 200,000 L (50,000 gal) | 200-RO-4 |

N/A = Information not available.

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Table 2-2. Radionuclide Waste Inventory Summary.

| Waste Management Unit No. | Quantity of Radionuclide Disposed of in Unit in Cl | | | | | | | | | | | | |
|-----------------------------|--|------------------|-------------------|-------------------|------------------|------------------|----------------|-----------------|-------------------|---------------------|-------------------|-------------------|-------------------|
| | Total Pu in gm | ²³⁴ U | ¹³⁷ Cs | ¹⁰⁶ Ru | ⁹⁰ Sr | ⁶⁰ Co | ³ H | ¹⁴ C | ¹⁵⁴ Eu | Other Radionuclides | ²³⁴ Pu | ²³⁹ Pu | ²⁴⁰ Pu |
| Crisks and Drains | | | | | | | | | | | | | |
| 216-S-1 & 2 | 1.2 E+3 | -- | 1.1 E+3 | 6.19 E-8 | 1.25 E+3 | -- | -- | -- | -- | 4.8 E+3 | -- | -- | -- |
| 216-S-3 | 5.0 E-1 | -- | 2.19 E+1 | 1.09 E-9 | 4.14 E-1 | -- | -- | -- | -- | 4.3 E+1 | -- | -- | -- |
| 216-S-5 | 5.8 E+2 | -- | 2.64 E+1 | 7.14 E-10 | 5.41 E+1 | -- | -- | -- | -- | 1.9 E+2 | -- | -- | -- |
| 216-S-6 | 4.73 E+2 | -- | 1.15 E+2 | 5.89 E-6 | 2.04 E+2 | -- | -- | -- | -- | 6.6 E+2 | -- | -- | -- |
| 216-S-7 | 4.4 E+2 | -- | 7.03 E+2 | 1.3 E-6 | 1.39 E+3 | -- | -- | -- | -- | 4.3 E+3 | -- | -- | -- |
| 216-S-9 | 6.5 E+1 | -- | 2.9 E+2 | 2.87 E-4 | 9.63 E1 | -- | -- | -- | -- | 7.6 E+2 | -- | -- | -- |
| 216-S-13 | 8.0 E0 | -- | 2.77 E0 | 2.36 E-6 | 2.04 E-2 | -- | -- | -- | -- | 6.0 E0 | -- | -- | -- |
| 216-S-20 | 1.71 E+2 | -- | 5.65 E0 | 2.49 E-7 | 2.27 E+1 | -- | -- | -- | -- | 1.7 E+2 | -- | -- | -- |
| 216-S-22 | 1.01 E-1 | -- | 4.78 E-1 | 1.41 E-9 | 4.55 E-1 | -- | -- | -- | -- | 1.8 E0 | -- | -- | -- |
| 216-S-23 | 9.94 E-1 | -- | 3.47 E0 | 3.49 E-5 | 1.14 E0 | -- | -- | -- | -- | 9.1 E0 | -- | -- | -- |
| 216-S-25 | 4.66 E-2 | -- | 6.47 E-2 | 1.6 E-5 | 4.1 E-2 | -- | 1.48 E2 | -- | -- | 3.1 E-1 | -- | -- | -- |
| 216-S-26 | -- | -- | 3.09 E-3 | -- | 1.83 E-3 | -- | -- | -- | -- | 1.1 E-2 | -- | 1.72 E-4 | -- |
| Ponds, Ditches and Trenches | | | | | | | | | | | | | |
| 216-S-11 | 3.1 E-1 | -- | 8.2 E-1 | 2.92 E-1 | 8.14 E-1 | -- | -- | -- | -- | 2.0 E0 | -- | -- | -- |
| 216-S-16P | -- | -- | 3.0 E-1 | 4.47 E-6 | 4.5 E+1 | -- | -- | -- | -- | 1.7 E+2 | -- | -- | -- |
| 216-S-17 | 3.0 E0 | -- | 1.27 E+1 | 3.12 E-10 | 1.59 E+1 | -- | -- | -- | -- | 5.6 E+1 | -- | -- | -- |
| 216-S-19 | 2.06 E+1 | -- | 1.29 E0 | 1.29 E-3 | 1.3 E0 | 1.10 E-1 | 1.87 E-1 | -- | -- | 6.4 E0 | -- | -- | -- |
| 216-S-10D | 1.0 E-1 | -- | 1.24 E0 | 3.46 E-1 | 1.07 E0 | 2.93 E-2 | -- | -- | -- | 3.6 E0 | -- | 4.68 E-3 | -- |
| 216-S-8 | 2.0 | -- | 4.92 E+0 | 1.3 E-10 | 3.86 E-1 | -- | -- | -- | -- | 1.1 E+1 | -- | -- | -- |
| 216-S-12 | 1.0 E0 | -- | 4.34 E-1 | 1.38 E-11 | 4.1 E-1 | -- | -- | -- | -- | 1.7 E0 | -- | -- | -- |
| Burial Sites | | | | | | | | | | | | | |
| 218-W-7 | 7.0 E-1 | 7.0 E+2g | 3.924 E+1 | 2.295 E-8 | 3.484 E+1 | -- | -- | -- | -- | -- | -- | -- | -- |
| 218-W-9 | -- | -- | 9.215 E-4 | 5.766 E-14 | 8.152 E-4 | -- | -- | -- | -- | -- | -- | -- | -- |

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Table 2-3. Chemical Waste Inventory Summary.

| Waste Management Unit No. | Quantity of Chemical Waste Disposed of in Unit in kg | | | | | |
|-----------------------------|--|---------|--------|-------------|------------------|------------------|
| | MIBK | Nitrate | Sodium | Nitric Acid | Aluminum Nitrate | Sodium Hydroxide |
| Cribs and Drains | | | | | | |
| 216-S-1 & 2 and 216-S-5 | -- | 60,000 | 10,000 | 100,000 | 60,000 | -- |
| 216-S-3 | -- | 9.0 | 5.0 | -- | -- | 2.0 |
| 216-S-5 | -- | 100 | -- | -- | -- | -- |
| 216-S-6 | -- | 140 | -- | -- | -- | -- |
| 216-S-7 | -- | 110,000 | 7,000 | 250,000 | 40,000 | -- |
| 216-S-9 | -- | -- | -- | 30,000 | -- | -- |
| 216-S-13 | 10,000 | 10,000 | 1,000 | -- | -- | -- |
| 216-S-20 | -- | 20,000 | -- | -- | -- | -- |
| 216-S-22 | -- | 7,000 | 3,000 | -- | -- | -- |
| 216-S-23 | -- | -- | -- | 300 | -- | -- |
| 216-S-25 | -- | 1.0 | -- | -- | -- | -- |
| 216-S-26 | -- | 30 | -- | -- | -- | -- |
| Ponds, Ditches and Trenches | | | | | | |
| 216-S-15 | 10,000 | 1.0 | -- | -- | -- | -- |
| 216-S-17 | -- | 140 | -- | -- | -- | -- |
| 216-S-16D | -- | 10 | -- | -- | -- | -- |
| 216-S-8 | -- | 100 | -- | -- | -- | -- |

9 3 1 2 9 5 1 4 1 4

Table 2-4. Description of S Plant Tank Farm.

| 241-S Tank Farm | Type | Integrity | Interim Stabilized | Isolation | Total Waste Volume (L) | Drainable Waste Volume (L) | Flammable Gas Generation |
|-----------------|--------------|----------------|--------------------|-----------------------|------------------------|----------------------------|--------------------------|
| 241-S-101 | Single-shell | Sound | No | Part-interim isolated | 1,616,200 | 363,400 | No |
| 241-S-102 | Single-shell | Sound | No | Part-interim isolated | 2,078,000 | 870,600 | Yes |
| 241-S-103 | Single-shell | Sound | No | Part-interim isolated | 938,700 | 386,100 | No |
| 241-S-104 | Single-shell | Assumed leaker | Yes | Interim isolated | 1,112,800 | 109,800 | No |
| 241-S-105 | Single-shell | Sound | Yes | Interim isolated | 1,726,000 | 132,500 | No |
| 241-S-106 | Single-shell | Sound | No | Part-interim isolated | 2,055,300 | 435,300 | No |
| 241-S-107 | Single-shell | Sound | No | Part-interim isolated | 1,392,900 | 193,000 | No |
| 241-S-108 | Single-shell | Sound | No | Part-interim isolated | 2,286,100 | 389,900 | No |
| 241-S-109 | Single-shell | Sound | No | Part-interim isolated | 2,149,900 | 469,300 | No |
| 241-S-110 | Single-shell | Sound | No | Part-interim isolated | 2,619,200 | 227,100 | No |
| 241-S-111 | Single-shell | Sound | No | Part-interim isolated | 2,255,900 | 764,600 | Yes |
| 241-S-112 | Single-shell | Sound | No | Part-interim isolated | 2,411,000 | 545,000 | Yes |

Source: Hanlon 1991.

Table 2-4. Description of S Plant Tank Farm.

| 241-SX Tank Farm | Type | Integrity | Interim Stabilized | Isolation | Total Waste Volume (L) | Drainable Waste Volume (L) | Flammable Gas Generation |
|------------------|--------------|----------------|--------------------|-----------------------|------------------------|----------------------------|--------------------------|
| 241-SX-101 | Single-shell | Sound | No | Part-interim isolated | 1,726,000 | 552,600 | Yes |
| 241-SX-102 | Single-shell | Sound | No | Part-interim isolated | 2,055,300 | 692,700 | Yes |
| 241-SX-103 | Single-shell | Sound | No | Part-interim isolated | 2,467,800 | 919,800 | Yes |
| 241-SX-104 | Single-shell | Assumed leaker | No | Part-interim isolated | 2,324,000 | 522,300 | Yes |
| 241-SX-105 | Single-shell | Sound | No | Part-interim isolated | 2,585,200 | 987,900 | Yes |
| 241-SX-106 | Single-shell | Sound | No | Part-interim isolated | 2,036,300 | 965,200 | Yes |
| 241-SX-107 | Single-shell | Assumed leaker | Yes | Interim isolated | 393,600 | 18,900 | No |
| 241-SX-108 | Single-shell | Assumed leaker | Yes | Interim isolated | 435,300 | 22,700 | No |
| 241-SX-109 | Single-shell | Assumed leaker | Yes | Interim isolated | 946,200 | 37,900 | Yes |
| 241-SX-110 | Single-shell | Assumed leaker | Yes | Interim isolated | 234,700 | --- | No |
| 241-SX-111 | Single-shell | Assumed leaker | Yes | Interim isolated | 473,100 | 26,500 | No |
| 241-SX-112 | Single-shell | Assumed leaker | Yes | Interim isolated | 348,200 | 11,400 | No |
| 241-SX-113 | Single-shell | Assumed leaker | Yes | Interim isolated | 98,400 | --- | No |
| 241-SX-114 | Single-shell | Assumed leaker | Yes | Interim isolated | 685,100 | 53,000 | No |
| 241-SX-115 | Single-shell | Assumed leaker | Yes | Interim isolated | 45,400 | --- | No |

Source: Hanlon 1991.

9 3 1 2 8 4 5 1 4 1 6

Table 2-4. Description of S Plant Tank Farm.

| 241-SY Tank Farm | Type | Integrity | Interim Stabilized | Isolation | Total Waste Volume (L) | Drainable Waste Volume (L) | Flammable Gas Generation |
|------------------|--------------|-----------|--------------------|-----------|------------------------|----------------------------|--------------------------|
| 241-101-SY | Double-shell | Sound | No | No | 4,243,000 | 897,000 | N/A |
| 241-102-SY | Double-shell | Sound | No | No | 2,426,200 | 2,157,400 | N/A |
| 241-103-SY | Double-shell | Sound | No | No | 2,835,000 | 651,000 | N/A |

N/A = Data not available.

Source: Hanlon 1991.

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Table 2-5. Partial Inventory of Hazardous Constituents
Disposed of in S Plant Aggregate Area Tanks.

| S TANK FARM | |
|---------------------------------|-------------------------|
| CONSTITUENT | Minimum Inventory in Kg |
| <u>RADIONUCLIDE CONTENT</u> | |
| 235, 238 U | 4x10 ⁴ |
| 235U | 3x10 ² |
| Pu | 3x10 ¹ |
| Np | — |
| Th | — |
| 233 U | — |
| ⁹⁰ Sr | 3x10 ⁶ (Ci) |
| ¹³⁷ Cs | 5x10 ⁶ (Ci) |
| <u>LIQUID CONTENT</u> | |
| NaOH | 2x10 ⁶ |
| NaAlO ₂ | 1x10 ⁶ |
| NaNO ₃ | 2x10 ⁶ |
| NaNO ₂ | 1x10 ⁶ |
| Na ₂ CO ₃ | 3x10 ⁵ |
| Na ₃ PO ₄ | 2x10 ⁴ |
| <u>SOLID CONTENT</u> | |
| NaNO ₃ | 2x10 ⁷ |
| NaNO ₂ | 1x10 ⁶ |
| NaOH | 3x10 ⁶ |
| NaAlO ₂ | 3x10 ⁵ |
| Na ₂ CO ₃ | 5x10 ⁵ |

9 3 1 2 8 5 1 4 1 8

Table 2-5. Partial Inventory of Hazardous Constituents
Disposed of in S Plant Aggregate Area Tanks.

| S X TANK FARM | |
|---------------------------------|----------------------------|
| CONSTITUENT | Minimum Inventory in Kg |
| <u>RADIONUCLIDE CONTENT</u> | |
| 235, 238 U | 5×10^7 |
| 235U | 3×10^5 |
| Pu | 5×10^1 |
| Np | -- |
| Th | -- |
| 233 U | -- |
| ^{90}Sr | $3 \times 10^6(\text{Ci})$ |
| ^{137}Cs | $4 \times 10^6(\text{Ci})$ |
| <u>LIQUID CONTENT</u> | |
| NaOH | 1×10^6 |
| NaAlO ₂ | 1×10^6 |
| NaNO ₃ | 4×10^6 |
| NaNO ₂ | 1×10^6 |
| Na ₂ CO ₃ | 2×10^5 |
| Na ₃ PO ₄ | 2×10^4 |
| <u>SOLID CONTENT</u> | |
| NaNO ₃ | 5×10^6 |
| NaNO ₂ | 5×10^5 |
| NaOH | 5×10^5 |
| NaAlO ₂ | 3×10^6 |
| Na ₂ CO ₃ | 1×10^6 |

9 0 1 0 0 5 1 4 1 9

Table 2-6. Summary of Unplanned Releases.

| Unplanned Release No. | Location (Operable Unit) | Date | Associated Waste Management Unit | Reported Waste - Related History |
|-----------------------|---|----------------|----------------------------------|---|
| UPR-200-W-47 | Approximately 137m (150 yd) to the west of the 216-S-16P Pond (200-RO-01) | June 1958 | N/A | <ul style="list-style-type: none"> • Dike break resulted in soil contamination that spread approximately 137 m (150 yd) to the west of the 216-S-16P Pond and extended 274 m (300 yd) from north to south. • Readings to a maximum of 750 mR/h were observed. • Contaminated ground was bladed under during a remediation effort in 1959. |
| UPR-200-W-59 | No. 1 Pond at 202-S Building (200-RO-01) | September 1965 | N/A | <ul style="list-style-type: none"> • Failure of an F-1 process vessel coil in the 202-S Building allowed effluent to mix with the cooling water. • Beta/gamma readings with a maximum dose rate of 190 mR/h at the No. 1 Pond inlet were recorded. • Remedial actions not identified. |
| UPR-200-W-124 | 202-S Building Pond (200-RO-01) | Unknown | N/A | <ul style="list-style-type: none"> • Dike break caused contamination over an area 9 m (30 ft) wide and extending approximately 305 m (1,000 ft) southwest of the 202-S Building pond. • No monitoring data reported for this release. • Remedial actions not identified. |
| UPR-200-W-139 | 216-U-9 Ditch (200-RO-01) | September 1953 | 216-U-9 Ditch | <ul style="list-style-type: none"> • Contamination from an unknown source was detected at the 216-U-9 Ditch. • No radiation readings or analytical data reported. • Site was covered in the Spring of 1954; additional corrective action may have been provided but not documented. |
| UN-200-W-32 | Near northwest corner of 202-S Building exclusion area (200-RO-02) | 1954 | N/A | <ul style="list-style-type: none"> • A ruptured transfer line enroute to 224-U from the 202-S Building spilled uranyl nitrate hexahydrate solution to the ground. • No analytical data provided on the level of contamination associated with this release. • The contaminated area was covered with clean soil, and the site removed from radiation zone status in February 1971. |

2T-6a

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Table 2-6. Summary of Unplanned Releases.

| Unplanned Release No. | Location (Operable Unit) | Date | Associated Waste Management Unit | Reported Waste - Related History |
|-----------------------|---|------------------|----------------------------------|---|
| UN-200-W-34 | 202-S Building chemical sewer trenches (200-RO-02) | May 1955 | N/A | <ul style="list-style-type: none"> • Release involved overflow from an open ditch and the 202-S Building chemical sewer trenches resulting in contamination of approximately 5,000 m² (1 acre) between the open ditch and the trenches. • Maximum dose rate of 1 R/h was recorded. • Remedial actions not identified. |
| UN-200-W-41 | Right-of-way from the 202-S railroad cut to the burial ground (200-RO-02) | July 7, 1956 | N/A | <ul style="list-style-type: none"> • Transport of a burial box caused ground contamination at the right-of-way from the 202-S railroad cut to the burial ground. • Unknown beta/gamma readings to 1,000 mR/h were recorded. • Remedial actions not identified. |
| UN-200-W-42 | S Plant Aggregate Area near a railroad shack (200-RO-02) | February 3, 1957 | N/A | <ul style="list-style-type: none"> • Contaminated spots from an unknown source were found in the S Plant Aggregate Area near a railroad shack. • Contamination consisted of unknown beta/gamma readings ranging from 50 to 500 mR/h. • The site was cleaned to readings of 2,000 to 5,000 c/h. |
| UN-200-W-49 | 241-SX Tank Farm, outside of southeast corner (200-RO-02) | July 31, 1958 | N/A | <ul style="list-style-type: none"> • Release from the 241-SX Tank Farm caused contamination of ground outside of the Tank Farm's southeast corner. • Unknown beta/gamma readings up to 150 mR/h were noted, with a single spot with readings up to 10 R/h. • Remedial actions not identified. |

2T-6b

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Draft A

Table 2-6. Summary of Unplanned Releases.

| Unplanned Release No. | Location (Operable Unit) | Date | Associated Waste Management Unit | Reported Waste - Related History |
|-----------------------|---|--------------------|---|---|
| UN-200-W-50 | 241-SX-113 Single-Shell Tank (200-RO-02) | August 25, 1958 | 241-SX-113 Single-Shell Tank | <ul style="list-style-type: none"> Contamination deposited on the ground around the 241-SX-113 Single-Shell Tank was spread outside of the 241-SX Tank Farm by high winds. Contamination inside the 241-SX Tank Farm covered approximately 1,400 m² (15,000 ft²) and showed a maximum level of 5 rads/h. In an area of about 8,000 m² (2 acres) east of the tank farm, unknown beta/gamma readings of 40,000 c/min with spots up to 100 mR/h were noted. Remedial actions not identified. |
| UN-200-W-52 | South of the 241-S-151 Diversion Box toward 10th Street (200-RO-02) | September 15, 1958 | 207-S Retention Basin and 241-S-151 Diversion Box | <ul style="list-style-type: none"> Leakage from the 241-S-151 Diversion Box caused ground contamination in an oval shaped area approximately 91 m (300 ft) wide, lying immediately south of the diversion box toward 10th Street, including the 207-S Retention Basin. Contaminated soil was saturated with water and turned over with a bulldozer. |
| UN-200-W-69 | Between the 204-S railroad spur and the 202-S Building railroad cut (202-RO-02) | March 2, 1973 | N/A | <ul style="list-style-type: none"> Numerous spots of ground contamination of 2,000 to 50,000 c/min with infrequent spots of 20 to 100 mrad/h were noted north and northeast from the 204-S Unloading Station and between the 204-S railroad spur and the 202-S Building railroad cut. Inside established radiation zone, the sump pit was found contaminated from 1,000 to 5,000 mrad/h and the grating from the sump stacked nearby to 800 mrad/h. Extension of survey outside the 202-S Building exclusion fence produced readings of 5,000 to 100,000 c/min between 204-S railroad spur and the 202-S Building railroad cut embankment. Remedial actions not identified. |

2T-6c

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Draft A

Table 2-6. Summary of Unplanned Releases.

| Unplanned Release No. | Location (Operable Unit) | Date | Associated Waste Management Unit | Reported Waste - Related History |
|-----------------------|---|-------------------|--|--|
| UN-200-W-82 | Near the 241-S-151 Diversion Box and the 241-S-302 Catch Tank (200-RO-02) | January 15, 1980 | 241-S-151 Diversion Box and 241-S-302 Catch Tank | <ul style="list-style-type: none"> Traffic from daily routine surveillance deposited specks of contamination outside the radiation zone over an area of approximately 11x18 m (35x60 ft) near the 241-S-151 Diversion Box and the 241-S-302 Catch Tank. Unknown beta/gamma readings were noted with spots outside of the zone reading up to 80,000 c/min. The specks were picked up and removed to the burial ground. |
| UN-200-W-83 | Vicinity of 204-S radiation zone (200-RO-02) | November 23, 1981 | N/A | <ul style="list-style-type: none"> An unknown amount of radioactive contamination was spilled on the ground in the vicinity of the 204-S radiation zone. No other details provided. |
| UN-200-W-108 | Underground crib waste lines (200-RO-02) | January 8, 1969 | N/A | <ul style="list-style-type: none"> Ruptures in the underground crib waste lines produced unknown beta/gamma with dose rates of 40 R/h detected at the bottom of the waste line. Leakage occurred over an unknown time period with unknown quantity of waste discharged. Release was cleaned up by redirecting approximately 110L (30 gal) of waste solution into a hole in the ground below the opening of the line and approximately 6 m (20 ft) below the ground surface. Annual surface radiological monitoring is performed at this site; during the October 1990 survey no contamination was detected, a decrease from the previous survey. |

2T-6d

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Table 2-6. Summary of Unplanned Releases.

| Unplanned Release No. | Location (Operable Unit) | Date | Associated Waste Management Unit | Reported Waste - Related History |
|-----------------------|---|-------------------|---|---|
| UN-200-W-109 | Underground crib waste lines (200-RO-02) | January 24, 1969 | N/A | <ul style="list-style-type: none"> Ruptures in underground crib waste lines resulted in waste water bubbling to the surface; radiation dose rates of unknown beta/gamma were measured at 450 mR/h are decreased to 20 mR/h after the water sank back into the ground. Annual surface radiological monitoring is performed at the site; during the October 1990 survey general contamination was detected from 200 to 6,000 c/min, indicating no change in contamination from the previous survey. Remedial actions not identified. |
| UN-200-W-114 | Vicinity of 241-SX Tank Farm, 241-SX-151 Diversion Box, and 241-S-151 Diversion Box (200-RO-02) | 1980 | 241-SX Tank Farm, 241-SX-151 Diversion Box, and the 241-S-151 Diversion Box | <ul style="list-style-type: none"> Annual surface contamination monitoring performed October 1990 in the vicinity of the 241-SX Tank Farm, 241-SX-151 Diversion Box, and the 241-S-151 Diversion Box detected contamination from 200 to 450 c/min with specks of contamination up to 4 mR/h. Similar conditions were reported during surveys in September 1988 and 1989. Cleanup operations have reduced but not eliminated particulate contamination. |
| UN-200-W-123 | 204-S unloading facility (200-RO-02) | January 18, 1989 | N/A | <ul style="list-style-type: none"> Release of 1/2 gal of radioactive liquid waste occurred at the 204-S unloading facility area, caused by a leak from a frozen discharge line. Contaminated ground at the site was cleaned up. |
| UN-200-W-127 | East side of Building 242-S (200-RO-02) | February 26, 1980 | N/A | <ul style="list-style-type: none"> A pool of liquid was found on the ground at the east side of Building 242-S; high radiation levels were noted all around the building. Spill area was remediated by covering with clean dirt. |

2T-6e

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Draft A

Table 2-6. Summary of Unplanned Releases.

| Unplanned Release No. | Location (Operable Unit) | Date | Associated Waste Management Unit | Reported Waste - Related History |
|-----------------------|---|---------------------------|----------------------------------|--|
| UN-216-W-30 | Northeast of the 241-SY Tank Farm including 216-S-23 Crib (200-RO-02) | 1985 | 216-S-23 Crib | <ul style="list-style-type: none"> • Release of unknown origin and type resulted in contamination of a site extending 900 ft to the northeast of the 241-SY Tank Farm and spreading 250 ft. wide. • Current levels of radioactivity are 3500 dis/min beta, less than .5 mrem/h. • Site crosses the northern portion of the 216-S-23 Crib; it is heavily vegetated and shows no sign of stabilization. |
| UPR-200-W-13 | 207-S Retention Basin (200-RO-02) | December 23, 1952 | 207-S Retention Basin | <ul style="list-style-type: none"> • Release may have been related to the failure of the H-4 oxidizer coil at the 202-S Building. • Beta/gamma readings from an unknown source indicated a dose rate that increased from 6 mR/h to 700 mR/h over a 30-day period. • Remedial actions not identified. |
| UPR-200-W-15 | 207-S Retention Basin | November 1952 | 207-S Retention Basin | <ul style="list-style-type: none"> • Failure of a steam coil in the 202-S Building D-12 waste concentrator associated with the 207-S Retention Basin was responsible for this release. • An unknown beta/gamma source with dose rates up to 2 rem/h was released and contamination was measured at 35 rem/h 2 in from the ground. • Remedial actions not identified. |
| UPR-200-W-20 | Near 241-S-151 Diversion Box (200-RO-02) | January and February 1953 | 241-S-151 Diversion Box | <ul style="list-style-type: none"> • Release occurred as a result of leakage from the 241-S-151 Diversion Box, contaminating a 93 m² (1,000 ft²) area near the 241-SX Tank Farm. • Reported readings indicated an unknown beta/gamma source; actual readings not recorded. • Remedial actions not identified. |
| UPR-200-W-36 | 216-S-1 and-2 Cribs (200-RO-02) | August 4, 1955 | 216-S-1 and-2 Cribs | <ul style="list-style-type: none"> • A ruptured test well caused this release from 216-S-1 and -2 Cribs. • No data concerning contamination detailed. • Remedial actions not identified. |

2T-6f

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Table 2-6. Summary of Unplanned Releases.

| Unplanned Release No. | Location (Operable Unit) | Date | Associated Waste Management Unit | Reported Waste - Related History |
|-----------------------|---|----------------------------|----------------------------------|---|
| UPR-200-W-51 | South of 241-S-151 Diversion Box (200-RO-02) | September 12, 1958 | 241-S-151 Diversion Box | <ul style="list-style-type: none"> Leakage from the 241-S-151 Diversion Box contaminated a narrow strip of ground south of the diversion box. Unknown beta/gamma readings up to 50 mR/h were taken within 30 m (100 ft) of the diversion box and readings outside the fenced area were recorded at approximately 4,000 c/min. Contaminated soil was saturated with water and turned over with a bulldozer. |
| UPR-200-W-95 | 207-S Retention Basin 1,200 ft west of 222-S Building (200-RO-02) | Late 1952 until April 1954 | 207-S Retention Basin | <ul style="list-style-type: none"> A number of process coil leaks from the 202-S Building caused this release. The site has been interpreted as low-activity containing approximately 10 Ci of mixed fission products. No monitoring data provided. The gross amounts of radioactivity remaining on the concrete floors and walls of this site were covered by an overfill of dirt. |
| UN-200-W-30 | 216-S-12 Trench (200-RO-03) | July 1954 | 216-S-12 Trench | <ul style="list-style-type: none"> The designation UPR-200-W-30 is scheduled for deletion, because it is a duplicate of the 216-S-12 Trench. |
| UN-200-W-35 | Outside and north of 202-S Building exclusion area (200-RO-03) | September 1955 | N/A | <ul style="list-style-type: none"> Release was a leak that occurred in the uranyl nitrate hexahydrate process line from the 202-S Building to U Plant, at a location just outside and to the north of the 202-S Building exclusion area. Contamination was removed to the 200 west solid waste burial ground; area was removed from radiation zone status in January 1972. |
| UN-200-W-43 | Near radiation zone east of 223-S (200-RO-03) | February 12, 1957 | N/A | <ul style="list-style-type: none"> Site originated from wind blown contamination from a nearby radiation zone east of 223-S; site is approximately 110 m² (1,200 ft²) with 4,500 kg (5 tons) of soil contaminated. Unknown alpha with readings to 2,000 c/h. Remedial actions not identified. |

2T-6g

DOE/RL-91-60
Draft A

Table 2-6. Summary of Unplanned Releases.

| Unplanned Release No. | Location (Operable Unit) | Date | Associated Waste Management Unit | Reported Waste - Related History |
|-----------------------|---|----------------|----------------------------------|--|
| UN-200-W-56 | Near the 202-S Column Carrier Trench (200-RO-03) | February 1961 | N/A | <ul style="list-style-type: none"> • Heavy rainfall washed contamination from a radiation zone (216-S-12) and contaminated 19 m² (200 ft²) of gravelled surface, and 5 m² (50 ft²) of blacktop. • Unknown beta/gamma readings of 30,000 c/min on gravelled surface and 80,000 c/min on the blacktop were recorded. • Remedial actions not identified. |
| UN-200-W-61 | Near the southwest corner of the 202-S Building (200-RO-03) | April 24, 1966 | N/A | <ul style="list-style-type: none"> • A firehose rupture while flushing the H-10 to the 241-SX transfer line near the southwest corner of the 202-S Building resulted in contamination of approximately 19 m² (200 ft²) area containing 9,000 kg (10 tons) of soil. • Unknown beta/gamma readings from 4,000 to 100,000 c/min were recorded. • Contaminated walkways were washed down and the top 15 cm (6 in) of contaminated soil were removed; the unit has been released from radiation zone status. |
| UN-200-W-116 | Near the 204-S Waste Storage Tank (200-RO-03) | 1968-1981 | N/A | <ul style="list-style-type: none"> • Site was contaminated with particulate matter spread by wind from the 204-S Waste Storage Tank exhaust and the related railroad tanker waste unloading station. • General contamination was measured at 200 c/min with isolated specks up to 2 mR/h during annual surface radiation monitoring in October 1990. • Surface monitoring results did not change from the previous year's survey. |

2T-6h

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Table 2-6. Summary of Unplanned Releases.

| Unplanned Release No. | Location (Operable Unit) | Date | Associated Waste Management Unit | Reported Waste - Related History |
|---------------------------------|---|------------------|----------------------------------|--|
| Radiation Emissions UN-216-W-25 | Encasement containing transfer lines between the 242-S Evaporator and the U Tank Farm (200-RO-03) | Unknown | N/A | <ul style="list-style-type: none"> Not an unplanned release, but has been given that designation; an encasement containing transfer lines between the 242-S Evaporator (inactive) to the U Tank Farm is emitting radioactivity. No release of radioactive material has occurred; current levels range from 2,000 to 40,000 dis/min beta. A series of 24 clean-out boxes are regularly surveyed for radiation. |
| UPR-200-W-57 | 233-S Building (200-RO-03) | 1963 | N/A | <ul style="list-style-type: none"> A fire in the plutonium column in the 233-S Building spread plutonium contamination throughout the building. Parts of the building were cleaned of gross contamination and nonflammable alpha contamination was remediated using an Amercoat paint. |
| UPR-200-W-87 | 291-S HEPA filter housing (200-RO-03) | January 28, 1982 | 291-S Stack Complex | <ul style="list-style-type: none"> Water leak from the 291-S HEPA filter housing contaminated the ground at its base. Readings to 2,000 c/min were recorded. Contaminated soil was removed. |
| UPR-200-W-96 | Adjacent to and north of the 233-SA Filter House (200-RO-03) | January 9, 1969 | N/A | <ul style="list-style-type: none"> Release of 0.01 gram of ²³⁹Pu contaminated water overflowed from the 233-SA Filter House and accumulated on a low spot directly to the north, forming a pool on the frozen ground. Current radioactivity has been measured at less than detection for alpha and beta, and background for gamma. Site has been covered with gravel. |
| UN-200-W-10 | Near the 203-S Uranium Storage Tanks (200-RO-04) | 1952 | N/A | <ul style="list-style-type: none"> An unknown source caused spotty uranium contamination. Maximum reading was noted at 10,000 c/min at 2 cm (1 in.). Cleanup action was instituted by covering the contaminated area with asphalt. |

2T-6i

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Table 2-6. Summary of Unplanned Releases.

| Unplanned Release No. | Location (Operable Unit) | Date | Associated Waste Management Unit | Reported Waste - Related History |
|-----------------------|---|------------------|----------------------------------|---|
| UN-200-W-80 | 244-S Catch Station and areas adjacent to the 241-S and 241-SX Tank Farms (200-RO-04) | October 24, 1978 | N/A | <ul style="list-style-type: none"> The 241-S and 241-SX Tank Farms contaminated the 244-S Catch Tank Station construction site and other areas adjacent to the tank farms. Radionuclides known to be present are ⁹⁰Sr and ¹³⁷Cs with readings to 60,000 c/min. Remedial actions not identified. |
| UN-200-W-81 | Near the 241-S and 241-SX Tank Farms (200-RO-04) | January 2, 1979 | N/A | <ul style="list-style-type: none"> Airborne migration for the 241-S and 241-SX Tank Farms resulted in contamination. Unknown beta/gamma with readings from 500 to over 100,000 c/min were recorded. Remedial actions not identified. |
| UPR-200-W-140 | 241-SX-107 Single-Shell Tank (200-RO-04) | 1964 | 241-SX-107 Single-Shell Tank | <ul style="list-style-type: none"> Release is the result of 19,000 L (5,000 gal) of contamination leaking from the 241-SX-107 Single-Shell Tank, spreading laterally in subsurface strata 17 to 18 m (55 to 60 ft) below ground surface. Tank is currently inactive and was removed from service in 1964 as a "confirmed leaker". |
| UPR-200-W-141 | 241-SX-108 Single-Shell Tank (200-RO-04) | 1962 | 241-SX-108 Single-Shell Tank | <ul style="list-style-type: none"> Release is associated with and surrounds 241-SX-108 Single-Shell Tank within the 241-SX Tank Farm, and consists of approximately 9,100 L (2,400 gal.) of supernatant containing 202-S Building high-level waste and concrete. Remedial actions not identified. |
| UPR-200-W-142 | 241-SX-109 Single-Shell Tank (200-RO-04) | 1965 | 241-SX-109 Single-Shell Tank | <ul style="list-style-type: none"> Release is associated with and surrounds 241-SX-109 Single-Shell Tank within the SX Tank Farm, and consists of approximately 19,000 L (5,000 gal) of 202-S Building high-level liquid waste. Remedial actions not identified. |
| UPR-200-W-143 | 241-SX-111 Single-Shell Tank (200-RO-04) | 1974 | 241-SX-111 Single-Shell Tank | <ul style="list-style-type: none"> Release is associated with and surrounds 241-SX-111 Single-Shell Tank within the SX Tank Farm, and consists of approximately 6,600 L (2,000 gal) of 202-S Building high-level liquid waste and ion exchange liquid waste from the 241-SX tanks. Remedial actions not identified. |

2T-6j

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Draft A

Table 2-6. Summary of Unplanned Releases.

| Unplanned Release No. | Location (Operable Unit) | Date | Associated Waste Management Unit | Reported Waste - Related History |
|-----------------------|--|------|----------------------------------|---|
| UPR-200-W-144 | 241-SX-112 Single-Shell Tank (200-RO-04) | 1969 | 241-SX-112 Single-Shell Tank | <ul style="list-style-type: none"> • Release is associated with an surrounds 241-SX-112 Single-Shell Tank within the 241-SX Tank Farm, and consists of approximately 100,000 L (30,000 gal) of 202-S Building high-level liquid waste. • Remedial actions not identified. |
| UPR-200-W-145 | 241-SX-113 Single-Shell Tank (200-RO-04) | 1962 | 241-SX-113 Single-Shell Tank | <ul style="list-style-type: none"> • Release is associated with and surrounds 241-SX-113 Single-Shell Tank within the SX Tank Farm, and consists of approximately 57,000 L (15,000 gal) of 202-S Building high-level liquid waste. • Remedial actions not identified. |
| UPR-200-W-146 | 241-SX-115 Single-Shell Tank (200-RO-04) | 1965 | 241-SX-115 Single-Shell Tank | <ul style="list-style-type: none"> • Release is associated with and surrounds 241-SX-115 Single-Shell Tank within the SX Tank Farm, and consists of approximately 190,000 L (50,000 gal) of 202-S Building high-level liquid waste. • Remedial actions not identified. |

2T-6K

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Draft A

Table 2-7. Summary of Waste-Producing Processes in the S Plant Aggregate Area.

| Process | Waste Generated | Major Chemical Constituents | Ionic Strength | pH | Organic Concentration | Radioactivity |
|-----------------------|------------------------|--|----------------|-----------------|-----------------------|---------------|
| Feed Preparation | Jacket dissolution | Fission products, jacket constituents (alloy) sodium hydroxide, sodium aluminate | High | Basic | Low | High |
| | Slug dissolution | Sodium hydroxide, ferrous sulfamate, zirconium, niobium | High | Basic | Low | High |
| Extraction Cycles | Aqueous process waste | Sodium aluminate, fission products, sodium hydroxide | High | Neutral - Basic | Low | Low |
| | Organic process waster | Hexone | Low | Neutral | High | Low |
| Solvent Recovery | Aqueous waste | Sodium hydroxide, sodium carbonate | High | Basic | Low to Medium | High |
| Analytical Laboratory | Laboratory waste | Sodium hydroxide, organics, fission products | Low | Basic | Low | Low |

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Table 2-9. Chemicals Used in the 222-S Plant Laboratory. Page 1 of 2

| Compound Name | Formula |
|---------------------------------|---|
| Acetone | CH ₃ C ₂ OH ₃ |
| Aluminum nitrate nonahydrate | Al(NO ₃) ₃ ·9H ₂ O |
| Ammonium hydroxide | NH ₄ OH |
| Ammonium oxalate | (NH ₄) ₂ C ₂ O ₄ ·H ₂ O |
| Bromonaphthalene | C ₁₀ H ₇ Br |
| Butylated hydroxytoluene | -- |
| Calcium | Ca |
| Ceric sulfate | Ce(SO ₄) ₂ |
| Chloride | Cl |
| Di2-Ethyl Hexyl Phosphoric Acid | C ₁₆ H ₃₄ POOH |
| Ferrous sulfamate | Fe(SO ₃ NH ₂) ₂ |
| Ferrous sulfate | FeSO ₄ |
| Fluoride | F |
| Hydrazine | H ₂ NNH ₂ ·H ₂ O |
| Hydrochloric acid | HCl |
| Hydroxylamine hydrochloride | NH ₂ OH·HCl |
| Hydroxyquinoline | C ₉ H ₆ NOH |
| Lead nitrate | Pb(NO ₃) ₂ |
| Mercuric thiocyanate | Hg(SCN) ₂ |
| Methyl ethyl ketone | CH ₃ COC ₂ H ₅ |
| Methyl isobutyl ketone | CH ₃ COC ₄ H ₉ |
| Mineral oil | Light hydrocarbons |
| Nitrate | NO ₃ |
| Nitric Acid | HNO ₃ |
| Normal paraffin hydrocarbon | C ₁₀ H ₂₂ to C ₁₄ H ₃₀ |
| O-phenanthroline | C ₁₂ H ₈ N ₂ |
| Potassium fluoride | KF |
| Potassium oxalate | K ₂ C ₂ O ₄ |
| Potassium permanganate | KMnO ₄ |
| Radium | Ra |

9 0 1 2 3 4 5 1 9 3 3

Table 2-9. Chemicals Used in the 222-S Plant Laboratory. Page 2 of 2

| Compound Name | Formula |
|-------------------------------|-----------------------------|
| S-diphenyl carbazide | $C_{13}H_{14}N_4O$ |
| Shell spray base ¹ | $C_{10}H_{22}-C_{16}H_{34}$ |
| Sodium dichromate | $Na_2CR_2O_7 \cdot 2H_2O$ |
| Sodium fluoride | NaF |
| Sodium hydroxide | NaOH |
| Sodium nitrate | $NaNO_2$ |
| Sulfate | SO_3 |
| Sulfuric acid | H_2SO_4 |
| Tetrabromoethane | $(CHBr_2)_2$ |
| Tetraphenyl boron | $(C_6H_5)_4B$ |
| Thenoyltrifluoroacetone | $C_7H_5SO_2F_3$ |
| Tributyl phosphate | $(C_4H_9)_3PO_4$ |
| Trichloromethane | -- |
| Titanium chloride | $TiCl_4$ |
| Tri-iso-octamine | $C_{24}H_{51}N$ |
| Tri-n-ocylamine | $C_{24}H_{51}N$ |
| Vanadium | V |
| Xylene | $C_6H_4(CH_3)_2$ |
| Zinc amalgam | ZnHg |

¹Product Name
Source: Klein 1990

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Table 2-10. Radionuclides and Chemicals Disposed of to S Plant Aggregate Area Waste Management Units.

| RADIONUCLIDES | | | ORGANIC CHEMICALS |
|-------------------|---------------------------|---------------------------|----------------------------------|
| ^{108}Ag | ^{93}Mo | ^{99}Tc | Acetone |
| ^{110}Ag | ^{22}Na | ^{121}Te | Ammonia |
| ^{28}Al | $^{93\text{m}}\text{Nb}$ | $^{125\text{m}}\text{Te}$ | Bromonaphthalene |
| ^{241}Am | ^{94}Nb | ^{127}Te | Butylated hydroxy toluene |
| ^{133}Ba | ^{95}Nb | $^{129\text{m}}\text{Te}$ | Di-2-Ethyl Hexyl Phosphoric Acid |
| ^7Ba | ^{59}Ni | ^{204}Ti | Hydroxyquinoline |
| ^7B | ^{63}Ni | ^{170}Tm | Methyl isobutyl carbinal |
| ^{10}Be | ^{32}P | ^{234}U | Methyl isopropyl diketone |
| ^{14}C | ^{231}Pa | ^{235}U | Methyl isobutyl ketone |
| ^{45}Ca | ^{212}Pb | ^{236}U | Mineral oil |
| ^{109}Cd | ^{214}Pb | ^{238}U | Normal paraffin hydrocarbon |
| ^{141}Ce | ^{147}Pm | ^{49}V | O-phenanthroline |
| ^{36}Cl | ^{210}Po | ^{87}Y | Organic acids |
| ^{243}Cm | ^{239}Pu | ^{88}Y | Organic salts |
| ^{57}Co | ^{240}Pu | ^{65}Zn | Propane |
| ^{58}Co | ^{241}Pu | ^{95}Zr | S-diphenyl carbazide |
| ^{60}Co | ^{280}Pu | | Shell spray base |
| ^{51}Cr | ^{228}Ra | | Tetraphenyl boron |
| ^{134}Es | ^{86}Rb | | Thenoyltrifluoroacetone |
| ^{137}Cs | ^{187}Re | | Tributyl phosphate |
| ^{254}Es | ^{106}Ro | | Trichloromethane |
| ^{152}Eu | ^{103}Ru | | Tri-iso-octylamine |
| ^{154}Eu | ^{106}Ru | | Tri-n-octylamine |
| ^{155}Eu | ^{35}S | | Xylene |
| ^{55}Fe | ^{122}Sb | | |
| ^{59}Fe | ^{124}Sb | | |
| ^{153}Gd | ^{125}Sb | | |
| ^{68}Ge | ^{126}Sb | | |
| ^3H | ^{46}Sc | | |
| ^{123}I | ^{75}Se | | |
| ^{125}I | ^{151}Sn | | |
| ^{129}I | $^{123\text{m}}\text{Sn}$ | | |
| ^{40}K | ^{82}Sr | | |
| ^{85}Kr | ^{90}Sr | | |
| ^{54}Mn | ^{182}Ta | | |

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Table 2-10. Radionuclides and Chemicals Disposed of to S Plant Waste Management Units.

| INORGANIC CHEMICALS | | |
|--------------------------|------------------------|----------------------------|
| Aluminum | Krypton gas | Sodium hydroxide |
| Aluminum nitrate | Lead nitrate | Sodium metasilicate |
| Aluminum oxide | Magnesium | Sodium nitrate |
| Ammonium fluoride | Manganese dioxide | Sodium nitrite |
| Ammonium hydroxide | Mercuric nitrate | Sodium ruthenium tetroxide |
| Ammonium nitrate | Mercuric thiocyanate | Sulfamic acid |
| Ammonium oxalate | Mistron | Super Filtrol 1 |
| Anti-Foam 601 | Nitric acid | Tetrabromoethane |
| Barium | Nitric oxide | Tin |
| Boron | Nitrogen | Titanium chloride |
| Boric acid | Nitrogen dioxide | Uranyl nitrate |
| Cadmium | Nonahydrate | Uranyl nitrate hexahydrate |
| Carbon | Oxalic acid | Xenon gas |
| Ceric ammonium nitrate | Periodic acid | Zinc |
| Ceric sulfate | Potassium | Zinc amalgam |
| Chromic nitrate | Potassium dichromate | |
| Cobalt | Potassium fluoride | |
| Copper | Potassium oxalate | |
| Dibasic aluminum nitrate | Potassium permanganate | |
| Ferrous ammonium sulfate | Ruthenium tetroxide | |
| Ferrous sulfamate | Silicon | |
| Ferrous sulfate | Silicon dioxide | |
| Hydrazine | Silver iodide | |
| Hydrochloric acid | Silver nitrate | |
| Hydrofluoric acid | Sodium | |
| Hydrogen | Sodium aluminate | |
| Hydroxylamine | Sodium bismuthate | |
| Hydrochloride | Sodium carbonate | |
| Iodine gas | Sodium dichromate | |
| Iron | Sodium fluoride | |

1 Product Name
Source: WHC 1991

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3.0 SITE CONDITIONS

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

- Physiography and Topography (Section 3.1)
- Meteorology (Section 3.2)
- Surface Hydrology (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 Westinghouse Hanford (Delaney et al. 1991 and Lindsey et al. 1991) for that purpose.

3.1 PHYSIOGRAPHY AND TOPOGRAPHY

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

The physiography of the Hanford Site is dominated by the low-relief plains of the Central Plains physiographic region and anticlinal ridges of the Yakima Folds physiographic region (Figure 3-3). Surface topography seen at the Hanford Site is the result of (1) uplift of anticlinal ridges, (2) Pleistocene cataclysmic flooding, (3) Holocene eolian activity, and (4) landsliding. Uplift of the ridges began in the Miocene epoch and continues to the present. Cataclysmic flooding occurred when ice dams in western Montana and northern Idaho were breached, allowing large volumes of water to spill across eastern and central Washington. The last major flood occurred about 13,000 years ago, during the late Pleistocene Epoch.

1 Anastomosing flood channels, giant current ripples, bermounds, and giant flood bars are
2 among the landforms created by the floods. Since the end of the Pleistocene Epoch, winds
3 have locally reworked the flood sediments, depositing dune sands in the lower elevations and
4 loess (windblown silt) around the margins of the Pasco Basin. Generally, sand dunes have
5 been stabilized by anchoring vegetation except where they have been reactivated where
6 vegetation is disturbed (Figure 3-4).
7

8 A series of numbered areas have been delineated at the Hanford Site. The 100 Areas
9 are situated in the northern part of the Site adjacent to the Columbia River in an area
10 commonly called the "Horn." The elevation of the Horn is between 119 and 143 m (390 and
11 470 ft) above mean sea level (msl) with a slight increase in elevation away from the river.
12 The 200 Areas are situated on a broad flat area called the 200 Areas plateau. The 200 Areas
13 plateau is near the center of the Hanford Site at an elevation of approximately 198 to 229 m
14 (650 to 750 ft) above msl. The plateau decreases in elevation to the north, northwest, and
15 east toward the Columbia River, and plateau escarpments have elevation changes of between
16 15 to 30 m (50 to 100 ft).
17

18 The 200 West Area is situated on the 200 Areas plateau on a relatively flat prominent
19 terrace (Cold Creek Bar) formed during the late Pleistocene flooding (Figure 3-5). Cold
20 Creek Bar trends generally east to west and is essentially bisected by a flood channel that
21 trends north to south. This terrace drops off rather steeply to the north and northwest with
22 elevation changes between 15 and 30 m (50 to 100 ft).
23

24 The topography of the 200 West Area is generally flat (Figure 3-1). The elevation in
25 the vicinity of the S Plant Aggregate Area ranges from approximately 219 m (720 ft) in the
26 eastern part of the unit to about 197 m (647 ft) above msl in the western part. A detailed
27 topographic map of the area is provided as Plate 2. There are no significant natural surface
28 drainage channels within the area.
29

30 31 3.2 METEOROLOGY

32
33 The following subsections provide information on Hanford Site meteorology including
34 precipitation (Section 3.2.1), wind conditions (Section 3.2.2), and temperature variability
35 (Section 3.2.3).
36

37 The Hanford Site lies east of the Cascade Mountains and has a semiarid climate because
38 of the rainshadow effect of the mountains. The weather is monitored at the Hanford
39 Meteorology Station, located between the 200 East and 200 West Areas, and at other points
40 situated through the reservation. The following sections summarize the Hanford Site
41 meteorology.
42
43

3.2.1 Precipitation

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

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

3.2.2 Winds

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

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

3.2.3 Temperature

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

3.2.4 Atmospheric Pressure

The atmospheric pressure averages are higher in the winter than in the summer. Between 1955 and 1980, atmospheric pressures averaged highest in January at 1,020 millibar (mb) (30.13 in.) of mercury and lowest in August at 1,012 mb (29.89 in.) of mercury. A pressure drop of 2.8 mb (0.082 in.) of mercury per hour over a 6-hour period, with a maximum hourly drop of 5.4 mb (0.160 in.) of mercury was recorded on November 3, 1958 (Stone et al. 1983).

3.2.5 Sky Cover

During the period of record (1954 through 1980), there has been an average of 192 sunny days per year at the Hanford Site. The majority of the sunny days occur during the summer months.

3.3 SURFACE HYDROLOGY

3.3.1 Regional Surface Hydrology

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

Total estimated precipitation over the basin averages less than 15.8 cm/yr (6.2 in./yr). 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 acre-ft/yr), or approximately 3% of the total precipitation. The remaining precipitation is assumed to be lost through evapotranspiration with a small component (perhaps less than 1%) recharging the groundwater system (DOE 1988).

3.3.2 Surface Hydrology of the Hanford Site

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 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.

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

10
11 Approximately one-third of the Hanford Site is drained by the Yakima River system.
12 Cold Creek and its tributary, Dry Creek, are ephemeral streams on the Hanford Site that are
13 within the Yakima River drainage system. Both streams drain areas along the western part of
14 the Hanford Site and cross the southwestern part of the Site toward the Yakima River.
15 Surface flow, which may occur during spring runoff or after heavier-than-normal
16 precipitation, infiltrates and disappears into the surface sediments. Rattlesnake Springs,
17 located on the western part of the Hanford Site, forms a small surface stream that flows for
18 about 2.9 km (1.8 mi) before infiltrating into the ground.

21 3.3.3 S Plant Aggregate Area Surface Hydrology

22
23 No natural surface water bodies exist in the four operable units of the S Plant Aggregate
24 Area. There are three ditches, six ponds, four trenches, and two retention basins in the
25 S Plant Aggregate Area. The 216-S-10 Ditch is the only waste management unit, with the
26 exception of the west fork of the 216-U-9 Ditch, that remains open for surface disposal of
27 liquid waste. The south pond area of the 216-S-11 pond is being used for root penetration
28 studies. The unlined 216-S-10 Ditch has approximately 0.3 m (1 ft) of standing water in the
29 unstabilized portion. All inactive waste management units have been either stabilized or
30 backfilled.

31
32 The 200 West Area and specifically the S Plant Aggregate Area is not in a designated
33 floodplain. Calculations of probable maximum flood for the Columbia River and the Cold
34 Creek watershed indicate that the 200 West Area is not expected to be inundated under
35 maximum flood conditions (DOE/RL 1991).

38 3.4 GEOLOGY

39
40 The following subsections provide information pertaining to geologic characteristics of
41 southcentral Washington, the Hanford Site, the 200 West Area, and the S Plant Aggregate
42 Area. Topics included are the regional tectonic framework (Section 3.4.1), regional
43 stratigraphy (Section 3.4.2), and 200 West Area and S Plant Aggregate Area geology
44 (Section 3.4.3).

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

11 3.4.1 Regional Tectonic Framework

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

17 **3.4.1.1 Regional Geologic Structure.** The Columbia Plateau is a part of the North
18 American continental plate and lies in a back-arc setting east of the Cascade Range. It is
19 bounded on the north by the Okanogan Highlands, on the east by the Northern Rocky
20 Mountains and Idaho Batholith, and on the south by the High Lava Plains and Snake River
21 Plain (Figure 3-8).

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

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

41 Deformation of the Yakima folds occurred under a north-south compression and was
42 contemporaneous with the eruption of the basalt flows (Reidel 1984; Reidel et al. 1989a).
43 Deformation occurred during the eruption of the Columbia River Basalt Group and continued
44 through the Pliocene Epoch, into the Pleistocene Epoch, and perhaps to the present.
45

1 **3.4.1.2 Pasco Basin and Hanford Site Structural Geology.** The Pasco Basin, in which the
2 Hanford Site is located, is bounded on the north by the Saddle Mountains anticline, on the
3 west by the Umtanum Ridge, Yakima Ridge, and Rattlesnake Hills anticlines, and on the
4 south by the Rattlesnake Mountain anticline (Figure 3-11). The Pasco Basin is divided into
5 the Wahluke syncline on the north, and Cold Creek syncline on the south, by the Gable
6 Mountain anticline, the easternmost extension of the Umtanum Ridge anticline. The Cold
7 Creek syncline is bounded on the south by the Yakima Ridge anticline. Both the Cold Creek
8 and Wahluke synclines are asymmetric and relatively flat-bottomed structures. The north
9 limbs of both synclines dip gently (approximately 5°) to the south and the south limbs dip
10 steeply to the north. The deepest parts of the Cold Creek syncline, the Wye Barricade
11 depression, and the Cold Creek depression are approximately 12 km (7.5 mi) southeast of the
12 Hanford Site 200 Areas, and just to the west-southwest of the 200 West Area, respectively.
13 The deepest part of the Wahluke syncline lies just north of Gable Gap.
14

15 The 200 West Area is situated on the generally southward dipping north limb of the
16 Cold Creek syncline 1 to 5 km (0.6 to 3 mi) north of the syncline axis. The Gable Mountain-
17 Gable Butte segment of the Umtanum Ridge anticline lies approximately 4 km (2.5 mi) north
18 of the 200 West Area. The axes of the anticline and syncline are separated by a distance of 9
19 to 10 km (5.6 to 6.2 mi) and the crest of the anticline (as now exposed) is over 200 m
20 (656 ft) higher than the uppermost basalt layer in the syncline axis. As a result, the basalts
21 and overlying sediments dip to the south and southwest beneath the 200 West Area.
22

23 **3.4.1.3 Regional and Hanford Site Seismology.** Eastern Washington, especially the
24 Columbia Plateau region, is a seismically inactive area when compared to the rest of the
25 western United States (DOE 1988). The historic seismic record for eastern Washington began
26 in approximately 1850, and no earthquakes large enough to be felt had epicenters on the
27 Hanford Site. The closest regions of historic moderate-to-large earthquake generation are in
28 western Washington and Oregon and western Montana and eastern Idaho. The most
29 significant event relative to the Hanford Site is the 1936 Milton-Freewater, Oregon,
30 earthquake that had a magnitude of 5.75 and that occurred more than 90 km (54 mi) away.
31 The largest Modified Mercalli Intensity for this event was felt about 105 km (63 mi) from the
32 Hanford Site at Walla Walla, Washington, and was VII.
33

34 Geologic evidence of past moderate or possibly large earthquake activity is shown by the
35 anticlinal folds and faulting associated with Rattlesnake Mountain, Saddle Mountain, and
36 Gable Mountain. The currently recorded seismic activity related to these structures consists
37 of micro-size earthquakes. The suggested recurrence rates of moderate and larger-size
38 earthquakes on and near the Hanford Site are measured in geologic time (tens of thousands of
39 years).
40
41

3.4.2 Regional Stratigraphy

The following subsections summarize regional stratigraphic characteristics of the Columbia River Basalt and Suprabasalt sediments. Specific references to the Hanford Site and 200 West Area are made where applicable to describe the general occurrence of these units within the Pasco Basin.

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

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

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

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

Columbia River basalt flows were erupted from north-northwest-trending fissures of linear vent systems in north-central and northeastern Oregon, eastern Washington, and western Idaho (Swanson et al. 1979). The Columbia River Basalt Group is formally divided into five formations (from oldest to youngest): Imnaha Basalt, Picture Gorge Basalt, Grande Ronde

1 Basalt, Wanapum Basalt, and Saddle Mountains Basalt. Of these, only the Picture Gorge
 2 Basalt is not known to be present in the Pasco Basin. The Saddle Mountains Basalt, divided
 3 into the Ice Harbor, Elephant Mountain, Pomona, Esquatzel, Asotin, Wilbur Creek and
 4 Umatilla members (Figure 3-12), forms the uppermost basalt unit throughout most of the
 5 Pasco Basin. The Elephant Mountain member is the uppermost unit beneath most of the
 6 Hanford Site except near the 300 Area where the Ice Harbor member is found and north of
 7 the 200 Areas where the Saddle Mountains Basalt has been eroded down to the Umatilla
 8 member locally. On anticlinal ridges bounding the Pasco Basin, erosion has removed the
 9 Saddle Mountains Basalt, exposing the Wanapum and Grande Ronde Basalts.

10
 11 **3.4.2.2 Ellensburg Formation.** The Ellensburg Formation consists of all sedimentary units
 12 that occur between the basalt flows of the Columbia River Basalt Group in the central
 13 Columbia Basin. The Ellensburg Formation generally displays two main lithologies:
 14 volcanics, and siliciclastics. The volcanics consist mainly of primary pyroclastic air
 15 fall deposits and reworked epiclastics derived from volcanic terrains west of the Columbia
 16 Plateau. Siliciclastic strata in the Ellensburg Formation consists of clastic, plutonic, and
 17 metamorphic detritus derived from the Rocky Mountain terrain. These two lithologies occur
 18 as both distinct and mixed in the Pasco Basin. A detailed discussion of the
 19 Ellensburg Formation in the Hanford Site is given by Reidel and Fecht (1981). Smith et al.
 20 (1989) provides a discussion of age equivalent units adjacent to the Columbia Plateau.

21
 22 The stratigraphic names for individual units of the Ellensburg Formation are given in
 23 Figure 3-12. The nomenclature for these units is based on the upper- and lower- bounding
 24 basalt flows and thus the names are valid only for those areas where the bounding basalt
 25 flows occur. Because the Pasco Basin is an area where most bounding flows occur, the
 26 names given in Figure 3-12 are applicable to the Hanford Site. At the Hanford Site the three
 27 uppermost units of the Ellensburg Formation are the Selah interbed, the Rattlesnake Ridge
 28 interbed, and the Levey interbed.

29
 30 **3.4.2.2.1 Selah Interbed.** The Selah interbed is bounded on the top by the Pomona
 31 member and on the bottom by the Esquatzel member. The interbed is a variable mixture of
 32 silty to sandy vitric tuff, arkosic sands, tuffaceous clays, and locally thin stringers of
 33 predominantly basaltic gravels. The Selah interbed is found beneath most of the Hanford
 34 Site.

35
 36 **3.4.2.2.2 Rattlesnake Ridge Interbed.** The Rattlesnake Ridge interbed is bounded on
 37 the top of the Elephant Mountain member and on the bottom by the Pomona member. The
 38 interbed is up to 33 m (108 ft) thick and dominated by three facies at the Hanford Site: 1) a
 39 lower clay or tuffaceous sandstone, 2) a middle, micaceous-arkosic and/or tuffaceous
 40 sandstone, and 3) an upper, tuffaceous siltstone to sandstone. The unit is found beneath most
 41 of the Hanford Site.

42
 43 **3.4.2.2.3 Levey Interbed.** The Levey interbed is the uppermost unit of the Ellensburg
 44 Formation and occurs between the Ice Harbor member and the Elephant Mountain member.
 45 It is confined to the vicinity of the 300 Area. The Levey interbed is a tuffaceous sandstone

1 along its northern edge and a fine-grained tuffaceous siltstone to sandstone along its western
2 and southern margins.

3
4 **3.4.2.3 Ringold Formation.** The Ringold Formation at the Hanford Site is up to 185 m
5 (607 ft) thick in the deepest part of the Cold Creek syncline south of the 200 West Area and
6 170 m (558 ft) thick in the western Wahluke syncline near the 100-B Area. The Ringold
7 Formation pinches out against the Gable Mountain, Yakima Ridge, Saddle Mountains, and
8 Rattlesnake Mountain anticlines. It is largely absent in the northern and northeastern parts of
9 the 200 East Area and adjacent areas to the north in the vicinity of West Pond. The Ringold
10 Formation is assigned a late Miocene to Pliocene age (Fecht et al. 1987; DOE 1988).

11
12 Recent studies of the Ringold Formation (Lindsey and Gaylord 1989) indicate that it is
13 best described and divided on the basis of sediment facies associations and their distribution.
14 Facies associations in the Ringold Formation (defined on the basis of lithology, petrology,
15 stratification, and pedogenic alteration) include fluvial gravel, fluvial sand, overbank deposits,
16 lacustrine deposits, and alluvial fan. The facies associations are summarized as follows:

- 17
18 • Fluvial gravel - Clast-supported granule to cobble gravel with a sandy matrix
19 dominates the association. Intercalated sands and muds also are found. Clast
20 composition is very variable, with common types being basalt, quartzite,
21 porphyritic volcanics, and greenstones. Silicic plutonic rocks, gneisses, and
22 volcanic breccias also are found. Sands in this association are generally quartzo-
23 feldspathic, with basalt contents generally in the range of 5 to 15%. However,
24 basalt contents as high as 25% (or locally more) are encountered. Low angle to
25 planar stratification, massive channels, and large-scale cross-bedding are found in
26 outcrops. The association was deposited in a gravelly fluvial system characterized
27 by wide, shallow shifting channels.
- 28
29 • Fluvial sand - Quartzo-feldspathic sands displaying cross-bedding and cross-
30 lamination in outcrop dominate this association. These sands usually contain less
31 than 15% basalt. Intercalated strata consist of lenticular silty sands and clays up
32 to 3 m (10 ft) thick and thin (<0.5 m) gravels. Fining upwards sequences less
33 than 1 m (3.3 ft) to several meters thick are common in the association. Strata
34 comprising the association were deposited in wide, shallow channels incised into a
35 muddy floodplain.
- 36
37 • Overbank - This association dominantly consists of laminated to massive silt, silty
38 fine-grained sand, and paleosols containing variable amounts of calcium carbonate.
39 These sediments record deposition in a floodplain under proximal levee to more
40 distal floodplain conditions.
- 41
42 • Lacustrine - Plane laminated to massive clay with thin silt and silty sand interbeds
43 displaying some soft-sediment deformation characterize this association.
44 Coarsening upwards packages less than 1 m (3.3 ft) to 10 m (33 ft) thick are

1 common in the association. Strata comprising the association were deposited in a
2 lake under standing water to deltaic conditions.
3

- 4 • Alluvial fan - Massive to crudely stratified, weathered to unweathered basaltic
5 detritus dominates this association. This association was deposited largely by
6 debris flows in alluvial fan settings.
7

8 The lower half of the Ringold Formation contains five separate stratigraphic intervals
9 dominated by fluvial gravels. These gravels, designated units, A, B, C, D, and E
10 (Figure 3-13), are separated by intervals containing deposits typical of the overbank and
11 lacustrine facies associations. The lowermost of the fine-grained sequences, overlying unit A,
12 is designated the lower mud sequence. The uppermost gravel unit, unit E, grades upwards
13 into interbedded fluvial sand and overbank deposits. These sands and overbank deposits are
14 overlain by lacustrine-dominated strata.
15

16 Fluvial gravel units A and E correspond to the lower basal and middle Ringold units
17 respectively as defined by DOE (1988). Gravel units B, C, and D do not correlate to any
18 previously defined units. The lower mud sequence corresponds to the upper basal and lower
19 units as defined by DOE (1988). The upper basal and lower units are not differentiated. The
20 sequence of fluvial sands, overbank deposits, and lacustrine sediments overlying unit E
21 corresponds to the upper unit as seen along the White Bluffs in the eastern Pasco Basin. This
22 essentially is the same usage as originally proposed by Newcomb (1958) and Myers et al.
23 (1979).
24

25 **3.4.2.4 Plio-Pleistocene Unit.** Unconformably overlying the Ringold Formation in the
26 western Cold Creek syncline in the vicinity of 200 West Area (Figures 3-11, 3-12, and 3-13)
27 is the laterally discontinuous Plio-Pleistocene unit (DOE 1988). The unit is up to 25 m
28 (82 ft) thick and divided into two facies: (1) basaltic detritus and (2) calcic paleosol
29 (Stage III and Stage IV) (DOE 1988). The calcrete facies generally consists of interfingering
30 calcium carbonate-cemented silt, sand, gravel, and carbonate-poor silt and sand. The basaltic
31 detritus facies consists of weathered and unweathered basaltic gravels deposited as locally
32 derived slope wash, colluvium, and sidestream alluvium. The Plio-Pleistocene unit appears to
33 be correlative to other sidestream alluvial and pedogenic deposits found near the base of the
34 ridges bounding the Pasco Basin on the north, west, and south. These sidestream alluvial and
35 pedogenic deposits are inferred to have a late Pliocene to early Pleistocene age on the basis of
36 stratigraphic position and magnetic polarity of interfingering loess units.
37

38 **3.4.2.5 Pre-Missoula Gravels.** Quartzose to gneissic clast-supported pebble to cobble gravel
39 with a quartzo-feldspathic sand matrix underlies the Hanford formation in the east-central
40 Cold Creek syncline and at the east end of Gable Mountain anticline east and south of the
41 200 East Area (Figures 3-11, 3-12, and 3-13). These gravels, called the pre-Missoula gravels
42 (PSPL 1982), are up to 25 m (82 ft) thick, contain less basalt than underlying Ringold gravels
43 and overlying Hanford deposits, have a distinctive white or bleached color, and sharply
44 truncate underlying strata. The nature of the contact between the pre-Missoula gravels and
45 the overlying Hanford formation is not clear. In addition, it is unclear whether the pre-
46 Missoula gravels overlie or interfinger with the early "Palouse" soil and Plio-Pleistocene unit.

1 Magnetic polarity data indicates the unit is no younger than early Pleistocene in age (>1 Ma)
2 (Bjornstad et al. 1987).

3
4 **3.4.2.6 Early "Palouse" Soil.** The early "Palouse" soil consists of up to 20 m (66 ft) of
5 massive, brown yellow, and compact, loess-like silt and minor fine-grained sand (Tallman
6 et al. 1981; Bjornstad 1984; DOE 1988). These deposits overlie the Plio-Pleistocene unit in
7 the western Cold Creek syncline around the 200 West Area (Figures 3-11, 3-12, and 3-13).
8 The unit is differentiated from overlying graded rhythmites (Hanford formation) by greater
9 calcium carbonate content, massive structure in core, and high natural gamma response in
10 geophysical logs (Bjornstad 1984; DOE 1988). The upper contact of the unit is poorly
11 defined, and it may grade up-section into the lower part of the Hanford formation. Based on
12 a predominantly reversed polarity the unit is inferred to be early Pleistocene in age.

13
14 **3.4.2.7 Hanford Formation.** The Hanford formation consists of pebble to boulder gravel,
15 fine- to coarse-grained sand, and silt. These deposits are divided into three facies: 1) gravel-
16 dominated, 2) sand-dominated, and 3) slackwater or normally graded rhythmite. The
17 slackwater deposits also are referred to as the "Touchet Beds," while the gravelly facies are
18 generally referred to as the Pasco Gravels. The Hanford formation is thickest in the Cold
19 Creek bar in the vicinity of 200 West and 200 East Areas where it is up to 65 m (213 ft)
20 thick (Figures 3-11, 3-12, and 3-13). Hanford deposits are absent on ridges above
21 approximately 385 m (1,263 ft) above sea level. The following subsections describe the three
22 Hanford formation facies.

23
24 **3.4.2.7.1 Gravel Dominated Facies.** The gravel-dominated facies is dominated by
25 coarse-grained sand and granule to boulder gravel. These deposits display massive bedding,
26 plane to low-angle bedding, and large-scale cross-bedding in outcrop, while the gravels
27 generally are matrix-poor and display an open-framework texture. Lenticular sand and silt
28 beds are intercalated throughout the facies. Gravel clasts in the facies generally are
29 dominated by basalt (50 to 80%). Other clast types include Ringold and Plio-Pleistocene rip-
30 ups, granite, quartzite, and gneiss clasts. The relative proportion of gneissic and granitic
31 clasts in Hanford gravels versus Ringold gravels generally is higher (up to 20% as compared
32 to less than 5%). Sands in this facies usually are very basaltic (up to 90%), especially in the
33 granule size range. Locally Ringold and Plio-Pleistocene rip-up clasts dominate the facies
34 comprising up to 75% of the deposit. The gravel facies dominates the Hanford formation in
35 the 100 Areas north of Gable Mountain, the northern part of 200 East Area, and the eastern
36 part of the Hanford Site including the 300 Area. The gravel-dominated facies was deposited
37 by high-energy flood waters in or immediately adjacent to the main cataclysmic flood
38 channelways.

39
40 **3.4.2.7.2 Sand-Dominated Facies.** The sand-dominated facies consists of fine-grained
41 to granular sand displaying plane lamination and bedding and less commonly plane cross-
42 bedding in outcrop. These sands may contain small pebbles in addition to pebble-gravel
43 interbeds and silty interbeds less than 1 m (3.3 ft) thick. The silt content of these sands is
44 variable, but where it is low an open framework texture is common. These sands are
45 typically very basaltic, commonly being referred to as black or gray or salt and pepper sands.
46 This facies is most common in the central Cold Creek syncline, in the central to southern

1 parts of the 200 East and 200 West Areas, and in the vicinity of the WPPSS facilities. The
2 laminated sand facies was deposited adjacent to main flood channelways as water in the
3 channelways spilled out of them, losing their competence. The facies varied between gravel-
4 dominated facies and rhythmite facies.

5
6 **3.4.2.7.3 Slackwater Facies.** The slackwater facies consists of thinly bedded, plane
7 laminated and ripple cross-laminated silt and fine- to coarse-grained sand that commonly
8 display normally graded rhythmites a few centimeters to several tens of centimeters thick in
9 outcrop (Myers et al. 1979; DOE 1988). This facies is found throughout the central,
10 southern, and western Cold Creek syncline within and south of 200 East and West Areas.
11 These sediments were deposited under slackwater conditions and in backflooded areas (DOE
12 1988).

13
14 **3.4.2.8 Holocene Surficial Deposits.** Holocene surficial deposits consist of silt, sand, and
15 gravel that form a thin (<10 m, 33 ft) veneer across much of the Hanford Site. These
16 sediments were deposited by a mix of eolian and alluvial processes.

17 18 19 **3.4.3 200 West Area and S Plant Aggregate Area Geology**

20
21 The following subsections describe the occurrence of the uppermost basalt unit and the
22 suprabasalt sediments in the 200 West Area. The subsection discusses notable stratigraphic
23 characteristics, thickness variations, and the geometric relationships of the sediments.
24 Stratigraphic variations pertinent to the S Plant Aggregate Area are presented in the overall
25 context of stratigraphic trends throughout the 200 West Area.

26
27 Geologic cross-sections depicting the distribution of basalt and sedimentary units within
28 and near the S Plant Aggregate Area are presented in Figures 3-14 through 3-19. Figure 3-14
29 illustrates the cross-sections locations. A legend for symbols used on the cross-sections is
30 provided in Figure 3-15. The cross-sections are based on geologic information from wells
31 shown in the figures, as interpreted in Lindsey et al. (1991). To develop these stratigraphic
32 interpretations, logs for all the wells in the S Plant Aggregate Area were reviewed and a
33 selection was made of the most relevant to the Aggregate Area. Chamness et al. (1991)
34 provide a compilation of these ten geologic logs from the S Plant Aggregate Area, and a
35 listing of other logs which are available and additional geological, geochemical, and
36 geophysical data available from these and other boreholes. This information was compiled in
37 support of the S Plant Aggregate Area Management Study. The cross sections depict
38 subsurface geology in the S Plant Aggregate Area. For each cross-section, locations of
39 S Plant Aggregate Area waste management units are identified for reference. Figures 3-20
40 through 3-38 present structure maps of the top of the sedimentary units, and isopach maps
41 illustrating the thickness of each unit in the 200 West Area and S Plant Aggregate Area. The
42 structure and isopach maps are included from Lindsey et al. (1991). Plate 1 should be
43 consulted to identify locations of S Plant Aggregate Area buildings and waste management
44 units referenced in the text.
45

1 **3.4.3.1 Elephant Mountain Basalt.** The Elephant Mountain member of the Saddle
2 Mountains Basalt is continuous beneath the entire 200 West Area. The top of the Elephant
3 Mountain member dips to the southwest and south into the Cold Creek syncline, reflecting the
4 structure of the area (Figure 3-20). There is little evidence of significant erosion into the top
5 of the Elephant Mountain member and no indication of scours through the basalt into the
6 underlying Rattlesnake Mountain interbed.
7

8 **3.4.3.2 Ringold Formation.** Within the 200 West Area, the Ringold Formation includes the
9 fluvial gravels of unit A, the paleosol and lacustrine muds of the lower mud sequence, the
10 fluvial gravels of unit E, and the sands and minor muds of the upper unit. Ringold units B,
11 C, and D are not found in the immediate vicinity of the 200 West Area.
12

13 Several observations can be made regarding the variation of sediment types within the
14 Ringold units in the 200 West Area. In the Ringold unit A gravels, intercalated lenticular
15 sand and silt are most common in the western portion and in the southern part of the
16 200 West Area. In the overlying lower mud sequence, stratigraphic trends seen elsewhere in
17 the Pasco Basin suggest that paleosols in the unit become more common progressing
18 structurally up-dip (Lindsey et al. 1991). In the Ringold unit E gravels, intercalated lenticular
19 beds of sand and silt occur throughout the 200 West Area, although predicting where they
20 will occur is difficult. The upper unit of the Ringold in the 200 West Area tends to be
-21 dominated by sand, unlike the upper unit elsewhere in the Pasco Basin where paleosols tend
22 to dominate the upper unit.
23

24 Beneath the 200 West Area, the fluvial gravels of Ringold unit A, and the Ringold
25 lower mud sequence tend to thicken and dip to the south-southwest, toward the axis of the
26 Cold Creek Syncline (Figures 3-16 and 3-21 through 3-24). The top of unit A is relatively
27 flat in the 200 Area, dipping gently to the west and southwest. Like the unit A gravels, the
28 Ringold lower mud sequence thickens and dips to the south and southeast over the 200 West
29 Area (Figures 3-21 and 3-23). The top of the lower mud unit is less regular, however, and
30 the unit pinches out in the northeastern corner of the 200 West Area. Within the S Plant
31 Aggregate Area, unit A thins in the east and northeast (Figures 3-17, 3-21, and 3-23). The
32 top of the unit is a relatively flat surface (Figures 3-20 and 3-22). The overbank and
33 lacustrine deposits of the lower mud sequence also thicken and dip to the south and
34 southwest. The lower mud unit shows a depression in the northern part of the S Plant
35 Aggregate Area.
36

37 Isopach and structure contour maps of fluvial gravel unit E (Figures 3-25 and 3-26) and
38 the upper unit (Figures 3-27 and 3-28) show trends not seen in the underlying unit A and the
39 lower mud sequence. The gravels of unit E generally thin from north-northwest to the east-
40 southeast. The top of the unit is irregular, displaying several highs in the northern and
41 southern parts of the area and several lows in the central part of the 200 West Area including
42 a depression in the northern part of the S Plant Aggregate Area. The top of unit E generally
43 dips to the southeast and climbs to the northeast. Intercalated lenticular beds of sand and silt
44 occur throughout the 200 West Area, although predicting where they will occur is very
45 difficult. The gravels of unit E are thinnest in the southern area of the S Plant Aggregate

1 Area. Unit E gravels vary in thickness from 31 m (100 ft) in the southeastern corner to over
2 88 m (285 ft) in the northern part of the aggregate area.
3

4 The upper unit of the Ringold Formation is present only in the western, northern, and
5 central portion of the 200 West Area (Figures 3-27 and 3-28). Where the upper unit is
6 present, the top generally dips to the south-southwest. The upper unit is completely absent in
7 the S Plant Aggregate Area.
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 north, east, and west
11 boundaries of the area (Figures 3-16 through 3-19, 2-29, and 3-30). The westernmost extent
12 of the unit is not clear, although it seems to extend west and northwest of the 200 West Area.
13 Thickness variations in the unit are very irregular. It is thickest in the southeast, southwest,
14 and northcentral parts of the area while it thins in the south-central and central parts of the
15 area. It pinches out on a diagonal from northwest to southeast in the S Plant Aggregate Area.
16 Although no scours through the units were found, there is a good possibility they exist,
17 especially in the areas where the unit thins and depressions exist. In addition, fracturing in
18 the carbonate is potentially common and interbedded carbonate-poor lithologies are found at
19 many locations. The top of the unit generally dips to the south and southwest although
20 irregularities occur, especially in the center of the 200 West Area. The unit pinches out in
21 the southern part and may also in the northcentral part of the S Plant Aggregate Area
22 (Figure 3-29).
23

24 **3.4.3.4 Early "Palouse" Soil.** Like the Plio-Pleistocene unit, the early "Palouse" soil is
25 largely restricted to the vicinity of the 200 West Area (Figures 3-16 through 3-19, 3-31, and
26 3-32). The unit pinches out in the west-central part of the 200 West Area and near the
27 southern, eastern, and northern boundaries. The thickness of the unit varies irregularly. It is
28 thickest in the south, southeast, and central parts of the 200 West Area. The unit is thinnest
29 immediately adjacent to these thicker intervals, and at one location in the central part of the
30 200 West Area it appears to pinch out. Generally, the top of the unit dips to the south
31 although it becomes fairly irregular in the southern half of the area. The unit pinches out
32 through the center of the S Plant Aggregate Area and is thickest in the northeast and
33 northwest sections of the area ranging from approximately 12 m (40 ft) in the northeast to
34 approximately 15 m (50 ft) (Figures 3-31 and 3-32).
35

36 **3.4.3.5 Hanford Formation.** As discussed in the regional geology section, the cataclysmic
37 flood deposits of the Hanford formation are divided into three facies, gravel-dominated, sand-
38 dominated, and slackwater. Typical lithologic successions consist of fining upwards
39 packages, major fine-grained intervals, and laterally persistent coarse-grained sequences.
40 Mineralogic and geochemical data were not used in differentiating units because of the lack
41 of a comprehensive mineralogic and geochemical data set. The Hanford formation is divided
42 into two units, upper coarse-grained and lower fine-grained, based on lithology. These are
43 essentially the same units as defined in Last et al. (1989). Neither of these units are
44 continuous across the entire 200 West Area, they both display marked changes in thickness
45 and continuity, and they are very heterogeneous.
46

1 The lower fine-grained unit of the Hanford formation in the 200 West Area is thick, but
2 locally discontinuous (Figures 3-16 through 3-19, and 3-33, through 3-35). The lower unit is
3 0 to 32 m (0 to 105 ft) thick and consists dominantly of silt, silty sand, and sand typical of
4 the slackwater facies interbedded with coarser sands like those comprising the sand-dominated
5 facies. This lower unit is cross-cut in places by vertical clastic dikes. These dikes, believed
6 to be the product of dynamic loading from floodwaters, are distributed randomly throughout
7 this lower unit. They are commonly filled with fine sands and silts and oriented near vertical.
8 Thin (<3 m, 10 ft) intervals dominated by the gravel facies are found locally. The
9 distribution of facies within the unit is variable, although the unit generally fines to the south
10 where slackwater deposits become more common. The lower unit is not found in the
11 northern part of the 200 West Area and it generally thickens to the south. Scours through the
12 unit are found, most notably in the central part of the 200 West Area. These erosional
13 windows are elongated in a north-south direction. The unit appears thickest in the S Plant
14 Aggregate Area in the southeast and thins to the northwest attaining a maximum thickness of
15 75 m (245 ft) in the southeast and 18 m (60 ft) in the northwest (Figure 3-33).

16
17 The upper coarse-grained unit of the Hanford formation consists of interstratified gravel,
18 sand, and lesser silt (Figures 3-16 through 3-19, 3-36, and 3-37). Gravel-dominated deposits
19 typical of the gravel facies generally dominate the upper unit. However, at some localities
20 the unit is dominated by deposits typical of the sand-dominated facies that consists of sand
21 containing lesser silt and gravel. Minor silty deposits such as those forming the slackwater
22 facies are found locally. The thickness and distribution of these facies is very variable.
23 Fining upwards sequences going from coarser to finer gravel and gravel, sand and/or silt are
24 present at some locations. The upper coarse unit is up to 45 m (148 ft) thick and laterally
25 discontinuous, being found in the northern part of the area (Figure 3-36). The base of the
26 unit is incised into the underlying strata of the lower fine unit and where that unit is absent,
27 the upper coarse unit fills an erosional window. The contact between the upper coarse unit
28 and underlying strata is generally sharp, consisting of gravel facies strata overlying the fines
29 of the lower unit, the early Palouse soil, and the Plio-Pleistocene unit. The unit is
30 discontinuous in the S Plant Aggregate Area, being thickest in the north section 23 m (76 ft)
31 and pinching out to the south (Figure 3-36).

32
33 **3.4.3.6 Holocene Surficial Deposits.** Holocene-age surficial deposits in the 200 West Area
34 are dominated by eolian sands. These deposits have been removed from much of the area by
35 construction activities. Where the eolian sands are found they tend to consist of
36 thin (<3 m, 10 ft) sheets that cover the ground (Figure 3-38). Dunes are not generally well
37 developed within the 200 West Area, but two dunes existed in the northeastern part of the
38 S Plant Aggregate Area.
39
40
41

1 **3.5 HYDROGEOLOGY**
2

3 The following subsections present discussions of Pasco Basin hydrogeology (Section
4 3.5.1), Hanford Site hydrogeology (Section 3.5.2), and S Plant Aggregate Area hydrogeology
5 (Section 3.5.3). Sections 3.5.2 and 3.5.3 also discuss Hanford Site and S Plant Aggregate
6 Area vadose zone characteristics.
7

8
9 **3.5.1 Pasco Basin Hydrogeology**
10

11 The hydrogeology of the Pasco Basin is characterized by a multiaquifer system that
12 consists of four hydrogeological units that correspond to the upper three formations of the
13 Columbia River Basalt Group (Grande Ronde Basalt, Wanapum Basalt, and Saddle Mountains
14 Basalt) and the suprabasalt sediments. The basalt aquifers consist of the tholeiitic flood
15 basalts of the Columbia River Basalt Group and relatively minor amounts of intercalated
16 fluvial and volcanoclastic sediments of the Ellensburg Formation. Confined zones in the
17 basalt aquifers are present in the sedimentary interbeds and/or interflow zones that occur
18 between dense basalt flows. The main water-bearing portions of the interflow zones are
19 networks of interconnecting vesicles and fractures of the flow tops and flow bottoms (DOE
20 1988). The suprabasalt sediment or uppermost aquifer system consists of fluvial, lacustrine,
21 and glaciofluvial sediments. This aquifer is regionally unconfined and is contained largely
22 within the Ringold Formation and Hanford formation. The position of the water table in the
23 southwestern Pasco Basin is generally within Ringold fluvial gravels of unit E. In the
24 northern and eastern Pasco Basin the water table is generally within the Hanford formation.
25 Table 3-1 presents hydraulic parameters for various water-bearing geologic units at the
26 Hanford Site.
27

28 Local recharge to the shallow basalt aquifers results from infiltration of precipitation
29 and runoff along the margins of the Pasco Basin, and in areas of artificial recharge where a
30 downward gradient from the unconfined aquifer systems to the uppermost confined basalt
31 aquifer may occur. Regional recharge of the deep basalt aquifers is inferred to result from
32 interbasin groundwater movement originating northeast and northwest of the Pasco Basin in
33 areas where the Wanapum and Grande Ronde Basalts crop out extensively (DOE 1988).
34 Groundwater discharge from shallow basalt aquifers is probably to the overlying aquifers and
35 to the Columbia River. The discharge area(s) for the deeper groundwater system is uncertain,
36 but flow is inferred to be generally southeastward with discharge thought to be south of the
37 Hanford Site (DOE 1988).
38

39 Scours through dense basalt flow interiors allow direct interconnection between the
40 uppermost aquifer systems and underlying confined basalt aquifers. Graham et al. (1984)
41 reported that some contamination was present in the uppermost confined aquifer (Rattlesnake
42 Ridge interbed) south and east of Gable Mountain Pond. Graham et al. (1984) evaluated the
43 hydrologic relationships between the Rattlesnake Ridge interbed aquifer and the unconfined
44 aquifer in this area and delineated a potential area of intercommunication beneath the
45 northeast portion of the 200 East Area.
46

1 The base of the uppermost aquifer system is defined as the top of the uppermost basalt
2 flow. However, fine-grained overbank and lacustrine deposits in the Ringold Formation
3 locally form confining layers for Ringold fluvial gravels underlying unit E. The uppermost
4 aquifer system is bounded laterally by anticlinal basalt ridges and is approximately 152 m
5 (500 ft) thick near the center of the Pasco Basin.
6

7 Sources of natural recharge to the uppermost aquifer system are rainfall and runoff from
8 the higher bordering elevations, water infiltrating from small ephemeral streams, and river
9 water along influent reaches of the Yakima and Columbia Rivers. The movement of
10 precipitation through the unsaturated (vadose) zone has been studied at several locations on
11 the Hanford Site (Gee 1987; Routson and Johnson 1990; Rockhold et al. 1990). Conclusions
12 from these studies vary. Gee (1987) and Routson and Johnson (1990) conclude that no
13 downward percolation of precipitation occurs on the 200 Areas Plateau where the sediments
14 are layered and vary in texture, and that all moisture penetrating the soil is removed by
15 evapotranspiration. Rockhold et al. (1990) suggest that downward water movement below the
16 root zone is common in the 300 Area, where soils are coarse-textured and precipitation was
17 above normal.
18

19 20 **3.5.2 Hanford Site Hydrogeology**

21
22 This section describes the hydrogeology of the Hanford Site with specific reference to
23 the 200 Areas.
24

25 **3.5.2.1 Hydrostratigraphy.** The hydrostratigraphic units of concern in the 200 Areas are 1)
26 the Rattlesnake Ridge interbed (confined water-bearing zone), 2) the Elephant Mountain
27 Basalt member (confining horizon), 3) the Ringold Formation (unconfined and confined
28 water-bearing zones and lower part of the vadose zone), 4) the Plio-Pleistocene unit and early
29 "Palouse" soil (primary vadose zone perching horizons and/or perched groundwater zones)
30 and 5) the Hanford formation (vadose zone) (Figure 3-39). The Plio-Pleistocene unit and
31 early "Palouse" soil are only encountered in the 200 West Area. Strata below the Rattlesnake
32 Ridge interbed are not discussed because the more significant water-bearing intervals, relating
33 to environmental issues, are primarily closer to ground surface. The hydrogeologic
34 designations for the 200 Areas were determined by examination of borehole logs and
35 integration of these data with stratigraphic correlations from existing reports.
36

37 **3.5.2.1.1 Vadose Zone.** The vadose zone beneath the 200 Areas ranges from
38 approximately 55 m (180 ft) beneath the former U Pond to approximately 104 m (340 ft)
39 west of the 200 East Area (Last et al. 1989). Sediments in the vadose zone consist of the
40 1) fluvial gravel of Ringold unit E, 2) the upper unit of the Ringold Formation, 3) Plio-
41 Pleistocene unit, 4) early "Palouse" soil, and 5) Hanford formation. Only the Hanford
42 formation is continuous throughout the vadose zone in the 200 Areas. The upper unit of the
43 Ringold Formation, the Plio-Pleistocene unit, and the early "Palouse" soil only occur in the
44 200 West Area. The unconfined aquifer water table (discussed in Section 3.5.2.1.3) lies
45 within the Ringold unit E.
46

1 The transport of water through the vadose zone depends in complex ways on several
2 factors, including most significantly the moisture content of the soils and their hydraulic
3 properties. Darcy's law, although originally conceived for saturated flow only, was extended
4 by Richards to unsaturated flow, with the provisions that the soil hydraulic conductivity
5 becomes a function of the water content of the soil and the driving force is predominantly
6 differences in moisture level. The moisture flux, q , in cm/s in one direction is then described
7 by a modified form of Darcy's law commonly referred to as Richards' Equation (Hillel 1971)
8 as follows:

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

9
10
11 where

- 12 • $K(\theta)$ is the water-content-dependent unsaturated hydraulic conductivity in cm/s
- 13 • $\frac{\partial \phi}{\partial \theta}$ is the slope of the soil-moisture retention curve $\phi(\theta)$ at a particular
14 volumetric moisture content θ (a soil-moisture retention curve plots volumetric
15 moisture content observed in the field or laboratory against suction values for a
16 particular soil, see Figure 3-38 from Gee and Heller, 1985 for an example)
- 17 • $\frac{\partial \theta}{\partial x}$ is the water content gradient in the x direction.

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

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

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

36 Thirty-five soil samples from the 200 West Area have had moisture retention data
37 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 Bjornstad
2 (1990). The remaining 24 were analyzed as part of an ongoing performance assessment of
3 the low-level burial grounds. For each of these samples saturated hydraulic conductivity was
4 measured in the laboratory. Van Genuchten's computer program RETC was then used to
5 develop wetting and drying curves for the Hanford, early "Palouse," Plio-Pleistocene, upper
6 Ringold, and Ringold Gravel lithologic units. An example of the wetting and drying curves,
7 and corresponding grain size distributions, is provided on Figure 3-40.
8

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

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

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

38 An example of the potential use of this vadose zone hydraulic parameter information is
39 presented by Smoot et al. (1989) in which precipitation infiltration and subsequent
40 contaminant plume movement near a prototype single-shell tank was evaluated using a
41 numerical computer code. Smoot et al. (1989) used the UNSAT-H one-dimensional finite-
42 difference unsaturated zone water flow computer code to predict the precipitation infiltration
43 for several different soil horizon combinations and characteristics. The researchers used
44 statistically generated precipitation values which were based on actual daily precipitation
45 values recorded at the Hanford Site between 1947 and 1989 to simulate precipitation
46 infiltration from January 1947 to December 2020. The same authors also used the

1 PORFLO-3 computer code to simulate ^{106}Ru and ^{137}Cs movement through the unsaturated
2 zone.
3

4 Smoot et al. (1989) concluded that 68 to 86% of the annual precipitation infiltrated into
5 a gravel-capped soil column while less than 1% of the annual precipitation infiltrated into a
6 silt loam-capped soil column. For the gravel-capped soil column, the simulations showed the
7 ^{106}Ru plume approaching the water table after 10 years of simulated precipitation infiltration.
8 The simulated ^{137}Cs plume migrated a substantially shorter distance due to greater adsorption
9 on soil particles. In both cases, the simulated plume migration scenarios are considered to be
10 conservative due to the relatively soil absorption coefficients used.
11

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

20 Another facet of moisture migration in the vadose zone is moisture retention above the
21 water table. Largely because of capillary forces, some portion of the moisture percolating
22 down from the ground surface to the unconfined aquifer will be held against gravity in soil
23 pore space. Finer-grained soils retain more water (against the force of gravity) on a
24 volumetric basis than coarse-grained soils (Hillel 1971). Because unsaturated hydraulic
25 conductivity increases with increasing moisture content, finer-grained soils may be more
26 permeable than coarse-grained soils at the same water content. Also, because the moisture
27 retention curve for coarse-grained soils is generally quite steep (Smoot et al. 1989), the
28 permeability contrast between fine-grained and coarse-grained soils at the same water content
29 can be substantial. The occurrence of interbedded fine-grained and coarse-grained soils may
30 result in the formation of "capillary barriers" and can in turn lead to the formation of perched
31 water zones. General conditions leading to the formation of perched water zones at the
32 Hanford Site are discussed in Subsection 3.5.2.1.2. Potential perched water zones in the
33 S Plant Aggregate Area are discussed in Subsection 3.5.3.1.2.
34

35 **3.5.2.1.2 Perched Water Zones.** Moisture moving downward through the vadose zone
36 may accumulate on top of highly cemented horizons and may accumulate above the contact
37 between a fine-grained horizon and an underlying coarse-grained horizon as a result of the
38 "capillary barrier" effect. If sufficient moisture accumulates, the soil pore space in these
39 perching zones may become saturated. In this case, the capillary pressure within the horizon
40 may locally exceed atmospheric pressure, i.e., a water table condition may develop.
41 Additional input of downward percolating moisture to this horizon may lead to a hydraulic
42 head buildup above the top of the horizon. Consequently, a monitoring well screened within
43 or above this horizon would be observed to contain free water.
44

45 The lateral extent and composition of the Plio-Pleistocene and early "Palouse" soil units
46 may provide conditions amenable to the formation of perched water zones in the vadose zone

1 above the unconfined aquifer. The calcrete facies of the Plio-Pleistocene unit, consisting of
2 calcium-carbonate-cemented silt, sand, and gravel, is a potential perching horizon due to its
3 likely low hydraulic conductivity. However, the Plio-Pleistocene unit is typically fractured
4 and may have erosional scours in some areas, potentially allowing deeper infiltration of
5 groundwater, a factor which may limit the lateral extent of accumulated perched groundwater.
6 The early "Palouse" soil horizon, consisting of compact, loess-like silt and minor fine-grained
7 sand, is also a likely candidate for accumulating moisture percolating downward through the
8 sand and gravel-dominated Hanford formation.
9

10 **3.5.2.1.3 Unconfined Aquifer.** The uppermost aquifer system in the 200 Areas occurs
11 primarily within the sediments of the Ringold Formation and Hanford formation. In the 200
12 West Area the upper aquifer is contained within the Ringold Formation and displays
13 unconfined to locally confined or semiconfined conditions. In the 200 East Area the upper
14 aquifer occurs in the Ringold Formation and Hanford formation. The depth to groundwater in
15 the upper aquifer underlying the 200 Areas ranges from approximately 60 m (197 ft) beneath
16 the former U Pond in 200 West Area to approximately 105 m (340 ft) west of the 200 East
17 Area. The saturated thickness of the unconfined aquifer ranges from approximately 67 to
18 112 m (220 to 368 ft) in the 200 West Area and approximately 61 m (200 ft) in the southern
19 200 East Area to nearly absent in the northeastern 200 East Area where the aquifer thins out
20 and terminates against the basalt located above the water table in that area.
21

22 The upper part of the uppermost aquifer in the 200 West Area consists of generally
23 unconfined groundwater within the Ringold unit E. The lower part of the uppermost aquifer
24 consists of confined to semi-confined groundwater within the gravelly sediments of Ringold
25 unit A. The Ringold unit A is generally confined by fine-grained sediments of the lower mud
26 sequence. The thickness of this confined zone ranges from greater than 38 m (125 ft) in the
27 southeastern portion of the 200 West Area to nearly absent where it pinches out just north of
28 the northern 200 West Area boundary. The lower mud sequence confining zone overlying
29 unit A is up to 30 m (100 ft) thick below the south-central section of the 200 West Area
30 before pinching out in the northeastern corner of the 200 West Area. Where it is absent, the
31 Ringold units A and E combine to form a single thick unconfined aquifer.
32

33 Because of its importance with respect to contaminant transport, the unconfined aquifer
34 is generally the most characterized hydrologic unit beneath the Hanford Site. A number of
35 observation wells have been installed and monitored in the unconfined aquifer. Additionally,
36 in situ aquifer tests have been conducted in a number of the unconfined aquifer monitoring
37 wells. Results of these in situ tests vary greatly depending on the following:
38

- 39 • Horizontal position/location between areas across the Hanford Site and even
40 smaller areas (such as across portions of the 200 Areas)
- 41
- 42 • Depth, even within a single hydrostratigraphic unit
- 43
- 44 • Analytical methods for estimating hydraulic conductivity.
45

1 Details regarding this aquifer system can be found in the 200 West Groundwater
2 Aggregate Management Study Report (AAMSR).
3

4 **3.5.2.2 Natural Groundwater Recharge.** Sources of natural recharge to groundwater at the
5 Hanford Site include precipitation infiltration, runoff from higher bordering elevations and
6 subsequent infiltration within the Hanford Site boundaries, water infiltrating from small
7 ephemeral streams, and river water infiltrating along influent reaches of the Yakima and
8 Columbia Rivers (Graham et al. 1981). The principal source of natural recharge is believed
9 to be precipitation and runoff infiltration along the periphery of the Pasco Basin. Small
10 streams such as Cold Creek and Dry Creek, west of the 200 West Area, also lose water to the
11 ground as they spread out on the valley plain. Considerable debate exists as to whether any
12 recharge to groundwater occurs from precipitation falling on broad areas of the 200 Areas
13 Plateau.
14

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

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

31 Examples of precipitation recharge studies include:
32

- 33 • A study by Gee and Heller (1985) described various models used to estimate
34 natural recharge rates. Many of the models use a water retention relationship for
35 the soil. This relates the suction required to remove (or move) water to its
36 dryness (saturation or volumetric moisture content). Two of these have been
37 developed by Gee and Heller (1985) for soils in lysimeters on the Hanford Site.
38 As an example of available data, the particle size distribution and the water
39 retention curves of these two soils are shown in Figure 3-41. Additional data and
40 information about possible models for unsaturated flow may be found in Brownell
41 et al. (1975), and Rockhold et al. (1990).
42
- 43 • Moisture contents have been obtained from a number of core-barrel samples in the
44 200 Areas (East and West) and varied from 1 to 18%, with most in the range of 2
45 to 6% (Last et al. 1989). The data appear to indicate zones of increased moisture
46 content that could be interpreted as signs of moisture transport. None of the

1 boreholes that this study used (for moisture content or other parameters) were
2 located in the vicinity of the S Plant Aggregate Area.
3

- 4 • A lysimeter study reported by Routson and Johnson (1990) was conducted at a
5 location 1.6 km south of the 200 East Area. During much of the lysimeters' 13-
6 year study period between 1972 and 1985, the surface of the lysimeters were
7 maintained unvegetated with herbicides. No information regarding the soil types
8 in the lysimeters was found. To a precision of +/- 0.2 cm, no downward moisture
9 movement was observed in the instruments during periodic neutron-moisture
10 measurements or as a conclusion of a final soil sample collection and moisture
11 content analysis episode.
12
- 13 • An assessment of precipitation recharge involving the redistribution of ¹³⁷Cs in
14 vadose zone soil also reported by Routson and Johnson (1990). In this study,
15 split-spoon soil samples were collected beneath a solid waste burial trench in the
16 T Plant Aggregate Area. The trench, apparently located just south and west of the
17 218-W-3AE Burial Ground, received soil containing ¹³⁷Cs from an unspecified
18 spill. Cesium-137 was not detected below the bottom of the burial trench.
19 However, increased ¹³⁷Cs activity was observed above the top of the waste fill
20 which Routson and Johnson concluded indicated that net negative recharge (loss
21 of soil moisture to evapotranspiration) had occurred during the 10-year burial
22 period.
23
24 Sparse Russian thistle was observed at the burial trench area in 1980. Rockhold
25 et al. (1990) noted that ¹³⁷Cs appears to strongly sorb to Hanford Site soils
26 indicating that the absence of the radionuclide at depth below the burial trench
27 may not support the conclusion that no downward moisture movement occurred.
28
- 29 • A weighing lysimeter study reported by Rockhold et al. (1990) which was
30 conducted at a grassy plot approximately 5 km (3 mi) northwest of the 300 Area.
31 The grass test site was located in a broad, shallow topographic depression
32 approximately 900 m (2,953 ft) wide, several hundred meters long, trending
33 southwest. The area is covered with annual grasses (cheatgrass and bluegrass).
34 The upper 3.5 m (11.5 ft) of the soil profile consists of slightly silty to silty sand
35 (sandy loam) with an estimated saturated hydraulic conductivity of 9×10^{-3} cm/s.
36 Rockhold et al. (1990) estimated that approximately 0.8 cm (0.3 in.) of downward
37 moisture movement occurred between July 1987 and June 1988. This represents
38 approximately 7% of the total precipitation recorded in that area during that time
39 period.
40
- 41 • A gravel-covered lysimeter study discussed by Rockhold et al. (1990) which was
42 conducted at the 622 Area Lysimeter Site, approximately 0.5 km (0.3 mi) east of
43 the 200 West Area. Approximately 4 cm (1.6 in.) of downward moisture
44 movement was observed in two gravel-covered lysimeters during 1988 and 1989.
45 This represented approximately 25% of the total precipitation recorded in the area

1 during the study period. The authors concluded that gravel placed on the soil
2 surface reduces evaporation and facilitates precipitation infiltration.
3

4 The drainage (downward moisture movement) observed in these studies may represent
5 potential recharge to deeper vadose zone soils and/or the underlying water table.
6

7 **3.5.2.3 Groundwater Flow.** Groundwater flow in the unconfined aquifer beneath the 200
8 West Area is generally toward the north and east, away from the groundwater mound that had
9 been created by past discharges to the 216-U-10 Pond. Groundwater elevations in June 1990
10 for the unconfined aquifer in the 200 Areas are shown on Figure 3-42 (Kasza et al. 1990).
11 Graham et al. (1981) calculated horizontal hydraulic gradients for the 200 West Area of 0.004
12 to 0.015 for data collected in December 1979. Graham et al. (1981) estimated that vertical
13 hydraulic gradients in the unconfined aquifer exceed 10% in some areas of the unconfined
14 aquifer.
15

16 Natural groundwater inflow to the unconfined aquifer primarily occurs along the
17 western boundary of the Hanford Site. Currently, man-made recharge occurs in several active
18 waste management units (e.g., the 216-S-10 Ditch, 216-S-25 Crib, and the 216-S-26 Crib)
19 located within the S Plant Aggregate Areas in the 200 West Area. Historically, much greater
20 recharge occurred from a number of waste management units in the 200 Areas. Man-made
21 recharge probably substantially exceeds natural precipitation recharge in these areas. The
22 unconfined aquifer ultimately discharges to the Columbia River, either near the 100 Areas,
23 north of the 200 Areas through Gable Gap, or between the 100 Areas and the 300 Area, east
24 of the 200 Areas. The precise path is strongly dependent on the hydrologic conditions in the
25 200 East Area (Delaney et al. 1991). If recharge in the 200 East Area is large, more of the
26 recharge from the 200 West Area is diverted north through Gable Gap toward the 100 Areas.
27 Generally, however, the easterly route appears to be more likely for recharge from the 200
28 West Area.
29

30 **3.5.2.4 Historical Effects of Operations.** Historical effluent disposal at the Hanford Site
31 altered previously prevailing groundwater hydraulic gradients and flow directions. Before
32 operations at the Hanford Site began in 1944, groundwater flow was generally toward the
33 east, and the groundwater hydraulic gradient in the 200 West Area was on the order of 0.001
34 (Delaney et al. 1991). Prior to disposing liquid waste to the soil column in the 200
35 (Separations) Areas, groundwater elevations in the 200 West Area may have been as much as
36 20 m (65 ft) lower in 1944 than at present. As seen in Figure 3-40, a distinct groundwater
37 mound is still apparent beneath the 200 West Area. The horizontal hydraulic gradient is
38 expected to increase and shift to the east as the mound continues to dissipate.
39
40

41 **3.5.3 S Plant Aggregate Area Hydrogeology**

42

43 This section presents additional hydrogeologic information identified with specific
44 application to the S Plant Aggregate Area.
45

1 **3.5.3.1 Hydrostratigraphy.** The hydrostratigraphic units of concern beneath the S Plant
2 Aggregate Area are (1) the Rattlesnake Ridge Interbed, (2) the Elephant Mountain Basalt
3 Member, (3) the Ringold Formation units A and E, (4) the Plio-Pleistocene unit and early
4 "Palouse" soil, and (5) the Hanford formation. The hydrogeologic designations for the S
5 Plant Aggregate Area were determined by examination of borehole logs from Lindsey et al.
6 (1991) and Chamness et al. (1991) and integration of these data with stratigraphic correlations
7 from existing reports. For the purposes of the S Plant AAMSR, this discussion will be
8 limited to the vadose zone and possible perching horizons with the vadose zone underlying
9 the aggregate area. Additional information on the aquifer systems in contained in the 200
10 West Groundwater AAMSR.

11
12 **3.5.3.1.1 Vadose Zone.** The vadose zone beneath the S Plant Aggregate Area ranges
13 in thickness from about 71 m (230 ft) along the northern part of the aggregate area boundary
14 to 56 m (190 ft) in the vicinity of the 216-S-10 Ditch based on December 1990 groundwater
15 elevation data (Kasza 1990). The observed variation in vadose zone thickness is the result of
16 variable surface topography and the variable elevation of the water table in the underlying
17 unconfined aquifer. The area of least saturated thickness generally lies above a groundwater
18 mound identified in the unconfined aquifer southwest and northwest of the S Plant Building
19 Complex (Figure 3-41). As discussed in Section 3.5.2.4, the mound apparently originated
20 from historic discharges to the U Pond and 216-S-10 Ditch.

21
22 A report regarding the installation of monitoring wells 299-W22-40, -41, -42, and -43,
23 adjacent to the 216-U-12 Crib (Goodwin 1990) and at the southeastern border of the U Plant
24 Aggregate Area, provides data which may be applicable to the vadose zone soils in the
25 S Plant Aggregate Area. The analysis indicates that moisture contents of between less than
26 1% and up to 24% are typically found in these borings and may be typical of the area. Of
27 the 105 samples analyzed for moisture contents, 86% of them were between 1 and 10%. It
28 should be noted, however, that this investigation is in the vicinity of a previously active crib,
29 and it is possible that there is some impact of disposal of liquid wastes on these moisture
30 contents.

31
32 Published vadose zone hydraulic data specific to soil samples or subsurface explorations
33 advanced in the S Plant Aggregate Area were not found. However, ongoing work by the
34 Westinghouse Hanford Company Environmental Technology, Risk and Performance
35 Assessment group to evaluate potential contaminant transport from a proposed facility in the
36 Low-Level Solid Waste Burial Grounds utilizes soil samples from Well 299-W7-9 on the
37 north side of the 218-W-5 Burial Ground in the Z Plant Aggregate Area. The similarity in
38 vadose zone properties to the S Plant Aggregate Area make this study applicable. In this
39 study, laboratory-measured soil moisture retention curves were used to estimate vadose zone
40 soil hydraulic conductivity values for use in a numerical modeling analysis. The soil samples
41 used to prepare the moisture retention curves were collected from the referenced well. A
42 summary of the moisture content and hydraulic conductivity values is presented below.
43

| 1 | Soil Horizon | Sample Depth In Meters | Moisture Content Weight % | Calculated Saturated Hydraulic Conductivity in cm/s |
|---|-----------------------|---------------------------|------------------------------|---|
| 2 | Hanford Formation | 3.05 | 0.20 | 1.2×10^{-02} |
| 3 | Early "Palouse" Soil | 19.8 | 0.38 | 7.0×10^{-06} |
| | | 21.1 | 0.38 | 1.4×10^{-04} |
| 4 | Plio-Pleistocene Unit | 26.9 | 0.23 | 1.3×10^{-06} |
| | | 30.0 | 0.26 | 1.6×10^{-04} |
| | | 31.8 | 0.20 | 2.1×10^{-05} |
| 5 | Upper Ringold | 34.2 | 0.21 | 1.1×10^{-03} |
| 6 | Middle Ringold | 40.4 | 0.23 | 3.0×10^{-04} |
| | | 43.2 | 0.24 | 1.9×10^{-04} |

7
8 **3.5.3.1.2 Perched Water Zones.** The characteristics, extent and stratigraphic position
9 of the Plio-Pleistocene and early "Palouse" soil units in the 200 West Area (see Figures 3-15
10 through 3-19, and 3-29 through 3-32) provide conditions for collection and possible
11 movement of vadose zone recharge water above the unit. The high cementation and relatively
12 gentle (1.5°) dip to the southwest of the Plio-Pleistocene unit indicate the possibility of
13 perched water zones. The Plio-Pleistocene is a laterally discontinuous formation, thus
14 perched water on this unit would exist only in certain areas.
15

16 In 1966, perched water was detected at approximately 43 m (140 ft) in Wells 299-W22-
17 26A and 299-W22-27A, near the 216-S-9 Crib (Plate 3). In more recent years, perched water
18 was detected at approximately 38 m (125 ft) in Well 299-W26-11 and at approximately 45 m
19 (146 ft) in well 299-W26-12 both located near the active portion of the S-10 Ditch (Plate 3).
20

21 Apparently the calcareous cementation in the Plio-Pleistocene produces a significantly
22 lower permeability than the overlying soils. The perched water is confined on the top by the
23 slack-water sequence of the Hanford formation but can extend up into it. The slack-water
24 sequence is a laterally discontinuous unit and thus may only permit the development of
25 perched conditions locally.
26

27 Information about hydraulic properties of the perched water zones is very limited and
28 will vary according to how far vertically and in which unit the perched water reaches.
29

30 **3.5.3.2 Natural Groundwater Recharge.** As discussed in Section 3.3.3, no natural surface
31 water bodies exist within the S Plant Aggregate Area. Therefore, the potential for natural
32 groundwater recharge within the S Plant Aggregate Area is limited to precipitation infiltration.
33 No precipitation infiltration data were identified with specific reference to the S Plant
34 Aggregate Area. However, the amount of precipitation infiltration is likely comparable to the
35 range of values identified for various Hanford test sites, i.e., 0 to 10 cm/year.
36

1 As suggested in Section 3.5.2.2, precipitation infiltration rates probably vary with
2 respect to location within the S Plant Aggregate Area. Higher infiltration rates are expected
3 in unvegetated areas or areas with shallow rooting plants. Higher infiltration rates are also
4 expected in areas with gravelly soils exposed at the surface.
5

6 **3.5.3.3 Groundwater Flow Beneath the S Plant Aggregate Area.** Within the S Plant
7 Aggregate Area, groundwater flow is generally toward the east, based on December 1990
8 Hanford wells groundwater elevation data (DOE/RL 1991) (Figure 3-42). Flow is generally
9 very gradual with some influence from the 216-U-10 Pond mound and possibly from the 216-
10 S-10 Ditch and 216-S-26 Crib. A review of groundwater maps of the unconfined aquifer
11 (Kasza et al. 1990) indicates relatively steeper decreases in groundwater elevations in the
12 northern portion and more gradual elevation decreases in the southern portion of the aggregate
13 area.
14

15 **3.5.3.4 Historical Effects of Operations.** The early period of monitoring (1958 to 1967)
16 was characterized as a period of rising water tables. This effect can be attributed to the
17 operations of both U Plant (1952 to 1958) and S Plant (1951 to 1967), which contributed
18 recharge through sizable discharges to the cribs in the area. After the shutdown of the
19 S Plant in 1967, water levels dropped several feet, through 1973. The return rise to a plateau
20 at these earlier levels started in about 1974 that must be attributable to 216-U-10 Pond
21 discharges, although the major contributor to this facility, the 200 West Evaporator, did not
22 go online until 1975. The shutdown of the 200 West Evaporator in about 1980 had only a
23 minor effect on groundwater tables, but the subsequent decommissioning of 216-U-10 Pond in
24 1984 began a steady decline in water levels that has continued through the period of record
25 and is anticipated to continue for the foreseeable future until natural groundwater levels
26 (without any effect of recharge on the Hanford Site) are eventually reached.
27
28

29 **3.6 ENVIRONMENTAL RESOURCES**

30
31 The Hanford Site is characterized as a cool desert or a shrub-steppe and supports a
32 biological community typical of this environment.
33
34

35 **3.6.1 Flora and Fauna**

36
37 The 200 Areas Plateau is represented by a number of plant, mammal, bird, reptile,
38 amphibian, and insect species as discussed below.
39

40 **3.6.1.1 Vegetation of the 200 Areas Plateau.** The vegetation of the 200 Areas Plateau is
41 characterized by native shrub steppe interspersed with large areas of disturbed ground with a
42 dominant annual grass component. The native stands are classified as an *Artemisia*
43 *tridentata*/*Poa sandbergii* - *Bromus tectorum* community (Rogers and Rickard 1977) meaning
44 that the dominant shrub is Big Sagebrush (*Artemisia tridentata*) and the understory is
45 dominated by the native Sandberg's Bluegrass (*Poa sandbergii*) and the introduced annual
46 Cheatgrass (*Bromus tectorum*). Other shrubs that are typically present include Gray

1 Rabbitbrush (*Chrysothamnus nauseosus*), Green Rabbitbrush (*C. viscidiflorus*), Spiny Hopsage
 2 (*Grayia spinosa*), and occasionally Antelope Bitterbrush (*Pursia tridentata*). Other native
 3 bunchgrasses that are typically present include Bottlebrush Squirreltail (*Sitanion hystrix*),
 4 Indian Ricegrass (*Oryzopsis hymenoides*), Needle-and-Thread (*Stipa comata*), and Prairie
 5 Junegrass (*Koeleria cristata*). Common and important herbaceous species include Turpentine
 6 cymopterus (*Cymopterus terebinthinus*), Globemallow (*Spheracea munroana*), balsamroot
 7 (*Basamorhiza careyana*), several Milkvetch species (*Astragalus caricinus*, *A. sclerocarpus*, *A.*
 8 *succumbens*), Long-leaf Phlox (*Phlox longifolia*), the common Yarrow (*Achillea millifolium*),
 9 Pale Evening-primrose (*Oenothera pallida*), Thread-leaf phacelia (*Phacelia linearis*), and
 10 several Daisy/Fleabane Species (*Erigeron poliospermus*, *E. Filifolius*, and *E. pumilus*). In all,
 11 well over 100 plant species have been documented to occur in native stands on the 200 Areas
 12 Plateau.

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

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

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

41
 42 **3.6.1.2 Plant Species of Concern.** The Washington State Department of Natural Resources,
 43 Natural Heritage Program classifies rare plants in the State of Washington in three different
 44 categories, depending on the overall distribution of the taxon and the state of its natural
 45 habitat. These categories are: *Endangered*, which is a "vascular plant taxon in danger of
 46 becoming extinct or extirpated in Washington within the near future if factors contributing to

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

11
12 Of the two Endangered taxa, *Persistantsepal Yellowcress* is well documented along the
13 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 would
17 probably occur only on rocky areas immediately adjacent to the Columbia River if it were
18 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 west
21 of the Hanford site on both sides of Umptanum Ridge. This species could occur on the 200
22 Areas Plateau. Hoover's Desert Parsley inhabits the steep talus slopes near Priest Rapids
23 Dam. Potentially, it could be found on similar slopes on Gable Mountain and Gable Butte,
24 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 216-A-24 Crib, and 100-H Area. Bristly
34 Cryptantha, 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
41 1 consists of taxa in need of further field work before a formal status can be assigned. The
42 Tooth-sepal Dodder (*Cuscuta denticulata*), which has been found in the state of Washington
43 only on the Hanford Site is the only taxon in this group that is of concern to Hanford
44 operations. This parasitic species has been found in the area west of McGee Ranch. Group 2
45 of the Monitor list includes species with unresolved taxonomic questions. Thompson's
46 sandwort (*Arenaria franklinii* var. *thompsonii*) is of concern to Hanford operations. However,

1 the representatives of this species in the state of Washington are now believed to all be
2 variety *franklinii* which is not considered particularly rare. Group 3 of the Monitor list
3 includes taxa that are either more abundant or less threatened than previously believed. There
4 are approximately 15 taxa on the Hanford Site that are included on this list.

5
6 **3.6.1.3 Fauna of the 200 Areas Plateau.** The mammals, birds, reptiles, amphibians
7 inhabiting the 200 Areas Plateau are discussed below.

8
9 **3.6.1.3.1 Mammals.** The largest mammal occurring on the 200 Areas Plateau is the
10 mule deer (*Odocoileus hemionus*). Although mule deer are much more common to riparian
11 sites along the Columbia River they are frequently observed foraging throughout the 200
12 Areas. Elk (*Cervus elaphus*) also occur at Hanford but they have only been observed at the
13 Arid Lands Ecology Reserve. Other mammal species common to the 200 Areas include
14 badgers (*Taxidea taxus*), coyotes (*Canis latrans*), blacktail jackrabbits (*Lepus californicus*),
15 Townsend ground squirrels (*Spermophilus townsendii*), Great Basin pocket mice (*Perognathus*
16 *parvus*), pocket gophers (*Thomomys talpoides*), and deer mice (*Peromyscus maniculatus*).
17 Badgers are known for their digging capability and have been implicated several times for
18 encroaching into inactive burial grounds throughout the 200 Areas. The majority of the
19 badger excavations in the 200 Areas are a result of badgers searching for prey (mice and
20 ground squirrels). Coyotes are the principal predators, consuming such prey as rodents,
21 insects, rabbits, birds, snakes and lizards. The Great Basin pocket mouse is the most
22 abundant small mammal, which thrives in sandy soils and lives entirely on seeds from native
23 and revegetated plant species. Townsend ground squirrels are not abundant in the 200 Areas
24 but they have been seen at several different sites. Other small mammals that occur in low
25 numbers include the Western harvest mouse (*Reithrodontomys megalotis*) and the Grasshopper
26 mouse (*Onychomys leucogaster*). Mammals associated more closely with buildings and
27 facilities include Nuttall's cottontails (*Sylvilagus nuttallii*), house mice (*Mus musculus*),
28 Norway rats (*Rattus norvegicus*), and some bat species. Bats probably play a minor role in the
29 200 Areas's ecosystem but no documentation is available on bat populations at Hanford.
30 Mammals such as skunks (*Mephitis mephitis*), raccoons (*Procyon lotor*), weasels (*Mustela*
31 *spp.*), porcupines (*Erethizon dorsatum*), and bobcats (*Lynx rufus*) have only been observed on
32 very few occasions.

33
34 **3.6.1.3.2 Birds.** Over 235 species of birds have been documented to occur at the
35 Hanford Site (Landen et al. 1991). At least 100 of these species have been observed in the
36 200 Areas. The most common passerine birds include starlings (*Sturnus vulgaris*), horned
37 larks (*Ermophila alpestris*), meadowlarks (*Sturnella neglecta*), Western kingbirds (*Tyranus*
38 *verticalis*), rock doves (*Columba livia*), barn swallows (*Hirundo rustica*), cliff swallows
39 (*Hirundo pyrrhonota*), black-billed magpies (*Pica pica*) and ravens (*Corvus corax*). Common
40 raptors include the Northern harrier (*Circus cyaneus*), American kestrel (*Falco sparverius*),
41 and Red tailed hawk (*Buteo jamaicensis*). Swainson's hawks (*Buteo swainsoni*) sometimes
42 nest in the trees located at some of the army bunker sites that were used in the 1940's.
43 Golden eagles (*Aquila chrysaetos*) are observed infrequently. Burrowing owls (*Athene*
44 *cunicularia*) nest at several locations throughout the 200 Areas. The most common upland
45 game birds found in the 200 Areas are California Quail (*Callipepla californica*) and Chukar
46 partridge (*Alectoris chukar*); however, Ring-necked pheasants (*Phasianus colchicus*) and Gray

1 partridge (*Pertx perdix*) may be found in limited numbers. The only native game bird
2 common to the 200 Areas Plateau is the Mourning dove (*Zenaida macrora*) which migrates
3 south each fall. Other species of note which nest in undisturbed sagebrush habitats in the 200
4 Areas include Sage sparrows (*Amphispiza belli*), and Loggerhead shrikes (*Lanius*
5 *ludovicianus*). Long-billed Curlews (*Numenius americanus*) also use the sagebrush areas and
6 revegetated burial grounds for nesting and foraging.

7
8 Waterfowl and aquatic birds inhabit B Pond and other areas where there is running or
9 standing water. However many of these areas such as 216-A-29 Ditch are becoming more
10 scarce due to stabilization and remedial action cleanup activities. Aquatic birds and
11 waterfowl common to B-Pond on a seasonal basis include Canada Geese (*Branta canadensis*),
12 American coot (*Fulica americana*), Mallard (*Anas platyrhynchos*), Ruddy duck (*Oxyura*
13 *jamaicensis*), Redhead (*Aythya americana*), Bufflehead (*Bucephala albeola*) and Great blue
14 heron (*Ardea herodias*).

15
16 **3.6.1.3.3 Reptiles and Amphibians.** Common reptiles include gopher snakes
17 (*Pituophis melanoleucus*) and sideblotched lizards (*Uta stansburiana*). Other reptiles and
18 amphibians which are infrequently observed include sagebrush lizards (*Sceloporus graciosus*),
19 horned toads (*Phrynosoma douglassi*), western spadefoot toads (*Scaphiopus intermontana*)
20 yellow-bellied racer (*Coluber constrictor*), Pacific rattlesnake (*Crotalus viridis*), and striped
21 whipsnake (*Masticophis taeniatus*). Both lizards and snakes are prey items of mammalian and
22 avian predators.

23
24 **3.6.1.3.4 Insects.** There are hundreds of insect species which inhabit the 200 Areas.
25 Two of the most common groups of insects include several species of darkling beetles and
26 grasshoppers. Harvester ants are also common and have been implicated in the uptake of
27 radionuclides from some of the burial grounds in 200 East Area. Harvester ants have the
28 ability to excavate and bring up material from as far down as 4.6 to 6.1 m (15 to 20 ft).
29 Other major groups of insects include bees, butterflies and scarab beetles. Insects impact the
30 surrounding plant community as well as serving as the prey base for many species of birds,
31 reptiles and mammals.

32
33 **3.6.1.4 Wildlife Species of Concern.** Some animals which inhabit the Hanford Site have
34 been given special status designations by the state and federal government. Some of these
35 designations include state and federal threatened and endangered species, federal candidate,
36 state monitor, state sensitive, and state candidate species. Species listed in Table 3-4 as state
37 and/or federal threatened and endangered such as the bald eagle (*Haliaeetus leucocephalus*),
38 peregrine falcon (*Falco peregrinus*), American white pelican (*Pelecanus erythrorhynchos*),
39 ferruginous hawk (*Buteo regalis*), and sandhill crane (*Grus canadensis*) do not inhabit the 200
40 Areas. The bald eagle and American white pelican utilize the Columbia River and associated
41 habitats for roosting and feeding. Peregrine falcons and sandhill cranes fly over the Hanford
42 Site during migration. Ferruginous hawks nest on the Hanford Site but nesting has not been
43 documented for this species on the 200 Areas Plateau. Other species listed in Table 3-4 as
44 state and/or federal candidates and state monitor species such as burrowing owls, Great Blue
45 Herons, Prairie falcons (*Falco mexicanus*), Sage sparrows, and Loggerhead shrikes are not
46 uncommon to the 200 Areas Plateau.

3.6.2 Land Use

The 202-S Building was constructed between May 1950 and August 1951. Operations continued through July 1967, when the plant was shut down. An analytical laboratory (222-S) near the facility is still operating. This laboratory supports B Plant operations and performs research and development in support of waste management and environmental control operations. Plate 1 depicts the general location of facilities discussed in this report.

Numerous techniques have been employed at the Hanford Site to store and dispose the large quantities of liquid waste generated during site operation. Two common methods used were evaporation/infiltration ponds and underground storage tanks. There were operational problems associated with both methods. Waste minimization by forced evaporation was also employed at the site.

There are three main types of underground liquid disposal facilities at the Hanford Site; cribs, trenches, and french drains. Large quantities of liquid waste were disposed in injection wells (generally referred to as reverse wells in site records) and buried sumps (referred to as cribs in site records). Since 1950, crib facilities have been constructed in the 200 Area at Hanford Site. Cribs are essentially a high volume liquid dispersion system created by filling the bottom half of an excavation (less than 30 m [98 ft] deep) with very coarse granular material surrounding a distribution system of porous clay pipe. This material is then covered with finer grained soil. Trenches are long, narrow, unlined, shallow excavations (about 3 m [10 ft] deep) used for disposal of limited quantities of material, deposited over a short period of time, and they are backfilled after use. Trenches are commonly used for the disposal of high-salt waste or waste containing complexed radionuclides. French drains, which are covered or buried gravel-filled encasements with open bottoms, are similar to cribs in structure but much smaller in size (generally less than 1 m [3 ft] in diameter). French drains are used to dispose of small-volume and generally low-level waste.

There were several common methods for transporting liquid waste across the site; these include ditches, underground and aboveground pipelines, and trucks. The waste management units discussed in this report no longer have aboveground pipelines to them. The ditches are addressed, but the pipelines are not specifically discussed as potential waste units.

3.6.3 Water Use

Only one surface water facility exists in the S Plant Aggregate Area. The 216-S-10 Ditch is a manmade structure constructed in 1952 to dispose liquid effluents from the S Plant Building Complex (WHC 1990b). This waste site is located 427 m (1,470 ft) southwest of the S Plant and was recently deactivated. In the past, discharges were received from 202-S floor drains, funnels, process vessel cooling water, and chemical sewer lines and drains from the 241-S Tank Farm, 211-S station, and 276 Building. Until 1965, the unit received chemical sewer waste from the S Plant and overflow from the 2901-S-901 Water Tower. Since October 1984, the unit has been used as a trench because the 216-S-10 pond was stabilized. No dangerous wastes have been discharged to this unit since February 1987.

1 This unit is unlined and a portion remains uncovered. It has been partially stabilized.
2 In the portion of the unit that has not been stabilized, there is approximately 1 ft of standing
3 water with cattails growing in it.
4

5 Water from the 216-S-10 Ditch has apparently never been used for any purpose.
6

7 There are no domestic groundwater supply wells within the boundary of the S Plant
8 Aggregate Area. The nearest reported domestic groundwater wells to the southeast (generally
9 downgradient) are at the Fast Flux Test Facility (Figure 3-1) located over 32 km (20 mi) from
10 the aggregate area.
11

12 **3.7 HUMAN RESOURCES**

13 The environmental conditions at the S Plant Aggregate Area must be evaluated in
14 relationship to the surrounding population centers and other human resources. A very brief
15 summary of demography, archaeology, historical resources, and community involvement is
16 given below.
17

18 **3.7.1 Demography**

19 There are no residences on the Hanford Site. The nearest inhabited residences are farm
20 homes on land located 23 km (14 mi) north of the S Plant Aggregate Area. There are
21 approximately 258,000 people living within a 80 km (50 mi) radius of the 200 Areas plateau.
22 The primary population centers are the cities of Richland, Kennewick, and Pasco, located
23 southeast of the Hanford Site, Prosser to the south, Sunnyside to the southwest, and Benton
24 City to the southeast.
25

26 **3.7.2 Archaeology**

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

33 **3.7.3 Historical Resources**

34 The only historic site in 200 West Area is the old White Bluffs freight road which
35 crosses diagonally through the vicinity. This site is not considered to be eligible for the
36 National Register.
37
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1 **3.7.4 Community Involvement**

2
3 A Community Relations Plan (CRP) (Ecology et al. 1989) has been developed for the
4 Hanford Site Environmental Restoration Program which includes any potentially affected
5 community with respect to the S Plant AAMSR. The CRP includes a discussion on analysis
6 of key community concerns and perceptions regarding the project, along with a list of all
7 interested parties.

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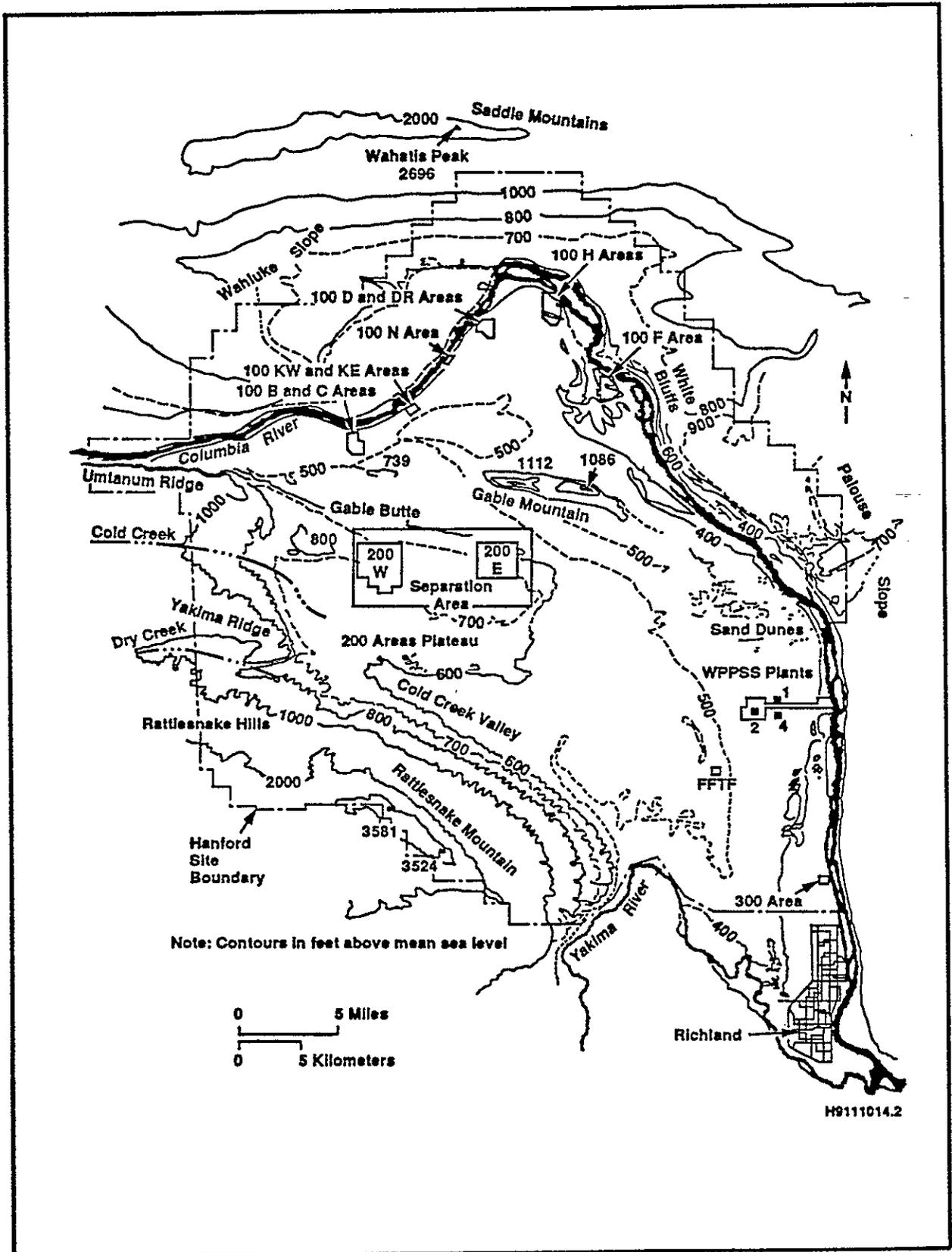
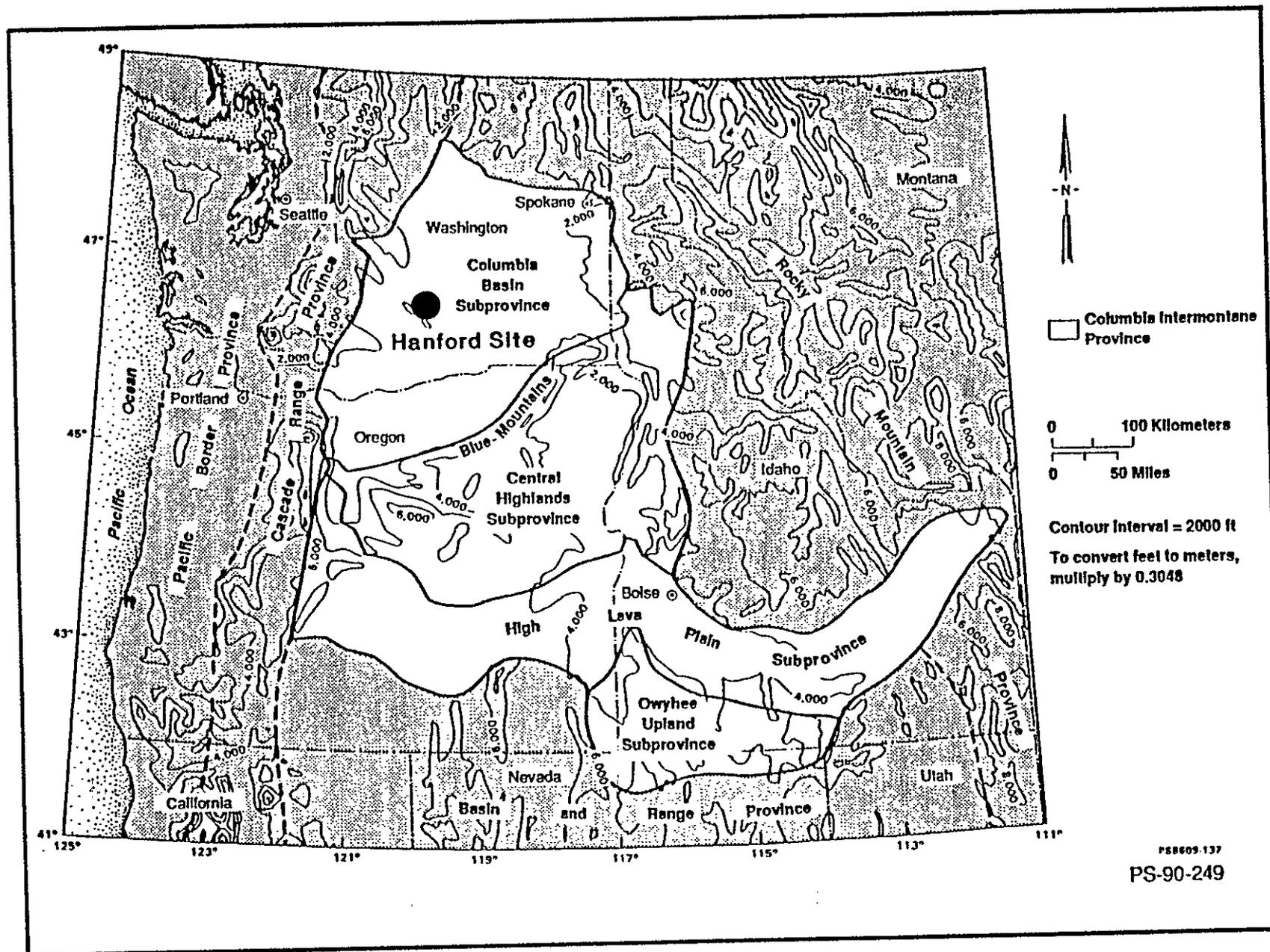


Figure 3-1. Topography and Location Map for the Hanford Site.
3F-1

3F-2



DOE/RL-91-60
Draft A

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

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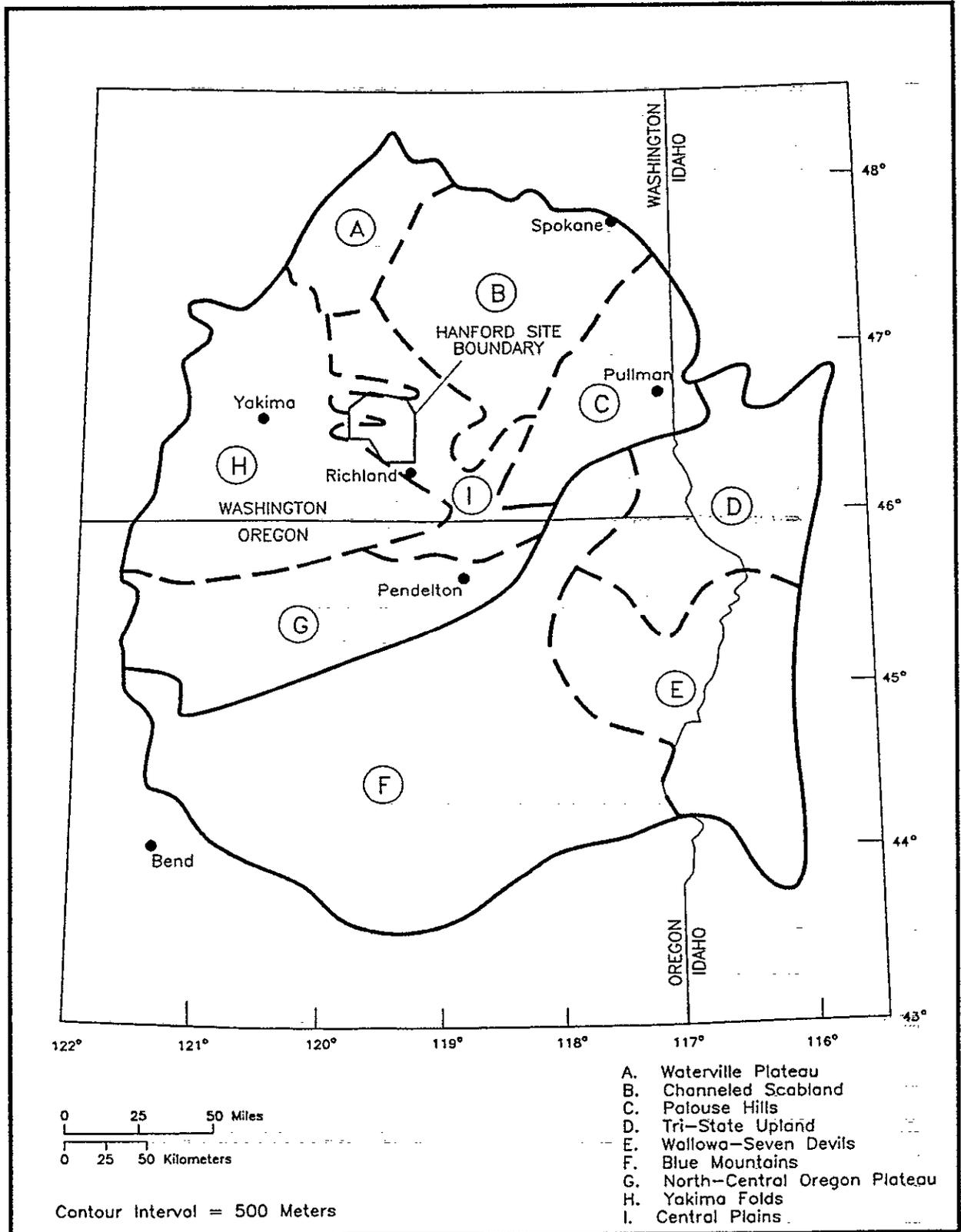


Figure 3-3. Geomorphic Units Within the Central Highlands and Columbia Basin Subprovinces that Contain the Columbia River Basalt Group (after Thornbury 1965)(Last et al. 1989).

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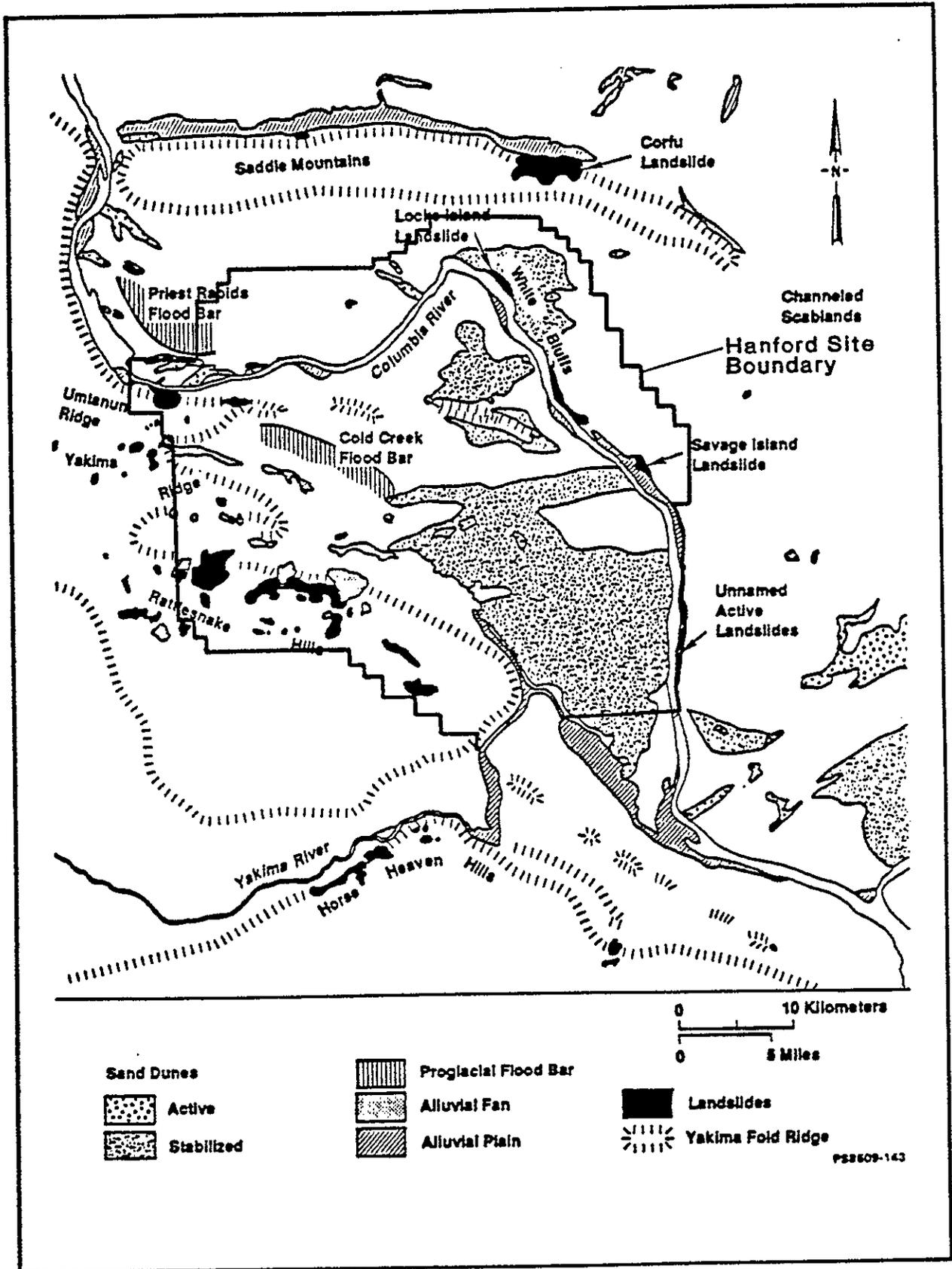


Figure 3-4. Landforms of the Pasco Basin and the Hanford Site.
3F-4

3F-5

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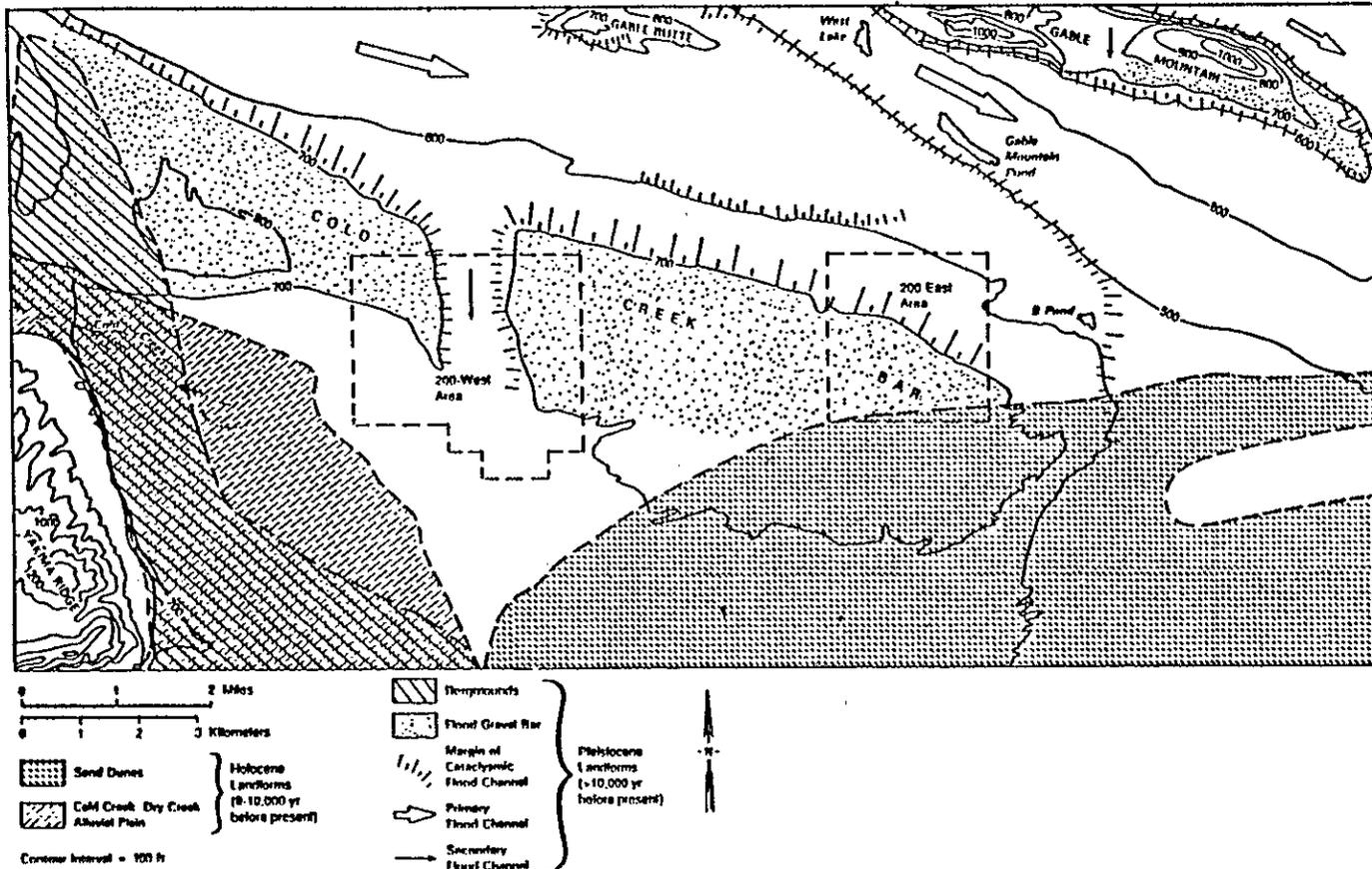


Figure 3-5. Geomorphic Features Surrounding the 200 Areas (Last et al. 1989).

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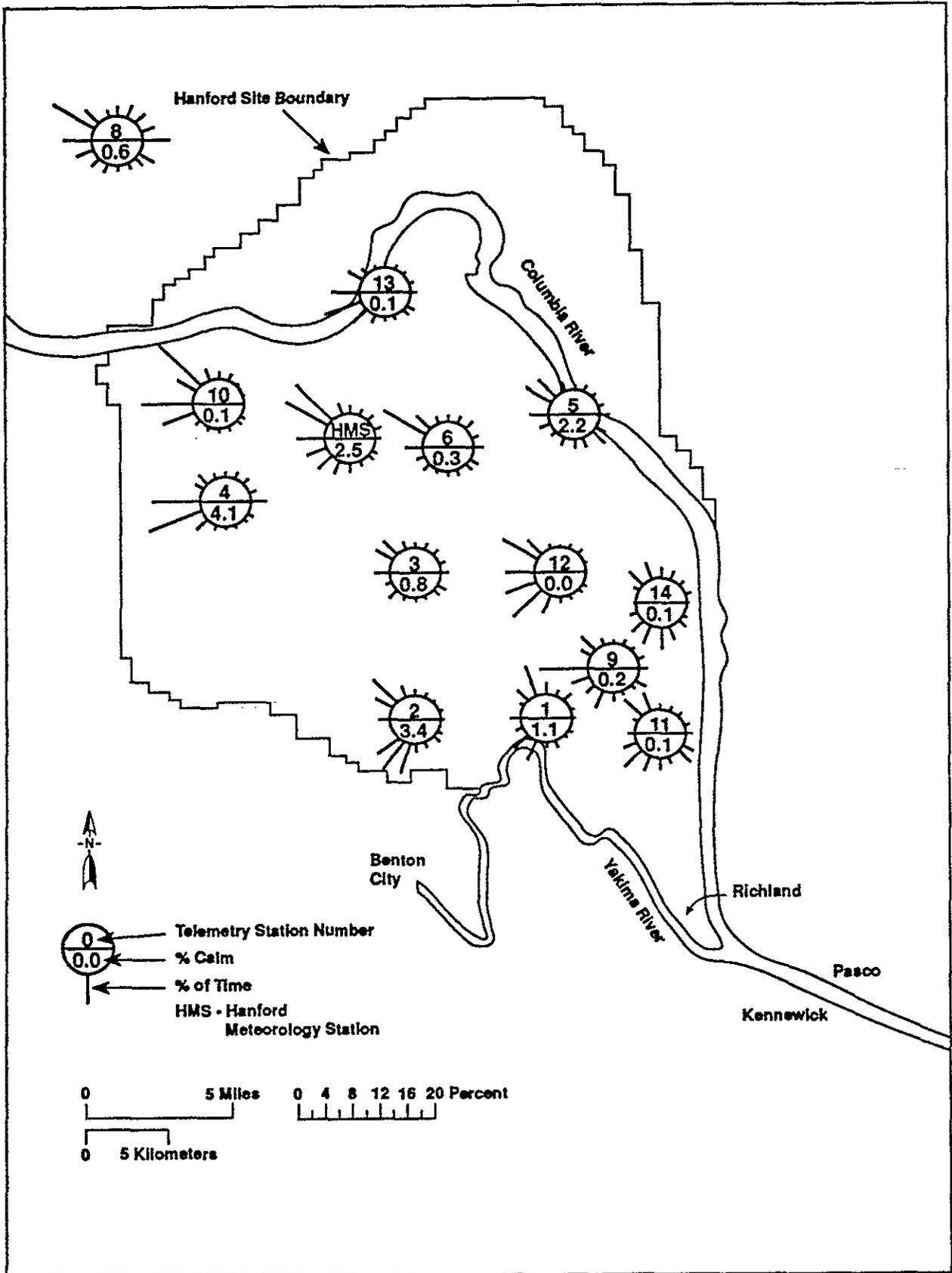
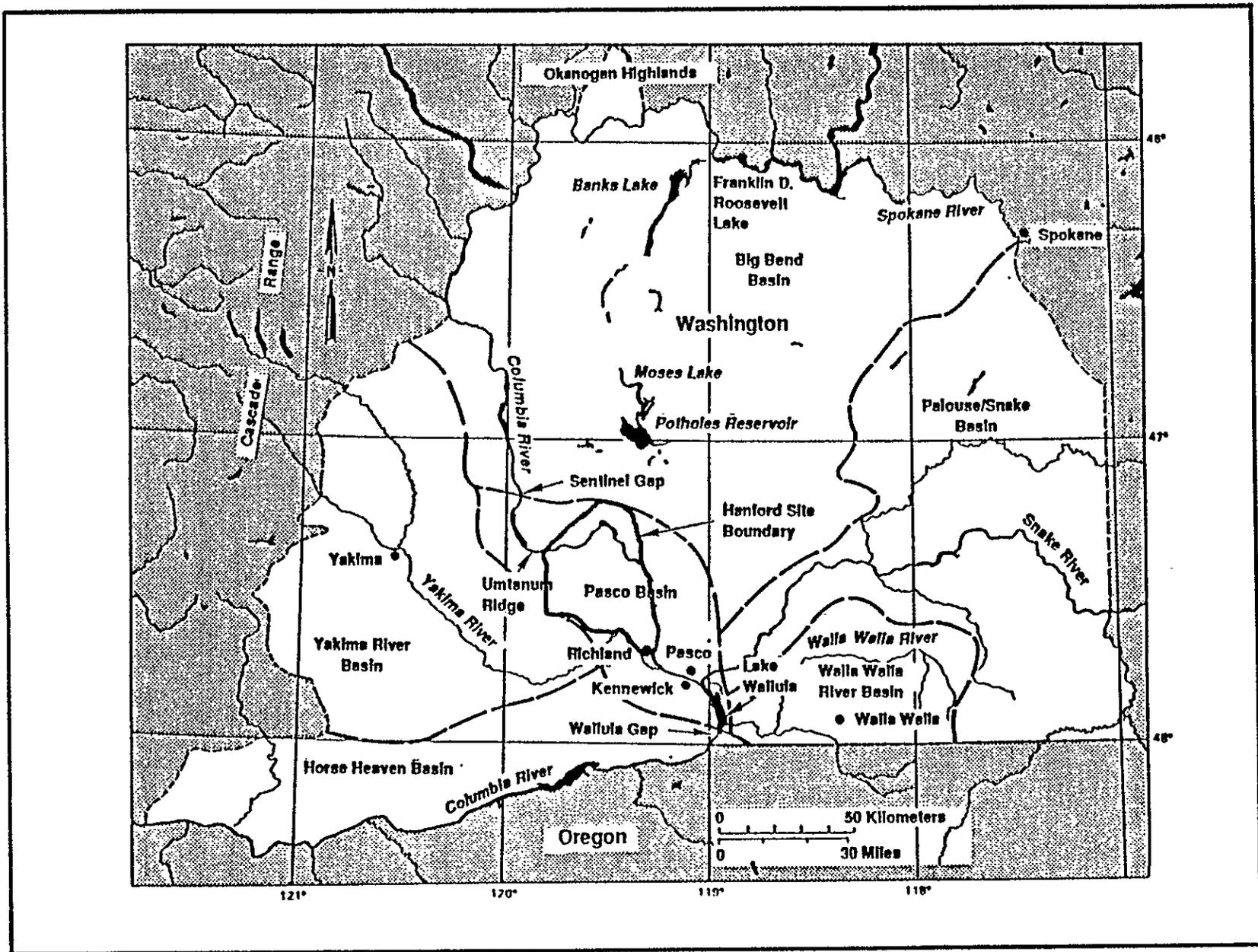


Figure 3-6. Hanford Site Wind Roses, 1979 through 1982 (Stone et al. 1983).

3F-7



DOE/RL-91-60
Draft A

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

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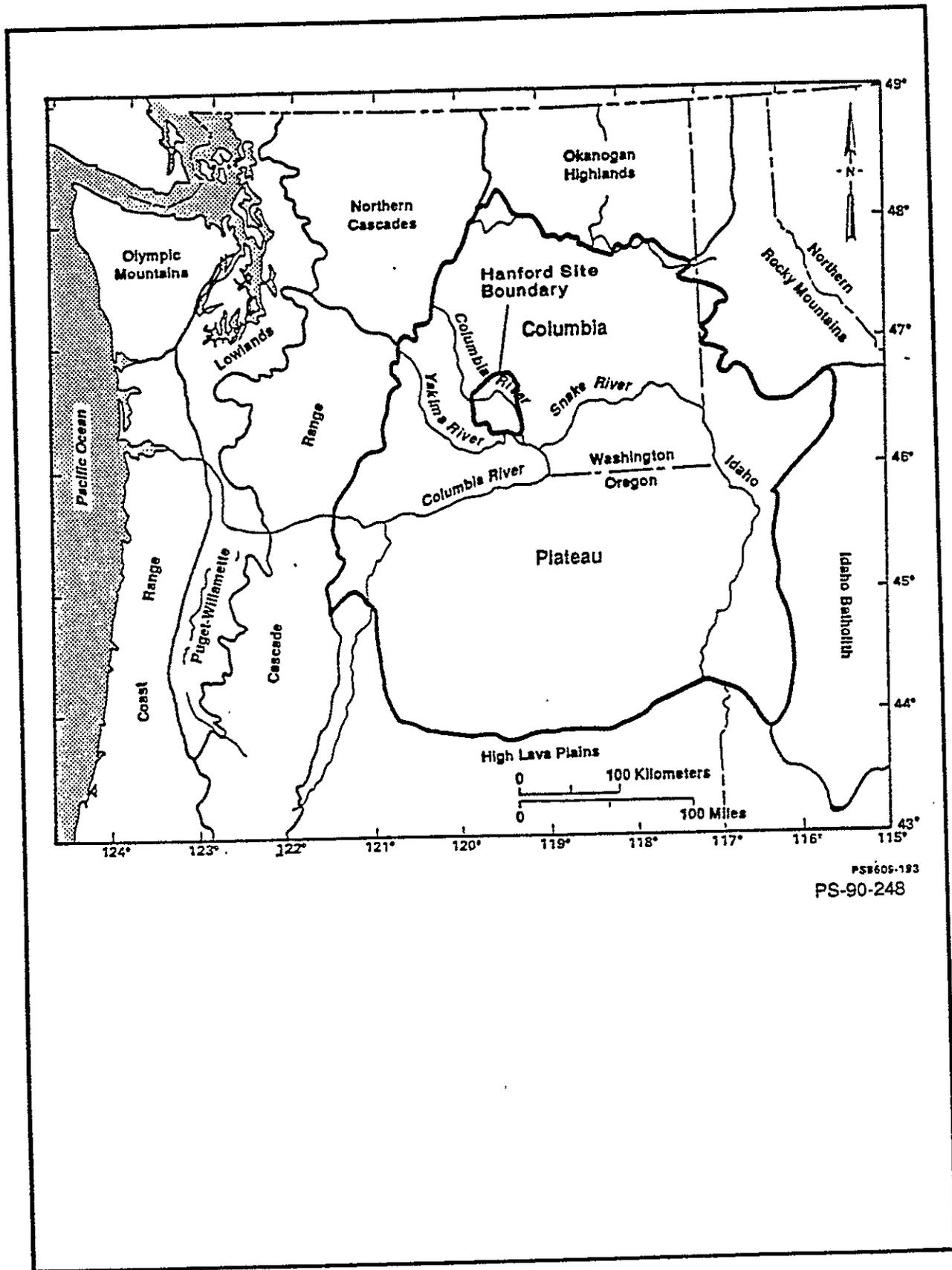


Figure 3-8. Structural Provinces of the Columbia Plateau.
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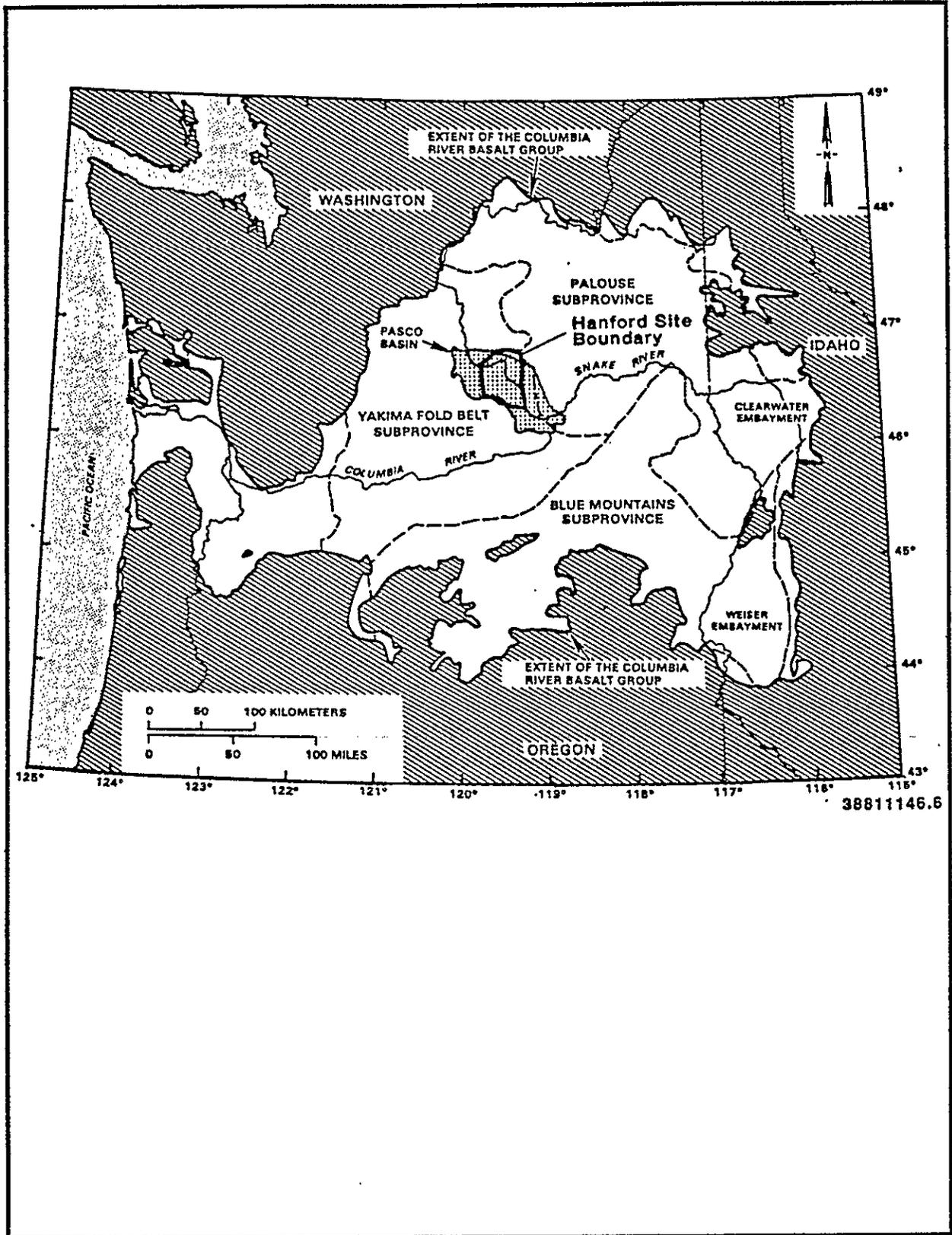
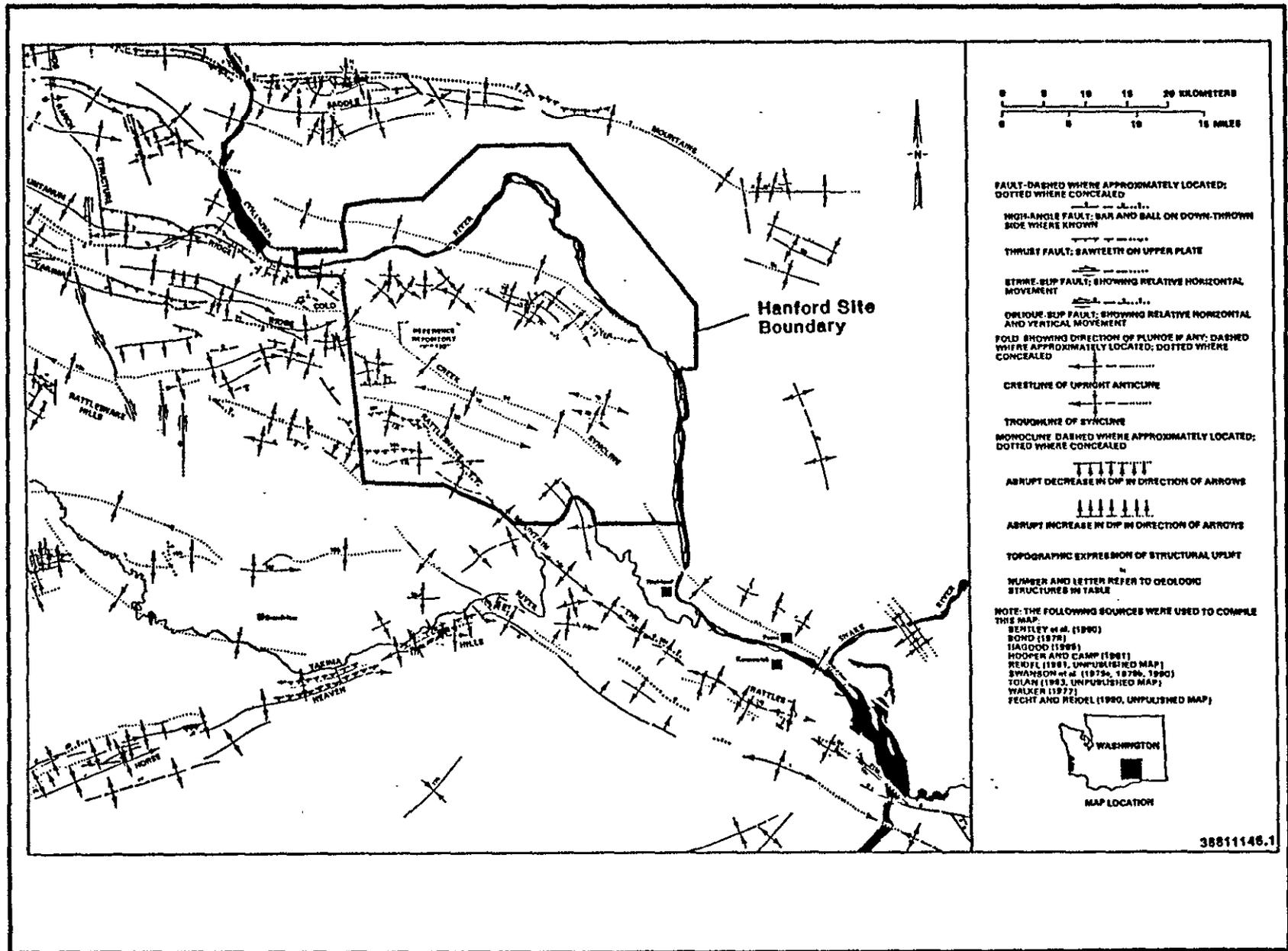


Figure 3-9. Structural Subprovinces of the Columbia Plateau (Last et al. 1989).

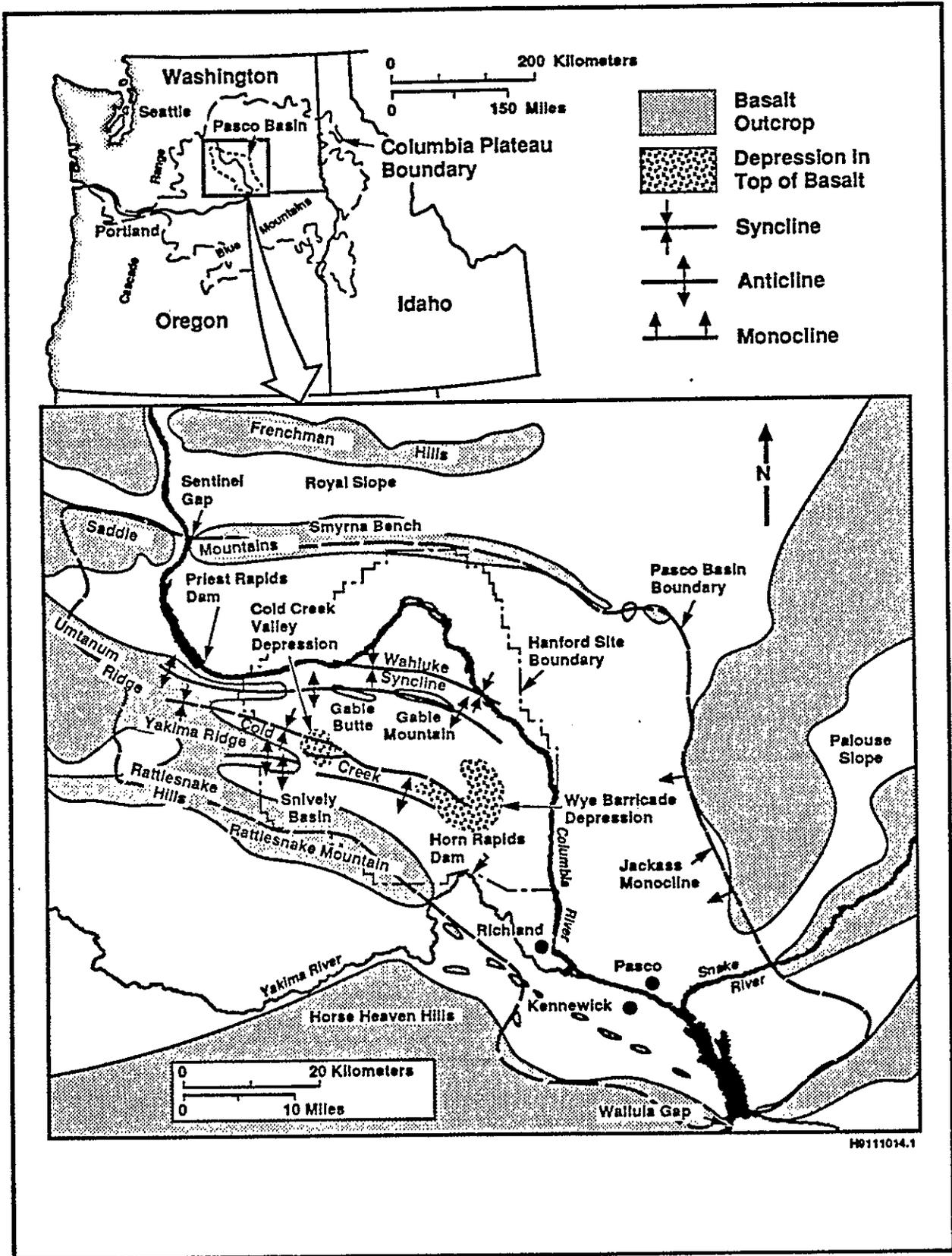
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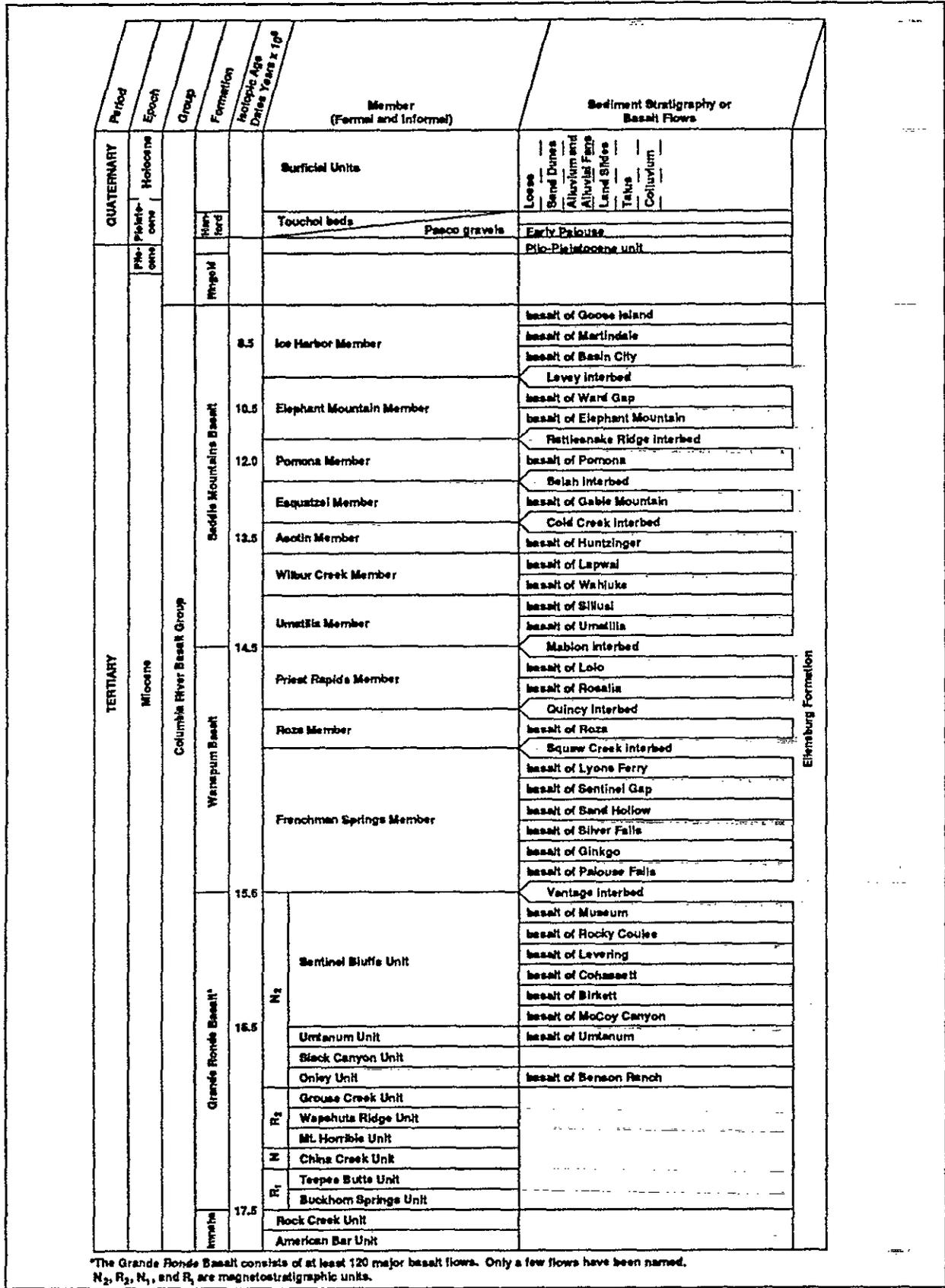
Figure 3-10. Structural Elements of the Yakima Fold Belt Subprovince (Last et al. 1989).



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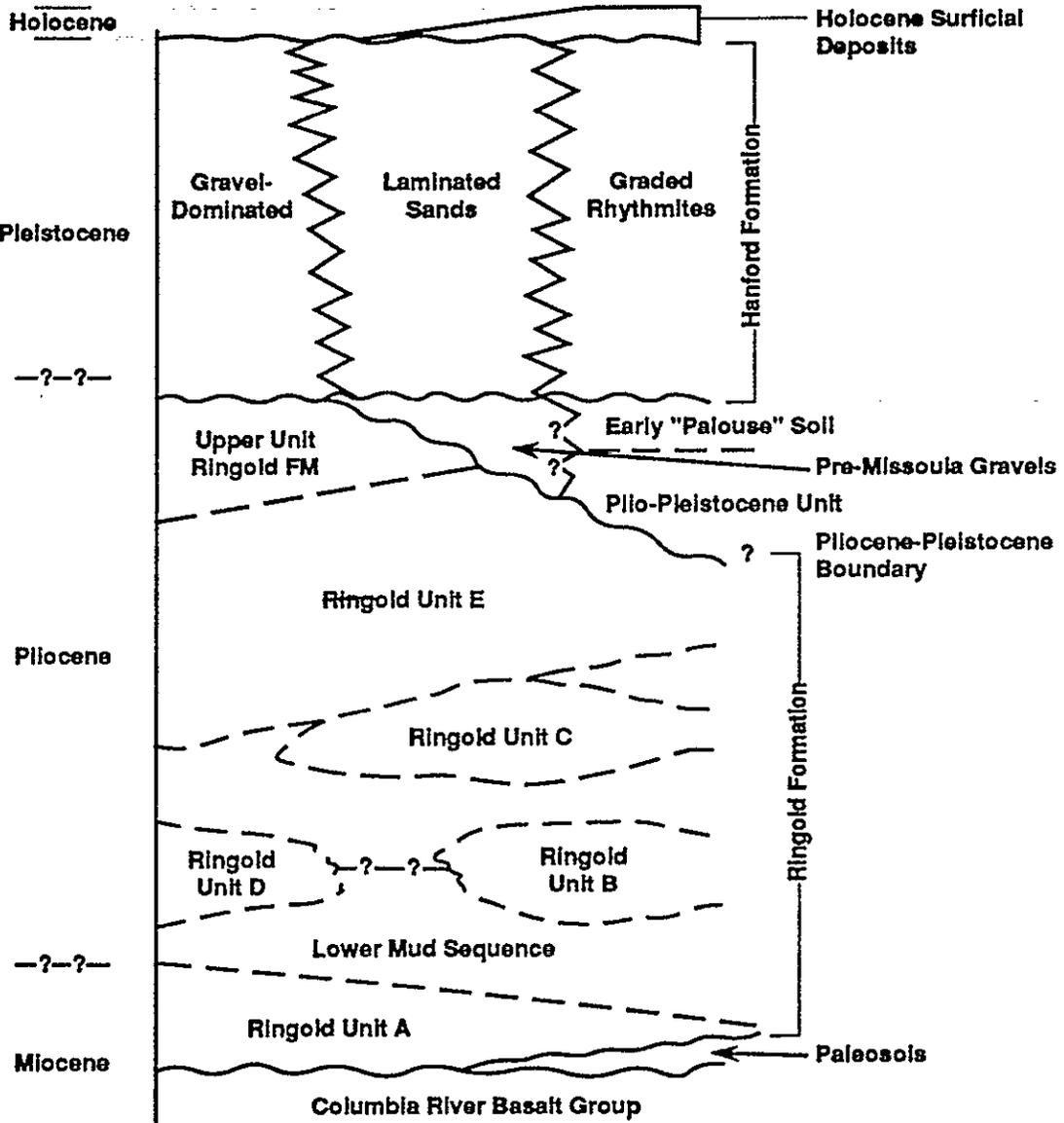
Figure 3-11. Geologic Structures of the Pasco Basin and the Hanford Site.
3F-11

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2 0 1 5 0 3 1 6 6



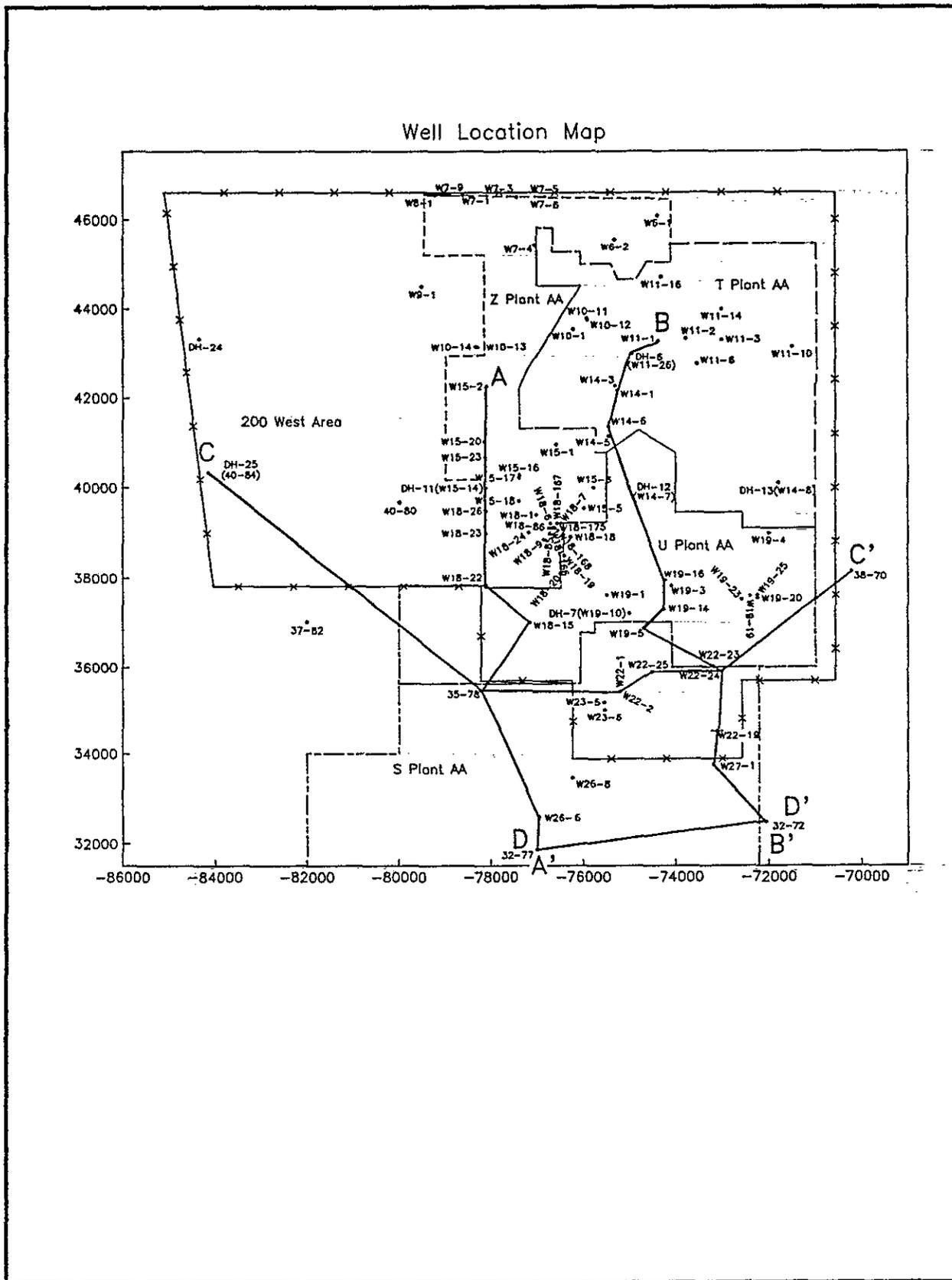
*The Grande Ronde Basalt consists of at least 120 major basalt flows. Only a few flows have been named. N₂, R₂, N₁, and R₁ are magnetostratigraphic units.

Figure 3-12. Generalized Stratigraphy of the Hanford Site.



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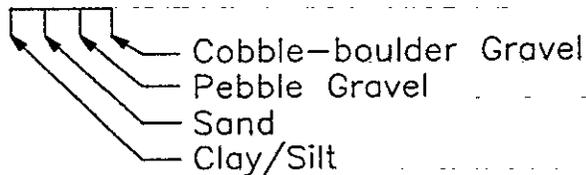
Figure 3-13. Generalized Stratigraphy of the Suprabasalt Sediments
Beneath the Hanford Site.



9 3 1 2 3 . 5 1 4 3 5

Figure 3-14. Location of Geologic Cross-Sections and Selected S Plant AA Wells.
3F-14

Grain Size Scale

Unit Abbreviations

| | |
|----|---------------------------------------|
| Hc | Upper Coarse Unit, Hanford Formation |
| Hf | Lower Fine Unit, Hanford Formation |
| EP | Early "Palouse" Soil |
| PP | Pliocene-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 |

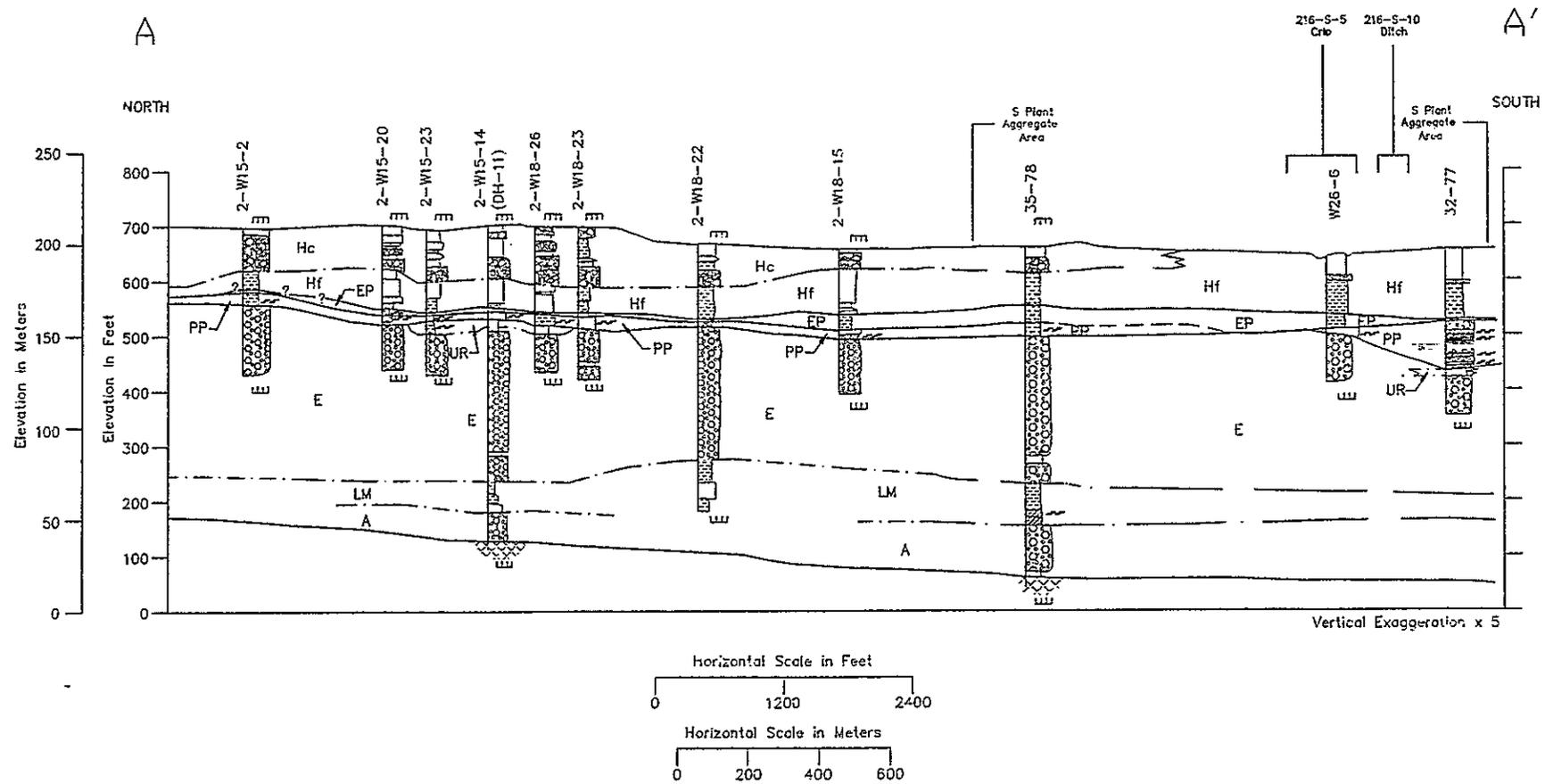
Symbols

| | |
|---|---------------------------------------|
| ———? | Formational Contact, ? Where Inferred |
| - - - ? - - - | Unit Contact, ? Where Inferred |
| ----- | Major Facies Contact |
| /// | Pedogenic Calcium Carbonate |
|  | Paleosols |
|  | Ringold Clast Supported Gravels |
|  | Open Framework Hanford Gravels |
|  | Laminated Mud |
|  | Basalt |

NOTES:

1. Refer to Figure 3-14 for cross section locations and designation. Cross sections presented on Figures 3-16 through 3-19.
2. Figures based on Lindsey et al. 1991 and Airhart et al. 1990.
3. Units predominantly consisting of Sand are indicated by blank spaces.

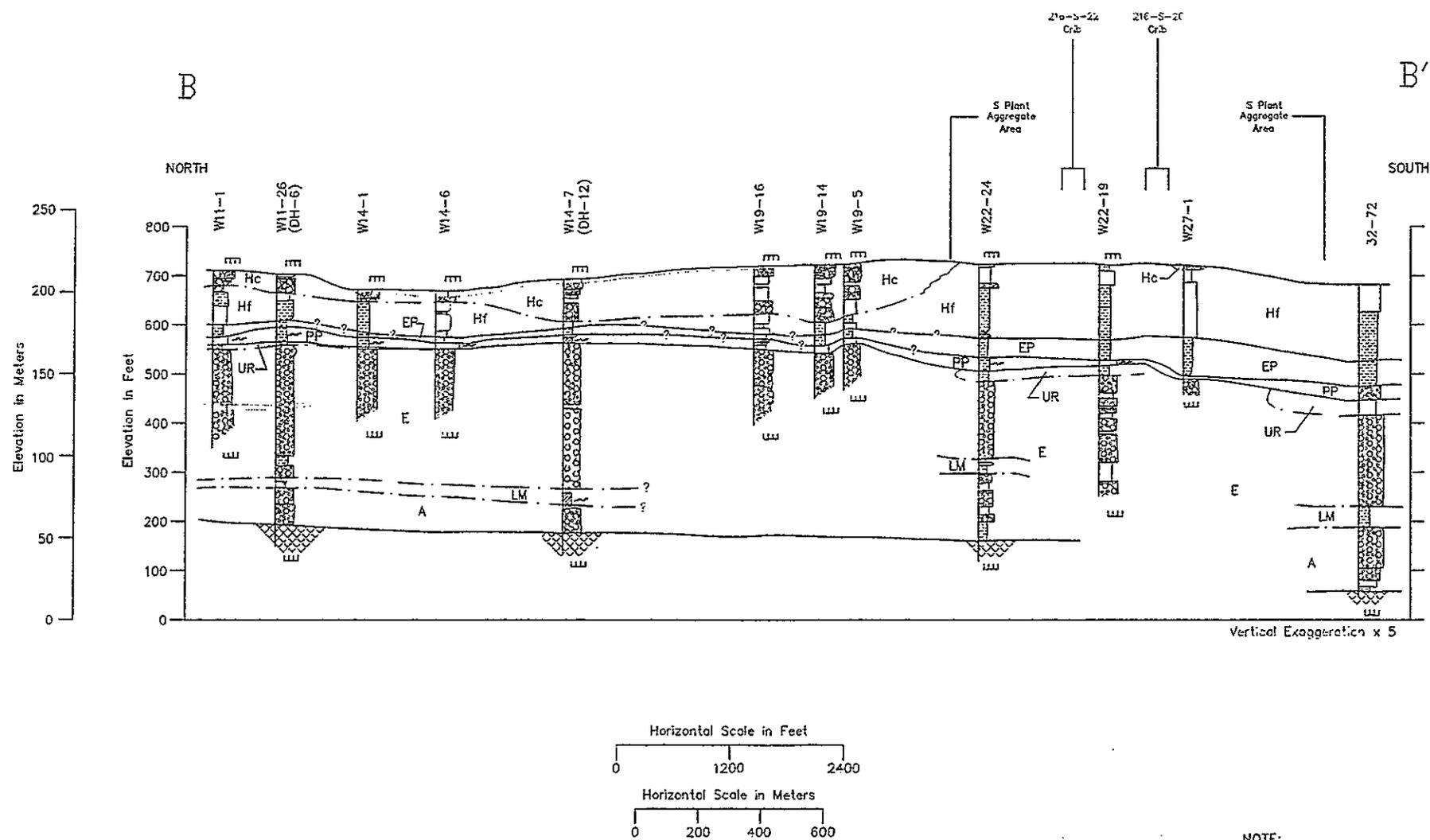
Figure 3-15. Legend for Cross Sections A-A' through D-D'.



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

Figure 3-16. Geologic Cross-Section A-A'.

93120651A07

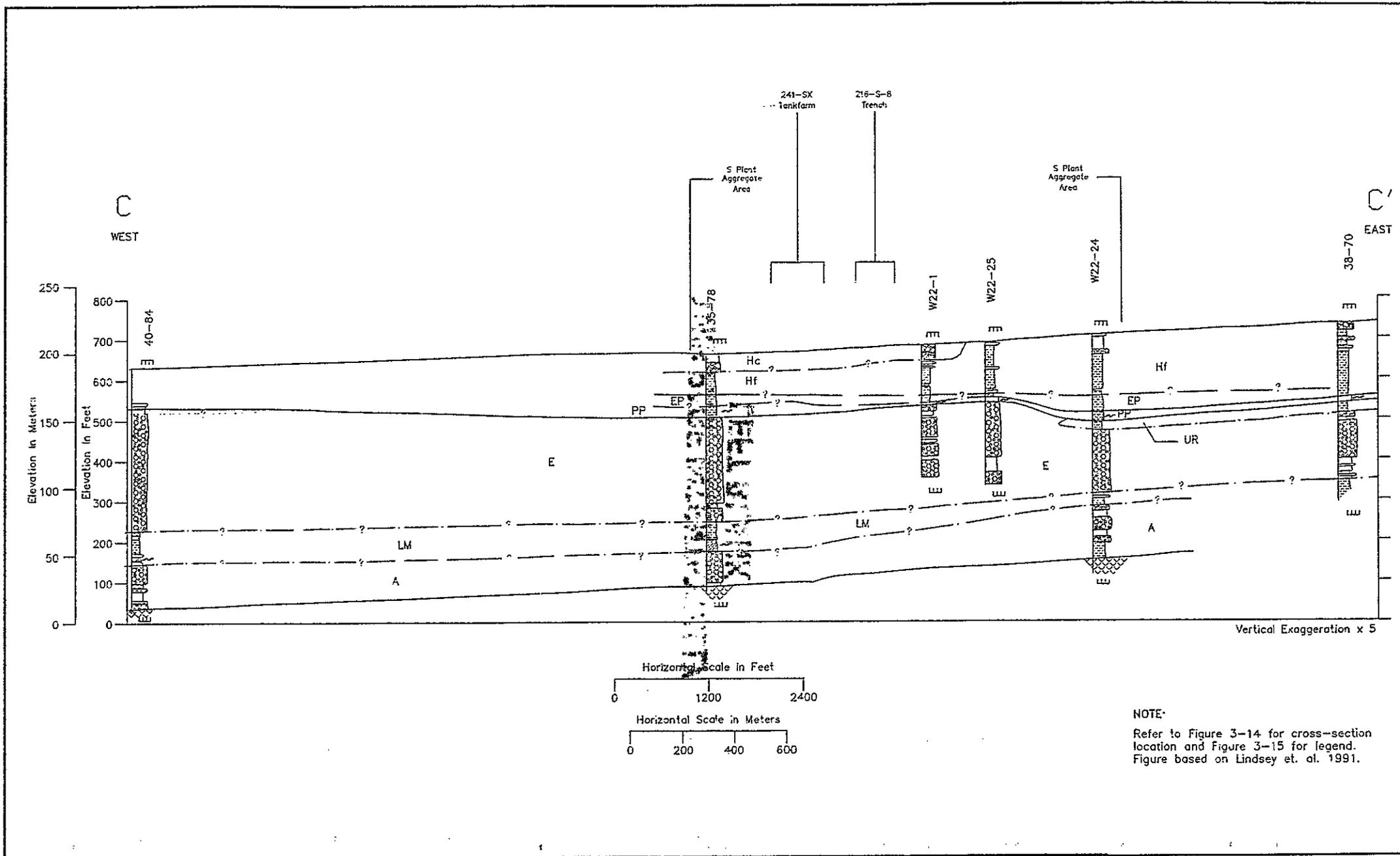


NOTE:
Refer to Figure 3-14 for cross-section location and Figure 3-15 for legend.
Figure based on Lindsey et. al. 1991.

9 3 1 9 6 1 5 1 4 9 8

Figure 3-17. Geologic Cross-Section B-B'.
3F-17

9 1 1 9 8 5 1 7 9 9



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

Figure 3-18. Geologic Cross-Section C-C'.
3F-18

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9 3 1 2 0 5 1 4 9 0

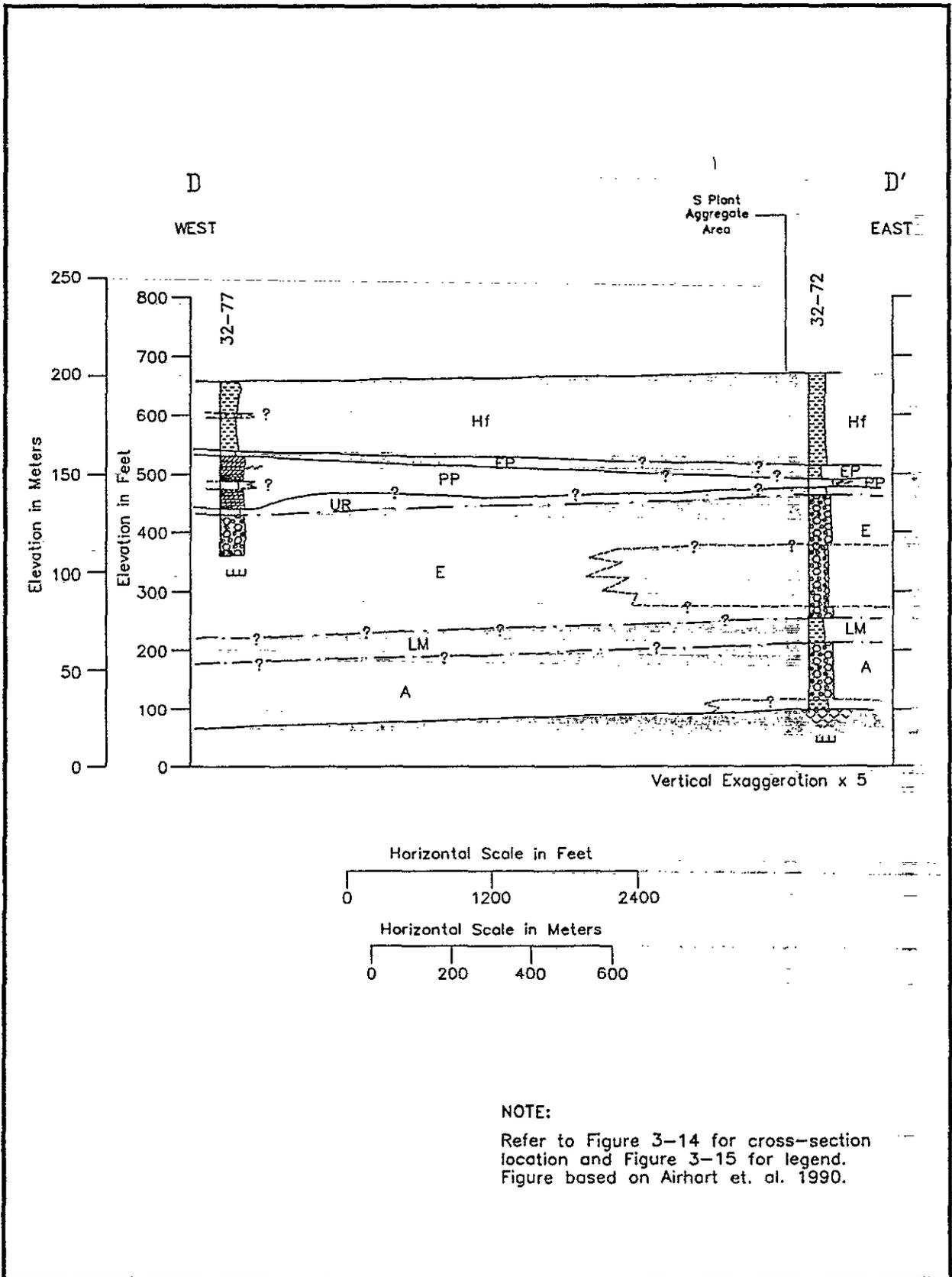


Figure 3-19. Geologic Cross-Section D-D'.
3F-19

9 3 1 2 8 5 1 4 9 1

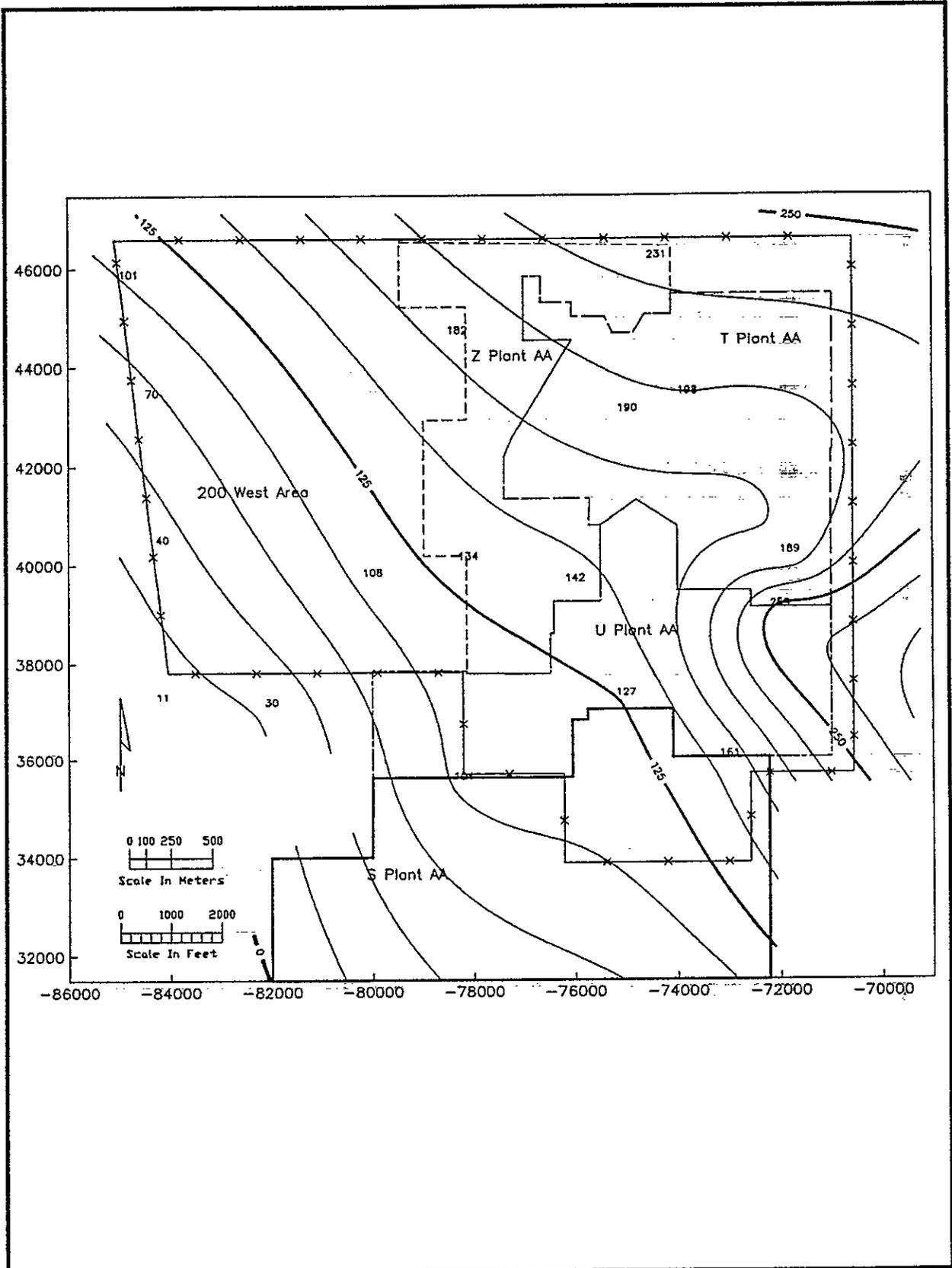


Figure 3-20. Top of the Elephant Mountain Basalt.
3F-20

9 3 1 2 0 5 1 0 9 2

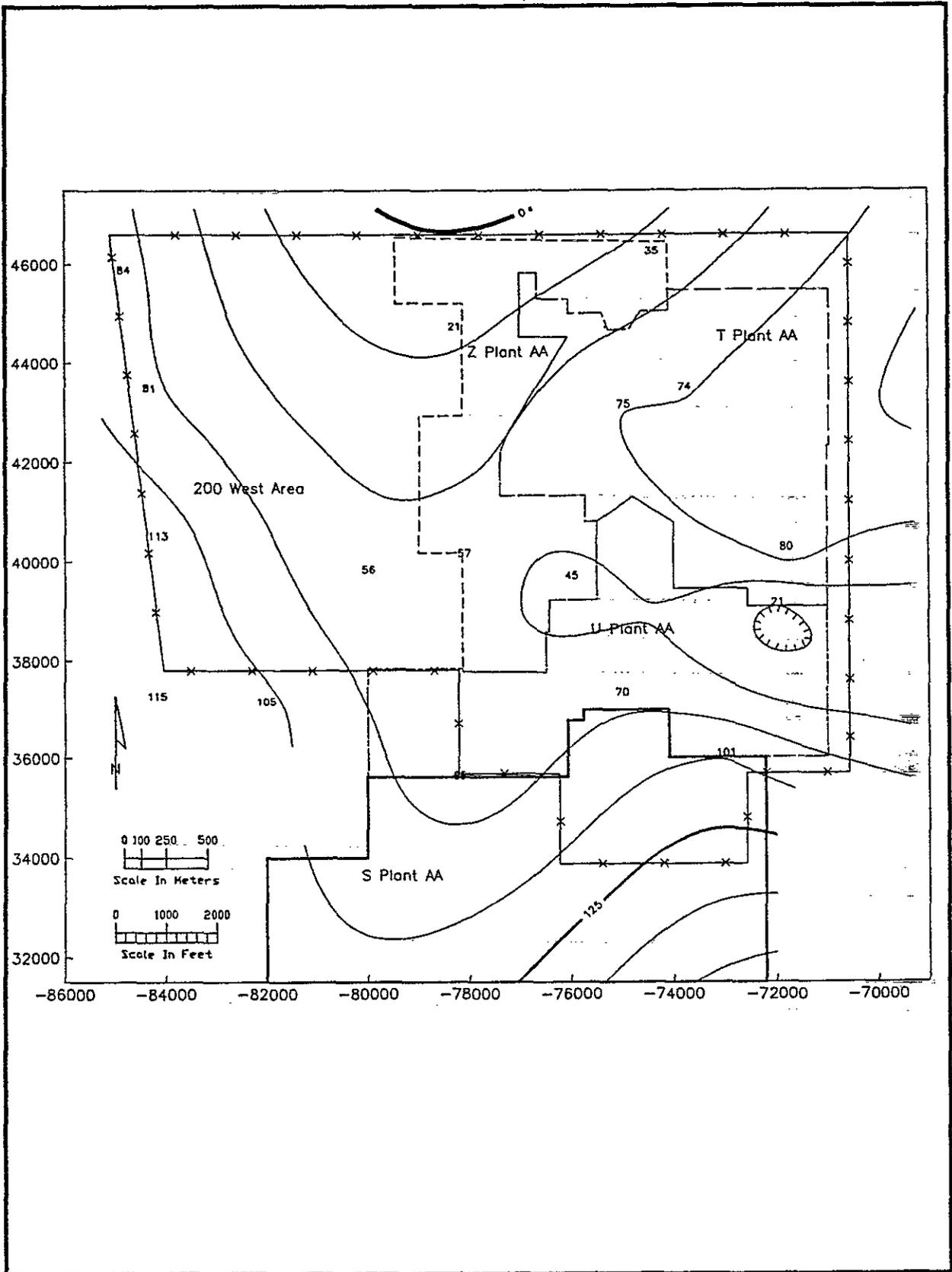


Figure 3-21. Isopach Map of the Ringold Gravel Unit A.
3F-21

9 3 1 2 8 5 1 4 9 3

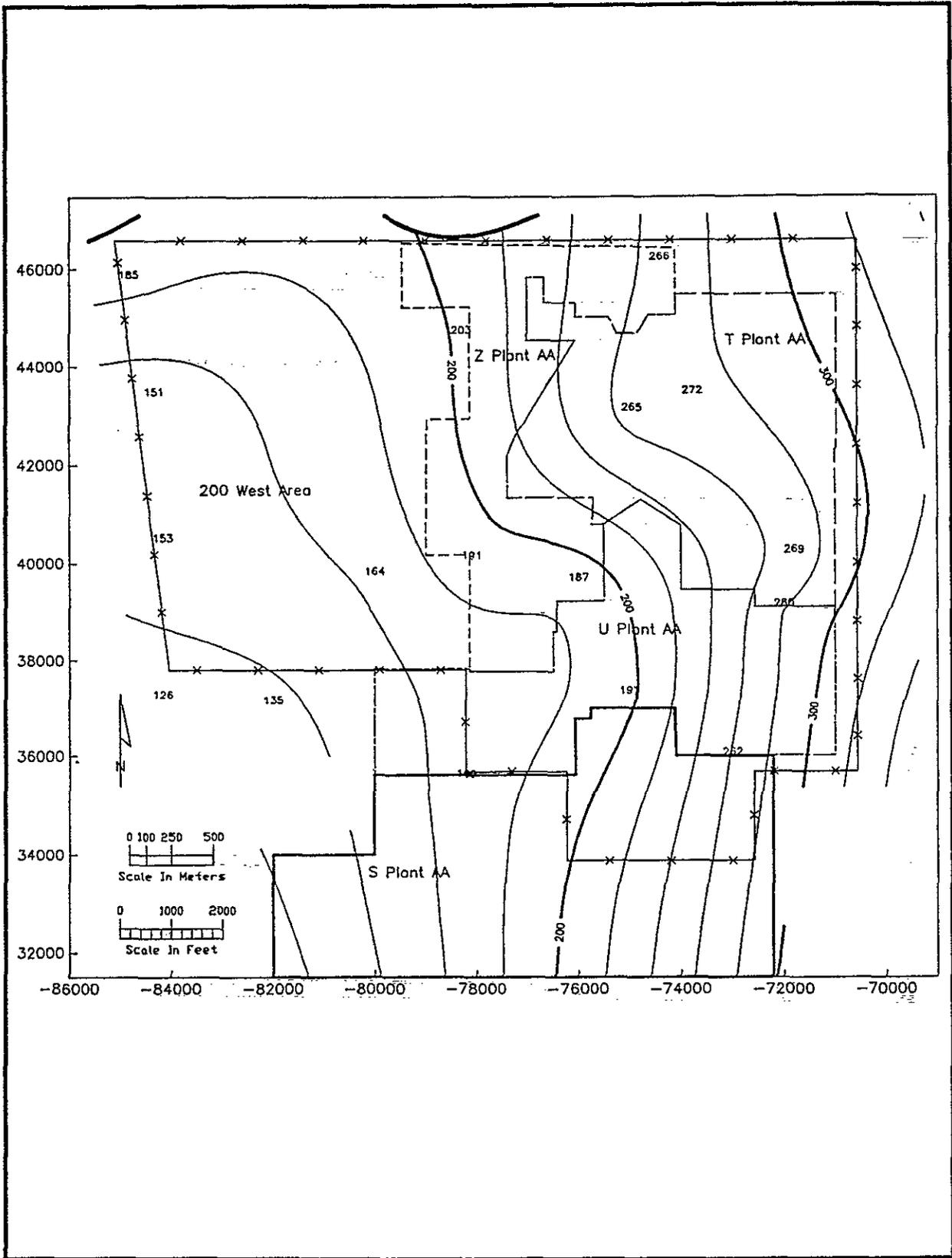


Figure 3-22. Structure Map of the Ringold Gravel Unit A.
3F-22

9512051494

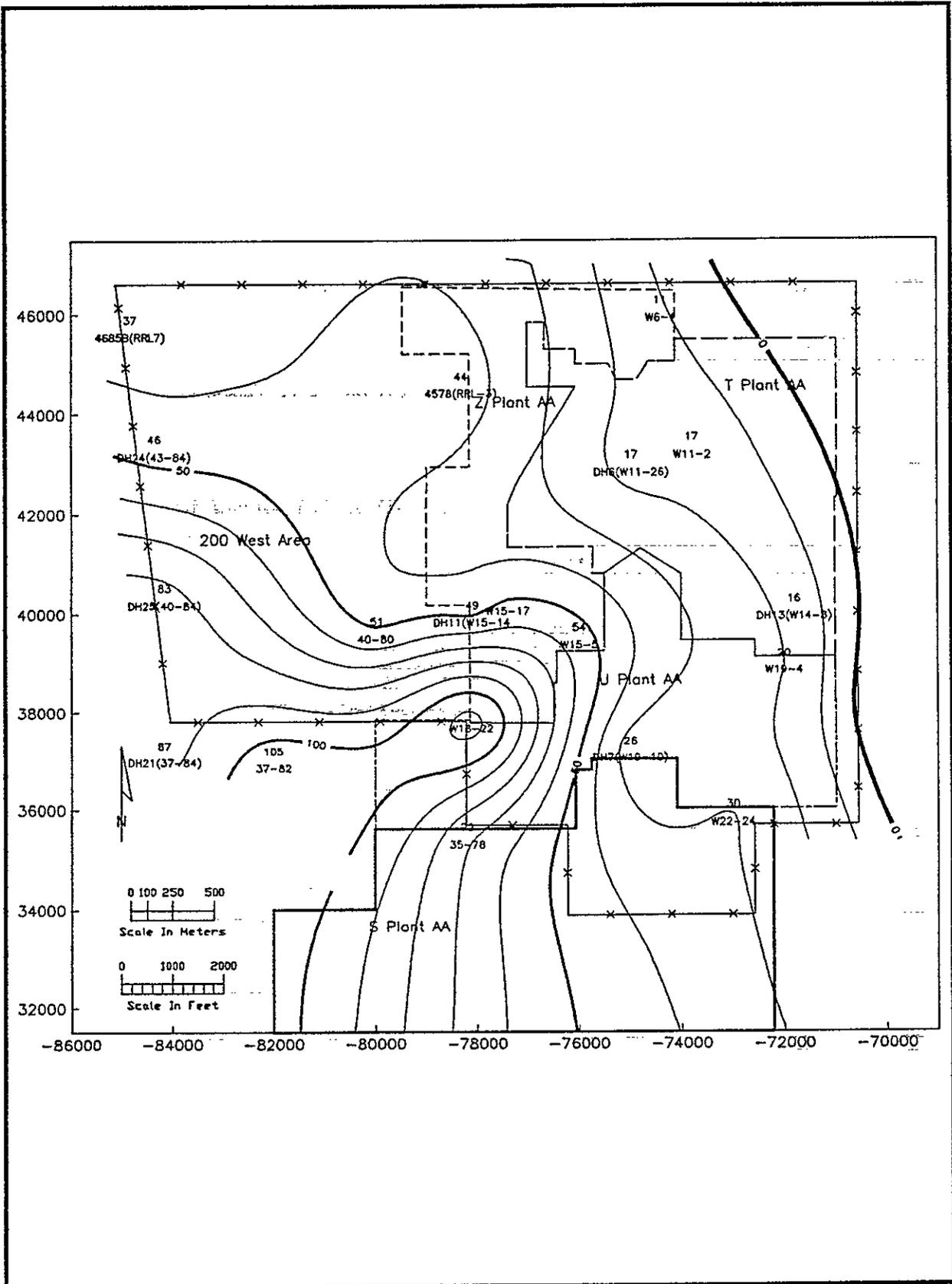


Figure 3-23. Isopach Map of the Ringold Lower Mud Unit.
3F-23

9 3 1 2 0 1 5 1 4 9 5

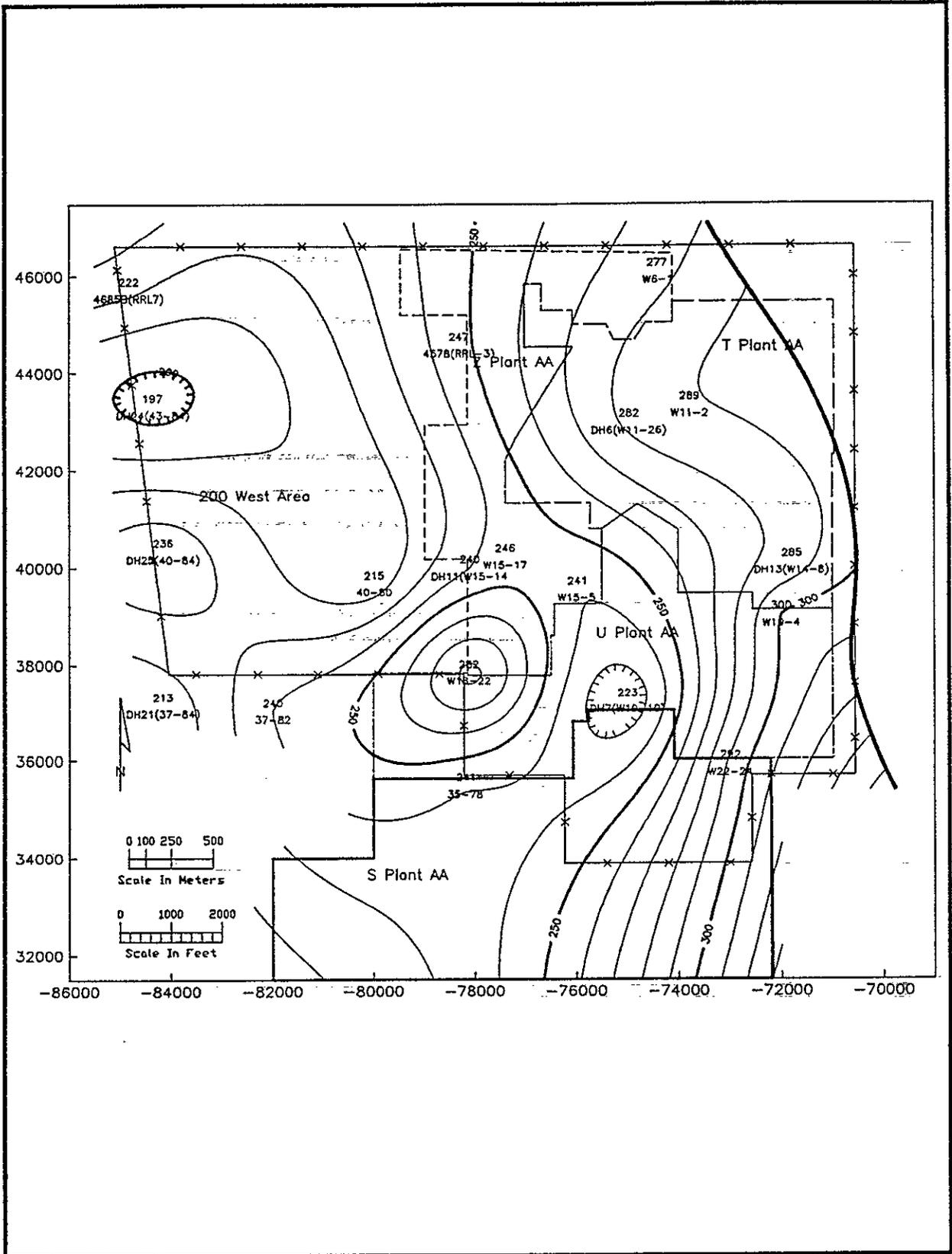


Figure 3-24. Structure Map of the Ringold Lower Mud Unit.
3F-24

9 5 1 9 0 5 1 4 9 6

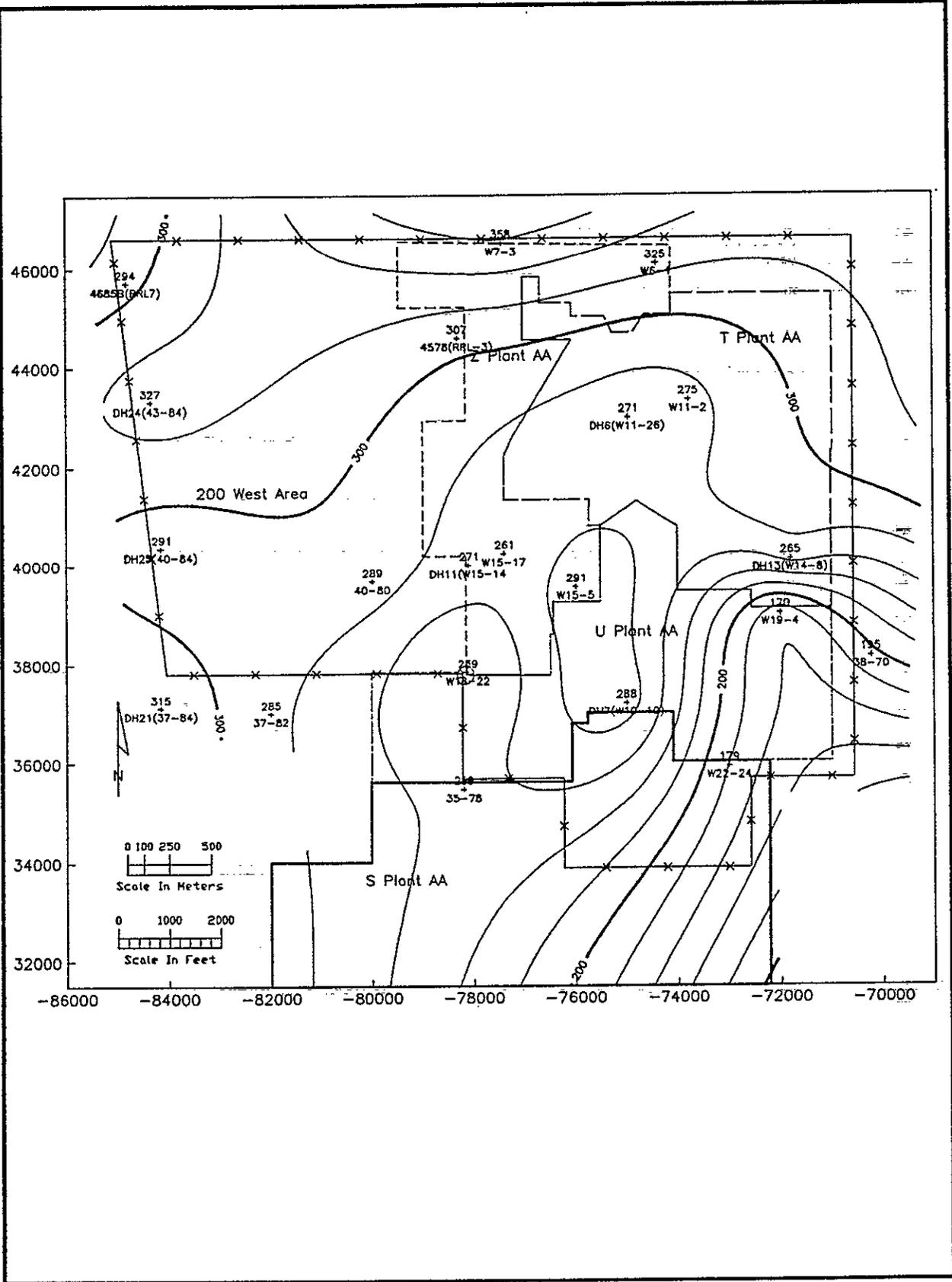


Figure 3-25. Isopach Map of the Ringold Gravel Unit E.
3F-25

9 3 1 0 9 5 1 0 9 7

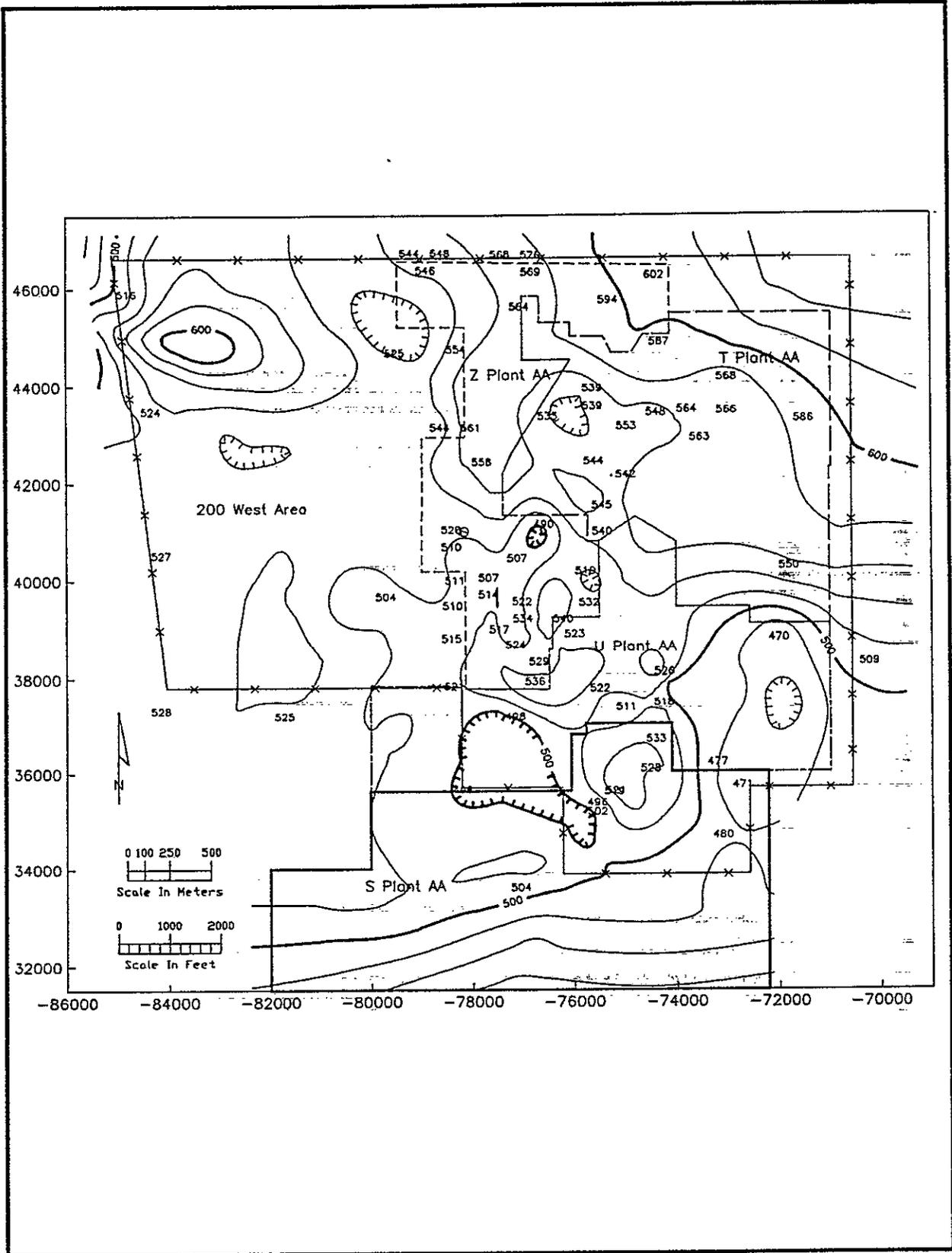
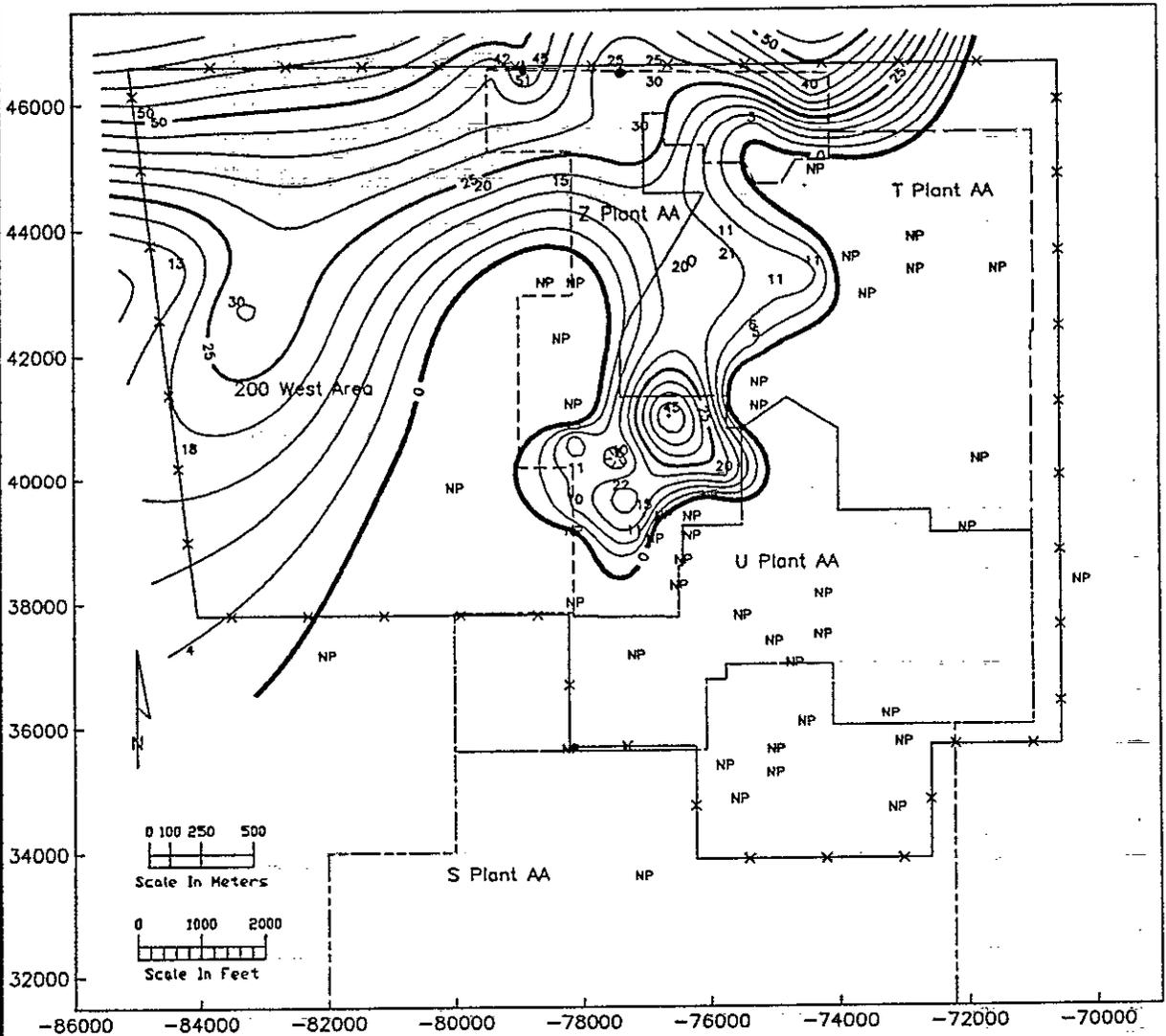


Figure 3-26. Structure Map of the Ringold Gravel Unit E.
3F-26

(ur_thk) Isopach Map of the Upper Ringold Formation



9 6 7 1 5 7 0 6 1 9 8

Figure 3-27. Isopach Map of the Upper Ringold Formation.
3F-27

9 5 1 0 0 1 5 1 0 9 9

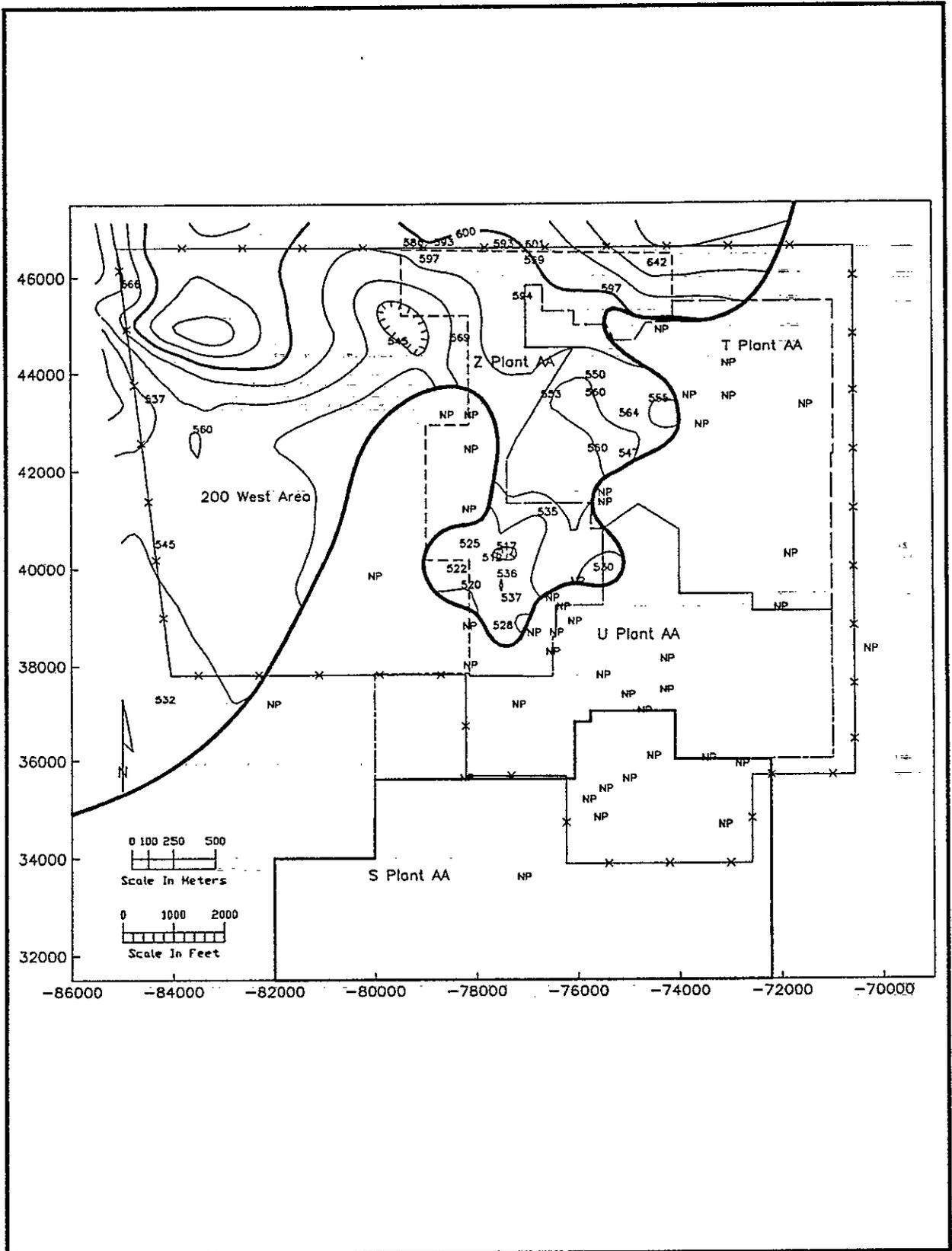


Figure 3-28. Structure Map of the Upper Ringold Formation.
3F-28

91005100

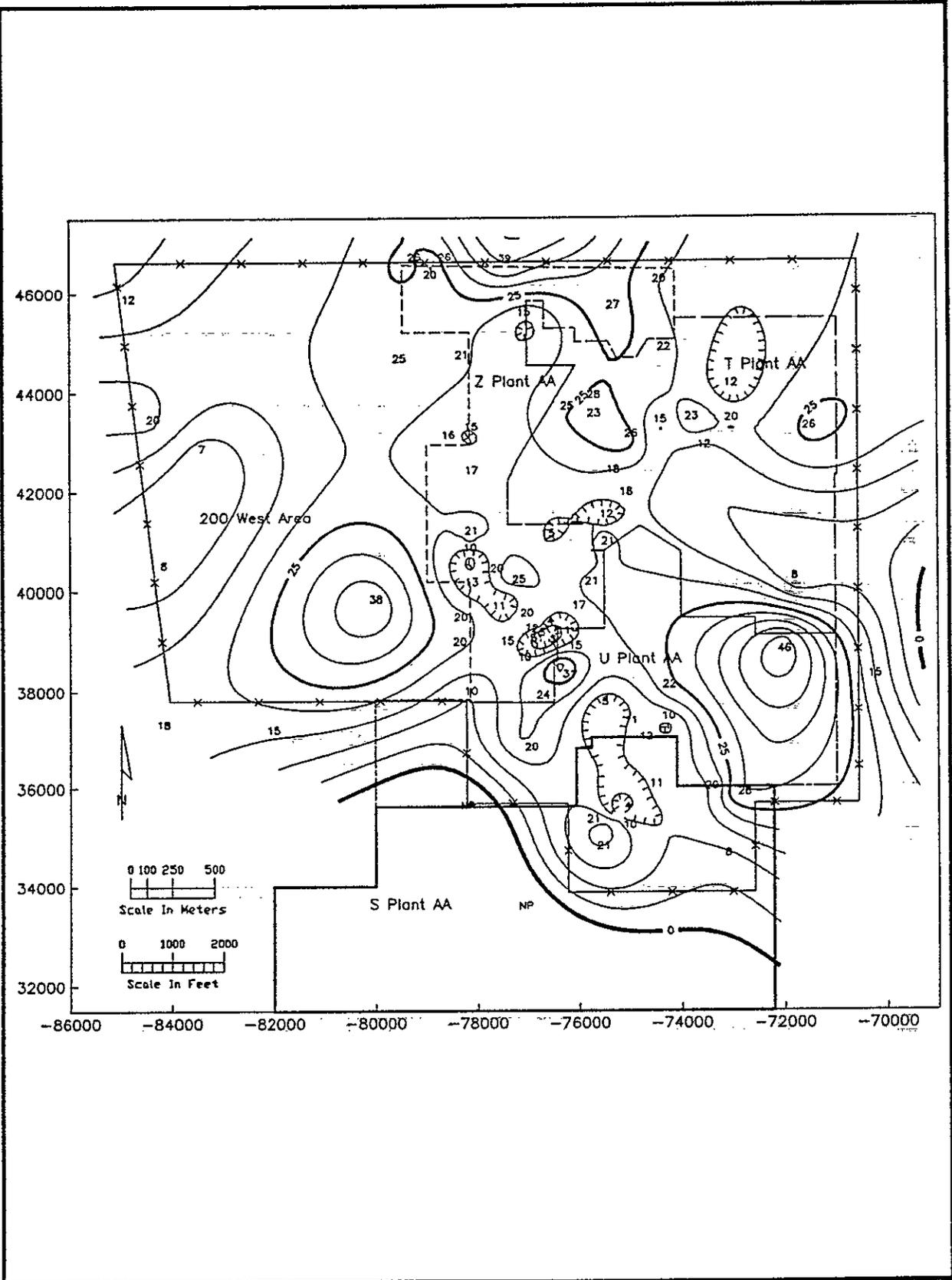


Figure 3-29. Isopach Map of the Plio-Pleistocene Unit.
3F-29

9 5 1 9 9 . 5 1 5 0 2

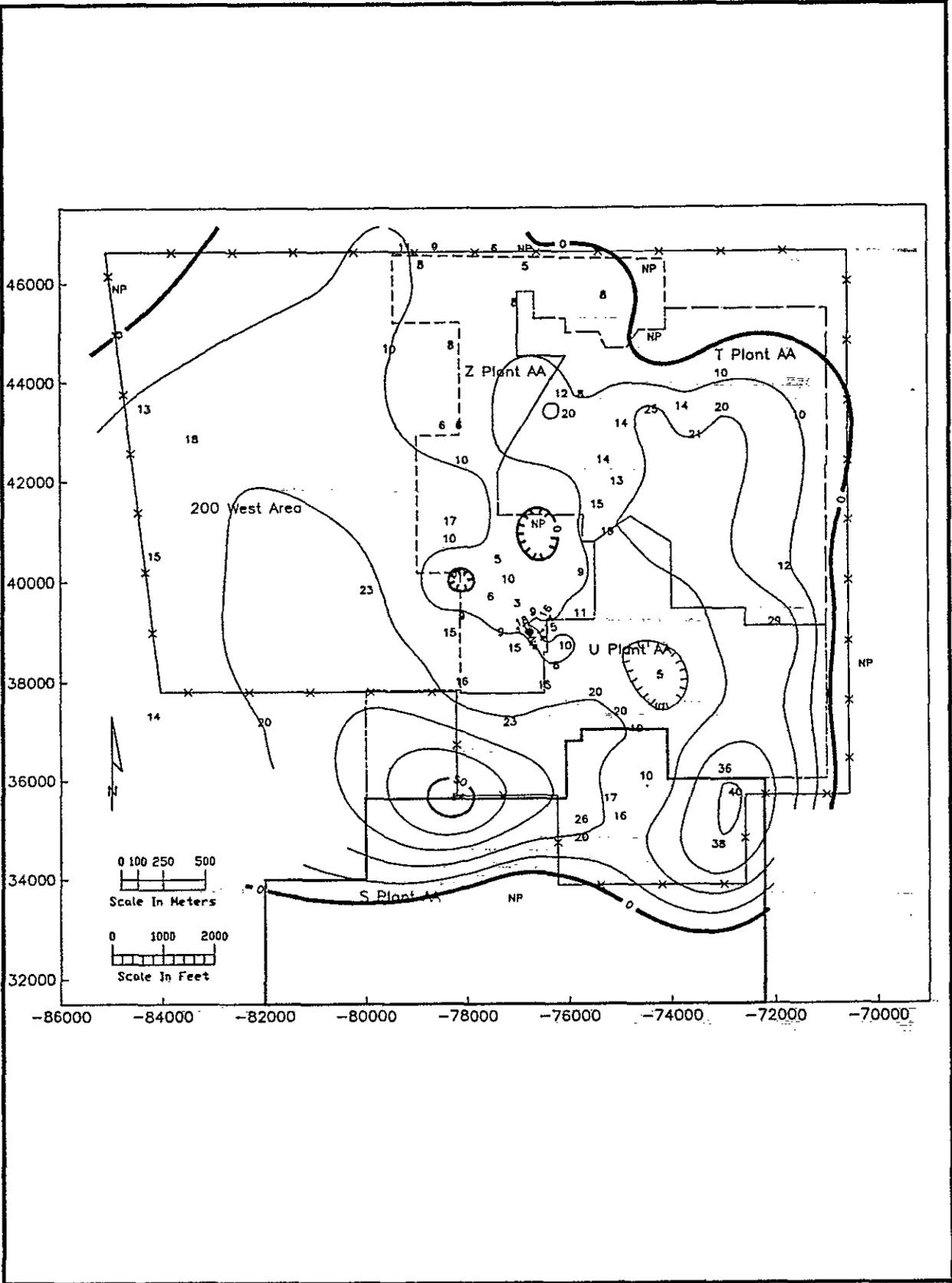


Figure 3-31. Isopach Map of the Early Palouse Soils.
3F-31

9 5 1 2 0 5 1 9 0 3

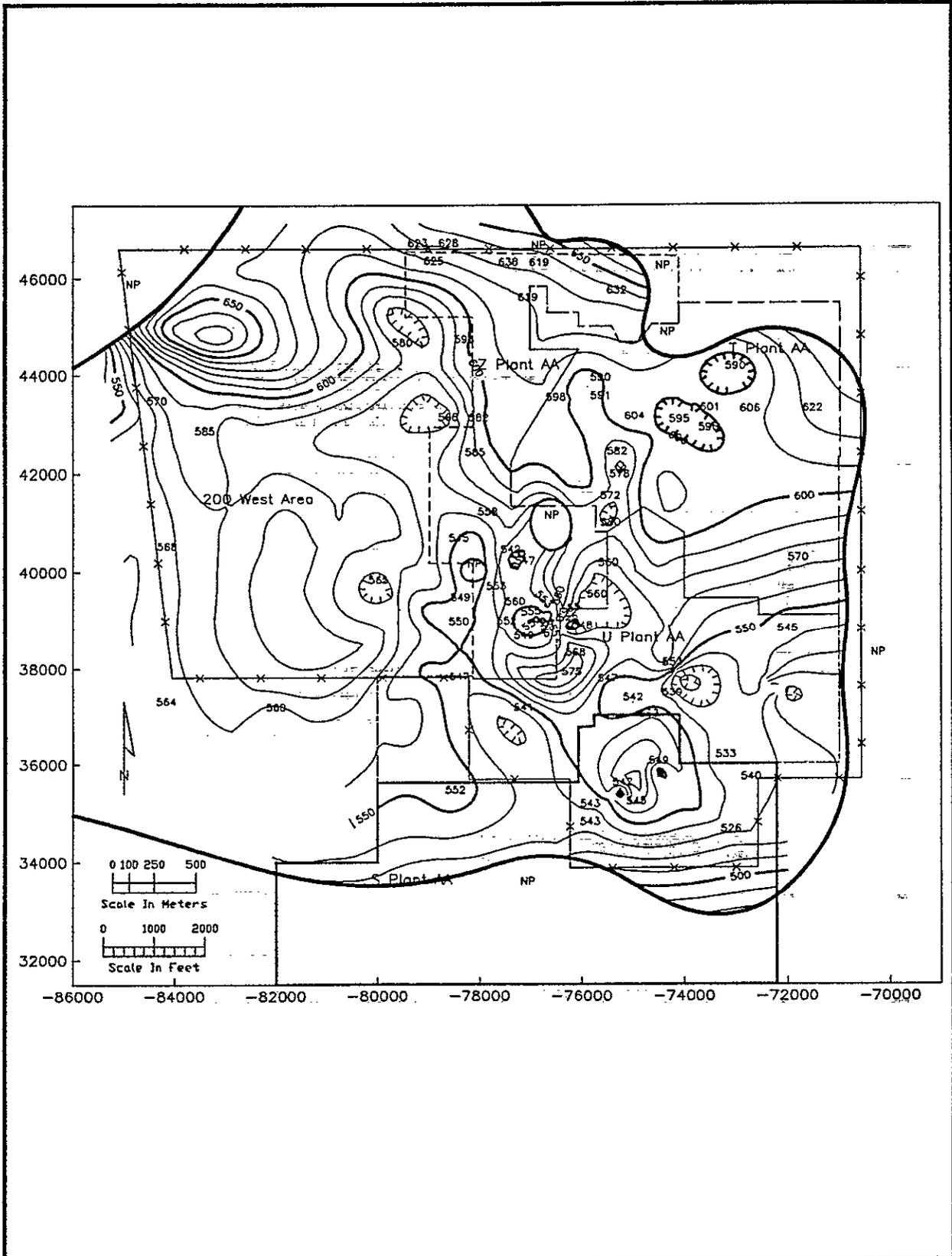


Figure 3-32. Structure Map of the Early Palouse Soils.
3F-32

9 5 1 0 0 5 1 5 0 4

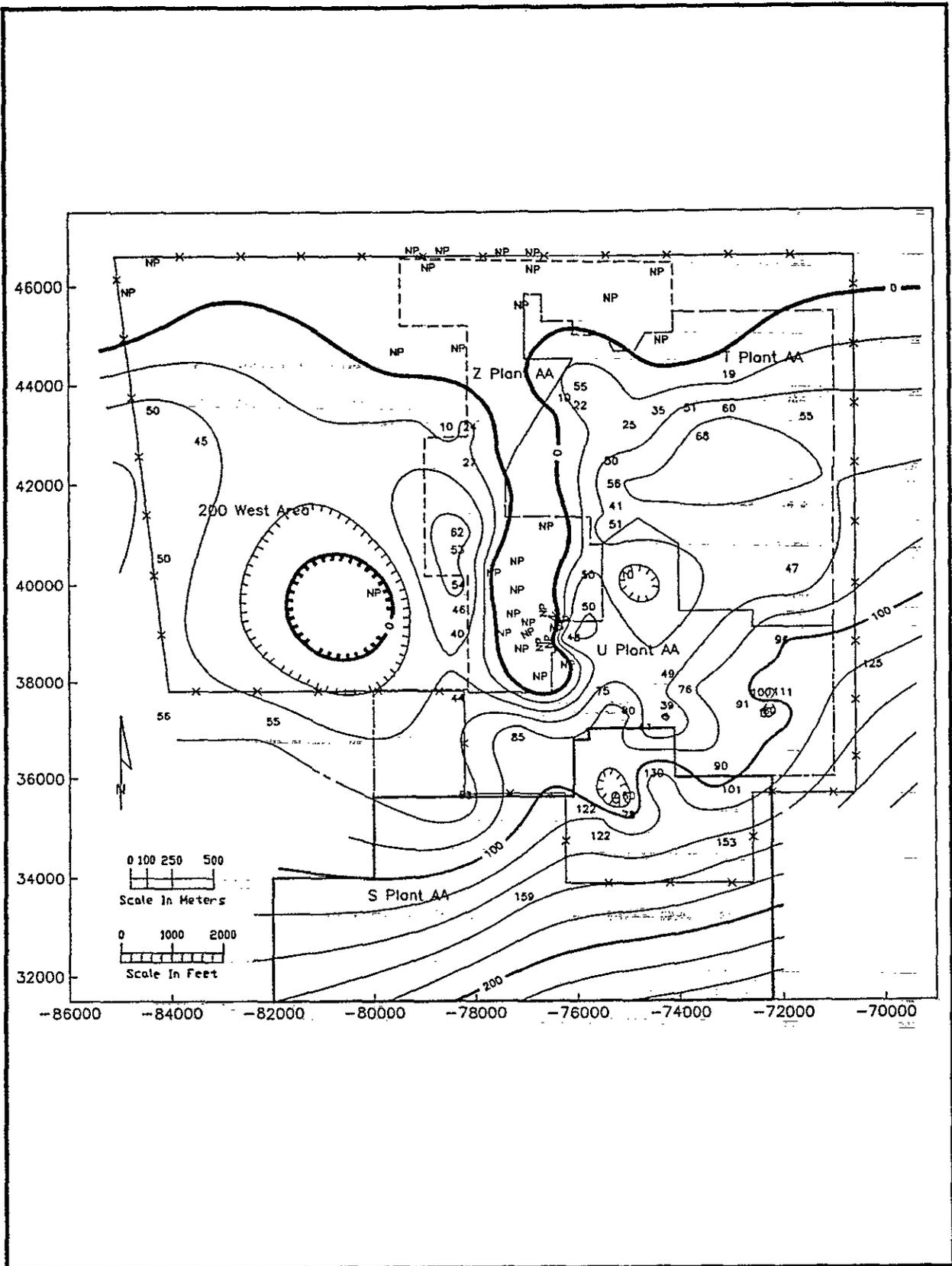


Figure 3-33. Isopach Map of the Lower Fine-Grained Unit of the Hanford formation.
3F-33

9 5 1 9 0 7 5 1 7 0 5

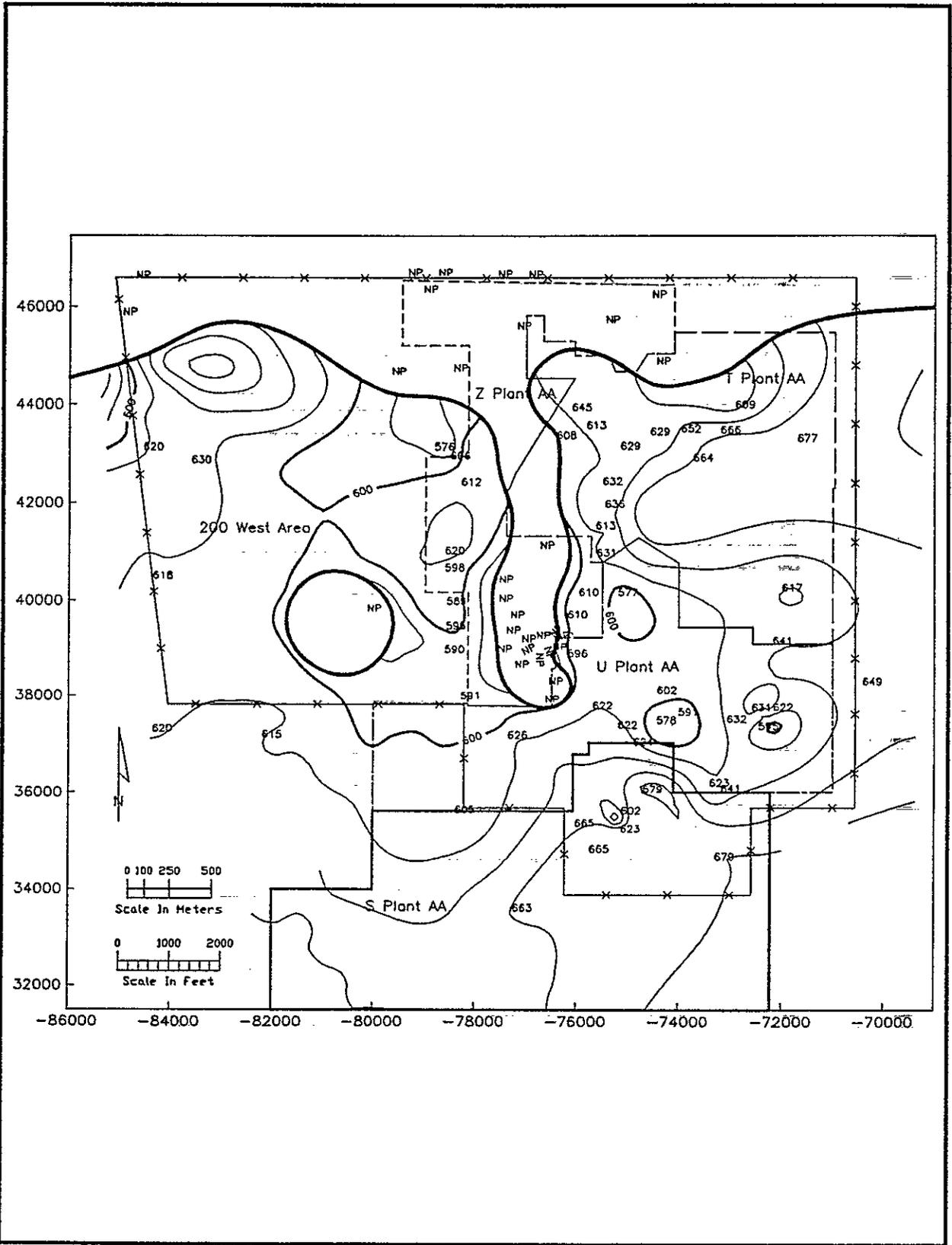


Figure 3-34. Structure Map of the Lower Fine-Grained Unit of the Hanford formation.

9 3 1 2 9 / 5 1 7 0 6

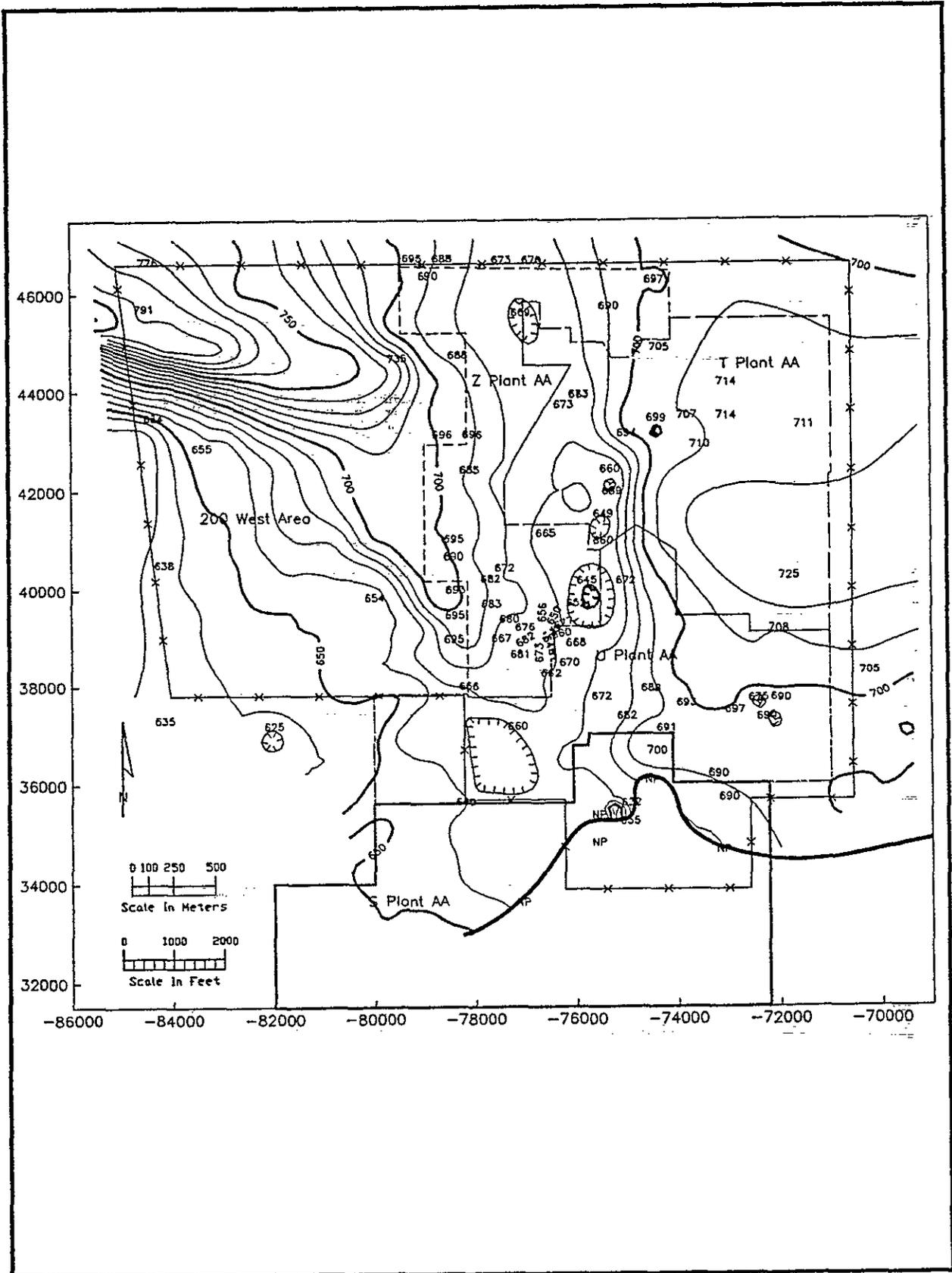


Figure 3-35. Structure Map of the Hanford formation (Basal Slackwater Facies).
3F-35

9 3 1 2 0 7 5 1 7 0 7

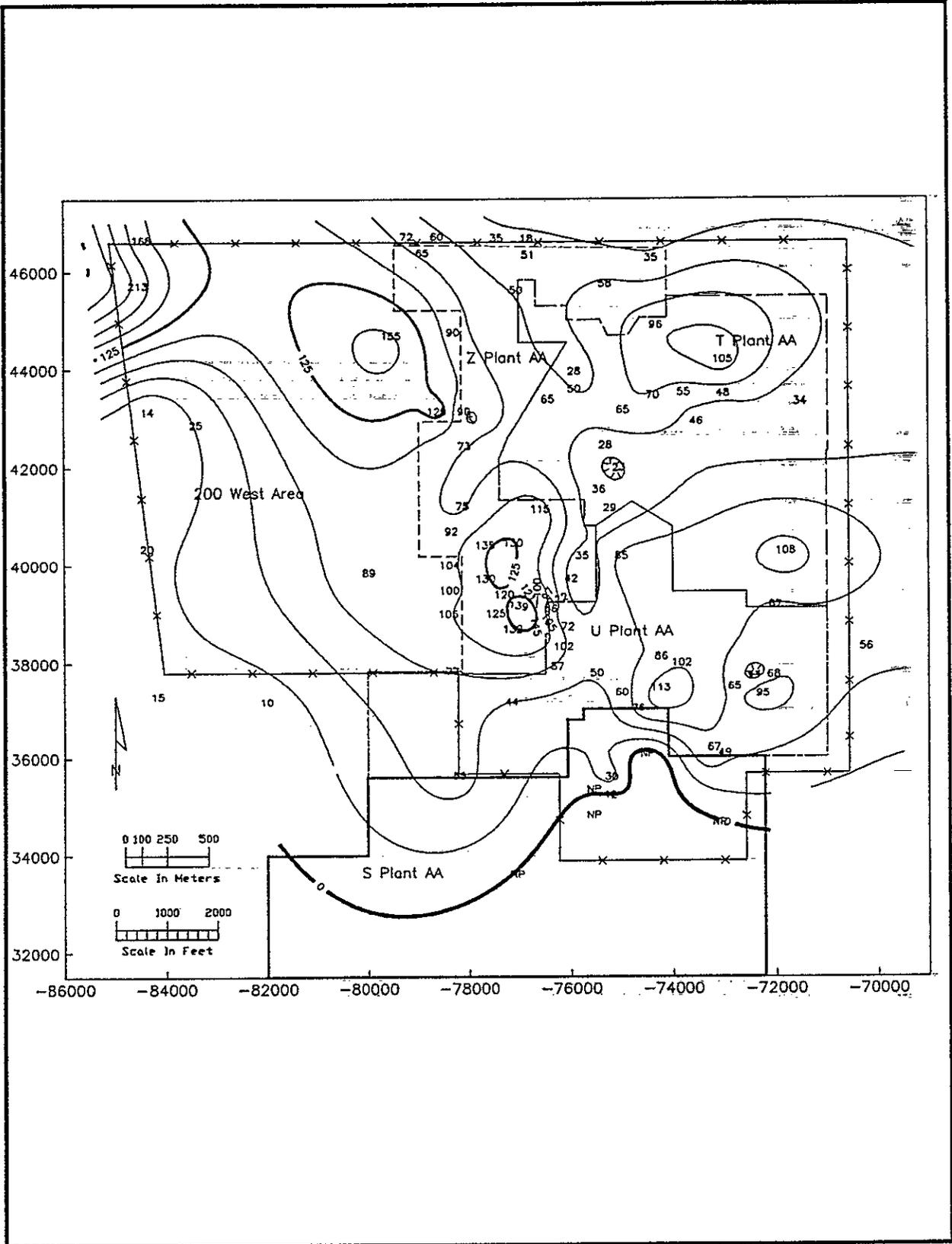


Figure 3-36. Isopach Map of the Upper Coarse-Grained Unit of the Hanford formation.
3F-36

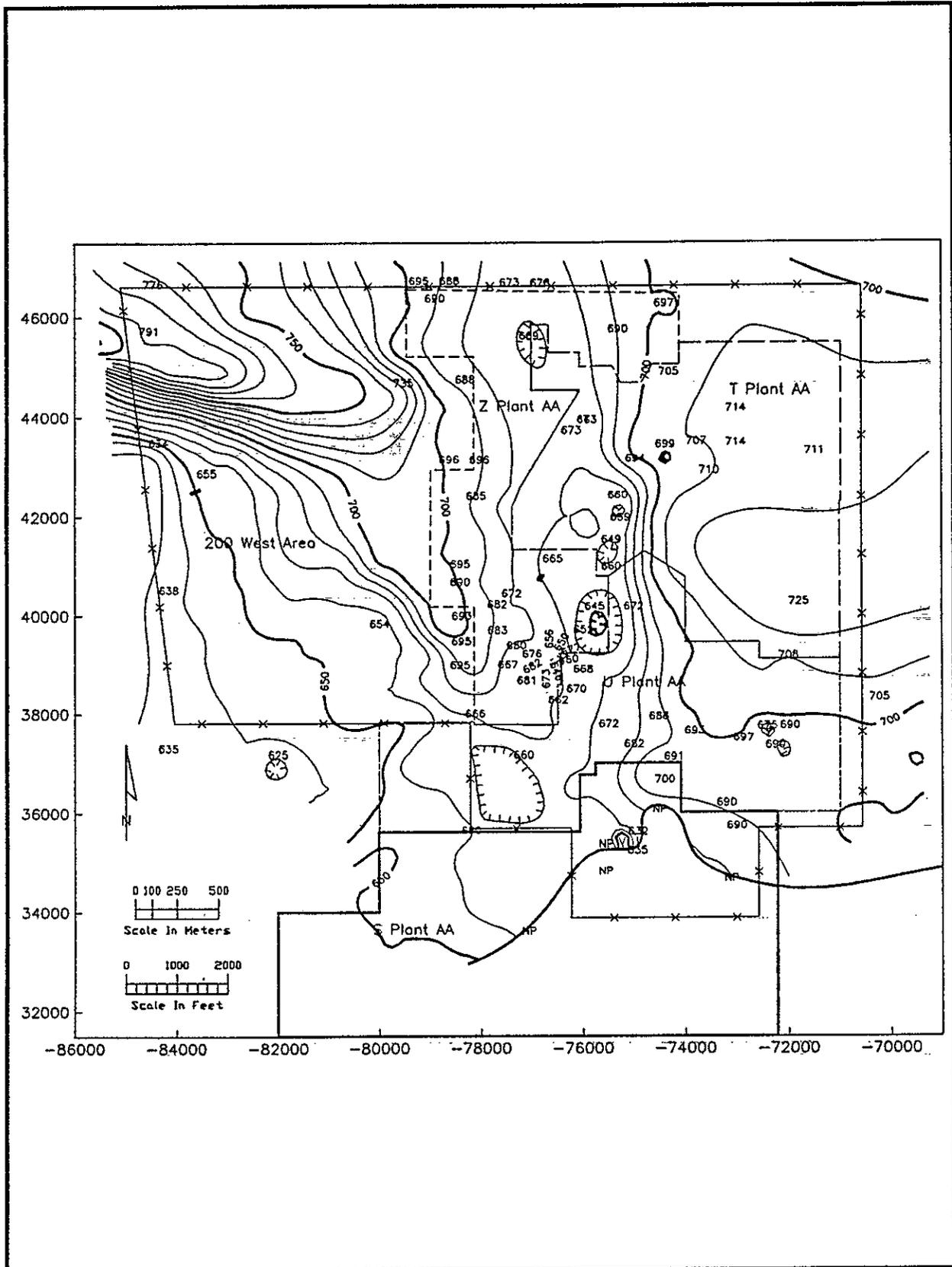


Figure 3-37. Structure Map of the Upper Coarse-Grained Unit of the Hanford formation.

3F-37

9 0 1 2 3 4 5 6 7 8

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

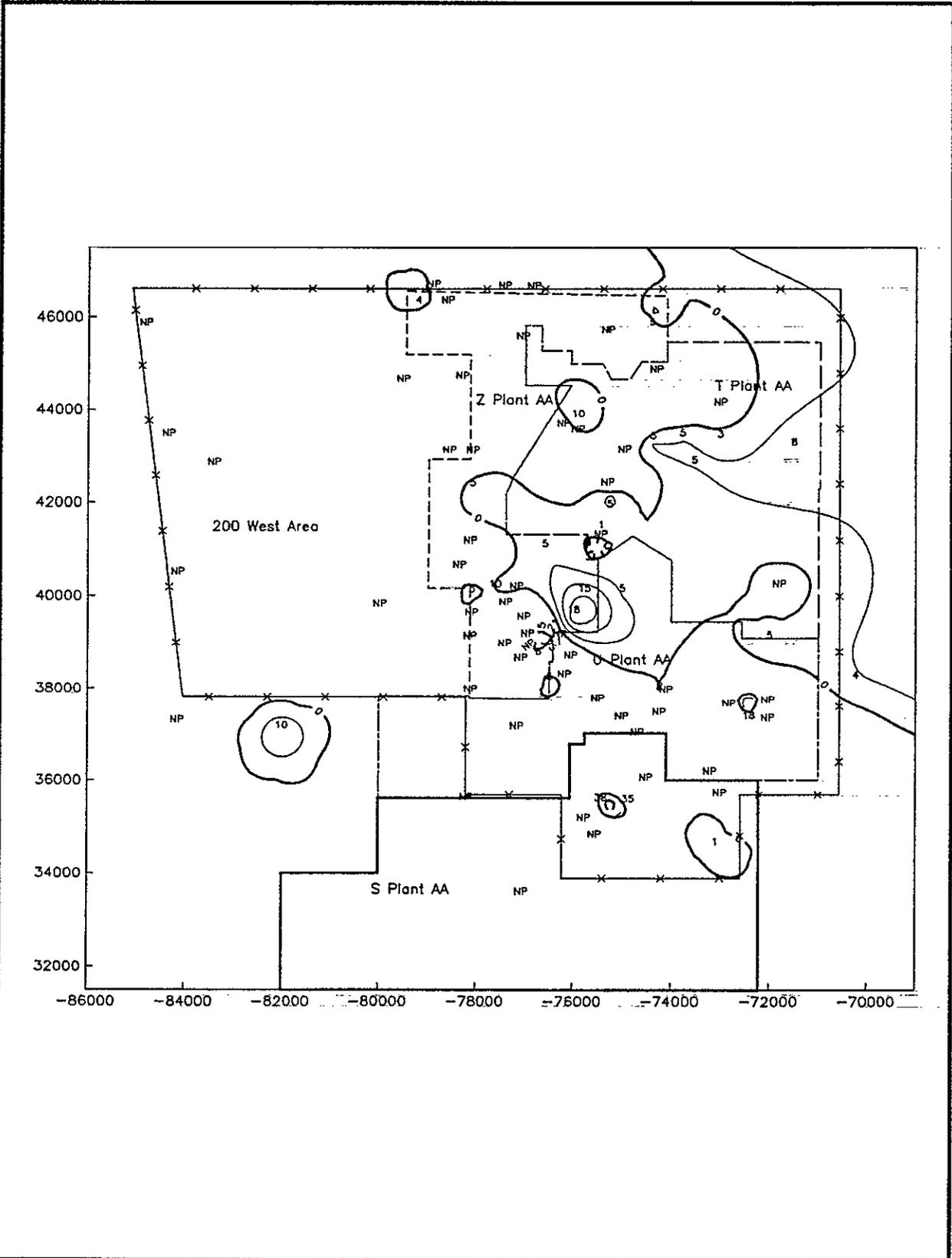


Figure 3-38. Isopach Map of the Backfilled Gravels and Eolian Sands.
3F-38

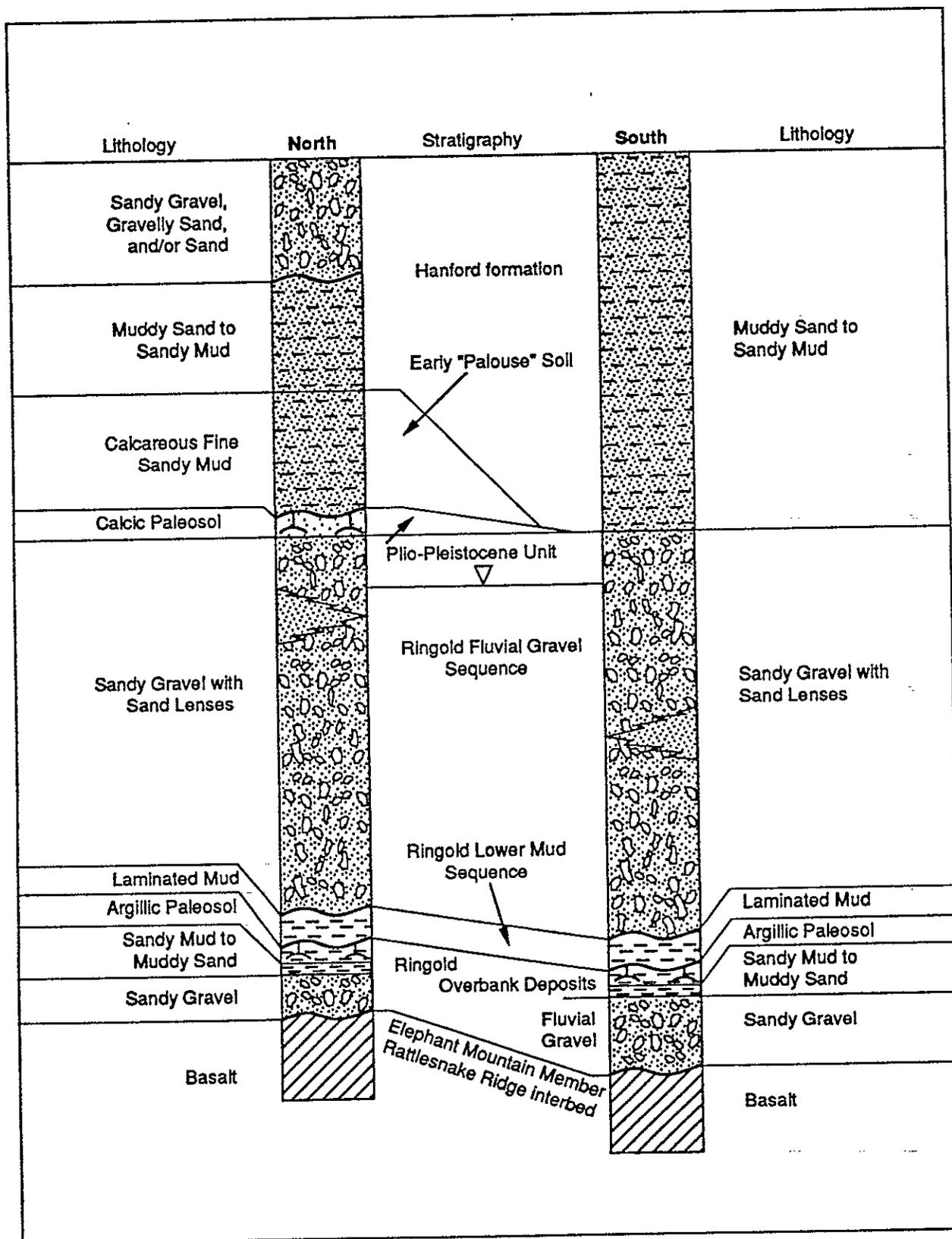
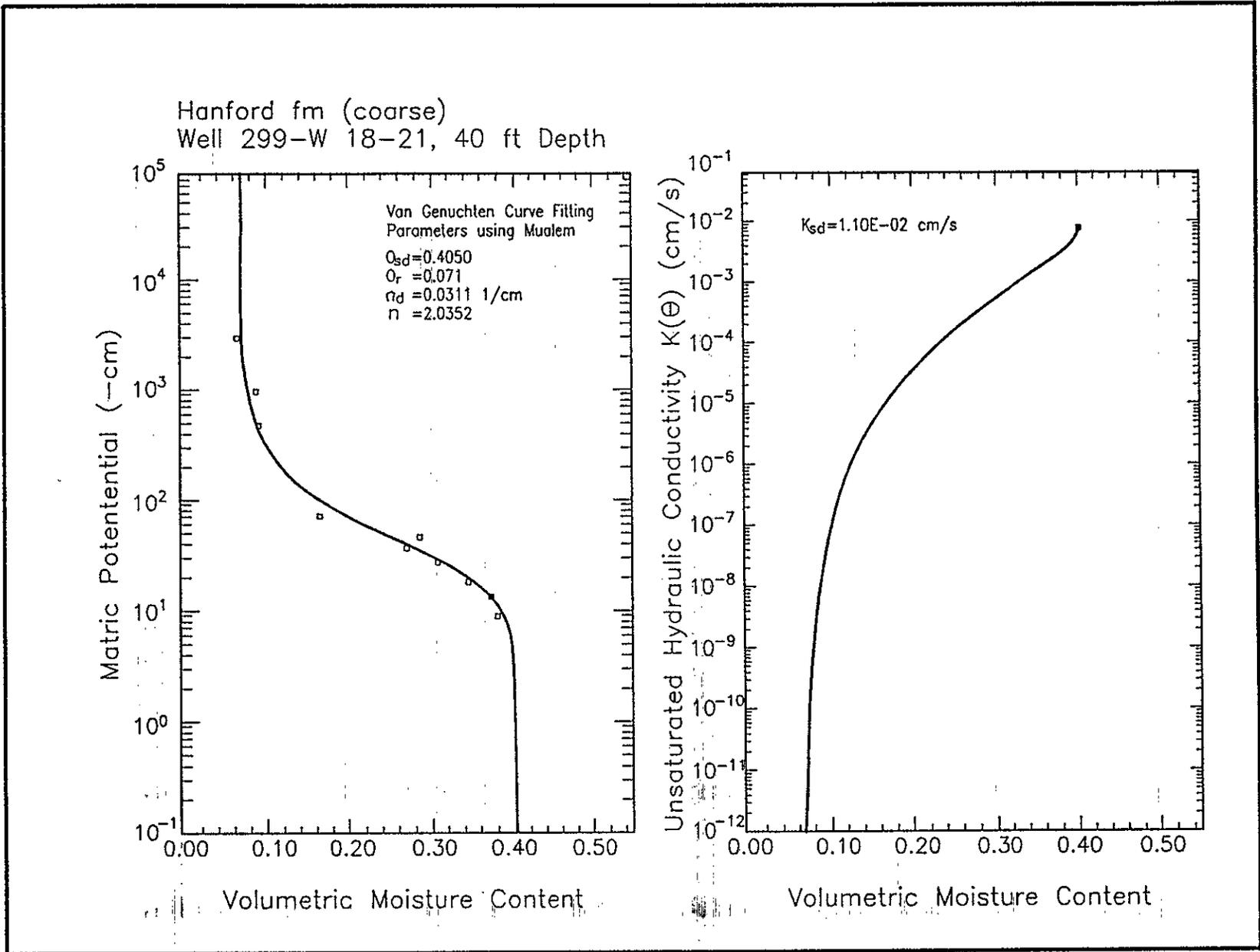


Figure 3-39. Conceptual Geologic and Hydrogeologic Column for the S Plant AAMS. (Last et al. 1989)

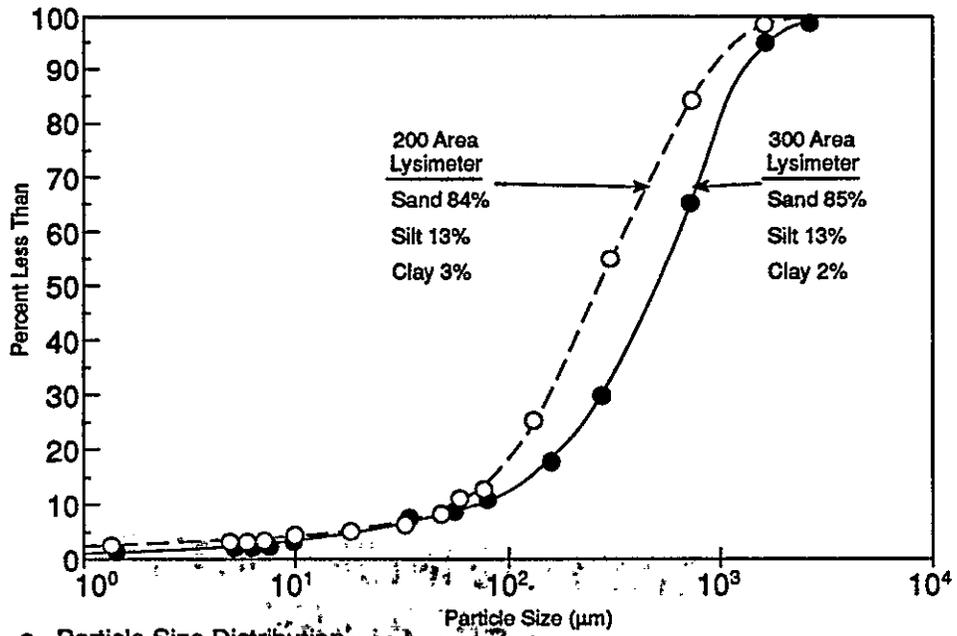
01315-02156

3F-40

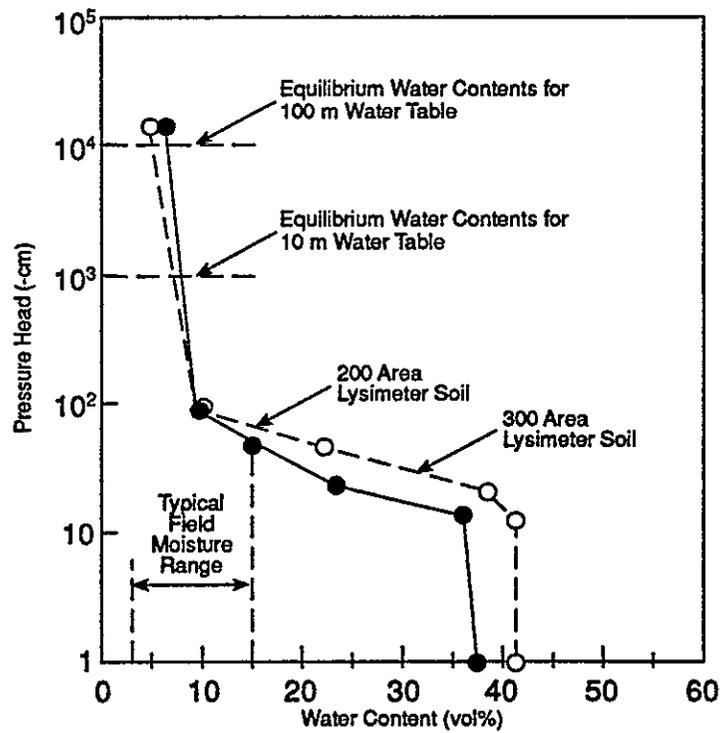


DOE/RL-91-60
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Figure 3-40. Wetting and Drying Curves for Well 299-W18-21.



a. Particle Size Distribution



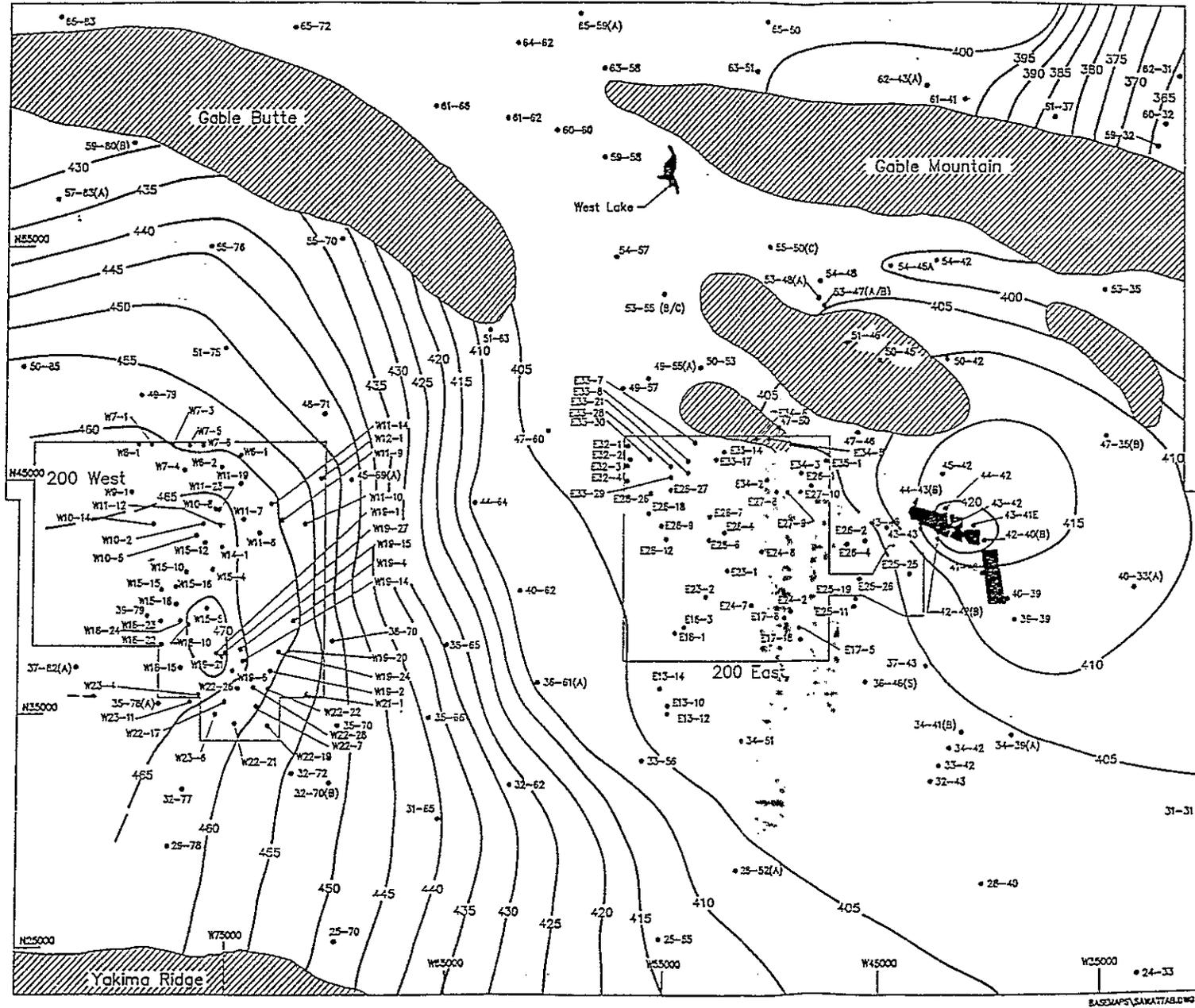
b. Water Retention Characteristics

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

9 3 1 2 0 5 1 5 1 2

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200 Areas
Water-Table Map
June 1990



- Water table contours in feet above mean sea level
- W22-26 Data points used to prepare map
- ▭ Ponds
- ▨ Areas where the basalt surface is generally above the water table

The 200 Areas water table map has been prepared by the Geosciences Group, Environmental Division, of Westinghouse Hanford Company.

Note: To convert to metric, multiply elevation (ft) by 0.3048 to obtain elevation (m).

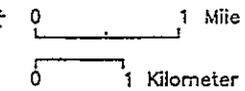


Figure 3-42 200 Areas Water Table Map, June 1990 (Kasza et al. 1990).

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Table 3-1. Hydraulic Parameters for Various Areas and Geologic Units at the Hanford Site.

| Location | Interval tested | Hydraulic conductivity (ft/d) | Transmissivity (ft ² /d) | Effective porosity |
|-------------------------|----------------------------------|---|-------------------------------------|--------------------|
| Pasco Basin | Hanford formation | 500 - 20,300 | | |
| | Ringold Formation Unit E | 20 - 600 | | |
| | Ringold Formation Unit A | 0.1 - 10 | | |
| Hanford Site | Saddle Mountain Basalt Flowtop | 10 ⁻² - 10 ⁻⁶ | | 5% |
| Hanford Site | Selah Interbed | 3 X 10 ⁻³ | | |
| 100 Area | Ringold Formation Unit E | 29 - 1,297 | 5,750 - 26,700 | |
| 100 Area | Rattlesnake Ridge Interbed | 0-100 | | <10% |
| 200 Areas | Hanford formation | 2,000 - 10,000 | | |
| | Ringold Formation Unit E | 9 - 230 | | |
| | Ringold Formation Unit A | 1 - 12 | | |
| 200 West Area | Ringold Formation Unit E | 0.06 - 200 | | |
| | Ringold Formation Unit A | 1.7-4 | | |
| | Lower Ringold laboratory | 3 x 10 ⁻⁵ - 8 x 10 ⁻⁵ | | |
| Slug Tests at U-12 Crib | Upper Ringold | 8 - 44 | | |
| 200 East Area | Elephant Mountain Interflow Zone | | 7.5 - 6,120 | |
| 200 Area | Rattlesnake Ridge Interbed | | 8 - 1,165 | |
| 300 Area | Hanford formation | 11,000 - 50,000 | | |
| 300 Area | Ringold Formation | 1.9 - 10,000 | | |
| 300 Area | Levey Interbed | 0.01 - 1,000 | | |
| 1100 Area | Ringold Formation Units C/B | 3 X 10 ⁻¹ - 5 | | |
| 1100 Area | Ringold Formation | 8 X 10 ⁻⁴ | | |
| | Overbank Deposits | 1 X 10 ⁻¹ | | |

Table 3-2. Summary of Reported Hydraulic Conductivity Values for Hanford Site
Vadose Zone Sediments. Page 1 of 2

| Reported Hydraulic Conductivity Value or Range of Values in cm/s | Water Content Volume Percent | Reported Geologic Unit or Sediment Type | Test Area or Sampling Location | Measurement Method or Basis for Reported Value |
|--|------------------------------|---|--|--|
| 6.7 x 10 ⁻⁷ | 10 | Sand | 200 Area | Lysimeter Soil Experiments |
| 1.7 x 10 ⁻⁸ | 7 | | | |
| 1.7 x 10 ⁻⁹ | 5.5 | | | |
| 1.7 x 10 ⁻¹⁰ | 5 | | | |
| 1.3 x 10 ⁻¹¹ | 4.3 | | | |
| 2.6 x 10 ⁻³ | 31 | Sandy soil reported as "typical or many surface materials at the Hanford Site." | | Unsaturated column studies. |
| 5.7 x 10 ⁻⁴ (sat) | 56 | | | |
| 6.3 x 10 ⁻¹¹ | 2.9 | Near-surface soils | 2-km south of 200 East Area | K estimates by Gee 1987 using water retention curve data from Figure 7 in Hsieh et al. 1973. |
| 2.2 x 10 ⁻¹¹ | 2.8 | | | |
| 5.40 x 10 ⁻⁸ | 8.3 | Sandy fill excavated from near-surface soil (Hanford formation) with 1.27-cm particle size fraction screened out. | Buried Waste Test Facility (BWTF): 300 North Area Burial Grounds | Laboratory steady-state flux measurements. |
| 9.78 x 10 ⁻³ (sat) | 42.2 | | | |
| 8.4 x 10 ⁻³ (sat, arithmetic mean of four measurements) | na | | | |
| 8 x 10 ⁻⁸ | 11 | na | BWTF: Southeast Caisson, and North Caisson | Unsteady drainage-flux field measurements. |
| 4 x 10 ⁻³ (Southeast Caisson) | 26 | na | | |
| 1 x 10 ⁻⁸ | 10 | na | | |
| 1 x 10 ⁻² (North Caisson) | 29 | na | | |
| 4.5 x 10 ⁻³ (arithmetic mean of 15 measurements) | Field Saturation | na | BWTF North Caisson and area north of caisson | Guelph permeameter field measurements |

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Table 3-2. Summary of Reported Hydraulic Conductivity Values for Hanford Site
Vadose Zone Sediments.

Page 2 of 2

| Reported Hydraulic Conductivity Value or Range of Values in cm/s | Water Content Volume Percent | Reported Geologic Unit or Sediment Type | Test Area or Sampling Location | Measurement Method or Basis for Reported Value |
|--|------------------------------|---|--|--|
| 1 x 10 ⁻³ (Upper Soil, arithmetic mean of 7 measurements) | Field Saturation | Loam sand over sand | Grass Site; 3 km of BWTF | Guelph permeameter field measurements |
| 9.2 x 10 ⁻³ (Lower Soil, arithmetic mean of 4 measurements) | Field Saturation | na | | |
| 8 x 10 ⁻⁷ | 16 | Loam to sandy loam | McGee Ranch; NW of 200 West Area on State Rt. 240 | Unsteady drainage-flux field measurements. |
| 9 x 10 ⁻⁴ | 40 | | | |
| 9 x 10 ⁻⁴ (arithmetic mean of 9 measurements) | Field Saturation | na | | Guelph permeameter field measurements. |
| 5 x 10 ⁻³ (sat) | 50 | Sand, Gravel | Sediment types are idealized to represent stratigraphic layers commonly encountered below 200 Areas liquid disposal sites. | K _{sat} values derived from idealized moisture content curves on Figure B-1. |
| 1 x 10 ⁻³ (sat) | 50 | Coarse Sand | | |
| 5 x 10 ⁻⁴ (sat) | 40 | Fine Sand | | |
| 1 x 10 ⁻⁴ (sat) | 40 | Sand, Silt | | |
| 5 x 10 ⁻⁵ (sat) | 40 | Caliche | | |
| 1.2 x 10 ⁻⁵ (sat) | 19.6 to 18.9 | Hanford formation | Well 299-W7-9, 218-W-5 Burial Ground | van Genuchten equation fitted to moisture characteristic curves for Well 299-W7-9 soil samples |
| 6.7 x 10 ⁻⁶ to 2.8 x 10 ⁻¹ (sat) | 37.6 to 41.4 | Early "Palouse" Soils | | |
| 1.10 x 10 ⁻³ (sat) | 18.3 to 21 | Upper Ringold | | |
| 1.80 x 10 ⁻⁴ to 3.00 x 10 ⁻⁴ (sat) | 24 to 25 | Middle Ringold | | |

Notes:

na - Not identified in source.

sat - Value for saturated soil.

field saturation - Equilibrium water content after several days of gravity drainage.

Table 3-3. Endangered, Threatened, and Sensitive Plant Species Reported on or near the Hanford Site.

| Scientific Name | Common Name | Family | Washington State Status |
|---|------------------------------|------------------|-------------------------|
| <i>Rorippa columbiae</i> ** Suksd. ex Howell | Persistent-sepal Yellowcress | Brassicaceae | Endangered |
| <i>Artemisia campestris</i> L. ssp. <i>borealis</i> (Pall.) Hall & Clem. var. <i>wormskioldii</i> ** (Bess.) Cronq. | Northern Wormwood | Asteraceae | Endangered |
| <i>Astragalus columbianus</i> ** Barneby | Columbia milk-vetch | Fabaceae | Threatened |
| <i>Lomatium tuberosum</i> ** Hoover | Hoover's Desert-Parsley | Apiaceae | Threatened |
| <i>Astragalus arrectus</i> Gray | Palouse Milk-vetch | Fabaceae | Sensitive |
| <i>Collinsia sparsiflora</i> Fisch. & Mey. var. <i>bruceae</i> (Jones) Newsom | Few-Flowered Collinsia | Scrophulariaceae | Sensitive |
| <i>Cryptantha interrupta</i> (Greene) Pays. | Bristly Cryptantha | Boraginaceae | Sensitive |
| <i>Cryptantha leucophea</i> Dougl. Pays | Gray Cryptantha | Boraginaceae | Sensitive |
| <i>Erigeron piperianus</i> Cronq. | Piper's Daisy | Asteraceae | Sensitive |
| <i>Carex densa</i> L.H. Bailey | Dense Sedge | Cyperaceae | Sensitive |
| <i>Cyperus rivularis</i> Kunth | Shining Flatsedge | Cyperaceae | Sensitive |
| <i>Limosella acaulis</i> Ses. & Moc. | Southern Mudwort | Scrophulariaceae | Sensitive |
| <i>Lindernia anagallidea</i> (Michx.) Pennell | False-pimpernel | Scrophulariaceae | Sensitive |
| <i>Nicotiana attenuata</i> Torr. | Coyote Tobacco | Solanaceae | Sensitive |
| <i>Oenothera pygmaea</i> Dougl. | Dwarf Evening-Primrose | Onagraceae | Sensitive |

** Indicates candidates on the 1991 Federal Register, Notice of Review.

9 3 1 2 3 4 5 1 7

Table 3-4. Federal and State Classifications of Animals That Could Occur on the 200 Area Plateau.

| Common Name | Status Federal* | State |
|------------------------|-----------------|-------|
| American White Pelican | | SE |
| Peregrine Falcon | FE | SE |
| Sandhill Crane | | SE |
| Bald Eagle | FT | ST |
| Ferruginous Hawk | FC2 | ST |
| Swainson's Hawk | FC2 | SC |
| Golden Eagle | | SC |
| Burrowing Owl | | SC |
| Loggerhead Shrike | | SC |
| Sage Sparrow | | SC |
| Great Blue Heron | | SM |
| Merlin | | SM |
| Prairie Falcon | | SM |
| Long-billed Curlew | FC2 | SM |
| Striped Whipsnake | | SC |

*FE - Federal Endangered

FT - Federal Threatened

FC2 - Federal Candidate

SE - State Endangered

ST - State Threatened

SC - State Candidate

SM - State Monitor

Above information taken from Washington Department of Wildlife June 1991. Species of Concern in Washington.

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4.0 PRELIMINARY CONCEPTUAL SITE MODEL

1
2
3
4 Section 4.1 presents the chemical and radiological data that are available for each waste
5 management unit. These chemical data, along with physical descriptions of the waste
6 management units (Section 2.0) and descriptions of the surrounding environment (Section 3.0)
7 are evaluated in Sections 4.2 and 5.0 in order to qualitatively assess the potential impacts of
8 the contamination to human health and to the environment. The quality and sufficiency of
9 the existing data are assessed in Section 8.0. This information is also used to identify
10 applicable or relevant and appropriate requirements (ARARs) (Section 6.0). Contaminant
11 information is assessed in Section 7.0 to provide a basis for selecting technologies which can
12 be implemented at the sites.
13

14 Contaminants that are released into the environment at a waste management unit or
15 unplanned release site may migrate from the point of release into other types of media. The
16 potentially site-specific data in the S Plant Aggregate Area include surface soil, surface water,
17 vadose zone soil and perched groundwater, air, and biota. The media that are affected at a
18 specific site will depend upon the quantities, chemical and physical properties of the material
19 that was released, and the subsequent site history. The potentially affected media at each
20 waste management unit or unplanned release site are listed in Table 4-1 for radionuclide
21 contamination and Table 4-2 for chemical contamination.
22

4.1 NATURE AND EXTENT OF CONTAMINATION

23
24
25
26 There are two major types of chemical and radiological data available for the S Plant
27 Aggregate Area: site-specific data that are applicable to individual waste management units
28 and unplanned releases; and area-wide environmental data that are useful in characterizing
29 regional contamination trends.
30

31 Some of the waste management units and unplanned releases have been the subject of
32 chemical and radiological studies in the past. However, most of these studies were limited in
33 scope and did not provide a comprehensive analysis of the character and distribution of the
34 contamination at each site. The types of area-wide data that are available include inventory
35 information, surface radiological surveys, external radiation monitoring, soil and sediment
36 sampling, biota sampling, borehole geophysics, and groundwater sampling. Table 4-3
37 summarizes the types of unit-specific data for each of the waste management units. It should
38 be emphasized that the table only summarizes what types of data are available, it does not
39 indicate the sufficiency of the data, either in terms of quality or quantity. Data quality issues
40 are addressed in Section 8.0.
41

42 Reported mixed waste inventory data are available for 117 of the 125 waste
43 management units. These data have been compiled from the waste information data system
44 (WIDS) inventory sheets (WHC 1991a). The inventory data are presented in Appendix A.1.
45 Table 2-2 presents a list of chemicals identified as potentially present in the S Plant
46 Aggregate Area separation process and laboratory waste streams. The list does not

1 necessarily include wastes that may have originated in the S Plant Aggregate Area or other
2 areas of the Hanford Site. This list should be adequate for identifying the majority of
3 contaminants potentially present in S Plant waste disposal units. Chemicals identified as
4 "Used in laboratory" would have been present in much smaller quantities than process
5 chemicals; however, because the laboratory has continued to operate since the S Plant
6 operations ceased in 1967, laboratory chemicals may be more relevant in areas where disposal
7 operations are ongoing. The available site-specific information is summarized for each
8 individual waste management unit or unplanned release in Sections 4.1.2 through 4.1.2.8.

9
10 In addition to these site-specific data, there are area-wide data that are not directly
11 applicable to any waste management unit within the S Plant Aggregate Area. The most
12 important sources of this general environmental data are quarterly and annual environmental
13 surveillance reports published by Westinghouse Hanford. There are also area-wide
14 geophysical data available that include gravity, magnetic, magnetotelluric, seismic refraction
15 and seismic reflection surveys (DOE 1988). However, these studies are not useful for
16 characterizing the extent of chemical and radionuclide contamination and so are not presented
17 in Section 4.0. These data are discussed in more detail in Section 8.1.2.

18
19 The most recent environmental monitoring of the Hanford Site was conducted by the PNL
20 and Westinghouse Hanford. However, most of the data that are applicable to the S Plant
21 Aggregate Area have been published by Westinghouse Hanford. The Third Quarterly
22 Environmental Radiological Survey Summary Reports (Huckfeldt 1991) were reviewed during
23 the current study, as well as four of the last six annually published environmental surveillance
24 reports (Elder et al. 1986, 1987, 1988, 1989; Schmidt et al. 1990, 1991). The quarterly
25 reports only contain surface radiological survey results. The annual reports describe several
26 different sampling and survey programs including surface soil sampling, external radiation
27 measurements, biota sampling, air sampling, surface water sampling, groundwater sampling,
28 and radiological surveys.

29
30 Air, soil, surface water, and biota samples were collected each year at the same
31 locations within the 200 West Area. External radiation measurements were also taken
32 annually at several locations. Until 1990, few of the sample locations were directly
33 associated with any of the identified waste management units and so most of this information
34 is only useful in characterizing area-wide trends. In 1990, however, new sampling locations
35 were established that are near areas of known surface contamination. Currently, only external
36 radiation data are available for these new sample locations. Both the new and old sampling
37 locations are shown on Plate 3.

38
39 Section 4.1 describes available data regarding known and suspected contamination in the
40 S Plant Aggregate Area on a media-specific basis (air, surface soil and biota, and vadose zone
41 soil). The text summarizes sources of chemical and radiological sampling information.
42 Section 4.1.1 presents data on a media-specific basis. Section 4.1.1.1 describes results of an
43 aerial gamma ray radiation survey. Section 4.1.1.2 reports exposure rates from external
44 radiation measurements at selected grid locations. Section 4.1.1.3 presents results of air
45 quality sampling data. Surface soil data are described in Section 4.1.1.4. Results of surface
46 water sampling are presented in Section 4.1.1.5. Results of vegetation and other biota sample

1 analyses are presented in Section 4.1.1.6. Available vadose zone sampling data are presented
2 in Section 4.1.1.7. Section 4.1.1.7 also discusses evidence for contamination migration within
3 the vadose zone to the unconfined aquifer underlying the site. Additional assessment of the
4 nature and extent of groundwater contamination is presented in the 200 West Aggregate Area
5 Management Study Reports (AAMSR).
6

7 To supplement available radiological and chemical analytical data, historical waste
8 inventory information for the S Plant Aggregate Area Waste Management Units were also
9 included in the evaluation of known and suspected contaminants. Historical waste inventory
10 data are detailed in Section 2.0 of this report (Tables 2-2 and 2-3). As discussed in
11 Section 2.0, the compilation is based on supporting data from the WIDS (WHC 1991a) and
12 the Hanford Inactive Site Survey Database. Waste management units with available waste
13 inventory data are identified in the following sections according to the nature of documented
14 or suspected contamination.
15

16 Available data were reviewed to assess whether air, surface soil, vadose zone soil, or
17 groundwater was potentially impacted by waste handling activities at each S Plant Aggregate
18 Area waste management unit. Table 4-2 summarizes available information regarding known
19 or suspected radionuclide contamination at the S Plant Aggregate Area. Table 4-3
20 summarizes available information regarding known and suspected organic and inorganic
21 compound contamination. In Tables 4-2 and 4-3 waste management units are arranged by
22 physical type (cribs, burial grounds, unplanned releases, etc.). Entries in the tables identify
23 known or suspected releases based on available sampling information or historical waste
24 inventory data.
25

26 27 **4.1.1 Affected Media** 28

29 **4.1.1.1 Air.** Ambient air monitoring has been conducted within or adjacent to the S Plant
30 Aggregate Area since 1979. There is one high volume particulate sampler located east of the
31 241-S and -SX Tank Farm, whose filters are analyzed quarterly for ⁹⁰Sr, ¹³⁷Cs, ²³⁹Pu, and total
32 uranium. The results have shown a steady decline in the concentration of these radionuclides
33 throughout the sampling program throughout the 200 West Area (Schmidt et al. 1990). The
34 only exception to this trend was during the four weeks following the partial meltdown of
35 unit 4 at the Chernobyl Nuclear Power Station. Data from this period, approximately May 13
36 to June 3, 1986, were analyzed separately and assumed to be anomalous (Elder et al. 1987).
37 Air monitoring data for 1985, 1986, and 1988 in the S Plant Aggregate Area are presented,
38 along with background data for the 200 West Area in Tables 4-4 and 4-7.
39

40 An aerial gamma ray radiation survey was run over the 200 West Area in July and
41 August 1988. The survey lines were flown with a 122 m (400 ft) spacing at an altitude of 61
42 m (200 ft). The data were normalized to a height of 1 m (3 ft) above the ground surface.
43 Figure 4-1 presents the gross count data in counts/seconds (c/s) on an isoradiation contour
44 map that covers the entire 200 West Area. It is impractical to convert these gross gamma
45 counts to a meaningful exposure rate because of the complex distribution of radionuclides on

1 the site, however, they do allow a qualitative indication of regions of elevated radiological
2 contamination in the study area.

3
4 The entire area has gross gamma counts that are above background. The highest gross
5 count results in the S Plant Aggregate Area were between 220,000 and 700,000 c/s measured
6 over S Plant in Figure 4-1. The second highest results were between 70,000 and 220,000 c/s
7 as measured over the 241-S and 241-SX Tank Farms (location 5 in Figure 4-1). Other
8 significant areas in S Plant include waste management unit 216-S-6 (high potential condensate
9 crib) and waste management unit 216-S-16P (Pond).

10
11 Exposure rates from penetrating radiation, primarily gamma rays, were measured
12 annually at 5 grid locations within or adjacent to the S Plant Aggregate Area from 1978 to
13 1988. The purpose of this sampling was to establish the baseline exposure rates in the 200
14 West environment. The measurements were taken with thermoluminescent dosimeters and
15 were reported in mrem/yr. The grid sample locations for the 200 West area from 1978 to
16 1988 are presented in Plate 3. The results of thermoluminescent dosimeter sampling for
17 1985, 1986, and 1989 are presented in Table 4-6. The results of this sampling are presented
18 in Appendix A.

19
20 In 1989, the external radiation monitoring stations in 200 West were reconfigured. The
21 new sites were generally located on or near areas of known contamination and the results
22 appear to be slightly elevated over the previous sampling rounds. Measurements associated
23 with facilities (of which the S Plant Aggregate Area is one) were consistent with background
24 levels found in the general Separations Area environment (Schmidt et al. 1990). Under the
25 new program in the S Plant Aggregate Area, two new sampling locations were established,
26 and the five previous locations were discontinued. One of the new locations monitors waste
27 management unit 216-S-19 (Pond), and the other is located in a background area north of the
28 241-SX Tank Farm. The results of 1990 sampling are presented in Appendix A.

29
30 Surface radiological surveys are performed on a number of S Plant Aggregate Area
31 waste management units. The results are summarized in the third quarterly monitoring
32 reports authored by Christine Huckfeldt (1991). Table 4-5 summarizes the surface
33 radiological survey results for each waste management unit and unplanned release in the
34 S Plant Aggregate Area.

35
36 **4.1.1.2 Surface Soil.** Between 1978 and 1989, surface soil samples were collected annually
37 or semiannually from a regular rectangular grid that covers the 200 West Area with 33
38 sampling points. Five of these sampling sites are located within or adjacent to the S Plant
39 Aggregate Area. The grid sample points are generally located close to the intersections of
40 Hanford Site coordinate lines at 610 m (2,000 ft) spacings, and are intended to monitor the
41 overall 200 West Area environment without being specific to any potential source site. In
42 addition to the grid sites, there are three fence line sampling locations surrounding the 241-S,
43 -SX, and -SY Tank Farms which are intended to monitor downwind areas where
44 contamination could accumulate.

1 The samples from the grid and fenceline sampling are analyzed for common
2 radionuclides found in the 200 West Area, that is, gamma-emitting radionuclides, ⁹⁰Sr,
3 uranium, and plutonium isotopes. The results are compared to mean regional background
4 levels derived from offsite data gathered by Pacific Northwest Laboratory (PNL). This
5 comparison allows identification of radionuclide contributions from the 200 West Area versus
6 contributions from natural background and fallout from nuclear weapons testing. Any
7 radionuclide detections which are above the mean regional background are not considered
8 significant until they exceed the mean plus two standard deviations. The detections are also
9 compared to the soil contamination standards established for the 200 West Area. The soil
10 standards represent permissible radionuclide concentrations, above which restrictions are
11 posted restricting the area. Between the 1986 and 1988 sampling, the soil contamination
12 standards were increased in number and threshold concentration. This resulted in more
13 analyses being run, and a higher contamination level being required for posting a site as a
14 radiological control zone.

15
16 The results of the sampling indicate that the regional background concentrations were
17 exceeded in the S Plant Aggregate Area, however, the soil contamination standards were not
18 exceeded. In general, the concentration of radiological contamination decreased within the S
19 Plant Aggregate Area, with the exception of ⁹⁰Sr at the S-TF-SE station, located at the
20 southeast corner of the 241-S, -SX, -SY Tank Farms. This location has exhibited an upward
21 trend in concentration since 1986. It is possible that the increase at this site is related to the
22 upward trend displayed at grid site 2W28, located east of the 241-S and -SX Tank Farms
23 (Schmidt et al. 1990). The sampling locations are presented in Plate 3. The yearly averages
24 of sampling from 1978 to 1988 are presented in Appendix A. Tables 4-8 and 4-9 present the
25 results of grid and fenceline soil sampling within the S Plant Aggregate Area for 1985, 1986,
26 and 1988.

27
28 **4.1.1.3 Surface Water.** Samples related to surface water quality were collected from the
29 216-S-10 Ditch (216-S-10D) until August 15, 1991. For the purposes of this report, data
30 were taken from the *Annual Environmental Monitoring Reports for 1985, 1986, 1988, and*
31 *1990* (Elder et al. 1986, 1987, 1989; Schmidt et al. 1991; WHC 1991a). The samples include
32 water analyzed for radiological parameters, pH, and nitrates (not done in 1985); vegetation
33 analyzed for radionuclides (not done in 1985 and 1986); and sediments analyzed for
34 radionuclides (not done in 1985 and 1986). The results of the sampling indicate that no
35 significant increases in radioactivity occurred in 1985, 1986, 1988, and 1990. Sampling
36 locations are presented in Plate 3, and analytical results are presented in Tables 4-10 and
37 4-11.

38
39 **4.1.1.4 Biota.** Various biota sampling activities have been conducted by PNL beginning in
40 1971 through 1988 in and around the Hanford Site. During the program, no upward trends in
41 radionuclide concentrations were detected for any of the wildlife species. A significant
42 downward trend was exhibited in many sample types, particularly ¹³⁷Cs and ⁶⁵Zn.

43
44 Three factors are believed to have contributed to the decline in concentration of
45 radionuclides: the cessation of atmospheric testing, the 1971 shutdown of the last Hanford
46 reactor that discharged once-through cooling water to the river, and the reduction of

1 environmental radionuclide contamination associated with some Hanford facilities and
2 operations.

3
4 Biota samples have been collected since 1978 from sites within or adjacent to the
5 S Plant Aggregate Area. Vegetation samples were collected from the same locations as the
6 grid soil samples described in Section 4.1.1.3. The vegetation samples have generally had
7 radionuclide concentrations that are slightly elevated above regional background, but have not
8 exhibited statistically significant trends since 1979 (Schmidt et al. 1990). The most
9 commonly detected radionuclides include ^{137}Cs , ^{90}Sr , ^{60}Co , ^{238}Pu , and ^{239}Pu . The sampling
10 locations are presented in Plate 3, and summaries of the analytical results from 1985 through
11 1989 are presented in Appendix A. Sampling results are presented in Tables 4-12 and 4-13.
12 Radionuclide levels found in contaminated mammals in the 200 Areas over the past 10 years
13 are reported in WHC-SA-1252-S.

14
15 **4.1.1.5 Vadose Zone.** The extent of contamination in the vadose zone has been most
16 extensively studied by geophysical well logging. This technique has been conducted in the
17 S Plant Aggregate Area since the late 1950's. Gross gamma-ray logs have been used to
18 evaluate radionuclide migration in the vadose zone near selected waste management units. A
19 report by Hanlon (1991) summarizing the logging efforts and original well logs was reviewed
20 for this report. In addition, original well logs were reviewed by an Ebasco Services
21 Incorporated staff geophysicist. The log interpretations are discussed in detail in Appendix A.
22 The evaluation process generally consisted of identifying zones with anomalously high
23 gamma-ray counts that could be indicative of radionuclide contamination. The depths,
24 thicknesses, and intensities of these zones were then compared to logs from the same holes.
25 Any significant changes may be indicative of contaminant migration in the vadose zone.
26 Interpretations of this data are qualitative due to variations in logging equipment and
27 procedures over the years. The results of the log interpretations are included for each
28 applicable site in Sections 4.1.2 through 4.1.2.8.

29
30 Waste management units that have received large volumes of liquid are more likely to
31 cause subsurface contaminant migration. The potential for liquid wastes to migrate through
32 the vadose zone to the groundwater can be estimated by comparing the volume of waste
33 discharged at each waste management unit to the estimated pore volume in the vadose zone
34 soil column below the waste management unit. If the volume of liquid discharged to the
35 ground is larger than the total soil column pore volume, then it is likely that wastewater
36 would reach the groundwater. These calculations are summarized in Table 4-14. They are
37 based upon several conservative assumptions: (1) the discharged water does not spread out
38 laterally from the point of discharge (i.e., the area of affected vadose zone is equal to the
39 depth to groundwater times the plan view cross-sectional area of the base of the waste
40 management unit); (2) there is no significant change in liquid volume being introduced to the
41 soil column due to evapotranspiration or precipitation; and (3) the average pore volume of the
42 soil column is between 0.10 and 0.30 (the upper and lower pore volumes estimates shown on
43 Table 4-14); and (4) groundwater migration may occur within an effective pore volume of
44 0.10. According to these calculations, 17 waste management units have the potential for the
45 migration of liquid discharges to the unconfined aquifer based on a soil column pore volume

1 of 0.30. If an effective pond volume of 0.10 is used, 18 total waste management units have
2 the potential for discharge to the unconfined aquifer.
3

4 As was discussed in Section 3.0, perched water zones may form locally under waste
5 management units with large liquid discharges. However, the occurrence of contaminated
6 perched water has only been documented beneath the 216-U-16 Crib (Baker et al. 1988).
7
8

9 **4.1.2 Site-Specific Data**

10 This section presents the site-specific data that are available for each waste management
11 unit and unplanned release. The units are discussed in the same groups as were presented in
12 Section 2.0. These groupings are useful because like units tend to have the similar types of
13 available data.
14
15
16

17 **4.1.2.1 Plants, Buildings, and Storage Areas.**

18
19 **4.1.2.1.1 291-S Stack Complex.** Fission products and volatile organics have been
20 detected at this site.
21

22 **4.1.2.2 Tanks and Vaults.** The data available for the single-shell tanks (SSTs) generally
23 include: inventory information, limited waste sampling, surface radiological surveys, vadose
24 zone well geophysics, and internal tank monitoring of chemical and physical parameters.
25 Less monitoring data are available for the three newer double-shell tanks (DSTs) in the 241-
26 SY Tank Farm. In the past, there has been much less emphasis in characterizing the catch
27 tanks, settling tanks and vaults, and little information is available regarding these units.
28

29 Most of the SSTs are surrounded by an array of vadose zone boreholes. Gamma
30 logging is performed on these boreholes on a regular basis in order to identify new tank leaks
31 and to monitor the migration of existing contaminant releases to the soil. The 241-SX Tank
32 Farm has four assumed leaking tanks and five confirmed leaking tanks. Nine of these tanks
33 exhibit elevated gamma radiation levels in associated monitoring wells.
34

35 Chemical inventories for the SSTs have been modeled with the Tracks Radioactive
36 Components (TRAC) computer code. This program calculated tank inventories for 68
37 radioactive constituents and 30 chemical constituents. The estimates were based on the
38 historical records of the quantities of material initially placed in the tanks from nuclear fuel
39 production and later modified by tank transfers and radioactive decay. The TRAC
40 inventories, though recognized as having serious limitations, represent the best current
41 information on the contents of the tanks. The TRAC predictions for ^{14}C , ^{137}Cs , ^{137}Ba and
42 uranium isotopes show the least agreement with other data sources.
43

44 The TRAC inventory data are presented in Table 4-15. These data are for the total tank
45 inventories and do not differentiate between drainable liquid and solids within the tanks. As
46 shown in Table 2-4, some of the unstabilized tanks still contain large volumes of liquid,

1 drainable waste. It is the radionuclides that are partitioned to this liquid phase which are of
2 primary concern should a tank begin to leak. From a comparison of solid and liquid phase
3 data presented in an earlier TRAC report, it appears that ²⁴¹Am, ¹⁴C, ¹³⁵Cs, ¹³⁷Cs, ⁹³Nb, ⁹⁹Tc,
4 ⁷⁹Se and ⁹⁰Sr are most strongly partitioned to the liquid phase in the tanks and would be the
5 most likely radionuclides, present at high concentrations, to migrate in the event of a leak.
6

7 The available chemical data for each tank is summarized in Table 4-16. The table
8 includes any radionuclide data that are available for each sample as well as total organic
9 carbon (TOC) and pH information. Solutions with low pHs and high TOCs (organic solvents)
10 would tend to enhance radionuclide migration through the soil column.
11

12 **4.1.2.2.1 241-S Tank Farm.** An aerial gamma ray radiation survey over the 200 West
13 Area in July and August 1988 indicates that gross gamma counts in the 241-S Tank Farm
14 ranged between 70,000 and 220,000 c/s. The waste management units in these areas are
15 discussed below.
16

17 The area is being used as a temporary storage area for drums and boxes presumably full
18 of monitoring well installation waste. Transuranics, fission products, uranium, heavy metals,
19 and inorganics are possibly present at this site.
20

21 **4.1.2.2.2 241-S-101 Single-Shell Tank.** The WIDS database (WHC 1991a) notes that
22 the five vadose zone boreholes monitoring this waste management unit for leaks have
23 remained stable. This waste management unit is considered sound. The tank received wastes
24 which consisted of transuranic (TRU), fission products, uranium, heavy metals, and
25 inorganics.
26

27 **4.1.2.2.3 241-S-102 Single-Shell Tank.** The WIDS database (WHC 1991a) notes that
28 the eight vadose zone boreholes monitoring this waste management unit for leaks have
29 remained stable. Westinghouse Hanford Company (1991a) indicates that this unit has the
30 potential to generate hydrogen or other flammable gases. This waste management unit is
31 considered sound. The tank received wastes which consisted of TRU, fission products,
32 uranium, heavy metals, and inorganics.
33

34 **4.1.2.2.4 241-S-103 Single-Shell Tank.** The WIDS database (WHC 1991a) notes that
35 seven vadose zone boreholes monitor this waste management unit for leaks. Activity detected
36 in Borehole 40-03-09 in 1974 has slowly receded to less than 50 c/s and was not interpreted
37 as indicative of a tank leak because the activity was limited to the surface. Limited and
38 unsuccessful augering has been done to identify the source of the surface contamination.
39 With this one exception, the vadose zone boreholes have remained stable, indicating this tank
40 is not leaking. This waste management unit is considered sound. The tank received wastes
41 which consisted of TRU, fission products, uranium, heavy metals, and inorganics.
42

43 **4.1.2.2.5 241-S-104 Single-Shell Tank.** The WIDS database (WHC 1991a) notes that
44 this unit was removed from service and categorized as having "questionable integrity" because
45 of a liquid level decrease. The WIDS database indicates that four vadose zone boreholes
46 have remained stable, however, the tank remains an assumed leaker. Borehole 40-04-05

1 shows elevated radiation levels between 12 and 14 m (40 and 46 ft), and Borehole 40-04-08
2 shows elevated radiation levels between 6.4 and 7.0 m (21 and 23 ft). In August 1978 a jet
3 pump saltwell system was installed to remove liquids from the tank, and the unit is now
4 considered primary stabilized. The tank received wastes which consisted of TRU, fission
5 products, uranium, heavy metals, and inorganics.
6

7 **4.1.2.2.6 241-S-105 Single-Shell Tank.** The WIDS database (WHC 1991a) notes that
8 the five vadose zone boreholes monitoring this waste management unit for leaks have
9 remained stable. Borehole 40-05-03 shows slightly elevated radiation levels from 9 to 11 m
10 (30 to 37 ft). WIDS indicates a jet pump saltwell system was installed and operations for the
11 removal of interstitial liquid were commenced during August 1978. The tank received wastes
12 which consisted of TRU, fission products, uranium, heavy metals, and inorganics.
13

14 **4.1.2.2.7 241-S-106 Single-Shell Tank.** The WIDS database (WHC 1991a) notes that
15 the six vadose zone boreholes monitoring this waste management unit for leaks have
16 remained stable. Data from past liquid levels have not been satisfactorily explained, but the
17 tank is considered sound. A jet pump saltwell system was installed and operations for the
18 removal of interstitial liquid were commenced during August 1978. The tank received wastes
19 which consisted of TRU, fission products, uranium, heavy metals, and inorganics.
20

21 **4.1.2.2.8 241-S-107 Single-Shell Tank.** The WIDS database (WHC 1991a) notes that
22 the six vadose zone boreholes monitoring this waste management unit for leaks have
23 remained stable. Data from past liquid levels have not been satisfactorily explained, but the
24 tank is considered sound. Intermittent liquid level increases since July 1981 have been
25 attributed to decontamination work of precipitation via the 241-S-D Valve Pit. Although the
26 unit was partially isolated on December 15, 1982, liquid level measurements continue to show
27 a slow increase. The tank received wastes which consisted of TRU, fission products,
28 uranium, heavy metals, and inorganics.
29

30 **4.1.2.2.9 241-S-108 Single-Shell Tank.** The WIDS database (WHC 1991a) notes that
31 the five vadose zone boreholes monitoring this waste management unit for leaks have
32 remained stable. This waste management unit is considered sound. The tank received wastes
33 which consisted of TRU, fission products, uranium, heavy metals, and inorganics.
34

35 **4.1.2.2.10 241-S-109 Single-Shell Tank.** The WIDS database (WHC 1991a) notes that
36 six vadose zone boreholes monitor this waste management unit for leaks. This tank is
37 considered sound. The tank received wastes which consisted of TRU, fission products,
38 uranium, heavy metals, and inorganics.
39

40 **4.1.2.2.11 241-S-110 Single-Shell Tank.** The WIDS database (WHC 1991a) notes that
41 the eight vadose zone boreholes monitoring this waste management unit for leaks have
42 remained stable. Slightly elevated radiation levels are noted in Borehole 40-10-01 from 13 to
43 14 m (42 to 47 ft). WIDS indicates that a jet pump saltwell system was installed and
44 operations for the removal of interstitial liquid were commenced during August 1978. The
45 tank received wastes which consisted of TRU, fission products, uranium, heavy metals, and
46 inorganics.

1 **4.1.2.2.12 241-S-111 Single-Shell Tank.** The WIDS database (WHC 1991a) notes that
2 the six vadose zone boreholes monitoring this waste management unit for leaks have
3 remained stable. Data from past liquid levels have not been satisfactorily explained, but the
4 waste management unit is considered sound. This unit has the potential to generate hydrogen
5 or other flammable gases. The tank received wastes which consisted of TRU, fission
6 products, uranium, heavy metals, and inorganics.

7
8 **4.1.2.2.13 241-S-112 Single-Shell Tank.** The WIDS database (WHC 1991a) notes that
9 the five vadose zone boreholes monitoring this waste management unit for leaks have
10 remained stable. The waste management unit is considered sound. This unit has the potential
11 to generate hydrogen or other flammable gases. A jet pump saltwell system was installed and
12 placed in operation during August 1978. The tank received wastes which consisted of TRU,
13 fission products, uranium, heavy metals, and inorganics.

14
15 **4.1.2.2.14 241-SX Tank Farm.** An aerial gamma ray radiation survey over the 200
16 West Area in July and August 1988 indicates that gross gamma counts in the SX Tank Farm
17 ranged between 70,000 and 220,000 c/s.

18
19 The *1990 Annual Environmental Monitoring Report* (Schmidt et al. 1991) indicates that
20 a 6-acre surface contamination area (waste management unit UPR-216-W-24) extends from
21 the east fence line of the SX Tank Farm. Speck contamination with levels up to 14 mR/h has
22 been identified in this area. Tank farms and related facilities are considered to be sources of
23 environmental contamination. Recontamination of the same fence lines from year to year
24 appears to be associated with blowing of known contamination in the prevailing wind
25 direction.

26
27 A considerable amount of apparatus associated with the site is on the surface. The site
28 also contains two abovegroundwater tanks. Transuranics, fission products, uranium, heavy
29 metals, and inorganics are possibly present at this site.

30
31 The waste management units in these areas are discussed below.

32
33 **4.1.2.2.15 241-SX-101 Single-Shell Tank.** The WIDS database (WHC 1991a) notes
34 that the seven vadose zone boreholes monitoring this waste management unit for leaks have
35 remained stable. Borehole 41-01-06 shows slightly elevated radiation levels from 8 to 10 m
36 (26 to 33 ft). WIDS indicates that the waste management unit is considered sound, and that it
37 has the potential to generate hydrogen or other flammable gases. The tank received wastes
38 which consisted of TRU, fission products, uranium, heavy metals, and inorganics.

39
40 **4.1.2.2.16 241-SX-102 Single-Shell Tank.** The WIDS database (WHC 1991a) notes
41 that the five vadose zone boreholes monitoring this waste management unit for leaks have
42 remained stable. Three wells show slightly elevated radiation levels: Boreholes 41-02-02
43 from 13 to 15 m (44 to 49 ft), Boreholes 41-02-08 from 13 to 15 m (43 to 51 ft), and
44 Boreholes 41-02-11 from 7 to 8.2 m (23 to 27 ft). WIDS indicates that the waste
45 management unit is considered sound, and surface level radiation measurements remain within
46 guidelines. This unit has the potential to generate hydrogen or other flammable gases. As a

1 cleanup action, the tank contents have been pumped to a minimum supernatant heel. The
2 tank received wastes which consisted of TRU, fission products, uranium, heavy metals, and
3 inorganics.
4

5 **4.1.2.2.17 241-SX-103 Single-Shell Tank.** The WIDS database (WHC 1991a) notes
6 that the six vadose zone boreholes monitoring this waste management unit for leaks have
7 remained stable. Borehole 41-03-02 shows slightly elevated radiation readings from 14 to
8 15 m (45 to 49 ft). WIDS indicates that the waste management unit is considered sound, and
9 surface level radiation measurements remain within guidelines. This unit has the potential to
10 generate hydrogen or other flammable gases. As a cleanup action, the tank contents have
11 been pumped to a minimum supernatant heel. The tank received wastes which consisted of
12 TRU, fission products, uranium, heavy metals, and inorganics.
13

14 **4.1.2.2.18 241-SX-104 Single-Shell Tank.** The WIDS database (WHC 1991a) notes
15 that the seven vadose zone boreholes monitoring this waste management unit for leaks have
16 remained stable. Borehole 41-04-03 shows increased radiation levels at 6.4 m (21 ft). WIDS
17 indicates that the waste management unit is considered sound, and surface level radiation
18 measurements remain within guidelines. This unit has the potential to generate hydrogen or
19 other flammable gases. As a cleanup action, the tank contents have been pumped to a
20 minimum supernatant heel. The tank received wastes which consisted of TRU, fission
21 products, uranium, heavy metals, and inorganics.
22

23 **4.1.2.2.19 241-SX-105 Single-Shell Tank.** The WIDS database (WHC 1991a) notes
24 that the seven vadose zone boreholes and three laterals monitoring this waste management
25 unit for leaks have remained stable. Three lateral wells also monitor this waste management
26 unit, and they have remained stable. WIDS indicates that the waste management unit is
27 considered sound. This unit has the potential to generate hydrogen or other flammable gases.
28 As a cleanup action, the tank contents have been pumped to a minimum supernatant heel.
29 The tank received wastes which consisted of TRU, fission products, uranium, heavy metals,
30 and inorganics.
31

32 **4.1.2.2.20 241-SX-106 Single-Shell Tank.** The WIDS database (WHC 1991a) notes
33 that the six vadose zone boreholes monitoring this waste management unit for leaks have
34 remained stable. The waste management unit is considered sound. This unit has the potential
35 to generate hydrogen or other flammable gases. The tank received wastes which consisted of
36 TRU, fission products, uranium, heavy metals, and inorganics.
37

38 **4.1.2.2.21 241-SX-107 Single-Shell Tank.** The WIDS database (WHC 1991a) notes
39 that radiation laterals and seven vadose zone boreholes monitor this waste management unit
40 for leaks. Five of the boreholes have remained stable. Radiation levels in dry Borehole 41-
41 08-07 continues to slowly increase. High radiation levels have been observed in three
42 boreholes: Borehole 41-07-07 from 18 to 20 m (59 to 64 ft), Borehole 41-07-05 from 16 to
43 17 m (53 to 57 ft), and Borehole 41-07-08 from 17 to 18 m (56 to 60 ft). Lateral wells also
44 show high radiation readings. WIDS indicates that this tank is classified an assumed leaker,
45 and is considered to have a high heat load of 12,300 J/s (42,000 Btu/h) estimated through

1 1989. The tank received wastes which consisted of TRU, fission products, uranium, heavy
2 metals, and inorganics.

3
4 **4.1.2.2.22 241-SX-108 Single-Shell Tank.** The WIDS database (WHC 1991a) notes
5 that radiation laterals and six vadose zone boreholes and three laterals monitor this waste
6 management unit for leaks. Five of the boreholes have remained stable. Radiation levels in
7 Borehole 41-08-04 were substantially reduced in November 1981 when a caisson, located
8 between it and the waste management unit, was filled with dirt. High gamma ray responses
9 were noted in four boreholes: Borehole 41-08-02 from 16 to 17 m (53 to 56 ft); Borehole
10 41-08-04 from 6.4 to 6.7 m (21 to 22 ft) and from 13 to 14 m (43 to 46 ft); Borehole 41-08-
11 07 from 20 to 22 m (66 to 71 ft); and Borehole 41-08-11 from 15 to 17 m (51 to 57 ft). All
12 three lateral wells show increases in radiation levels. WIDS indicates that this tank is
13 classified an assumed leaker, and is considered to have a high heat load of 13,000 J/s
14 (45,000 Btu/hr) estimated through 1989. The tank received wastes which consisted of TRU,
15 fission products, uranium, heavy metals, and inorganics.

16
17 **4.1.2.2.23 241-SX-109 Single-Shell Tank.** The WIDS database (WHC 1991a) notes
18 that seven vadose zone boreholes and three laterals monitor this waste management unit for
19 leaks. Seven of the boreholes have remained stable. Radiation levels in Borehole 41-09-09
20 have continued to show a steady increase at the 23 m (74 ft) level. High gamma ray
21 responses were noted in five boreholes: Borehole 41-09-03 from 19 to 20 m (61 to 65 ft),
22 Borehole 41-09-04 from 24 to 25 m (79 to 82 ft), Borehole 41-09-07 from 19 to 20 m (63 to
23 67 ft), Borehole 41-09-09 from 22 to 23 m (72 to 74 ft), and Borehole 41-09-08 from 23 to
24 24 m (74 to 79 ft). All three lateral wells show elevated gamma ray readings. WIDS
25 indicates that this unit was removed from service as a "confirmed leaker," and is currently
26 considered an assumed leaker. It has the potential for flammable gas accumulation because
27 other SX tanks vent through it. The tank is considered to have a high heat load of 15,000 J/s
28 (50,000 Btu/h). The tank received wastes which consisted of TRU, fission products, uranium,
29 heavy metals, and inorganics.

30
31 **4.1.2.2.24 241-SX-110 Single-Shell Tank.** The WIDS database (WHC 1991a) notes
32 that eight vadose zone boreholes and three laterals monitor this waste management unit for
33 leaks, and that all boreholes remained stable. Borehole 41-10-01 shows slightly elevated
34 gamma ray readings from 19 to 20 m (63 to 67 ft), and that Lateral Well No. 1 (one of three)
35 also shows elevated readings. WIDS indicates that this unit was classified as having
36 "questionable integrity" in 1976 due to an unexplained liquid level decrease, and it is
37 currently considered to be an assumed leaker. The unit is considered to have a high heat load
38 of 12,300 J/s (42,000 Btu/h). The tank received wastes which consisted of TRU, fission
39 products, uranium, heavy metals, and inorganics.

40
41 **4.1.2.2.25 241-SX-111 Single-Shell Tank.** The WIDS database (WHC 1991a) notes
42 that seven vadose zone boreholes and three laterals monitor this waste management unit for
43 leaks, and that all wells remained stable. Borehole 41-11-10 shows slightly elevated gamma
44 ray readings from 18 to 21 m (64 to 69 ft), and that Lateral Well No. 2 (one of three) also
45 shows elevated readings. WIDS indicates that this unit was removed from service as a
46 "declared leaker" in May 1974 on the basis of an increase in radiation readings for the center

1 leak detection lateral. It is currently considered to be an assumed leaker. The unit is
2 considered to have a high heat load of 13,000 J/s (44,000 Btu/h). A cleanup action consisting
3 of pumping out the supernatant was completed in May 1974. A saltwell system was then
4 installed for final removal of interstitial liquor. The tank received wastes which consisted of
5 TRU, fission products, uranium, heavy metals, and inorganics.
6

7 **4.1.2.2.26 241-SX-112 Single-Shell Tank.** The WIDS database (WHC 1991a) notes
8 that seven vadose zone boreholes and three laterals monitor this waste management unit for
9 leaks, and that all boreholes remained stable. High radiation readings were noted in two
10 boreholes: Borehole 41-12-02 from 21 to 22 m (68 to 72 ft), and Borehole 41-12-03 from 19
11 to 20 m (64 to 67 ft). All three lateral wells at this location also show elevated radiation
12 readings. WIDS indicates that this unit was removed from service as a "confirmed leaker,"
13 and it is currently considered to be an assumed leaker. The unit is considered to have a high
14 heat load of 13,000 J/s (43,000 Btu/h). The tank received wastes which consisted of TRU,
15 fission products, uranium, heavy metals, and inorganics.
16

17 **4.1.2.2.27 241-SX-113 Single-Shell Tank.** The WIDS database (WHC 1991a) notes
18 that three vadose zone boreholes monitor this waste management unit for leaks, and that all
19 boreholes remained stable. This unit was removed from service as a "confirmed leaker," and
20 it is currently considered to be an assumed leaker. In early June 1958 measurements showed
21 that the bottom of the unit had lifted 1.2 m (4 ft) and then returned to its original position. A
22 cleanup action in 1962 added diatomaceous earth to the tank, and photographs indicate that no
23 liquid is present. The tank received wastes which consisted of TRU, fission products,
24 uranium, heavy metals, and inorganics.
25

26 **4.1.2.2.28 241-SX-114 Single-Shell Tank.** The WIDS database (WHC 1991a) notes
27 that radiation laterals and seven vadose zone boreholes and three laterals monitor this waste
28 management unit for leaks, and that all laterals and wells remained stable. Borehole 41-14-04
29 shows high radiation readings decreasing to low stable readings; and Boreholes 41-14-06 and
30 41-14-09 show slightly elevated readings from 9.0 to 21 and 18 to 19 m (32 to 68 and 60 to
31 64 ft), respectively. Lateral Well No. 3 (of three) shows slightly elevated readings decreasing
32 to low stable readings. WIDS indicates that this tank is classified an assumed leaker, and is
33 considered to have a high heat load of 17,000 J/s (58,000 Btu/h) estimated through 1989.
34 The tank received wastes which consisted of TRU, fission products, uranium, heavy metals,
35 and inorganics.
36

37 **4.1.2.2.29 241-SX-115 Single-Shell Tank.** The WIDS database (WHC 1991a) notes
38 that six vadose zone boreholes and three laterals monitor this waste management unit for
39 leaks, and that all boreholes remained stable. Borehole 41-15-07 shows elevated radiation
40 readings from 16 to 18 m (52 to 59 ft), and that all three lateral wells show elevated radiation
41 readings. WIDS indicates that this unit was removed from service as a "confirmed leaker,"
42 and it is currently considered to be an assumed leaker. Photographs taken inside the tank
43 indicate there are no surface liquids. The tank received wastes which consisted of TRU,
44 fission products, uranium, heavy metals, and inorganics.
45

1 **4.1.2.2.30 241-SY-101 Double-Shell Tank.** This tank currently contains interstitial
2 liquid and saltcake. The waste type is complexant concentrate waste which consists of
3 concentrated product from the evaporation of dilute complexed waste (Hanlon 1991). The
4 waste stored in this DST is classified as mixed waste because it contains both radioactive and
5 regulated chemical constituents. It is considered as corrosive, toxic, persistent, carcinogenic,
6 and extremely hazardous in accordance with Washington State Dangerous Waste Regulations
7 (WAC 173-303). The mixed waste in the DSTs could include the fission products strontium
8 and cesium and actinide series elements such as uranium and plutonium. Metals also could
9 be concentrated in the sludge at the bottom of the tanks; therefore, the waste could be
10 extremely hazardous waste based on a high metal content.

11
12 **4.1.2.2.31 241-SY-102 Double-Shell Tank.** This tank currently contains supernatant
13 liquid and sludge. The waste type is dilute noncomplexed waste, and plutonium finishing
14 plant TRU solids (Hanlon 1991). The waste stored in this DST is classified as mixed waste
15 because it contains both radioactive and regulated chemical constituents. It is considered as
16 corrosive, toxic, persistent, carcinogenic, and extremely hazardous in accordance with
17 Washington State Dangerous Waste Regulations [Washington Administrative Code (WAC)
18 173-303]. The mixed waste in the DSTs could include the fission products strontium and
19 cesium and actinide series elements such as uranium and plutonium. Metals also could be
20 concentrated in the sludge at the bottom of the tanks; therefore, the waste could be extremely
21 hazardous waste based on a high metal content.

22
23 **4.1.2.2.32 241-SY-103 Double-Shell Tank.** This tank currently contains supernatant
24 liquid and saltcake. The waste type is complexant concentrate waste which consists of
25 concentrated product from the evaporation of dilute complexed waste (Hanlon 1991). The
26 waste stored in this DST is classified as mixed waste because it contains both radioactive and
27 regulated chemical constituents. It is considered as corrosive, toxic, persistent, carcinogenic,
28 and extremely hazardous in accordance with Washington State Dangerous Waste Regulations
29 (WAC 173-303). The mixed waste in the DSTs could include the fission products strontium
30 and cesium and actinide series elements such as uranium and plutonium. Metals also could
31 be concentrated in the sludge at the bottom of the tanks; therefore, the waste could be
32 extremely hazardous waste based on a high metal content.

33
34 **4.1.2.2.33 240-S-302 Catch Tank.** The WIDS database (WHC 1991a) indicates that
35 this waste management unit was removed from service in March 1987 as a "leaker."

36
37 The catch tank is below grade and has been taken out of service as a leaker. The tank
38 received low-level, dilute laboratory wastes which included plutonium, volatiles, and
39 inorganics.

40
41 **4.1.2.2.34 241-S-302A Catch Tank.** The WIDS database (WHC 1991a) indicates this
42 waste management unit began service in 1952, and that it is currently an assumed leaker.
43 The catch tank is below grade and is being pumped per PM 90-062. The liquid waste
44 disposed in the tank is reported as mixed waste.

1 **4.1.2.2.35 241-S-302B Catch Tank.** The WIDS database (WHC 1991a) indicates that
2 this waste management unit was isolated in 1985. The liquid waste disposed into the tank is
3 reported as mixed waste.
4

5 **4.1.2.2.36 241-SX-302 Catch Tank.** The catch tank is below grade and was isolated
6 in 1985. The liquid waste disposed into the tank is reported as mixed waste.
7

8 **4.1.2.2.37 244-S Receiver Tank.** The WIDS database (WHC 1991a) indicates this
9 active waste management unit began service in 1987, transporting waste solutions from
10 processing and decontamination operations. Leak detection and air monitoring are performed
11 continuously within the 241-SY Tank Farm and the unit's sump is monitored manually. The
12 liquid waste disposed into the tank is reported as mixed waste.
13

14 **4.1.2.3 Cribs, Drains, and Drain Fields.** The types of information available for the cribs,
15 drains, and drain fields include inventory data, radiological survey results, and borehole
16 geophysical data. Soil, vegetation, and air monitoring data are generally unavailable for these
17 sites. Inventory and radiological information have largely been compiled from the WIDS
18 sheets (WHC 1991a) and the Hanford Inactive Site Survey (HISS) database entries.
19

20 **4.1.2.3.1 216-S-1 and 216-S-2 Cribs.** The WIDS database (WHC 1991a) notes that
21 wells monitor this site, and annual surface radiological surveys are performed here. Data
22 from Wells W22-2, -5, -6, -10, -15, -16, -17, -18, -29, -30, -31, -36, and -67 indicate minor
23 redistribution of radionuclides in the soil beneath the site. It is believed that breakthrough of
24 contaminants could have occurred here. Annual radiological monitoring during August 1990
25 noted a sagebrush stump in the center of the waste management unit with a reading of
26 35,000 c/min, an increase over the 1989 survey. A tumbleweed gave a reading of
27 150,000 d/min (beta) and a flagged area along the southwest border of the fenced area gave a
28 reading of 20,000 d/min (beta) also in August 1990. At that time, background radiation was
29 measured to be 2,500 d/min (beta) at this unit.
30

31 Transuranics, fission products, uranium, and inorganics are assumed to be present at this
32 site. The crib received approximately 160,000 kL (4.2×10^7 gal) of waste.
33

34 Gross gamma-ray well logs have been used to qualitatively evaluate radionuclide
35 migration in the vadose zone near the 216-S-1 and S-2 cribs. Wells 22-1, W22-2, W22-15,
36 W22-18, W22-29, W22-30, W22-31, W22-36, and W22-67 immediately adjacent to the crib
37 show radioactive contaminants from the bottom of the crib to the water table. In the
38 peripheral wells W22-5, W22-6, W22-10, W22-16, and W22-17, radiation levels are near
39 background. Wells W22-2, W22-5, W22-6, W22-10, W22-15, W22-16, W22-17, W22-18,
40 W22-29, W22-30, W22-31, W22-36, and W22-67, have all been geophysically logged since
41 1977. Examination of the gamma ray log from these wells showed only one major change.
42 In 1986, Well W22-6 recorded radiation level above background (275 c/s) from 14 to 15 m
43 (46 to 48 ft). A relog of this well in 1987 showed only radiation levels near background.
44

45 **4.1.2.3.2 216-S-5 Crib.** The WIDS database (WHC 1991a) indicates radionuclides are
46 held high in the sediments beneath the unit, and monitoring of Wells W26-1, -3, -4, and -5

1 have shown no breakthrough from the sediment to the groundwater. During the annual
2 surface radiological surveys in August 1990 and August 1991, no contamination was detected.
3 WIDS also notes that the waste management unit was surface stabilized on August 24, 1990.
4 Transuranics, fission products, uranium, and inorganics are assumed to be present. The unit
5 received approximately 4,470,000 kL (1.18×10^9 gal) of waste.
6

7 Gross gamma-ray well logs have been used to qualitatively evaluate radionuclide
8 migration in the vadose zone near the 216-S-5 crib. Logs from Well 26-1 shows radioactive
9 contaminants from approximately 1.5 to 12 m (5 to 38 ft) below the ground surface. The
10 contamination is held high beneath the crib and breakthrough to the groundwater has not
11 occurred at this site. Peripheral wells W26-3, W26-4, and W26-5 show only background
12 radiation levels. These wells have not been geophysically logged since 1977.
13

14 **4.1.2.3.3 216-S-6 Crib.** During the annual surface radiological survey in August 1991,
15 no contamination was detected at this unit. The WIDS database (WHC 1991a) notes that
16 during the same survey in August 1990, no contamination was detected at the perimeter of the
17 waste management unit. Only the perimeters were surveyed due to the surface stabilization
18 effort occurring on September 14, 1990. During the previous annual survey which included
19 the interior of the waste management unit, no contamination was detected. Transuranics,
20 fission products, uranium, and inorganics are assumed to be present at this site. The unit
21 received approximately 4,470,000 kL (1.18×10^9 gal) of waste.
22

23 Gross gamma-ray logs from Well W26-2 have been used to qualitatively evaluate
24 radionuclide migration in the vadose zone near the 216-S-2 crib. Only background radiation
25 levels are detected at this well and no breakthrough to the groundwater has occurred at this
26 site. Well W26-2 has not been geophysically logged since 1977.
27

28 An aerial gamma ray radiation survey over the 200 West Area in July and August 1988
29 indicates that gross gamma counts in the vicinity of this waste management unit ranged
30 between 2,200 and 7,000 c/s.
31

32 **4.1.2.3.4 216-S-7 Crib.** The WIDS database (WHC 1991a) notes that wells monitor
33 this site, and annual surface radiological surveys are performed here. Data from
34 Wells W22-12, -13, -14, and -32 indicate no measurable migration of radionuclides have been
35 detected beneath this waste management unit since waste disposal to the site was terminated
36 in July 1965. It is believed that breakthrough of contaminants could have occurred here.
37 Annual perimeter radiological monitoring during August 1990 and August 1991 did not detect
38 contamination, and there has been no change in this condition since the August 1988 survey.
39 Perimeter surveys are being conducted due to the potential for collapse of the structure, which
40 could spread contamination currently below ground surface. Transuranics, fission products,
41 uranium, and inorganics are assumed to be present at this site. The crib received
42 approximately 390,000 kL (1.0×10^8 gal) of waste.
43

44 Gross gamma-ray logs from Wells W22-12, W22-13, W22-14, W22-32, W22-33 have
45 been used to qualitatively evaluate radionuclide migration in the vadose zone near the 216-S-7
46 crib. Between 1958 and 1976, radioactive contaminants were detected from approximately

1 2 m (7 ft) below the base of the crib to the water table approximately 64 m (210 ft) below
2 ground surface on gamma ray logs. The radiation intensity decreased with time due to
3 radionuclide decay. Since waste disposal to the crib was terminated no measurable movement
4 of radionuclides beneath the crib have been detected. Wells W22-13, W22-14, and W22-33
5 were geophysically logged occasionally up to 1987. Gamma ray logs from these wells show
6 no major changes since 1977.
7

8 **4.1.2.3.5 216-S-9 Crib.** The WIDS database (WHC 1991a) notes that wells monitor
9 this site, and annual surface radiological surveys are performed here. Wells W22-26A and
10 W22-27A were drilled to depths of 65 m (215 ft) next to this waste management unit in 1966
11 to determine the radionuclide distribution below this site. Well W22-26A was drilled on the
12 east side of the unit and W22-27A on the west. Low-level ⁹⁰Sr (1.0E-11 Ci/g) was detected
13 in a perched water zone at 43 m (140 ft) in Well W22-26A, and no long-lived isotopes were
14 detected in Well W22-27A. Wells W22-25, -26, -34, and -35 presently monitor this waste
15 management unit. Data indicate breakthrough to groundwater could have occurred at this site.
16 During the annual surface radiological surveys in August 1990 and August 1991, no
17 contamination was detected. These data indicate no change since the August 1988 survey.
18 Transuranics, fission products, uranium, and inorganics exist at this site. The crib received
19 approximately 50,300 kL (1.33 x 10⁷ gal) of waste.
20

21 Gross gamma-ray logs from Wells W22-25, W22-26, W22-35, and W22-36 have been
22 used to qualitatively evaluate radionuclide migration in the vadose zone near the 216-S-9 crib.
23 Radioactive contaminants have been detected from the crib bottom to the water table since
24 1965. Gamma-ray logs show the radiation intensity in these monitoring wells has been
25 decreasing with time due to radionuclide decay. Wells W22-36, W22-25, and W22-35, have
26 been geophysically logged since 1977. Gamma ray logs from Well W22-35 showed a
27 decrease in radiation probably due to radionuclide decay.
28

29 **4.1.2.3.6 216-S-13 Crib.** A surface survey in December 1991 revealed a small area of
30 contamination near the center of the unit containing Rabbitbrush that gave readings of up to
31 4,000 d/min (beta). The area was stabilized when efforts to decontaminate it were
32 unsuccessful. The area around the center post at the unit was also noted as an area with
33 cave-in potential. The WIDS database (WHC 1991a) indicates that surficial radiological
34 surveys of the perimeter are performed annually, and during August 1990 no contamination
35 was detected. No change in the survey results had been noted since August 1988.
36 Transuranics, fission products, uranium, and inorganics have been detected at this site. The
37 crib received approximately 5,000 kL (1.3 x 10⁶ gal) of waste.
38

39 Gross gamma-ray logs from Well W22-21 have been used to qualitatively evaluate
40 radionuclide migration in the vadose zone near the 216-S-13 crib. Between 1952 to 1968,
41 contaminants were detected from approximately 2 m (6 ft) below the base of the crib to 33 m
42 (107 ft) below the ground surface. Radioactive contaminants are held high in the sediment
43 column indicating that breakthrough to groundwater has not occurred at this site. Gamma-ray
44 logs show radiation intensity decreasing with time. Well W22-21 has not been geophysically
45 logged since 1977.
46

1 **4.1.2.3.7 216-S-20 Crib.** No radiation was detected at this waste management unit
2 during the August 1991 annual surface radiation survey. The WIDS database (WHC 1991a)
3 also indicates that during the annual surface radiation monitoring in August 1990 no radiation
4 was detected at the perimeters of this unit. There has been no change in the surface
5 monitoring status of this site since the November 1987 survey. The perimeters are monitored
6 due to the collapse potential of this facility, which has been recapped three times since
7 December 13, 1974, due to subsidence. Transuranics, fission products, uranium, and
8 inorganics are assumed to be present at this site. The crib received approximately 135,000 kL
9 (3.57 x 10⁷ gal) of waste.

10
11 Gross gamma-ray logs from Wells W22-20 and W22-74 have been used to qualitatively
12 evaluate radionuclide migration in the vadose zone near the 216-S-20 crib. Near background
13 levels of radiation were detected in Well W22-20 at approximately 17 m (56 ft) above the
14 water table. Measurable movement of radionuclides beneath the crib have been noted since
15 1963 due to waste discharge to the crib but no breakthrough to the groundwater had occurred
16 at this site. Well W22-20 has not been geophysically logged since 1977. Well W22-74, first
17 logged in 1984 then again in 1987, show gamma-ray activity in the vadose zone from
18 approximately 9 to 12 m (30 to 38 ft).

19
20 **4.1.2.3.8 216-S-22 Crib.** No radiation was detected at this waste management unit
21 during the annual survey in August 1991. The WIDS database (WHC 1991a) also indicates
22 that during the annual survey in August 1990 no contamination was detected, and that no
23 change has occurred since the August 1990 survey. Transuranics, fission products, uranium,
24 and inorganics are assumed to be present at this site. The crib received approximately
25 98,000 L (26,000 gal) of waste.

26
27 Gross gamma-ray logs from Well W22-19 have been used to qualitatively evaluate
28 radionuclide migration in the vadose zone near the 216-S-22 crib. A gamma ray log from
29 1984 shows radiation levels slightly above background (150 c/s) at approximately 65 to 66 m
30 (214 to 216 ft). Well W22-19 has not been geophysically logged since 1984.

31
32 **4.1.2.3.9 216-S-23 Crib.** The WIDS database (WHC 1991a) notes that wells monitor
33 this site, and annual surface radiological surveys are performed here. Data from
34 Wells W19-5, W19-6, W22-37, and W22-38 indicate that breakthrough to groundwater has
35 not occurred at this site. During the August 1990 and August 1991 surface surveys, no
36 contamination was detected, a decrease from the August 1989 survey. Transuranics, fission
37 products, uranium, and inorganics are assumed to be present at this site. The crib received
38 approximately 34,100 kL (9.0 x 10⁶ gal) of waste.

39
40 Gross gamma-ray logs from Wells W19-5, W19-6, W22-37, and W22-38 have been
41 used to qualitatively evaluate radionuclide migration in the vadose zone near the 216-S23
42 crib. Gamma-ray profiles from these wells show near background levels of radiation. These
43 wells have not been geophysically logged since 1977.

44
45 **4.1.2.3.10 216-S-25 Crib.** The WIDS database (WHC 1991a) indicates that surficial
46 radiological surveys are performed semiannually, and during September 1990 no

1 contamination was detected. No contamination was noted at this unit in September 1991 and
2 background radiation was measured to be at 100 c/min. Radiological well surveys are
3 performed quarterly. Transuranics, fission products, uranium, and inorganics are assumed to
4 be present at this site. The crib received approximately 288,000 kL (7.61×10^7 gal) of waste.
5

6 Gross gamma-ray logs from Wells W23-9, W23-10, and W23-11 have been used to
7 qualitatively evaluate radionuclide migration in the vadose zone near the 216-S-25 crib.
8 Gamma-ray logs from these wells show only background radiation levels. These wells have
9 not been geophysically logged since 1977.
10

11 **4.1.2.3.11 216-S-26 Crib.** No contamination was noted at this unit during the surficial
12 radiological survey in December 1991. The WIDS database (WHC 1991a) indicates that
13 surficial radiological surveys are performed quarterly, and during September 1990 no
14 contamination was detected. No change has occurred in the surface survey data since
15 September 1989. Transuranics, fission products, uranium, volatiles, semivolatiles, and
16 inorganics are assumed to be present at this site. The crib received approximately 164,000 kL
17 (4.33×10^7 gal) of waste.
18

19 Well 299-W27-1 is located adjacent to the 216-S-26 crib. This well was never
20 geophysically logged.
21

22 **4.1.2.3.12 216-S-3 French Drain.** The WIDS database (WHC 1991a) indicates that
23 during the annual surface radiological survey in August 1990, no contamination was reported.
24 These results are a decrease from the 1989 survey. No contamination hot spots were detected
25 during an August 1991 surface survey, and background radiation was measured at
26 20,000 d/min (beta). The waste received was low salt and consisted of TRU, fission
27 products, uranium, and inorganics. The unit received approximately 4,000 kL (1.06×10^6 gal)
28 of waste.
29

30 **4.1.2.4 Ditches, Trenches, and Ponds.**

31 **4.1.2.4.1 216-S-10P Pond.** The WIDS database (WHC 1991a) indicates that
32 radiological surveys of the surface are performed semiannually. No contamination was
33 detected during January 1992, July 1991, and April or July 1990.
34

35 Well 699-32-77 is located near the 216-S-10P Pond. The gamma-ray log from this well
36 shows no radiation levels above background.
37

38 The unit is backfilled over and includes four finger leader trenches. The pond and ditch
39 cover 53 m² (13 acres). The pond received overflow from the high water tower and bearing
40 cooling water from S Plant via the 216-S-10 Ditch.
41

42 **4.1.2.4.2 216-S-11 Pond.** The WIDS database (WHC 1991a) indicates that the
43 southern portion of this waste management unit is covered with soil, is free of radioactive
44
45

1 contamination, and is being used as a root depth penetration study site. No contamination
2 was noted during July 1991 and January 1992 surface radiological surveys.

3
4 Wells 699-32-77 and 299-W26-9 were drilled near the 216-S-11 Pond and geophysically
5 logged during construction. Gamma-ray logs from these wells show no radiation readings
6 above background.

7
8 The site covers approximately 6,000 m² (65,000 ft²) and received waste from air
9 conditioning, drains, and chemical sewer in S Plant via the 216-S-10 Ditch. The site consists
10 of two ponds that are now covered and the south pond, free from radioactive contamination,
11 is being used for a root depth penetration study. The ponds received approximately
12 2,000,000 kL (5.3 x 10⁸ gal) of waste.

13
14 **4.1.2.4.3 216-S-15 Pond.** Background radiation readings of 1,500 d/min (beta) to
15 20,000 d/min (beta) along the southwest boundary of the unit were recorded during the
16 August 1991 surface radiological survey. The WIDS database (WHC 1991a) indicates that
17 surficial radiological surveys are performed annually, and that no contamination was detected
18 in August 1990. These survey results indicate a decrease from the 1989 survey. The site
19 received approximately 10,000 L (2,600 gal) of condenser spray cooling water from the 110-S
20 tank in the 241-S Tank Farm. The waste was low salt and composed mainly of nitrate and
21 MIBK.

22
23 **4.1.2.4.4 216-S-16P Pond.** The WIDS database (WHC 1991a) indicates that surficial
24 radiological surveys are performed semiannually. No contamination was detected in August
25 1990 or February 1991. There has been no change in activity since the September 1987
26 survey. This waste management unit was leveled and backfilled in 1975, a number of test
27 plots were sealed with asphalt, and a root toxin was applied. Fission products and uranium
28 are assumed to be present at this site.

29
30 An aerial gamma-ray radiation survey over the 200 West Area in July and August 1988
31 indicates that gross gamma counts in the vicinity of this waste management unit ranged
32 between 2,200 and 7,000 c/s.

33
34 **4.1.2.4.5 216-S-17 Pond.** The WIDS database (WHC 1991a) indicates that surficial
35 radiological surveys are performed semiannually. Decaying tumbleweeds on the south berm
36 of the waste management unit were read at 1,000 c/min in July 1990, and similar conditions
37 were reported during the April 1990 survey. No contamination was noted during January
38 1992 surface monitoring. The site has been stabilized previously. Transuranics, fission
39 products, uranium, and inorganics are assumed to be present at this site.

40
41 **4.1.2.4.6 216-S-19 Pond.** The WIDS database (WHC 1991a) indicates that surficial
42 radiological surveys are performed semiannually, and that no contamination was detected in
43 August 1990. In December 1953, surface dose rates up to 200 mR/h were detected at the
44 edge of this waste management unit. Over the ensuing years, the beta/gamma radioactivity
45 has decayed off until presently there is no activity detectable with radiation monitoring field
46 instruments. The absence of radioactivity was confirmed during a surficial survey in

1 February 1991. Mud samples taken from the site on July 14, 1977, contained ^{241}Am activity
2 to 38 nCi/g. The site was stabilized in October 1984. There is no radioactivity but the
3 possibility of the presence of hazardous chemicals (volatiles and semivolatiles) exists.
4

5 **4.1.2.4.7 216-S-10D Ditch.** The WIDS database (WHC 1991a) indicates that
6 radiological surveys of the surface are performed semiannually, surface water samples are
7 taken weekly, and sediment and vegetation samples are taken annually from this waste
8 management unit. Surface water sampling was discontinued in August 1991. No
9 contamination was detected during the semiannual surface monitoring in July 1989 and
10 January 1992. The site has been partially stabilized. Transuranics, fission products, uranium,
11 volatiles, and semivolatiles are assumed to be present at this site. The ditch received
12 approximately 4,000,000 kL (1.1×10^6 gal) of waste.
13

14 Wells W26-7, W26-8, W26-11, W26-12, drilled adjacent to the 216-S-10D Ditch, were
15 geophysically logged during construction. Gamma-ray logs from these wells show no
16 radiation levels above background.
17

18 **4.1.2.4.8 216-S-16D Ditch.** The WIDS database (WHC 1991a) indicates that this
19 waste management unit was surveyed for underground radioactive material in September 1984
20 and that no contamination was detected. Details of the sampling program were not available.
21 This waste management unit has been backfilled. Inorganics are assumed to be present in the
22 ditch.
23

24 **4.1.2.4.9 216-U-9 Ditch.** The WIDS database (WHC 1991a) indicates this waste
25 management unit was backfilled with 0.6 (2 ft) of clean soil in spring 1954. It is not
26 currently monitored as a radiation zone.
27

28 **4.1.2.4.10 216-S-8 Trench.** The WIDS database (WHC 1991a) indicates that
29 radiological surveys of the surface are performed annually. During the August 1990 survey,
30 three areas of contamination were identified at levels of 0.6 mR/h, 2.6 mR/h, and 1.1 mR/h.
31 These readings represent an increase from the 1989 survey. The August 1991 survey revealed
32 background radiation at 2,000 d/min (beta), but no other specific areas of contamination.
33 Transuranics, fission products, uranium, and inorganics are assumed to be present at the site.
34 The trench received approximately 10,000 kL (2.64×10^6 gal) of waste.
35

36 Well W22-39 drilled near the 216-S-8 Trench, was geophysically logged during
37 construction. Gamma-ray logs from this well shows no radiation levels above background.
38

39 **4.1.2.4.11 216-S-12 Trench.** The WIDS database (WHC 1991a) indicates that surface
40 radiological surveys of the site are performed annually. No contamination was detected
41 during the August 1990 and August 1991 surveys. No change in surface contamination has
42 been noted since the August 1989 survey. WIDS indicates that this site, which was active
43 only during July 1954, could in all probability be removed from the status of a radiation zone.
44 No subsurface data are presented to substantiate this interpretation.
45

1 The site received approximately 76,000 L (20,000 gal) of flush water containing
2 ammonium nitrate from the 291-S stack. Transuranics, fission products, uranium, and
3 inorganics are assumed to be present at this site.
4

5 **4.1.2.4.12 216-S-14 Trench.** The WIDS database (WHC 1991a) indicates that during
6 core drilling in 1971 at this waste management unit, a strong odor of hexone was noted in the
7 soil samples and the borehole. Radioactivity was not found in the samples, and the site was
8 released from radiation zone status on February 1971. The site received contaminated hexone
9 from initial test runs at S Plant.
10

11 **4.1.2.4.13 216-S-18 Trench.** The WIDS database (WHC 1991a) indicates that this site
12 was active in October 1954 as a receptacle for vehicle decontamination waste. In October
13 1972, this site was dug up and the remaining radioactive objects were removed to the 200
14 West Dry Waste Burial Ground for disposal. The site was then released from radiation zone
15 status. It is likely that organics were used in steam cleaning at this site.
16

17 **4.1.2.5 Septic Tanks and Associated Drain Fields.**

18 **4.1.2.5.1 2607-W6 Septic Tank and Tile Field.** No monitoring data were found for
19 this waste management unit.
20

21 **4.1.2.5.2 2607-WZ Septic Tanks (2) and Drain Field.** The WIDS database
22 (WHC 1991a) indicates that this waste management unit was used to process sanitary waste
23 water and sewage. Wastes associated with this facility are categorized as nonhazardous and
24 nonradioactive.
25

26 **4.1.2.5.3 Sanitary Crib.** No monitoring data were found for this waste management
27 unit.
28

29 **4.1.2.6 Transfer Facilities, Diversion Boxes, and Pipelines.**

30 **4.1.2.6.1 216-S-172 Control Structure.** The WIDS database (WHC 1991a) indicates
31 routine surficial radiation surveys, airborne radionuclide monitoring, and visual inspections are
32 performed at this waste management unit. The unit contains unquantified amounts of low-
33 level radioactive solid waste. The maximum radiation reading is 25 mR/h.
34
35

36 According to the 1990 Environmental Surveillance Report (Schmidt et al. 1991) this
37 waste management unit was stabilized during 1990. No radioactivity was detected during a
38 September 1991 surficial survey.
39

40 **4.1.2.6.2 2904-S-160 Control Structure.** The WIDS database (WHC 1991a) indicates
41 that routine surficial radiation surveys, airborne radionuclide monitoring and visual
42 inspections are performed at this waste management unit. Results of the monitoring indicates
43 the site contains an undetermined quantity of low-level contaminated concrete and piping.
44 Radiological readings indicate 5,000 c/min beta/gamma in the soil and up to 300 c/min
45 smearable contamination on the waste management unit surfaces.
46

1
2 **4.1.2.6.3 2904-S-170 Control Structure.** The WIDS database (WHC 1991a) indicates
3 that routine surficial radiation surveys, airborne radionuclide monitoring, and visual
4 inspections are performed at this waste management unit. Results of the monitoring indicates
5 the site contains an undetermined quantity of low-level contaminated concrete and piping.
6 Radiological readings indicate there is less than 200 c/min beta/gamma smearable
7 contamination, less than 7 mR/h penetrating radiation, and indications of nonpenetrating
8 radiation present.
9

10 **4.1.2.6.4 2904-S-171 Control Structure.** The WIDS database (WHC 1991a) indicates
11 that routine surficial radiation surveys, airborne radionuclide monitoring, and visual
12 inspections are performed at this waste management unit. Results of the monitoring indicates
13 the site contains an undetermined quantity of low-level contaminated concrete and piping.
14 Radiological readings indicate there is less than 100 c/min beta/gamma smearable
15 contamination and a 20 mR/h reading at contact with an open or closed window Cutie Pie
16 radiation monitoring instrument.

17
18 **4.1.2.6.5 240-S-151 Diversion Box.** Transuranics, fission products, and uranium are
19 assumed to be present at this site. Alpha radiation and total uranium remain above the ²³⁸U
20 concentration limit. The unit has been isolated and weather covered.
21

22 **4.1.2.6.6 240-S-152 Diversion Box.** This unit has been isolated and weather covered.
23 No other data were not found.
24

25 **4.1.2.6.7 241-S-151 Diversion Box.** This unit has been isolated and covered. No
26 other data were found.
27

28 **4.1.2.6.8 241-S-152 Diversion Box.** The WIDS database (WHC 1991a) indicates that
29 this waste management unit has been isolated and weather covered. No other data were
30 found.
31

32 **4.1.2.6.9 241-SX-151 Diversion Box.** The WIDS database (WHC 1991a) indicates that this
33 waste management unit has been isolated and weather covered. No other data were found regarding
34 this waste management unit.
35

36 **4.1.2.6.10 241-SX-152 Diversion Box.** The WIDS database (WHC 1991a) indicates that this
37 waste management unit has been isolated and weather covered. No other data were found regarding
38 this waste management unit.
39

40 **4.1.2.6.11 241-S-A Valve Pit.** No data were found regarding this waste management unit.
41

42 **4.1.2.6.12 241-S-B Valve Pit.** No data were found regarding this waste management unit.
43

44 **4.1.2.6.13 241-S-C Valve Pit.** No data were found regarding this waste management unit.
45

46 **4.1.2.6.14 241-S-D Valve Pit.** No data were found regarding this waste management unit.

1 **4.1.2.6.15 241-SX-A Valve Pit.** No data were found regarding this waste management unit.

2
3 **4.1.2.6.16 241-SX-B Valve Pit.** No data were found regarding this waste management unit.

4
5 **4.1.2.6.17 241-SY-A Valve Pit.** No data were found regarding this waste management unit.

6
7 **4.1.2.6.18 241-SY-B Valve Pit.** No data were found regarding this waste management unit.

8
9
10 **4.1.2.7 Basins.**

11
12 **4.1.2.7.1 207-S Retention Basin.** The WIDS database (WHC 1991a) notes that annual
13 surface contamination monitoring is performed on this site. Readings taken in July 1990
14 indicate that the center of the basin is densely contaminated up to 60,000 dis/min. There are
15 also areas of lesser contamination on the perimeters. Similar conditions were reported during
16 the July 1989 survey. The concrete floors and walls of the basin were filled with dirt to
17 prevent the spread of contamination. In June 1975, the soil was treated with herbicides and
18 covered with 20 cm (8 in.) of gravel to stop radioactive weed growth. Three unplanned
19 releases are associated with this site and fission products assumed to be present.

20
21 **4.1.2.7.2 207-SL Retention Basin.** The WIDS database (WHC 1991a) indicates that
22 this waste management unit is currently active. Annual surface radiological monitoring is
23 conducted around the perimeter of the site, and during the July 1990 survey no contamination
24 was detected. The surface monitoring has not noticed a change in conditions since the July
25 1988 survey. Liquid effluent sampling and analysis is performed weekly and results are
26 composited monthly, but were not summarized in WIDS. Transuranics, fission products,
27 uranium, heavy metals, inorganics, volatiles, and semivolatiles are assumed to be present at
28 this site.

29
30 **4.1.2.8 Burial Sites.**

31
32 **4.1.2.8.1 218-W-7 Vault.** The WIDS database (WHC 1991a) notes that annual surface
33 contamination monitoring is performed on this site. Readings taken in July 1990 indicate
34 3.5 mR/h directly on the waste shoot, and a similar condition was reported in the July 1989
35 survey. There is an unplanned release associated with the site, UPR-200-W-109. The site
36 may contain fission products.

37
38 In July 1991, an attempt was made to decontaminate this area by removing
39 contaminated soil. When this effort failed due to increasing radioactivity at increasing depths,
40 the area was stabilized with clean backfill.

41
42 **4.1.2.8.2 218-W-9 Burial Ground.** The WIDS database (WHC 1991a) indicates that
43 the waste in this waste management unit contains less than 0.1 Ci of total beta activity. The
44 site is annually monitored for surface radiological contamination. During the July 1990
45 survey contaminated specks were found up to 25,000 dis/min. Similar contamination was
46 noted in the July 1988 and 1989 surveys. The vault may contain TRU, uranium, and fission

1 products. This unit was stabilized with 0.5 to 0.7 m (18 to 24 in.) of clean soil in August
2 1991.

3
4 **4.1.2.9 Unplanned Releases.**

5
6 **4.1.2.9.1 UN-200-W-10 Unplanned Release.** The WIDS database (WHC 1991a)
7 indicates that this release occurred in summer 1952, and characterized spotty uranium
8 contamination from an unknown source. The maximum reading was noted at 10,000 c/min at
9 2 cm (1 in.). A cleanup action was instituted by covering the contaminated area with asphalt.

10
11 **4.1.2.9.2 UN-200-W-30 Unplanned Release.** The designation UN-200-W-30
12 unplanned release is scheduled for deletion because it is a duplicate of waste management
13 unit 216-S-12 (WHC 1991a).

14
15 **4.1.2.9.3 UN-200-W-32 Unplanned Release.** The WIDS database (WHC 1991a)
16 indicates that this release occurred in 1954, and involved a ruptured transfer line enroute to
17 224-U from 202-S that spilled uranium nitrate hexahydrate (UNH) solution on the ground.
18 Current radiation surveys show 7,000 to 30,000 dis/min beta radiation present. The
19 contamination was covered with clean soil, and the area was removed from radiation zone
20 status in February 1971.

21
22 **4.1.2.9.4 UN-200-W-34 Unplanned Release.** The WIDS database (WHC 1991a)
23 indicates that this release occurred in May 1955, and involved overflow from an open ditch
24 and the 202-S Building Chemical Sewer Trenches. The spill contaminated approximately
25 25,000 m² (1 acre) between the open ditch and the 202-S Building Chemical Sewer Trenches.
26 A maximum dose rate of 1 R/h was recorded at the ground surface, but the date of the
27 reading was not presented in WIDS.

28
29 **4.1.2.9.5 UN-200-W-35 Unplanned Release.** The WIDS database (WHC 1991a)
30 indicates that the UPR-200-W-35 unplanned release was a leak that occurred in the UNH
31 process line from 202-S to U Plant in September 1955 at a location just outside and to the
32 north of the 202-S Building exclusion area. The contamination was removed to the 200 West
33 solid waste burial ground. The area was removed from radiation zone status in January 1972.

34
35 **4.1.2.9.6 UN-200-W-41 Unplanned Release.** The WIDS database (WHC 1991a)
36 indicates this release was caused by a burial box in transit on July 7, 1956. The release
37 resulted in unknown beta/gamma contamination with readings to 1,000 mR/h, although the
38 date of the readings was not provided.

39
40 **4.1.2.9.7 UN-200-W-42 Unplanned Release.** The WIDS database (WHC 1991a)
41 indicated that contamination spots were found on the ground in S Plant near a railroad shack
42 on February 3, 1957. The cause of the contamination is unknown. The contamination
43 consisted of unknown beta/gamma with readings to 500 mR/h, and was cleaned to 2,000 to
44 5,000 c/h.

1 **4.1.2.9.8 UN-200-W-43 Unplanned Release.** The WIDS database (WHC 1991a)
2 indicates this site originated from wind blown contamination from a nearby radiation zone
3 east of 223-S. The result was unknown alpha with readings to 2,000 c/h, although the date of
4 the readings was not given. The site is approximately 110 m² (1,200 ft²) with 4,500 kg
5 (5 tons) of soil being contaminated.
6

7 **4.1.2.9.9 UN-200-W-49 Unplanned Release.** The WIDS database (WHC 1991a)
8 indicates this release occurred on July 31, 1958, when ground outside the southeast corner of
9 the 241-SX Tank Farm was contaminated by the farm. Unknown beta/gamma readings were
10 noted to 150 mR/h and a single spot up to 10 R/h, although a date for the readings was not
11 provided in WIDS.
12

13 **4.1.2.9.10 UN-200-W-50 Unplanned Release.** The WIDS database (WHC 1991a)
14 indicates this release occurred on August 25, 1958, from the 241-SX Tank Farm.
15 Contamination was deposited on the ground around the 241-SX-113 Tank and was spread
16 outside the tank farm by high winds. Contamination inside the tank farm covered
17 approximately 1,400 m² (15,000 ft²) and showed a maximum level of 5 rads/h. In an area of
18 about 8 m² (2 acres) east of the tank farm, unknown beta/gamma readings were noted of
19 40,000 c/min with spots up to 100 mR/h, although a date for the readings was not provided in
20 WIDS.
21

22 **4.1.2.9.11 UN-200-W-52 Unplanned Release.** The WIDS database (WHC 1991a)
23 indicates that the UPR-200-W-52 Unplanned Release occurred on September 15, 1958, at an
24 oval-shaped area approximately 91 m (300 ft) wide, lying immediately south of the 241-S-151
25 diversion box toward 10th Street. The area includes the 207-S Retention Basin at its south
26 end. Leakage from the 241-S Diversion Box caused the ground contamination. The soil was
27 saturated with water and turned over with a bulldozer.
28

29 **4.1.2.9.12 UN-200-W-56 Unplanned Release.** The WIDS database (WHC 1991a)
30 indicates this site originated when heavy rainfall washed contamination from a radiation zone
31 (216-S-12) on February 1961. The result was unknown beta/gamma with readings of
32 30,000 c/min on 19 m² (200 ft²) of gravelled surface, and 80,000 c/min on 5 m² (50 ft²) of the
33 blacktop. The date of the readings was not given.
34

35 **4.1.2.9.13 UN-200-W-61 Unplanned Release.** The WIDS database (WHC 1991a)
36 indicates that this site had unknown beta/gamma readings from 4,000 to 100,000 c/min
37 resulting from a fire hose rupture while flushing the H-10 to the 241-SX transfer line near the
38 southwest corner of the 202-S Building. The site is approximately 19 m² (200 ft²) and
39 contains 9,100 kg (10 tons) of soil. The waste management unit was released from radiation
40 zone status after contaminated walkways were washed down and the top 15 cm (6 in.) of
41 contaminated soil were removed.
42

43 **4.1.2.9.14 UN-200-W-69 Unplanned Release.** The UPR-200-W-69 unplanned release
44 occurred on March 2, 1973, north and northeast from the 204-S unloading station and
45 between the 204-S railroad spur and the 202-S Building railroad cut. Numerous spots of
46 ground contamination of 2,000 to 50,000 c/min were noted with infrequent spots of 20 to 100

1 mrad/h. Inside of the established radiation zone, the sump pit was found contaminated from
2 1,000 to 5,000 mrad/h and the grating from the sump stacked nearby to 800 mrad/h. The
3 survey was extended outside the 202-S Building exclusion fence of 5,000 to 100,000 c/min
4 were detected between the 204-S railroad spur and the 202-S Building railroad cut
5 embankment. The cause of the incident is unknown (WHC 1991a).
6

7 **4.1.2.9.15 UN-200-W-80 Unplanned Release.** The WIDS database (WHC 1991a)
8 indicates that the UPR-200-W-80 unplanned release occurred at the 244-S catch station
9 construction site and other areas adjacent to the 241-S and 241-SX Tank Farm on October 24,
10 1978. The 241-S and 241-SX Tank Farms contaminated the 244-S catch station construction
11 site and other areas adjacent to the two tank farms. The radionuclides known to be present
12 are ⁹⁰Sr and ¹³⁷Cs with readings to 60,000 c/min (WHC 1991a).
13

14 **4.1.2.9.16 UN-200-W-81 Unplanned Release.** The WIDS database (WHC 1991a)
15 indicates this release occurred on January 2, 1979, and consisted of unknown beta/gamma
16 with readings from 500 to over 100,000 c/min. The source of this contamination is believed
17 to be airborne migration from the 241-S and 241-SX Tank Farms.
18

19 **4.1.2.9.17 UN-200-W-82 Unplanned Release.** The WIDS database (WHC 1991a)
20 indicates this release occurred on January 15, 1980, near the 241-S-151 Diversion Box and
21 the 241-S-302 Catch Tank, when traffic from daily routine surveillance deposited specks
22 outside the radiation zone. Unknown beta/gamma readings were noted with spots outside of
23 the zone that read up to 80,000 c/min. The area of contamination was approximately 11 x
24 18 m (35 x 60 ft). The specks were picked up and removed to the burial ground.
25

26 **4.1.2.9.18 UN-200-W-83 Unplanned Release.** The WIDS database (WHC 1991a)
27 indicates that this release consisted of an unknown amount of radioactive contamination
28 spilled on the ground in the vicinity of the 204-S radiation zone. No other details were
29 provided.
30

31 **4.1.2.9.19 UN-200-W-108 Unplanned Release.** The WIDS database (WHC 1991a)
32 indicates that this release was noticed on January 8, 1969, and resulted from ruptures in
33 underground crib waste lines. There is no way of determining how long the lines had been
34 leaking or how much waste had been discharged to the ground. Unknown beta/gamma and
35 dose rate readings of 40 R/hr were detected at the bottom of the waste line, although WIDS
36 does not give a date for the readings. The release was cleaned up by redirecting
37 approximately 110 L (30 gal) of waste solution into a hole in the ground dug below the
38 opening of the line and approximately 6 m (20 ft) below the ground surface. The WIDS
39 notes that annual surface radiological monitoring is performed at this site, and that during the
40 October 1990 survey no contamination was detected. These results are a decrease from the
41 previous survey.
42

43 **4.1.2.9.20 UN-200-W-109 Unplanned Release.** The WIDS database (WHC 1991a)
44 indicates that this release was noticed on January 24, 1969, and resulted from ruptures in
45 underground crib waste lines. Waste water resulting from this release bubbled to the surface,
46 where radiation dose rates of unknown beta/gamma were measured at 450 mR/h and

1 decreased to 20 mR/h after the water sank back into the ground. WIDS notes that annual
2 surface radiological monitoring is performed at this site, and during the October 1990 survey
3 general contamination was detected from 200 to 6,000 c/min. These results indicate no
4 change has occurred in the contamination since the previous survey.
5

6 **4.1.2.9.21 UN-200-W-114 Unplanned Release.** The WIDS database (WHC 1991a)
7 notes that annual surface contamination monitoring is performed on this site in the vicinity of
8 the 241-SX Tank Farm, 241-SX-151 Diversion Box, and the 241-S-151 Diversion Box.
9 During the October 1990 survey, general contamination was detected from 200 to 450 c/min
10 with specks of contamination up to 4 mR/h. Similar conditions were reported during the
11 September 1988 and 1989 surveys. A number of cleanup actions have reduced but not
12 eliminated the particulate contamination at this waste management unit.
13

14 **4.1.2.9.22 UN-200-W-116 Unplanned Release.** The WIDS database (WHC 1991a)
15 indicates that this area became contaminated with particulate matter spread by wind from the
16 204-S Waste Storage Tank exhaust and the related railroad tanker waste unloading station.
17 During annual surface radiation monitoring in October 1990 general contamination was noted
18 at 200 c/min with isolated specks up to 2 mR/h. The surface monitoring results did not
19 change from the previous year's.
20

21 **4.1.2.9.23 UN-200-W-123 Unplanned Release.** The WIDS database (WHC 1991a)
22 indicates that this release consisted of 0.13 L (1/2 gal) of radioactive liquid waste at the
23 204-S unloading facility area, and occurred on January 18, 1979. The cause of the leak was a
24 frozen discharge line. The contaminated ground at this site was cleaned up.
25

26 **4.1.2.9.24 UN-200-W-127 Unplanned Release.** The WIDS database (WHC 1991a)
27 indicates this release consisted of a pool of liquid found on the ground at the east side of
28 Building 242-S on February 26, 1980. High radiation levels were noted all around the
29 building. The spill area was remediated by covering with clean dirt.
30

31 **4.1.2.9.25 UN-216-W-25 Radiation Emissions.** The UN-216-W-25 radiation emission
32 is not actually an unplanned release, but it does have that type of designation. An
33 encasement containing transfer lines that run from the 242-S Evaporator Building (inactive) to
34 the 241-U Tank Farm indicated an emission of radioactivity from the encasement but there
35 has not been a release of radioactive material. There are a series of 24 clean out boxes that
36 are regularly surveyed for radiation. Current levels range from 2,000 to 40,000 c/min beta.
37

38 **4.1.2.9.26 UN-216-W-30 Unplanned Release.** The WIDS database (WHC 1991a)
39 indicates that this release is of unknown origin and contamination type. Current levels of
40 radioactivity are 3500 dis/min beta and less than 0.5 mR/h. The contamination extends
41 approximately 274 m (900 ft) to the northeast of the 241-SY Tank Farm and is about 76 m
42 (250 ft) wide, crossing the northern part of the 216-S-23 Crib. The site is heavily vegetated
43 and shows no sign of stabilization; there is a light chain barricade posted with surface
44 radiation contamination warning signs.
45

1 **4.1.2.9.27 UPR-200-W-13 Unplanned Release.** The WIDS database indicates that this
2 release occurred on December 23, 1952, and may have been related to the failure of the H-4
3 oxidizer coil at S Plant. The release consisted of unknown beta/gamma with a dose rate that
4 increased from 6 mR/h to 700 mR/h over a 30-day period.
5

6 **4.1.2.9.28 UPR-200-W-15 Unplanned Release.** This release dates from November
7 1952, caused by failure of a steam coil in the REDOX D-12 waste concentrator associated
8 with the 207-S Retention Basin. This released an unknown beta/gamma source with dose
9 rates up to 2 rem/h and was measured at 35 rem/h 5 cm (2 in.) from the ground.
10

11 **4.1.2.9.29 UPR-200-W-20 Unplanned Release.** The WIDS database (WHC 1991a)
12 indicates that this release occurred during January and February 1953 as a result of leakage
13 from the 241-S-151 diversion box, which contaminated a 93 m² (1,000 ft²) area near the 241-
14 SX Tank Farm. Reported readings indicated unknown beta/gamma, however, actual readings
15 were not reported in WIDS. The area was covered with gravel.
16

17 **4.1.2.9.30 UPR-200-W-36 Unplanned Release.** The WIDS database (WHC 1991a)
18 indicates that this release occurred on August 4, 1955, from 216-S-1 and -2 via a ruptured test
19 well. No contamination or readings are detailed in WIDS but possible contamination includes
20 TRU, fission products, uranium, and inorganics.
21

22 **4.1.2.9.31 UPR-200-W-47 Unplanned Release.** The WIDS database (WHC 1991a)
23 indicates that this release was caused by a dike break in June 1958, which contaminated the
24 soil to a maximum of 750 mR/h. Contamination spread approximately 137 m (150 yd) to the
25 west of the 216-S-16P Pond and 274 m (300 yd) from north to south. In 1959, the
26 contaminated ground was bladed under in a remediation effort.
27

28 **4.1.2.9.32 UPR-200-W-51 Unplanned Release.** The WIDS database (WHC 1991a)
29 indicates that this release occurred on September 12, 1958, when leakage from the 241-S-151
30 Diversion Box contaminated a narrow strip of ground south of the diversion box. Unknown
31 beta/gamma readings were taken up to 50 mR/h within 30 m (100 ft) of the diversion box and
32 readings outside the fenced area were recorded at approximately 4,000 c/min. The
33 contaminated soil was saturated with water and turned over with a bulldozer.
34

35 **4.1.2.9.33 UPR-200-W-57 Unplanned Release.** Information on this unplanned release
36 could not be located at this time but maps indicate that it is near the 202-S Building.
37

38 **4.1.2.9.34 UPR-200-W-59 Unplanned Release.** This waste management unit is the
39 result of the failure of the F-1 process vessel coil in S Plant on September 26, 1965. The
40 radiological contamination readings consisted of unknown beta/gamma with a maximum dose
41 rate of 190 mR/h at the No. 1 Pond inlet.
42

43 **4.1.2.9.35 UPR-200-W-87 Unplanned Release.** Contaminated water was spilled from
44 the 291-S HEPA filter housing on January 28, 1982. Beta/gamma readings of 300 to
45 2,000 c/min were recorded in the site that covered an area of 2.8m² (30 ft²). The
46 contaminated soil was picked up and placed in drums (WHC 1991a).

1 **4.1.2.9.36 UPR-200-W-95 Unplanned Release.** The WIDS database (WHC 1991a)
2 indicates that this release occurred from late 1952 until April 1954, due to a number of
3 process coil leaks from the 202-S Building. It is interpreted as a low-activity site containing
4 approximately 10 Ci of mixed fission products, however, there are no monitoring data
5 provided in WIDS. The gross amounts of radioactivity remaining on the concrete floors and
6 walls of this site were covered by an overfill of dirt.

7
8 **4.1.2.9.37 UPR-200-W-96 Spill.** The WIDS database (WHC 1991a) indicates that this
9 release occurred when plutonium-contaminated water backed up in the 233-SA Filter House
10 drain and overflowed to a low spot in the ground directly north of the filter house. Because
11 of the frozen ground, the water formed a pool rather than drain into the ground. The release
12 consisted of 0.01 g of ²³⁹Pu contaminated water. Smear samples taken of the water and
13 surfaces involved were as follows:

- 14 • Water on the floor of the 233-SA Filter Exhaust Building at greater than
15 40,000 c/min
- 16 • Concrete pad outside the door of the filter building at 10,000 c/min
- 17 • Electric motor pad at 10,000 c/min
- 18 • Water in the overflow pool at 600 c/min.

19
20 The area was covered with 60 m³ (78 yd³) of clean gravel as a remediation effort. It is
21 currently the subject of annual surface radiation monitoring. During the October 1990 survey,
22 contamination of 200 to 3,000 c/min was detected in the northwest corner of the site. This
23 survey indicates an increase from the previous monitoring.

24
25 **4.1.2.9.38 UPR-200-W-124 Unplanned Release.** The WIDS database (WHC 1991a)
26 indicates that a dike break caused this contamination of an area near the 202-S Building.
27 Contamination spread over an area 9 m (30 ft) wide and running approximately 305 m
28 (1,000 ft) southwest of the pond. No date is given for the incident, and no monitoring is
29 reported in WHC (1991a).

30
31 **4.1.2.9.39 UPR-200-W-139 Unplanned Release.** The WIDS database (WHC 1991a)
32 indicates that contamination from an unknown source was detected in September 1953 at 216-
33 U-9, which is filled by this waste management unit. No radiation readings or analytical data
34 are provided. The site was covered in spring 1954, and additional corrective action may have
35 been provided but not documented.

36
37 **4.1.2.9.40 UPR-200-W-140 Unplanned Release.** The WIDS database (WHC 1991a)
38 indicates that this release is the result of 19,000 L (5,000 gal) of contamination leaking from
39 the 241-SX-107 SST. The contamination spread laterally in subsurface strata 17 to 18 m (55
40 to 60 ft) below ground surface. The tank is currently inactive and was removed from service
41 in 1964 as a "confirmed leaker." Thus it is possible that TRU, fission products, uranium, and
42 inorganics may have been released.

1 **4.1.2.9.41 UPR-200-W-141 Unplanned Release.** The WIDS database (WHC 1991a)
2 indicates that this release is associated with and surrounds waste management unit SST 241-
3 SX-108 within the 241-SX Tank Farm. It consists of 9,100 L (2,400 gal) of supernatant
4 containing reduction oxidation (REDOX) process high-level waste and concrete. Thus it is
5 possible that TRU, fission products, uranium, and inorganics may have been released.
6

7 **4.1.2.9.42 UPR-200-W-142 Unplanned Release.** The WIDS database (WHC 1991a)
8 indicates that this release is associated with and surrounds waste management unit SST 241-
9 SX-109 within the SX Tank Farm. It consists of approximately 19,000 L (5,000 gal) of
10 REDOX process high-level liquid waste. Thus it is possible that TRU, fission products,
11 uranium, and inorganics may have been released.
12

13 **4.1.2.9.43 UPR-200-W-143 Unplanned Release.** The WIDS database (WHC 1991a)
14 indicates that this release is associated with and surrounds waste management unit SST 241-
15 SX-111 within the 241-SX Tank Farm. It consists of approximately 6,600 L (2,000 gal) of
16 REDOX process high-level liquid waste and ion exchange liquid waste from the 241-SX
17 tanks. Thus it is possible that TRU, fission products, uranium, heavy metals and inorganics
18 may have been released.
19

20 **4.1.2.9.44 UPR-200-W-144 Unplanned Release.** The WIDS database (WHC 1991a)
21 indicates that this release is associated with and surrounds waste management unit SST 241-
22 SX-112 within the 241-SX Tank Farm. It consists of approximately 100,000 L (30,000 gal)
23 of REDOX process high-level liquid waste. Thus it is possible that TRU, fission products,
24 uranium, heavy metals, and inorganics may have been released.
25

26 **4.1.2.9.45 UPR-200-W-145 Unplanned Release.** The WIDS database (WHC 1991a)
27 indicates that this release is associated with and surrounds waste management unit SST 241-
28 SX-113 within the 241-SX Tank Farm. It consists of approximately 57,000 L (15,000 gal) of
29 REDOX process high-level liquid waste. Thus it is possible that TRU, fission products,
30 uranium, and inorganics may have been released.
31

32 **4.1.2.9.46 UPR-200-W-146 Unplanned Release.** The WIDS database (WHC 1991a)
33 indicates that this release is associated with and surrounds waste management unit SST 241-
34 SX-115 within the 241-SX Tank Farm. It consists of approximately 190,000 L (50,000 gal)
35 of REDOX process high-level liquid waste. Thus it is possible that TRU, fission products,
36 uranium, heavy metals and inorganics may have been released.
37

38

39 **4.2 POTENTIAL IMPACTS TO HUMAN HEALTH AND THE ENVIRONMENT**

40

41 This preliminary assessment is intended to provide a qualitative evaluation of potential
42 human health hazards associated with the known and suspected contaminants at the S Plant
43 Aggregate Area. The assessment includes a discussion of potential release mechanisms,
44 transport pathways, develops a conceptual model of human exposure based on these
45 pathways, and presents the physical, radiological, and toxicological characteristics of the
46 known or suspected contaminants.

1 In developing the conceptual model, potential exposures to groundwater have not been
2 addressed in detail. Since migration to groundwater is the primary route for potential future
3 exposures to many of the chemicals disposed at the site, this pathway (i.e., travel time,
4 receptors) will be addressed in the 200 West Groundwater AAMS.
5

6 It is important to note that these evaluations do not attempt to quantify potential human
7 health risks associated with exposure to S Plant Aggregate Area waste management unit
8 contaminants. Such a risk assessment cannot be performed until additional waste unit
9 characterization data are acquired. Risk assessment activities will be performed in accordance
10 with the *Hanford Site Baseline Risk Assessment Methodology* document (DOE/RL 1991)
11 being prepared in response to the M-29 milestone.
12

13 14 **4.2.1 Release Mechanisms**

15
16 S Plant Aggregate Area waste management units can be divided into two general
17 categories based on the nature of the waste release: (1) units where waste was discharged
18 directly to the environment; and (2) units where waste was disposed inside a containment
19 structure and bypassed an engineered barrier to reach the environment (e.g., through the
20 vadose zone to the aquifer, through the aquifer.
21

22 In the first group are those waste management units where release of wastes to the soil
23 column was an integral part of the waste disposal strategy. Included in this group are septic
24 system drain fields, ditches, french drains, cribs, and some disposal trenches. Also in this
25 group are unplanned releases that involved waste material released to the soil. For this group
26 of waste management units, if discharges to the unit contained contaminants of concern, it can
27 be assumed that soils underlying the waste unit are contaminated. The first task in
28 developing a conceptual model for these units is to determine whether contaminants of
29 concern are retained in soil near the waste management unit, or are likely to migrate to the
30 underlying aquifer and then to receptor points such as drinking water wells or surface water
31 bodies. Factors affecting migration of chemicals away from the point of release will be
32 discussed in the following section.
33

34 In the second group are units that were intended to act as a barrier to environmental
35 releases. Included in this group are vaults, tanks, waste transfer facilities, burial grounds and
36 unplanned releases that occurred within containment structures. Waste units that received
37 only packaged or solid waste (e.g., 218-W-7) could also be included in this category since the
38 potential for wastes to migrate to soils outside of the unit is low due to the negligible natural
39 recharge rate at the Hanford Site. For these units, the first consideration to be addressed in
40 developing a conceptual model is the integrity of the containment structure.
41

42 The ability of this report to evaluate the efficacy of engineered barriers is limited by the
43 lack of vadose zone soil sampling data and air sampling data for many waste units. Available
44 sampling information for the waste management units and unplanned releases was
45 summarized in Section 4.1.
46

1 The efficacy and integrity of concrete and steel tanks, transfer facilities, vaults, and
2 concrete liners such as the 207-S Retention Basin have not been determined. For the
3 218-W-7 Burial Ground (222-S Vault) that received only dry, packaged laboratory waste, and
4 sample water from the 222-S Laboratory, the potential for release is expected to be low.
5 However, releases of small amounts of liquid laboratory wastes to the surrounding soil are
6 possible.
7

8 In addition to evaluating releases to the subsurface, the conceptual model must address
9 the potential for releases to air and, for radionuclides, the potential for direct irradiation. All
10 units have some type of barrier to releases to the surface; however, barriers can fail over time
11 or may not be designed to prevent migration by certain transport pathways (e.g.,
12 volatilization).
13

14 Many of the cribs in the S Plant Aggregate Area have the potential for cave-ins due to
15 decomposition of the wooden framework of the cribs. Such collapse can lead to high levels
16 of direct radiation at the surface and the potential for spread of contaminated materials by
17 wind erosion and dispersion. Westinghouse Hanford has an ongoing program to detect and
18 remediate cave-ins by covering the cribs with additional soil, and any exposures from these
19 incidents are generally short-term. During September 1991 the 216-S-7 Crib was recognized
20 as a unit needing prompt remedial action due to a high potential for collapse (WHC 1991a).
21 The top of Crib 216-S-5 began to cave-in and the site was deactivated and stabilized in
22 August 1990 (WHC 1991a). Crib 216-S-20 has been backfilled on four separate occasions
23 and it is doubtful that any underground cavities remain. Recently, the 216-S-13 Crib was
24 stabilized (Huckfeldt 1991).
25

26 27 **4.2.2 Transport Pathways** 28

29 Transport pathways expected within the S Plant Aggregate Area are summarized in this
30 section, including:
31

- 32 • Drainage and leaching from soil to groundwater
- 33
- 34 • Volatilization from wastes and shallow soils
- 35
- 36 • Wind erosion of contaminated surface soils
- 37
- 38 • Deposition of fugitive dust on soils, plants, and surface water
- 39
- 40 • Uptake from soils by vegetation
- 41
- 42 • Uptake from soils by animals via direct contact with soils or ingestion of
43 vegetation.
44

45 In addition, transport within the saturated zone and subsequent release to groundwater
46 wells or to surface water (i.e., the Columbia River) is of potential concern, but will not be

1 addressed in this document since this topic will be the focus of the 200 West Groundwater
2 AAMS.

3
4 **4.2.2.1 Transport from Soils to Groundwater.** Soil is the initial receiving medium for
5 waste discharges in the S Plant Aggregate Area, whether the release is directly to soil or
6 through failure of a containment system. Several factors determine whether chemicals that
7 are introduced into the vadose zone will reach the unconfined aquifer, which lies at a depth of
8 approximately 60 m (200 ft) below ground surface. These factors are discussed in the
9 following sections.

10
11 **4.2.2.1.1 Depth of Release.** Units that released wastes at a greater depth below the
12 surface are more likely to contaminate groundwater than units where the release was shallow.
13 A monitoring well adjacent to the 216-S-1 and -2 Cribs apparently created an additional
14 pathway to the water table. The well was screened from 63 to 93 m (207 to 305 ft) below
15 grade.

16
17 **4.2.2.1.2 Liquid Volume or Recharge Rate.** For waste constituents to migrate to the
18 underlying water table, some source of recharge must be present. In the S Plant Aggregate
19 Area, the primary source of moisture for mobilizing contaminants are waste management
20 units that discharge liquid waste to the soil column and to a much lesser extent precipitation
21 recharge. As discussed in Section 3.5.2, estimates of natural precipitation recharge range
22 from 0 to 10 cm/yr, depending primarily on surface soil type, vegetation, and topography.
23 Gravelly surface soils with no or minor shallow-rooted vegetation appear to facilitate
24 precipitation recharge. One modelling study (Smoot et al. 1989) indicated that some
25 radionuclide (^{137}Cs and ^{106}Ru) transport could occur with as little as 5 cm/yr of natural
26 recharge. However, other researchers (Routson and Johnson 1990) have concluded that no
27 net precipitation recharge occurs in the 200 Areas, particularly at waste management units
28 that are capped with fine-grained soils or impermeable covers.

29
30 With respect to artificial recharge, some waste management units (e.g., the 216-S-6 crib)
31 were identified in which the known volume of liquid waste discharged substantially exceeded
32 the total estimated soil pore volume present below the footprint of the facility. In this case,
33 the moisture content of soil below the waste management units likely approached saturation
34 during the periods of use of these facilities. Because vadose zone hydraulic conductivities are
35 maximized at water contents near saturation, the volume of liquid wastewater historically
36 discharged to the waste management units probably enhanced fluid migration in the vadose
37 zone beneath these units.

38
39 Contaminants that are not initially transported to the water table by drainage may be
40 mobilized at a later date if a large volume of liquid is added to the unit. In addition, liquids
41 discharged to one unit could mobilize wastes discharged to an adjacent unit if lateral
42 migration takes place within the vadose zone. An example of this process occurred with the
43 U Plant Aggregate Area 216-U-16 Crib where lateral migration of acidic waste above a
44 caliche layer mobilized radionuclides in the 216-U-1 and 216-U-2 Cribs (Baker et al. 1988).
45 No examples of interactions between units are known to have occurred at S Plant.
46

1 **4.2.2.1.3 Soil Moisture Transport Properties.** The moisture flux in the vadose zone
2 is dependent on hydraulic conductivity as well as gradients of moisture content or matrix
3 suction. Higher unsaturated hydraulic conductivities are associated with higher moisture
4 contents. However, higher unsaturated hydraulic conductivities may be associated with fine-
5 grained soils compared to coarse-grained soils at low moisture contents. Due to the highly
6 stratified nature of the Hanford Site vadose zone soils and the moisture content dependence of
7 unsaturated hydraulic conductivity, substantial vertical anisotropy is expected, i.e., vadose
8 zone soils are likely to be more permeable in the horizontal direction than in the vertical.
9 This vertical anisotropy may substantially reduce the potential for contaminant migration to
10 the unconfined aquifer.
11

12 **4.2.2.1.4 Retardation.** The rate at which contaminants will migrate out of a complex
13 waste mixture and be transported through unsaturated soils depends on a number of
14 characteristics of the chemical, the waste, and the soil matrix. In general, chemicals that have
15 low solubilities in the leaching fluid or are strongly adsorbed to soils will be retarded in their
16 migration velocity compared to the movement of soil pore water. Studies have been
17 conducted of soil parameters affecting waste migration at the Hanford Site to attempt to
18 identify the factors that control migration of radionuclides and other chemicals. Recent
19 studies of soil sorption are summarized in Serne and Wood (1990). Some of the processes
20 that have been shown to control the rate of transport are:
21

- 22 • **Adsorption to Soils.** Most contaminants are chemically attracted to some degree
23 to the solid components of the soil matrix. For organic compounds, the
24 adsorption is generally to the organic fraction of the soil, although in extremely
25 low-organic soils, adsorption to inorganic components may be of greater
26 importance. Soil components contributing to adsorption of inorganic compounds
27 include clays, organic matter, and iron and aluminum oxyhydroxides. In general,
28 Hanford surface soils are characterized as sandy or gravelly with very low organic
29 content (less than 0.1%) and low clay content (less than 12%) (Tallman
30 et al. 1981). Thus, site-specific adsorption factors are likely to be lower, and rate
31 of transport higher, than the average for soils nationwide.
32
- 33 • **Filtration.** Filtration of suspended particulates by fine-grained sediments has
34 been suggested as a mechanism for concentration of radionuclides in certain
35 sedimentary layers. This finding suggests that migration of suspended particulates
36 may be an important mechanism of transport for poorly soluble contaminants.
37
- 38 • **Solubility.** The rate of release of some chemicals is controlled by the rate of
39 dissolution of the chemical from a solid form. The concentration of these
40 chemicals in the pore water will be extremely low, even if they are poorly sorbed.
41 An example cited by Serne and Wood (1990) is the solubility of plutonium oxide
42 which appears to be the limiting factor controlling the release of plutonium from
43 waste materials at neutral and basic pH.
44
- 45 • **Ionic Strength of Waste.** For some inorganics, the dominant mechanism leading
46 to desorption from the soil matrix is ion exchange. Leachant having high ionic

1 strength (high salt content) can bias the sorption equilibrium toward desorption,
2 leading to higher concentrations of the chemical in the soil pore water. Anions
3 generally have less effect on sorption but can have significant influence on
4 migration of wastes from tank leaks. These wastes contain high solution
5 concentrations of carbonate ions which are stable in the absence of appreciable
6 calcium ions. When a tank leaks, high concentrations of sodium ions in the waste
7 displace calcium ions in the soil resulting in the scavenging of ⁹⁰Sr from the waste
8 and essentially all of ⁹⁰Sr is retained near the tank. Nitrate in the waste solution is
9 known to form ion pairs with ⁶⁰Co making ⁶⁰Co less sorbable and more mobile.
10 Aqueous wastes from S Plant tanks can be considered high ionic strength wastes.

- 11
- 12 • **Waste pH.** The pH of a leachant has a strong effect on inorganic contaminant
13 transport. Acidic leachates tend to increase migration both by increasing the
14 solubility of precipitates and by changing the distribution of charged species in
15 solution. The exact impact of acidic or basic wastes will depend on whether the
16 chemical is normally in cationic, anionic, or neutral form, and the form that it
17 takes at the new pH. Cationic species tend to be more strongly adsorbed to soils
18 than neutral or anionic species. The extent to which addition of acidic leachate
19 will cause a contaminant to migrate will also depend on the buffering or
20 neutralizing capacity of the soil which is correlated with the calcium carbonate
21 (CaCO₃) content of the soil. The soils in the Hanford formation beneath the
22 S Plant Aggregate Area generally have carbonate contents that range from 0.1 to
23 5% (see Table A-2 in Appendix A). Higher carbonate contents (20 to 30%) are
24 observed within the Plio-Pleistocene caliche layer.

25
26 Once the leaching solution has been neutralized the dissolved constituents may re-
27 precipitate or become reabsorbed to the soil. Observations of pH impacts on
28 waste transport elsewhere at the Hanford Site include:

- 29
- 30 • Sites at S Plant where acidic wastes are reported to have been discharged
31 include the 216-S-5, -9, -23, and -26 Cribs. Discharge of acidic wastes at
32 the 216-S-5, -9, -23, and 26 Cribs.
- 33
- 34 • The remobilization of uranium beneath the 216-U-1 and 216-U-2 Cribs in
35 the U Plant Aggregate Area is believed to have occurred in part because of
36 this introduction of low pH solutions.
- 37
- 38 • Leaching of americium from the Z Plant Aggregate Area 216-Z-9 Crib
39 sediments was found to be solubility controlled and correlated to solution
40 pH.

41
42 **4.2.2.1.5 Complexation by Organics.** Certain organic materials disposed at S Plant
43 are known to form complexes with inorganic ions, which can enhance their solubility and
44 mobility. Methyl isobutyl ketone is the primary organic complexing agent disposed at the
45 S Plant Aggregate Area.
46

1 **4.2.2.1.6 Contaminant Loss Mechanisms.** Processes that can lead to loss of
2 chemicals from soils, and thus decrease the amount of chemical available for leaching to
3 groundwater include:
4

- 5 • **Radioactive Decay.** Radioactive materials decay over time, generally decreasing
6 the quantities and concentrations of radioactive isotopes.
7
- 8 • **Biotransformation.** Microorganisms in the soil may degrade organic chemicals
9 such as acetone and inorganic chemicals such as nitrate.
10
- 11 • **Chemical Transformation.** Hydrolysis, oxidation, reduction, radiolytic
12 degradation, and other chemical reactions are possible degradation mechanisms for
13 contaminants.
14
- 15 • **Vegetative Uptake.** Vegetation may remove chemicals from the soil, bring them
16 to the surface, and thereby introduce them to the food web.
17
- 18 • **Volatilization.** Organic chemicals and volatile radionuclides can be transported in
19 the vapor phase through open pores in soil either to adjacent soil or to the
20 atmosphere. These volatilized compounds could include acetone, radon (a decay
21 product of uranium), and tritium (HTO in tritiated water). Some elements (mainly
22 fission products such as iodine, ruthenium, cerium, and antimony) are referred to
23 as "semivolatiles" because they have a lesser tendency to volatilize.
24

25 **4.2.2.2 Transport from Soils to Air.** Transport of contaminants from waste management
26 units to the atmosphere can occur by means of vapor transport or by fugitive dust emissions.
27

28 Vapor transport may occur from waste management units where volatile organics (e.g.,
29 CCl₄ or volatile radionuclides (¹⁴C, CO₂, ¹²⁹I, and ³H) have been released. Transport
30 mechanisms include diffusion down a concentration gradient and gas-driven flow. Situations
31 where the latter process may occur include production of methane gas from degradation of
32 organic compounds in soil, or production of hydrogen and oxygen gases by radiolytic
33 hydrolysis of water.
34

35 In order for fugitive dust emissions to occur, contaminants must be exposed at the
36 surface of the waste management unit. A number of mechanisms could lead to exposure of
37 contaminants in soil-covered waste management units. These mechanisms include uptake by
38 vegetation, transport by animals, disruption of the waste management unit (e.g., cave-ins at
39 cribs), and wind erosion. Wind erosion can strip off surface soil and uncover waste materials.
40 This mechanism has been identified as an ongoing problem in some of the waste management
41 unit areas. The processes by which biota may expose contaminated soils are discussed in
42 Section 4.2.2.4.
43

44 The contribution of the S Plant Aggregate Area to the overall fugitive dust emissions at
45 the Hanford Site is expected to be relatively minor, based on results of air monitoring
46 downwind of the S Plant Aggregate Area waste management units.

1 **4.2.2.3 Transport from Soils to Surface Water.** The only surface water available in the
2 S Plant Aggregate Area is at the 216-S-10D Ditch that was constructed in 1952 to dispose
3 liquid effluent from the 202-S Building. The ditch receives wastewater from the 202-S
4 Building (principally air compressor cooling water) and the 2901-S-901 water tower (sanitary
5 water overflow). Transport of contaminants to surface water bodies outside of the Aggregate
6 Area via groundwater discharge and deposition of fugitive dust on water bodies are the
7 primary pathways of potential concern for surface water effects. Groundwater discharge will
8 be addressed in the 200 West Groundwater AAMS. The contribution of S Plant Aggregate
9 Areas to overall fugitive dust emissions at the Hanford Site was discussed in Section 4.2.2.2,
10 and is expected to be relatively minor, based on results of air monitoring downwind of
11 S Plant Aggregate Area waste units.

12
13 **4.2.2.4 Transport from Soils to Biota.** Biota, plants, and animals have the potential for
14 taking up (bio-uptake), concentrating (bioaccumulating), transporting, and depositing
15 contamination beyond its original extent. Transfer from one species to another in the food
16 chain is also possible because of predation. The possibility of these processes contributing
17 significantly to the transport of contamination from the S Plant Aggregate Area waste
18 management units is uncertain.

19
20 **4.2.2.4.1 Uptake by Vegetation.** Release of radioactivity to the surface by growth of
21 vegetation is an ongoing problem at S Plant Aggregate Area waste management units. Roots
22 of sagebrush and other native species can take up radionuclides from soils below the surface
23 and transport these chemicals to the foliage. Wind dispersal of portions of the contaminated
24 vegetation, or entire plants (tumbleweeds) can lead to transport of contaminants outside of the
25 unit. Westinghouse Hanford has an ongoing vegetation control (herbicide application,
26 reseeding with shallow-rooted vegetation, and mechanical removal) and radiological survey
27 program to prevent radioactivity from being transported by this mechanism. However, the
28 program does not assure complete removal of vegetation, and incidents of detection of
29 contaminated vegetation are reported occasionally in the radiological surveys.

30
31 **4.2.2.4.2 Transport by Animals.** Disturbance of waste management unit barriers by
32 animals occasionally leads to release of contaminants to the surface. Subsurface soils can be
33 transported to the surface by burrowing animals, thus exposing contaminants for release to the
34 air. Additionally, animals that become contaminated by contact with subsurface waste or
35 through ingestion of subsurface contaminants (e.g., chemical salts) and contaminated
36 vegetation, water, or other animals can spread contamination in their feces on the surface and
37 outside of the waste management unit. Burrowing rodents and Harvester ants can transport
38 near-surface contaminants to the surface. Rabbits were noted as causing the greatest spread
39 of contamination in the separations area in 1985 (Elder et al. 1986).

40
41 Transfer from one species to another in the food chain is also possible because of
42 predation. For example, rodents are prey for coyotes and other carnivores and Harvester ants
43 are fed upon by the side-blotched lizard. The possibility of these processes contributing
44 significantly to the transport of contamination from the S Plant Aggregate Area waste
45 management units is uncertain.

4.2.3 Conceptual Model

Figure 4-3, and in more detail on Plate 4, presents a graphical summary of the physical characteristics and mechanisms at the site that could potentially affect the generation, transport, and impact of contamination in the S Plant Aggregate Area on humans and biota (conceptual model).

The sources of contamination include process wastes (condensates, cooling water, sewage, discharge product, sludge removal, drain waste, organic waste, cold organic uranium scrap, immiscible organics) from S Plant, unirradiated uranium wastes from the cold startup of S Plant, "interface crud," condensate from 241-S and 241-SX Tank Farms, washwater from the 241-S Stack decontamination, waste from the 293-S caustic scrubber, laboratory wastes, drainage from diversion boxes, sanitary wastes, emissions from various stacks, and process feed materials, and some materials from outside the aggregate area (e.g., laundry water and powerhouse wastewater) and contaminated equipment or waste material that was spilled during transit or disposed in the burial ground.

Contaminants from these sources have been disposed at the waste management units that are under investigation. Waste management units include ponds, ditches, retention basins, trenches, cribs, french drains, diversion boxes, catch tanks, septic tanks and drain fields, single-shell tanks, a vault, a burial ground, and the various unplanned releases that have occurred on the site. These releases and disposal activities are described in Sections 2 and 4.1. Some of the unplanned releases are associated with specific waste sites groups, and are shown in Figure 4-3 and Plate 4 as dashed lines with "U" designations.

From these waste management units, contaminants may have been released via several mechanisms to the potentially affected media. Volatilization could release chemicals from surficial soils or surface waters into the atmosphere. Some of the more volatile constituents could be released from the vadose zone to the atmosphere through the soil gas system. Materials in the ditches flowing toward the ponds may have infiltrated/percolated into the vadose zone, or sorbed to the sediments in the ditch. The retention basins may have released contaminants in a similar fashion, with the exception of off-site flow. Biota may have taken up contaminants from the surface water and near-surface contaminated soils (via deep roots or burrowing animals).

Many waste management units discharge their waste effluents directly to the near surface (vadose zone) soils. The trenches are potential release points via leaching or drainage of the liquid portion of the disposed materials. The cribs provide seepage discharge and similarly the french drains, and septic system drain field directly inject their effluents into the subsurface sediments. Leakage from underground tanks may also percolate or move by capillary action through the vadose zone. The unplanned releases have mainly impacted surface soils although some deposition of contamination may have also taken place, including on building surfaces. Fugitive dust from sediment and surface soils has also been released or resuspended due to wind or surface water action, and some solid wastes, contaminated supplies and equipment and surface soils have been buried or removed to off-site disposal. Emissions from the various stacks in and adjacent to S Plant Aggregate Area may have

1 resulted in deposition of contaminants onto surface soils in the S Plant Aggregate Area.
2 Wind blown dust from waste management units or unplanned releases makes impossible to
3 distinguish this surface soil contamination from stack emissions deposition.
4

5 The primary mechanism of vertical contaminant migration is the downward movement
6 of water from the surface through the vadose zone to the unconfined aquifer. The
7 contaminants generally move as a dissolved phase in the water and their rate of migration is
8 controlled both by groundwater movement rates and by adsorption and desorption reactions
9 involving the surrounding sediments. Some contaminants are strongly sorbed on sediments
10 and their downward movement through the stratigraphic column is greatly retarded.
11 Significant lateral migration of contaminants is restricted to perched water zones and to the
12 unconfined aquifer, where water is moving laterally. Again adsorption and desorption
13 reactions may greatly retard lateral contaminant migration. Contaminants that were
14 introduced to the soil column outside of the aggregate area may migrate into the area along
15 with perched or aquifer water. Historically, perched water has been discovered beneath the
16 216-S-9 Crib and the 216-S-10D Ditch.

cdl7
18 There are four general exposure routes by which humans (offsite and onsite) and other
19 biota (plants and animals) can be exposed to these possible contaminants:

- 21 • Inhalation of airborne volatiles or fugitive dust with adsorbed contamination
- 22
- 23 • Ingestion of surface water, fugitive dust, surface soils, biota (either directly or
24 through the food chain), or groundwater
- 25
- 26 • Direct contact with the waste materials (such as those exhumed by burrowing
27 animals), contaminated surface soils, buildings, or plants
- 28
- 29 • Direct radiation from waste materials, surface soils, building surfaces, pipelines
30 and other facilities, or fugitive dusts.
- 31

32 4.2.4 Characteristics of Contaminants

33 Table 4-17 is a list of radioactive and nonradioactive chemical substances that represent
34 candidate contaminants of potential concern for this study based on their known presence in
35 wastes, usage, disposal in waste management units, historical association, or detection in
36 environmental media at the S Plant Aggregate Area. Table 4-18 summarizes the types of
37 known or suspected contamination that are thought to exist at the individual waste sites.
38 Known contaminants are those that have been proven to exist from sampling and inventory
39 data (Tables 2-2 and 2-3). Suspected contaminants are those which could have occurred
40 occur at a site based upon historical practices, chemical associations or in-growth during
41 radiological decay of discharged radionuclides. Given the large number of chemicals known
42 or suspected to be present, it is appropriate to focus this assessment on those contaminants
43 that have been detected through sampling efforts and which pose the greatest risk to human
44 health or the environment. Table 4-19 lists the contaminants of concern for the S Plant
45
46

1 Aggregate Area. This list was developed from Table 4-17 and includes only those
2 contaminants which meet the following criteria:

- 3
- 4 • Radionuclides that have a half-life of greater than one year.
 - 5
 - 6 • Radionuclides with a half-life of less than one year and are part of long-lived
7 decay chains that result in the buildup of the short-lived radionuclide activity to a
8 level of 1% or greater of the parent radionuclide's activity within the time period
9 of interest (in-growth).
 - 10
 - 11 • Contaminants that are known or suspected carcinogens or have an Environmental
12 Protectin Agency (EPA) noncarcinogenic toxicity factor.
 - 13

14 The following characteristics will be discussed for the contaminants listed in
15 Table 4-20:

- 16
- 17 • Detection of contaminants in environmental media
 - 18
 - 19 • Historical association with plant activities
 - 20
 - 21 • Mobility
 - 22
 - 23 • Persistence
 - 24
 - 25 • Toxicity
 - 26
 - 27 • Bioaccumulation.
 - 28

29 **4.2.4.1 Detection of Contaminants in Environmental Media.** The nature and extent of
30 surface and subsurface soils, surface water, groundwater, air, and biota contamination have
31 not yet been adequately characterized for the S Plant Aggregate Area. All recent
32 environmental monitoring data were reviewed and summarized for each media in Section 4.1.

33

34 The most extensive monitoring data available has been for groundwater. Because
35 groundwater will be evaluated in the 200 West Groundwater AAMS, it will not be discussed
36 further here. Surface soil and biota samples have been collected from locations on a regular
37 rectangular grid. However, these sampling locations do not correspond to any of the waste
38 management units, but are intended to characterize the S Plant Aggregate Area as a whole.
39 Air and external radiation samples have been collected at several locations within or adjacent
40 to the S Plant Aggregate Area. These sampling stations are also not located directly on any
41 of the waste management units and therefore the sampling results cannot be attributed to any
42 particular unit. Three surface soil sampling locations and one high volume air monitoring
43 station surround the 241-S, -SX, and -SY Tank Farms, and serve to characterize that grouping
44 of waste management units. The only other routine sampling data that correspond directly to
45 waste management units are the external radiation surveys, which are performed on a regular
46 basis. There is little soil or vegetation sampling data available for any of the units.

1 **4.2.4.2 Historical Association with S Plant Activities.** Radionuclides and chemicals that
2 are known components of S Plant Aggregate Area waste streams are listed in Table 2-10.
3 This list includes chemicals in the process wastes as well as chemicals that were detected at
4 elevated levels in wastewater. Since these waste streams are known to have been disposed of
5 directly to the soil column in some waste management units, it is probable that the chemicals
6 on this list have affected environmental media.
7

8 Based on the WIDS data (WHC 1991a), radionuclides that are known to have been
9 disposed of to S Plant Waste Management Units in the greatest quantities are as follows:

- 10 • ^{239}Pu
- 11 • ^{240}Pu
- 12 • ^{106}Ru
- 13 • ^{241}Am
- 14 • ^{137}Cs
- 15 • ^{58}Co
- 16 • ^{90}Sr
- 17 • ^3H
- 18 • ^{238}U

19 Note that a complete radionuclide analysis of the S Plant Aggregate Area waste streams
20 is not available. Thus, it is possible that additional radionuclides were disposed of to S Plant
21 Aggregate Area waste management units that are not included in the waste inventories.
22

23 Nonradioactive chemicals reportedly released into S Plant Aggregate Area Waste
24 Management Units in large quantities include nitric acid, nitrates, sodium, ammonium nitrate,
25 aluminum nitrate, sodium dichromate, and hexone.
26

27 **4.2.4.3 Mobility.** Since most wastes at the S Plant Aggregate Area were released directly to
28 subsurface soils via injection, infiltration, or burial, the mobility of the wastes in the
29 subsurface will determine the potential for future exposures. The mobility of the
30 contaminants listed in Table 4-21 varies widely and depends on site-specific factors as well as
31 the intrinsic properties of the contaminant. Much of the site-specific information needed to
32 characterize mobility is not available and will need to be obtained during future field
33 investigations. However, it is possible to make general statements about the relative mobility
34 of the candidate contaminants of concern.
35
36
37
38
39
40
41
42
43
44
45

1 **4.2.4.3.1 Transport to the Subsurface.** The mobility of radionuclides and other
2 inorganic elements in groundwater depends on the chemical form and charge of the element
3 or molecule, which in turn depends on site-related factors such as the pH, REDOX state, and
4 ionic composition of the groundwater. Cationic species (e.g., Cd^{2+} , Pu^{4+}) generally are
5 retarded in their migration relative to groundwater to a greater extent than anionic species
6 such as nitrate. The presence in groundwater of complexing or chelating agents can increase
7 the mobility of metals by forming neutral or negatively charged compounds.
8

9 The chemical properties of radionuclides are essentially identical to the nonradioactive
10 form of the element; thus, discussions of the chemical properties affecting the transport of
11 contaminants can apply to both radionuclides and nonradioactive chemicals.
12

13 A soil-water distribution coefficient (K_d) can be used to predict mobility of inorganic
14 chemicals in the subsurface. Table 4-20 presents a summary of K_d s that have been developed
15 for many of the inorganic chemicals of concern at the S Plant Aggregate Area. As discussed
16 above, the pH and ionic strength of the leaching medium has an impact on the absorption of
17 inorganics to soil; thus, the listed K_d s are valid only for a limited range of pH and waste
18 composition. In addition, soil sorption of inorganics is highly dependent on the mineral
19 composition of the soil, the ionic composition of the soil pore water, and other site-specific
20 factors. Thus, a high degree of uncertainty is involved with use of K_d s values that have not
21 been verified by experimentation with site soils.
22

23 Serne and Wood (1990) recommended K_d values for use with Hanford waste
24 assessments for a limited number of important radionuclides based on soil column or batch
25 desorption studies, and have proposed conservative average values for a more extensive list of
26 elements based on a review of the literature. An assumed retardation of <1 is recommended
27 for americium, cesium, plutonium, and strontium under acidic conditions.
28

29 Streng and Peterson (1989) developed default K_d values for a large number of elements
30 for use in the Multimedia Environmental Pollution Assessment System, a computerized waste
31 management unit evaluation system. The K_d values were based on findings in the scientific
32 literature, and include non-site-specific as well as Hanford Site values. Values are provided
33 for nine sets of environmental conditions: three ranges of waste pH and three ranges of soil
34 adsorbent material (sum of percent clay, organic material, and metal hydrous oxides). The
35 values presented in Table 4-21 are for conditions of neutral waste pH and less than 10%
36 adsorbent material, which is likely to be most representative of Hanford Site soils.
37

38 The mobility of inorganic species in soil can be divided roughly into three classes,
39 using site-specific values (Serne and Wood 1990) where available and generic values
40 otherwise: highly mobile ($K_d < 5$), moderately mobile ($5 < K_d < 100$), and low mobility ($K_d > 100$).
41 Table 4-21 lists the class ranking for each of the inorganic contaminants of concern.
42

43 The tendency of organic compounds to adsorb to the organic fraction of soils is
44 indicated by the soil organic matter partition coefficient, K_{oc} . Partition coefficients for the
45 organic chemicals of concern at the S Plant Aggregate Area are listed in Table 4-22.
46 Chemicals with low K_{oc} values are weakly absorbed by soils and will tend to migrate in the

1 subsurface, although their rate of travel will be retarded somewhat relative to the pore water
2 or groundwater flow. Soils at the Hanford Site have very little organic carbon content and
3 thus sorption to the inorganic fraction of soils may dominate over sorption to soil organic
4 matter.

5
6 **4.2.4.3.2 Transport to Air.** Transport between soils and air can occur either by
7 fugitive dust emissions or volatilization. Chemicals subject to transport via airborne dust
8 dispersion are those that are non-volatile and persistent on the soil surface, including most
9 radionuclides and inorganics, and some organics such as creosote and coal tar.

10
11 Chemicals subject to volatilization are primarily organic compounds; however, some of
12 the radionuclides detected at the site are subject to evaporation and could be lost from
13 shallow soils to the ambient air. The most important species in this category are ^{14}C , ^3H , and
14 ^{129}I .

15
16 The tendency of an organic compound to volatilize can be predicted from its Henry's
17 Law Constant, K_h , a measured or calculated parameter with units of atmospheres per cubic
18 meter per mole of chemical. Henry's Law Constants of the organic candidate contaminants of
19 concern are presented in Table 4-22. Compounds with a K_h greater than about 10^{-3} will be
20 lost rapidly to the atmosphere from surface water and shallow soils. Organic contaminants of
21 concern that fall into this class include chloroform and xylene.

22
23 **4.2.4.4 Persistence.** Once released to environmental media, the concentration of a
24 contaminant may decrease because of biological or chemical transformation, radioactive
25 decay, or the intermediate transfer processes discussed above that remove the chemical from
26 the medium (e.g., volatilization to air). Radiological, chemical, and biological decay
27 processes affecting the persistence of the S Plant Aggregate Area contaminants of concern are
28 discussed below.

29
30 The persistence of radionuclides depends primarily on their half-lives. A comparison of
31 the radiological properties for most radionuclide contaminants of concern for S Plant
32 Aggregate Area is presented in Table 4-23. The specific activity is the decay rate per unit
33 mass, and is inversely proportional to the half-life of the radionuclide. Half-lives for the
34 radionuclides listed in Table 4-23 range from seconds to over one billion years. Also listed
35 are the principal radiation emissions of concern for the radionuclide. Note that radionuclides
36 can emit multiple types of radiation and often undergo several decay steps in quick succession
37 (e.g., beta decay followed by release of one or more gamma rays associated with daughter
38 radionuclides). The daughter products of these decays are often themselves radioactive.

39
40 Decay will occur during transport (e.g., through the vadose zone to the aquifer, through
41 the aquifer) and may lead to significant reductions in levels ultimately produced offsite. For
42 direct exposures (e.g., to surface soils or air), the half-life of the radionuclide has less
43 importance, unless the half-life is so short that the radionuclide undergoes substantial decay
44 between the time of disposal and release to the environment.
45

1 Nonradioactive inorganic chemicals detected at the site are generally persistent in the
2 environment, although they may decline in concentration due to transport processes or change
3 their chemical form due to chemical or biological reactions. Nitrate undergoes chemical and
4 biological transformations that may lead to its loss to the atmosphere (as N₂) or incorporation
5 into living organisms, depending on the reduction/oxidation environment and microbiological
6 communities present in the medium.
7

8 Biotransformation rates for organics vary widely and are highly dependent on site-
9 specific factors such as soil moisture, reduction/oxidation conditions, and the presence of
10 nutrients and of organisms capable of degrading the compound. Ketones, such as acetone and
11 MIBK, are easily degraded by microorganisms in soil and thus would tend not to persist.
12 Volatile aromatics such as xylene are generally intermediate in their biodegradability.
13

14 **4.2.4.5 Toxicity.** Contaminants may be of potential concern for impacts to human health if
15 they are known or suspected to have carcinogenic properties, or if they have adverse
16 noncarcinogenic human health effects. The toxicity characteristics of the chemicals detected
17 at the operable unit are summarized below.
18

19 **4.2.4.5.1 Radionuclides.** All radionuclides are classified by EPA as known human
20 carcinogens based on their property of emitting ionizing radiation and on the evidence
21 provided by epidemiological studies of radiation-induced cancers in humans. Non-
22 carcinogenic health effects associated with radiation exposure include genetic and teratogenic
23 effects; however, these effects generally occur at higher exposure levels than those required to
24 induce cancer. Thus, the carcinogenic effect of radionuclides is the primary identified health
25 concern for these chemicals.
26

27 Risks associated with radionuclides differ for various routes of exposure depending on
28 the type of ionizing radiation emitted. Nuclides that emit alpha or beta particles are
29 hazardous primarily if the materials are inhaled or ingested, since these particles expend their
30 energy within a short distance after penetrating body tissues. Gamma-emitting radioisotopes,
31 which deposit energy over much larger distances, are of concern as both external and internal
32 hazards. A fourth mode of radioactive decay, neutron emission, is generally not of major
33 health concern, since this mode of decay is much less frequent than other decay processes. In
34 addition to the mode of radioactive decay, the degree of hazard from a particular radionuclide
35 depends on the rate at which particles or gamma radiation are released from the material.
36

37 Excess cancer risks for exposure to the primary radionuclide contaminants of concern
38 by inhaling air, drinking water, ingesting soil, and by external irradiation are shown in
39 Table 4-24. These values represent the increase in probability of cancer to an individual
40 exposed for a lifetime to a radionuclide at a level of 1 pCi/m³ in air, 1 pCi/L in drinking
41 water, 1 pCi/g in ingested soil, or to external radiation from soil having a radionuclide content
42 of 1 pCi/g (EPA 1991).
43

44 For those radionuclides without EPA (1991) slope factors, the *Hanford Baseline Risk*
45 *Assessment Methodology* (DOE/RL 1991) proposes to use the dose conversion factors
46 developed by the International Commission on Radiological Protection to calculate a risk

1 value. Any Hanford site risk assessments will be performed in accordance with the *Hanford*
2 *Baseline Risk Assessment Methodology* document (DOE/RL 1991).
3

4 The unit risk factors for different radionuclides incorporate factors to account for
5 distribution of each radionuclide within various body organs, the type of radiation emitted,
6 and the length of time that the nuclide is retained in the organ of interest, and physical half-
7 life.
8

9 Based on the factors listed in Table 4-24, the highest risk for continuous exposure to 1
10 pCi/m³ in air is from plutonium, americium and uranium isotopes, which are alpha emitters.
11 Among the radionuclide contaminants of concern for the S Plant Aggregate Area, the highest
12 risks from ingestion of soil at 1 pCi/g are for ²¹⁰Pb, ²²⁷Ac, ²⁴¹Am, ²⁴³Am, ²³⁸Pu, ²⁴⁴Cm, ¹³⁴Cs,
13 ¹²⁹I, ²³⁷Np, ²³¹Pa, ²²⁶Ra, ²²⁸Ra, ²²⁹Th, and the uranium isotopes. The primary gamma-emitters
14 are ²¹⁴Bi, ⁶⁰Co, ¹³⁴Cs, ¹³⁷Cs (because of its metastable decay product, ^{137m}Ba), ¹⁵²Eu, ¹⁵⁴Eu,
15 ²³⁹Np, and ²¹⁴Pb. It is important to note that this table only presents unit risk factors for the
16 listed radionuclides and does not necessarily include potential contributions from daughter
17 products.
18

19 The standard EPA risk assessment methodology assumes that the probability of a
20 carcinogenic effect increases linearly with dose at low dose levels, i.e., there is no threshold
21 for carcinogenic response. The EPA methodology also assumes that the combined effect of
22 exposure to multiple carcinogens is additive without regard to target organ or cancer
23 mechanism.
24

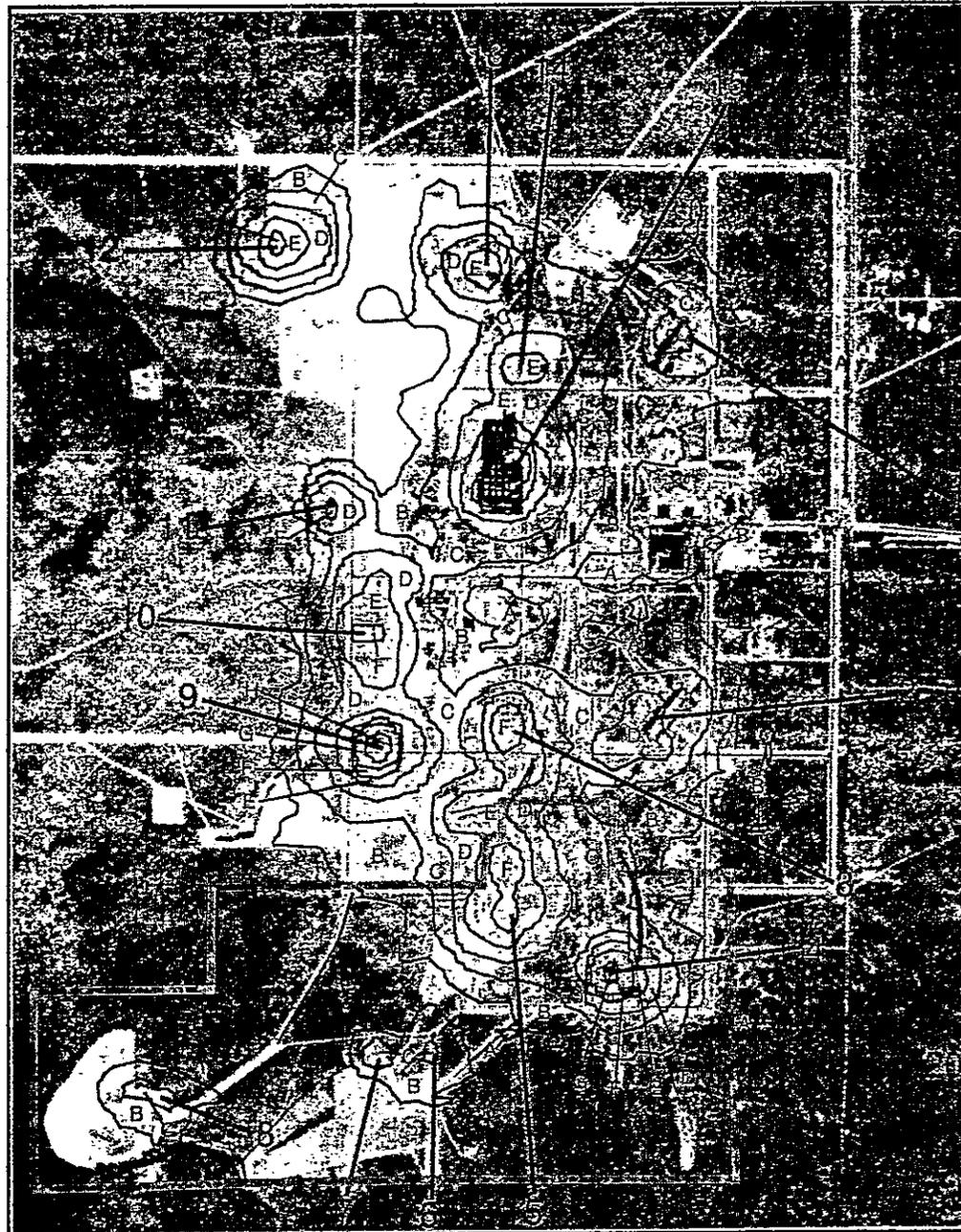
25 **4.2.4.5.2 Hazardous Chemicals.** Carcinogenic and non-carcinogenic health effects
26 associated with chemicals anticipated at the aggregate area are summarized in Table 4-25.
27

28 EPA has not derived toxicity criteria for many of the chemicals suspected of being
29 present or detected at the S Plant Aggregate Area. Many of the chemicals that lack toxicity
30 criteria have negligible toxicity or are necessary nutrients in the human diet.
31

32 Several of the chemicals have known toxic effects but no toxicity criterion is presently
33 available. In some instances the criteria have been withdrawn by EPA pending review of the
34 toxicological data and will be reissued at a future date. Chemicals with known toxicity for
35 which toxicity factors are presently not available include lead, selenium, kerosene and tributyl
36 phosphate.
37

38 **4.2.4.6 Bioaccumulation Potential.** Contaminants may be of concern for exposure if they
39 have a tendency to accumulate in plant or animal tissues at levels higher than those in the
40 surrounding medium (bioaccumulation) or if their levels increase at higher trophic levels in
41 the food chain (biomagnification). Contaminants may be bioaccumulated because of
42 element-specific uptake mechanisms (e.g., incorporation of strontium into bone) or by passive
43 partitioning into body tissues (e.g., concentration of organic chemicals in fatty tissues).
44

9 3 1 2 0 5 1 5 6 5



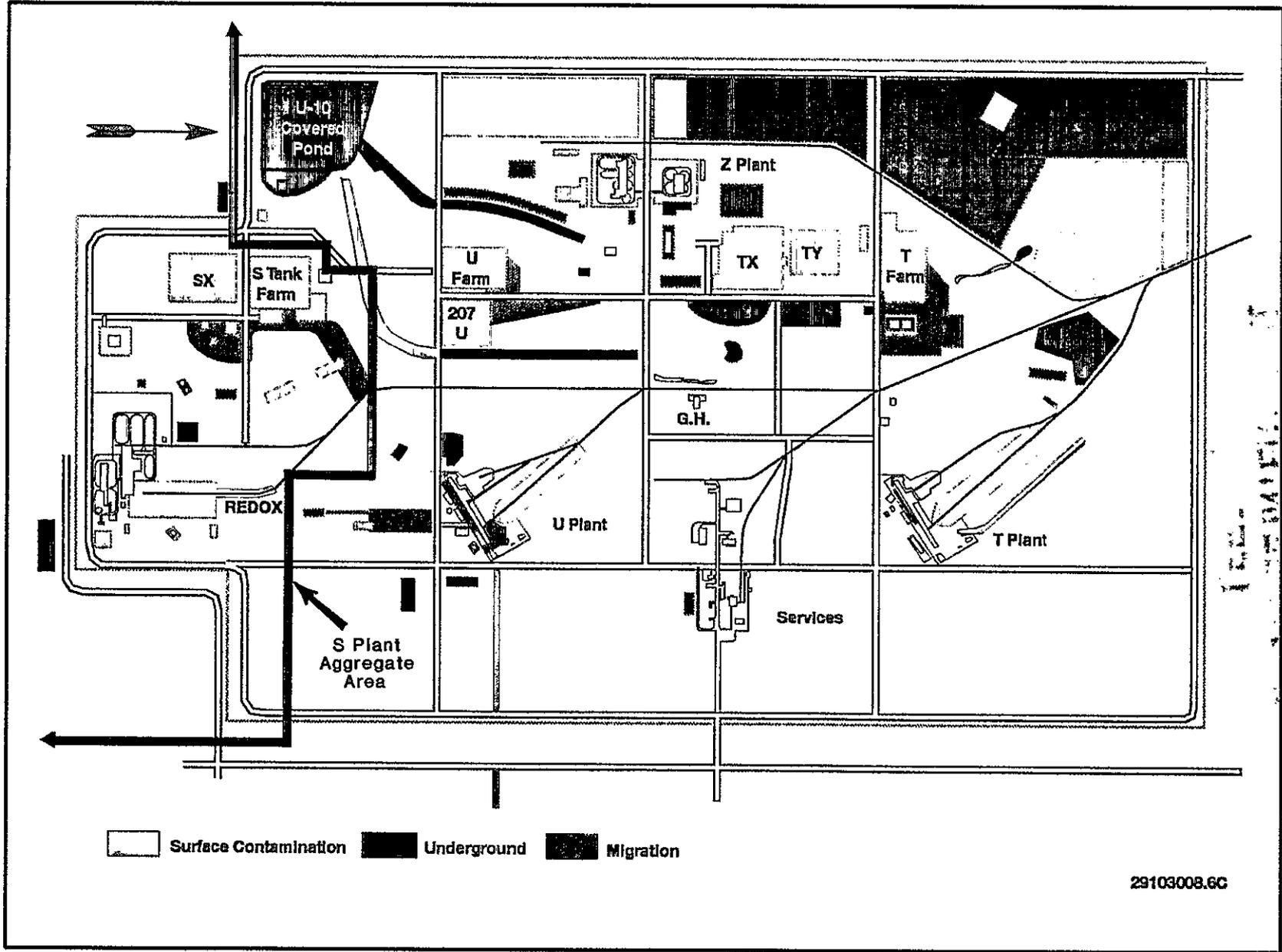
0 400 800 1600 meters

| | |
|-------------------------------|------------------------------------|
| 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 |

4 = S Plant Building Complex
5 = 241 - S, - SX, and - ST Tank Farms
6 = 216 - S - 10 D Ditch
7 = 216 - S - 17 P Pond
8 = 216 - S - 16 P Pond
Other numbers refer to sites outside the S Plant Aggregate Area.
S 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).
4F-1

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4F-2

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Figure 4-2. Surface Underground and Migrating Contamination Map of the 200 West Area (Huckfeldt 1991).

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9 6 1 2 3 4 5 1 - 6 7

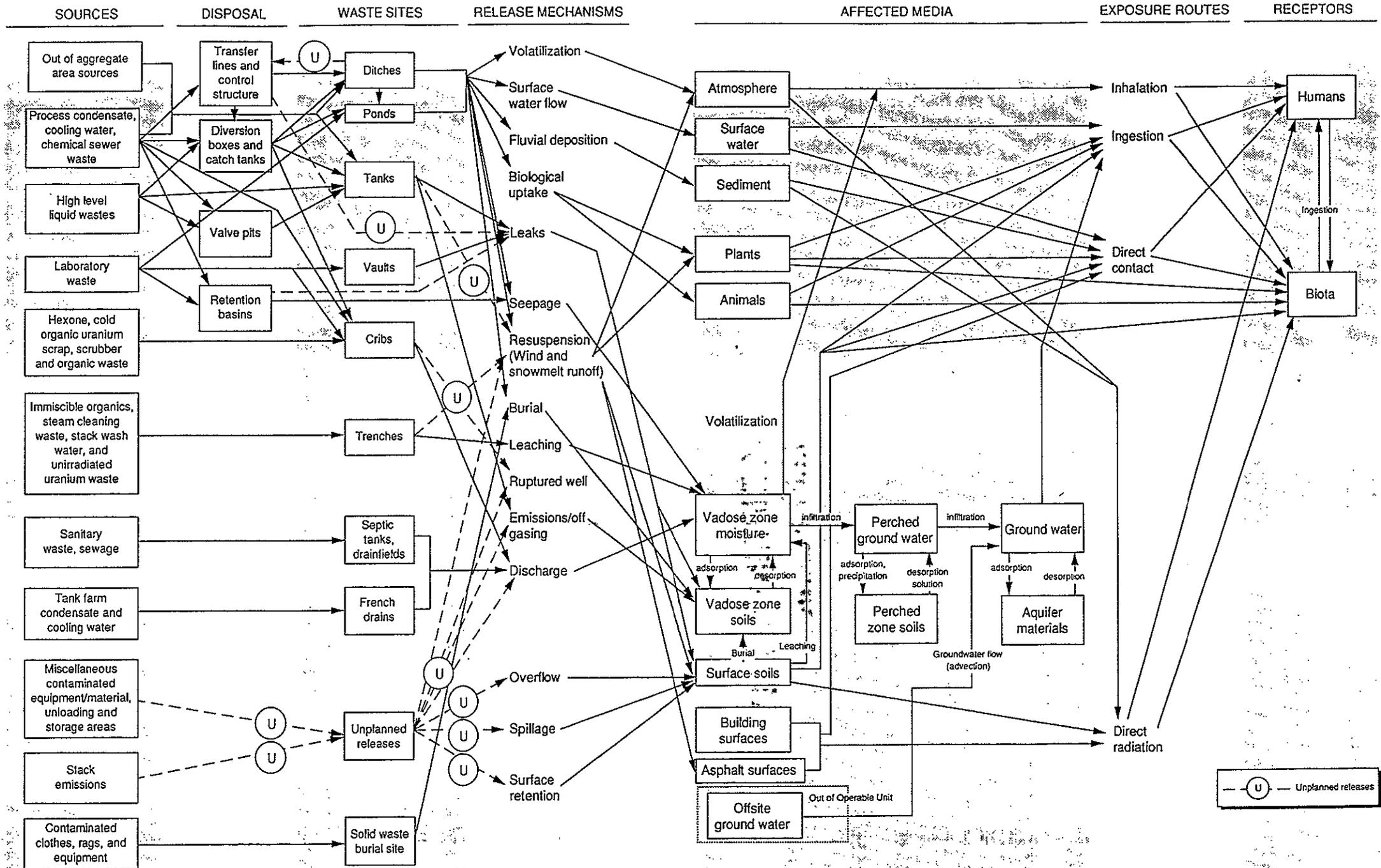


Figure 4-3. Conceptual Model of the S Plant Aggregate Area.
4F-3

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Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

| Source Site | Air | Surface Soil (0-1 m) | Surface Water | Biota | Vadose Zone | Structure | Remarks |
|--------------------------------------|-----|----------------------|---------------|-------|-------------|-----------|---------|
| Plants, Buildings, and Storage Areas | | | | | | | |
| 291-S Stack Complex | | | | | S | | |
| Tanks and Vaults | | | | | | | |
| 241-S Tank Farm | | S | | | S | | |
| 241-S-101 SS Tank | | | | | | | |
| 241-S-102 SS Tank | | | | | S | | |
| 241-S-103 SS Tank | | | | | S | | |
| 241-S-104 SS Tank | | | | | S | | |
| 241-S-105 SS Tank | | | | | S | | |
| 241-S-106 SS Tank | | | | | | | |
| 241-S-107 SS Tank | | | | | | | |
| 241-S-108 SS Tank | | | | | | | |
| 241-S-109 SS Tank | | | | | | | |
| 241-S-110 SS Tank | | | | | S | | |
| 241-S-111 SS Tank | | | | | | | |
| 241-S-112 SS Tank | | | | | | | |
| 241-SX Tank Farm | | K | | | | | |
| 241-SX-101 SS Tank | | | | | S | | |
| 241-SX-102 SS Tank | | | | | S | | |
| 241-SX-103 SS Tank | | | | | S | | |
| 241-SX-104 SS Tank | | | | | S | | |
| 241-SX-105 SS Tank | | | | | | | |
| 241-SX-106 SS Tank | | | | | | | |
| 241-SX-107 SS Tank | | | | | S | | |
| 241-SX-108 SS Tank | | | | | S | | |
| 241-SX-109 SS Tank | | | | | S | | |
| 241-SX-110 SS Tank | | | | | S | | |
| 241-SX-111 SS Tank | | | | | S | | |
| 241-SX-112 SS Tank | | | | | S | | |
| 241-SX-113 SS Tank | | | | | S | | |

9 3 1 2 3 4 5 1 5 6 8

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

| Source Site | Air | Surface Soil (0-1 m) | Surface Water | Biota | Vadose Zone | Structure | Remarks |
|-------------------------------------|-----|----------------------|---------------|-------|-------------|-----------|---------------------------------|
| 241-SX-114 SS Tank | | | | | S | | |
| 241-SX-115 SS Tank | | | | | S | | |
| 241-SY-101 DS Tank | | | | | | | |
| 241-SY-102 DS Tank | | | | | | | |
| 241-SY-103 DS Tank | | | | | | | |
| 240-S-302 Catch Tank | | | | | S | | |
| 241-S-302A Catch Tank | | | | | S | | |
| 241-S-302B Catch Tank | | | | | | | |
| 241-SX-302 Catch Tank | | | | | | | |
| 244-S Receiver Tank | | | | | | | |
| Cribs and Drains | | | | | | | |
| 216-S-1 & -2 Crib | | K | | | S | | Also described by UPR-200-W-139 |
| 216-S-5 Crib | | | | | S | | |
| 216-S-6 Crib | | S | | | S | | |
| 216-S-7 Crib | | | | | S | | |
| 216-S-9 Crib | | K | | | S | | |
| 216-S-13 Crib | | | | | S | | |
| 216-S-20 Crib | | | | | S | | |
| 216-S-22 Crib | | | | | S | | |
| 216-S-23 Crib | | | | | S | | |
| 216-S-25 Crib | | | | | S | | |
| 216-S-26 Crib | | | | | S | | |
| 216-S-3 French Drain | | | | | S | | |
| Ponds, Ditches, and Trenches | | | | | | | |
| 216-S-10P Pond | | | | | S | | |
| 216-S-11 Pond | | | | | S | | |
| 216-S-15 Pond | | | | | S | | |

9312075169

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

| Source Site | Air | Surface Soil (0-1 m) | Surface Water | Biota | Vadose Zone | Structure | Remarks |
|--|-----|----------------------|---------------|-------|-------------|-----------|--------------------------------|
| 216-S-16P Pond | | | | | S | | |
| 216-S-17 Pond | | | | | S | | |
| 216-S-19 Pond | | S | | | | | |
| 216-S-10D Ditch | | K | S | K | S | | |
| 216-S-16D Ditch | | | | | | | |
| 216-U-9 Ditch | | | | | | | |
| 216-S-8 Trench | | K | | | S | | |
| 216-S-12 Trench | | | | | S | | Also described by UPR-200-W-30 |
| 216-S-14 Trench | | | | | S | | |
| 216-S-18 Trench | | | | | | | |
| Septic Tanks and Associated Drain Fields | | | | | | | |
| 2607-W6 Septic Tank and Tile Field | | | | | | | |
| 2607-WZ Septic Tank | | | | | | | |
| Sanitary Crib | | | | | | | |
| Transfer Facilities, Diversion Boxes, and Pipelines | | | | | | | |
| 216-S-172 Cont. Struct. | | K | | | | | |
| 2904-S-160 Cont. Struct. | | | | | | | |
| 2904-S-170 Cont. Struct. | | | | | | | |
| 2904-S-171 Cont. Struct. | | | | | | | |
| 240-S-151 Diversion Box | | S | | | | | |
| 240-S-152 Diversion Box | | | | | | | |
| 241-S-151 Diversion Box | | | | | | | |
| 241-S-152 Diversion Box | | | | | | | |
| 241-SX-151 Diversion Box | | | | | | | |
| 241-SX-152 Diversion Box | | | | | | | |
| 241-S-A Valve Pit | | | | | | | |
| 241-S-B Valve Pit | | | | | | | |

9312051070

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

| Source Site | Air | Surface Soil (0-1 m) | Surface Water | Biota | Vadose Zone | Structure | Remarks |
|-----------------------------|-----|----------------------|---------------|-------|-------------|-----------|---------|
| 241-S-C Valve Pit | | | | | | | |
| 241-S-D Valve Pit | | | | | | | |
| 241-SX-A Valve Pit | | | | | | | |
| 241-SX-B Valve Pit | | | | | | | |
| 241-SY-A Valve Pit | | | | | | | |
| 241-SY-B Valve Pit | | | | | | | |
| Basins | | | | | | | |
| 207-S Retention Basin | | K | | | | | |
| 207-SL Retention Basin | | | | | | | |
| Burial Sites | | | | | | | |
| 218-W-7 Burial Ground | | K | | | | | |
| 218-W-9 Burial Ground | | K | | | | | |
| **Unplanned Releases | | | | | | | |
| UN-200-W-10 | | K, R? | | | | | |
| UN-200-W-30 | | | | | | | |
| UN-200-W-32 | | S, R | | | | | |
| UN-200-W-34 | | S | | | S | | |
| UN-200-W-35 | | S, R | | | | | |
| UN-200-W-41 | | S | | | S | | |
| UN-200-W-42 | | S | | | S | | |
| UN-200-W-43 | | S | | | S | | |
| UN-200-W-49 | | S | | | S | | |
| UN-200-W-50 | | S | | | S | | |
| UN-200-W-52 | | S, R? | | | | | |
| UN-200-W-56 | | S | | | S | | |
| UN-200-W-61 | | S, R | | | | | |
| UN-200-W-69 | | S | | | S | | |
| UN-200-W-80 | | K | | | S | | |
| UN-200-W-81 | | S | | | S | | |

93129451571

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

| Source Site | Air | Surface Soil (0-1 m) | Surface Water | Biota | Vadose Zone | Structure | Remarks |
|------------------------|-----|----------------------|---------------|-------|-------------|-----------|---------|
| UN-200-W-82 | | S | | | S | | |
| UN-200-W-83 | | S | | | S | | |
| UN-200-W-108 | | S | | | S | | |
| UN-200-W-109 | | K | | | S | | |
| UN-200-W-114 | | K | | | S | | |
| UN-200-W-123 | | S, R? | | | S | | |
| UN-200-W-127 | | S, R? | | | S | | |
| UN-216-W-25 Rad Emiss. | | | | | | | |
| UN-216-W-30 | | | | | | | |
| UPR-200-W-13 | | S | | | | | |
| UPR-200-W-15 | | S | | | | | |
| UPR-200-W-20 | | S | | | S | | |
| UPR-200-W-36 | | S | | | S | | |
| UPR-200-W-47 | | S, R? | | | | | |
| UPR-200-W-51 | | S, R? | | | | | |
| UPR-200-W-57 | | S | | | S | | |
| UPR-200-W-59 | | | | | | | |
| UPR-200-W-87 | | S | | | S | | |
| UPR-200-W-95 | | S, R? | | | | | |
| UPR-200-W-96 Spill | | K | | | S | | |
| UPR-200-W-124 | | S | | | S | | |
| UPR-200-W-139 | | S, R? | | | S | | |
| UPR-200-W-140 | | S | | | S | | |
| UPR-200-W-141 | | S | | | S | | |
| UPR-200-W-142 | | S | | | S | | |
| UPR-200-W-143 | | S | | | S | | |
| UPR-200-W-144 | | S | | | S | | |
| UPR-200-W-145 | | S | | | S | | |
| UPR-200-W-146 | | S | | | S | | |

9 3 1 2 0 5 1 7 2

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

- S - Suspected contamination, based on WIDS (WHC 1991a), *200-UP-2 Operable Unit Technical Baseline Report* (DeFord 1991), other waste inventory data, and available sampling and analysis information.
- K - Known contamination based on WIDS (WHC 1991a), *200-UP-2 Operable Unit Technical Baseline Report* (DeFord 1991), or other sources.
- R - Complete remediation reported.
- R? - Remediation attempted, effectiveness not documented.

9 1 1 2 4 5 1 5 7 3

Table 4-2. Summary of Chemical Contamination in Various Affected Media for S Plant Aggregate Area.

| Source Site | Air | Surface Soil (0-1 m) | Surface Water | Biota | Vadose Zone | Structure | Remarks |
|--------------------------------------|-----|----------------------|---------------|-------|-------------|-----------|---------|
| Plants, Buildings, and Storage Areas | | | | | | | |
| 291-S Stack Complex | | | | | S | | |
| Tanks and Vents | | | | | | | |
| 241-S Tank Farm | | S | | | S | | |
| 241-S-101 SS Tank | | | | | | | |
| 241-S-102 SS Tank | | | | | S | | |
| 241-S-103 SS Tank | | | | | S | | |
| 241-S-104 SS Tank | | | | | S | | |
| 241-S-105 SS Tank | | | | | S | | |
| 241-S-106 SS Tank | | | | | | | |
| 241-S-107 SS Tank | | | | | | | |
| 241-S-108 SS Tank | | | | | | | |
| 241-S-109 SS Tank | | | | | | | |
| 241-S-110 SS Tank | | | | | S | | |
| 241-S-111 SS Tank | | | | | | | |
| 241-S-112 SS Tank | | | | | | | |
| 241-SX Tank Farm | | | | | | | |
| 241-SX-101 SS Tank | | | | | S | | |
| 241-SX-102 SS Tank | | | | | S | | |
| 241-SX-103 SS Tank | | | | | S | | |
| 241-SX-104 SS Tank | | | | | S | | |
| 241-SX-105 SS Tank | | | | | | | |
| 241-SX-106 SS Tank | | | | | | | |
| 241-SX-107 SS Tank | | | | | S | | |
| 241-SX-108 SS Tank | | | | | S | | |
| 241-SX-109 SS Tank | | | | | S | | |
| 241-SX-110 SS Tank | | | | | S | | |
| 241-SX-111 SS Tank | | | | | S | | |
| 241-SX-112 SS Tank | | | | | S | | |
| 241-SX-113 SS Tank | | | | | S | | |

93128451374

Table 4-2. Summary of Chemical Contamination in Various Affected Media for S Plant Aggregate Area.

| Source Site | Air | Surface Soil (0-1 m) | Surface Water | Biota | Vadose Zone | Structure | Remarks |
|-------------------------------------|-----|----------------------|---------------|-------|-------------|-----------|---------------------------------|
| 241-SX-114 SS Tank | | | | | S | | |
| 241-SX-115 SS Tank | | | | | S | | |
| 241-SY-101 DS Tank | | | | | | | |
| 241-SY-102 DS Tank | | | | | | | |
| 241-SY-103 DS Tank | | | | | | | |
| 240-S-302 Catch Tank | | | | | S | | |
| 241-S-302A Catch Tank | | | | | S | | |
| 241-S-302B Catch Tank | | | | | | | |
| 241-SX-302 Catch Tank | | | | | | | |
| 244-S Receiver Tank | | | | | | | |
| Cribs and Drains | | | | | | | |
| 216-S-1 & -2 Cribs | | | | | S | | Also described by UPR-200-W-139 |
| 216-S-5 Crib | | | | | S | | |
| 216-S-6 Crib | | | | | S | | |
| 216-S-7 Crib | | | | | S | | |
| 216-S-9 Crib | | | | | S | | |
| 216-S-13 Crib | | | | | S | | |
| 216-S-20 Crib | | | | | S | | |
| 216-S-22 Crib | | | | | S | | |
| 216-S-23 Crib | | | | | S | | |
| 216-S-25 Crib | | | | | S | | |
| 216-S-26 Crib | | | | | S | | |
| 216-S-3 French Drain | | | | | S | | |
| Ponds, Ditches, and Trenches | | | | | | | |
| 216-S-10P Pond | | | | | S | | |
| 216-S-11 Pond | | | | | S | | |
| 216-S-15 Pond | | | | | S | | |
| 216-S-16P Pond | | | | | | | |
| 216-S-17 Pond | | | | | S | | |

9310351575

Table 4-2. Summary of Chemical Contamination in Various Affected Media for S Plant Aggregate Area.

| Source Site | Air | Surface Soil (0-1 m) | Surface Water | Biota | Vadose Zone | Structure | Remarks |
|--|-----|----------------------|---------------|-------|-------------|-----------|--------------------------------|
| 216-S-19 Pond | | | | | S | | |
| 216-S-10D Ditch | | | | | | | |
| 216-S-16D Ditch | | | | | S | | |
| 216-U-9 Ditch | | | | | | | |
| 216-S-8 Trench | | | | | S | | |
| 216-S-12 Trench | | | | | S | | Also described by UPR-200-W-30 |
| 216-S-14 Trench | | | | | S | | |
| 216-S-18 Trench | | | | | S | | |
| Septic Tanks and Associated Drain Fields | | | | | | | |
| 2607-W6 Septic Tank | | | | | | | |
| 2607-WZ Septic Tank | | | | | | | |
| Sanitary Crib | | | | | | | |
| Transfer Facilities, Diversion Boxes, and Pipelines | | | | | | | |
| 216-S-172 Cont. Struct. | | | | | | | |
| 2904-S-160 Cont. Struct. | | | | | | | |
| 2904-S-170 Cont. Struct. | | | | | | | |
| 2904-S-171 Cont. Struct. | | | | | | | |
| 240-S-151 Diversion Box | | | | | | | |
| 240-S-152 Diversion Box | | | | | | | |
| 241-S-151 Diversion Box | | | | | | | |
| 241-S-152 Diversion Box | | | | | | | |
| 241-SX-151 Diversion Box | | | | | | | |
| 241-SX-152 Diversion Box | | | | | | | |
| 241-S-A Valve Pit | | | | | | | |
| 241-S-B Valve Pit | | | | | | | |
| 241-S-C Valve Pit | | | | | | | |
| 241-S-D Valve Pit | | | | | | | |
| 241-SX-A Valve Pit | | | | | | | |
| 241-SX-B Valve Pit | | | | | | | |

9 2 1 2 9 4 5 1 7 6

Table 4-2. Summary of Chemical Contamination in Various Affected Media for S Plant Aggregate Area.

| Source Site | Air | Surface Soil (0-1 m) | Surface Water | Biota | Vadose Zone | Structure | Remarks |
|---------------------------|-----|----------------------|---------------|-------|-------------|-----------|---------|
| 241-SY-A Valve Pit | | | | | | | |
| 241-SY-B Valve Pit | | | | | | | |
| Basins | | | | | | | |
| 207-S Retention Basin | | | | | | | |
| 207-SL Retention Basin | | | | | | | |
| Burial Sites | | | | | | | |
| 218-W-7 Burial Ground | | | | | | | |
| 218-W-9 Burial Ground | | | | | | | |
| Unplanned Releases | | | | | | | |
| UN-200-W-10 | | | | | | | |
| UN-200-W-30 | | | | | | | |
| UN-200-W-32 | | | | | | | |
| UN-200-W-34 | | | | | | | |
| UN-200-W-35 | | | | | | | |
| UN-200-W-41 | | | | | | | |
| UN-200-W-42 | | | | | | | |
| UN-200-W-43 | | | | | | | |
| UN-200-W-49 | | | | | | | |
| UN-200-W-50 | | | | | | | |
| UN-200-W-52 | | | | | | | |
| UN-200-W-56 | | | | | | | |
| UN-200-W-61 | | | | | | | |
| UN-200-W-69 | | S | | S | | | |
| UN-200-W-80 | | S | | S | | | |
| UN-200-W-81 | | | | | | | |
| UN-200-W-82 | | S | | S | | | |
| UN-200-W-83 | | | | | | | |
| UN-200-W-108 | | | | | | | |
| UN-200-W-109 | | | | | | | |
| UN-200-W-114 | | | | | | | |

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Table 4-2. Summary of Chemical Contamination in Various Affected Media for S Plant Aggregate Area.

| Source Site | Air | Surface Soil (0-1 m) | Surface Water | Biota | Vadose Zone | Structure | Remarks |
|------------------------|-----|----------------------|---------------|-------|-------------|-----------|---------|
| UN-200-W-116 | | | | | | | |
| UN-200-W-123 | | | | | | | |
| UN-200-W-127 | | | | | | | |
| UN-216-W-25 Rad Emiss. | | | | | | | |
| UN-216-W-30 | | | | | | | |
| UPR-200-W-13 | | | | | | | |
| UPR-200-W-15 | | | | | | | |
| UPR-200-W-20 | | | | | | | |
| UPR-200-W-36 | | | | | | | |
| UPR-200-W-47 | | | | | | | |
| UPR-200-W-51 | | | | | | | |
| UPR-200-W-57 | | | | | | | |
| UPR-200-W-59 | | | | | | | |
| UPR-200-W-87 | | | | | | | |
| UPR-200-W-95 | | | | | | | |
| UPR-200-W-96 Spill | | | | | | | |
| UPR-200-W-124 | | | | | | | |
| UPR-200-W-139 | | S | | | S | | |
| UPR-200-W-140 | | S | | | S | | |
| UPR-200-W-141 | | | | | | | |
| UPR-200-W-142 | | S | | | S | | |
| UPR-200-W-143 | | S | | | S | | |
| UPR-200-W-144 | | | | | S | | |
| UPR-200-W-145 | | S | | | S | | |
| UPR-200-W-146 | | S | | | S | | |

S - Suspected contamination, based on WIDS (WHC 1991a), 200-UP-2 Operable Unit Technical Baseline Report (DeFord 1991), other waste inventory data, and available sampling and analysis information.

9 0 1 2 3 4 5 6 7 8

Table 4-3. Types of Data Available for Each Waste Site.

| Source Site | Inventory | Surface Radiological | External Radiation Monitoring | Waste, Soil, or Sediment Sampling | Biota Sampling | Borehole Geophysics |
|--------------------------------------|-----------|----------------------|-------------------------------|-----------------------------------|----------------|---------------------|
| Plants, Buildings, and Storage Areas | | | | | | |
| 291-S Stack Complex | R, C | | | | | |
| Tanks and Vaults | | | | | | |
| 241-S Tank Farm | R, C | R | | | | R |
| 241-S-101 SS Tank | R, C | | | | | R |
| 241-S-102 SS Tank | R, C | | | | | R |
| 241-S-103 SS Tank | R, C | | | | | R |
| 241-S-104 SS Tank | R, C | | | | | R |
| 241-S-105 SS Tank | R, C | | | | | R |
| 241-S-106 SS Tank | R, C | | | | | R |
| 241-S-107 SS Tank | R, C | | | | | R |
| 241-S-108 SS Tank | R, C | | | | | R |
| 241-S-109 SS Tank | R, C | | | | | R |
| 241-S-110 SS Tank | R, C | | | | | R |
| 241-S-111 SS Tank | R, C | | | | | R |
| 241-S-112 SS Tank | R, C | | | | | R |
| 241-SX Tank Farm | R, C | R | | | | R |
| 241-SX-101 SS Tank | R, C | | | | | R |
| 241-SX-102 SS Tank | R, C | | | | | R |
| 241-SX-103 SS Tank | R, C | | | | | R |
| 241-SX-104 SS Tank | R, C | | | | | R |
| 241-SX-105 SS Tank | R, C | | | | | R |
| 241-SX-106 SS Tank | R, C | | | | | R |
| 241-SX-107 SS Tank | R, C | | | | | R |
| 241-SX-108 SS Tank | R, C | | | | | R |
| 241-SX-109 SS Tank | R, C | | | | | R |
| 241-SX-110 SS Tank | R, C | | | | | R |
| 241-SX-111 SS Tank | R, C | | | | | R |
| 241-SX-112 SS Tank | R, C | | | | | R |
| 241-SX-113 SS Tank | R, C | | | | | R |

931235179

Table 4-3. Types of Data Available for Each Waste Site.

| Source Site | Inventory | Surface Radiological | External Radiation Monitoring | Waste, Soil, or Sediment Sampling | Biota Sampling | Borehole Geophysics |
|------------------------------|-----------|----------------------|-------------------------------|-----------------------------------|----------------|---------------------|
| 241-SX-114 SS Tank | R, C | | | | | R |
| 241-SX-115 SS Tank | R, C | | | | | R |
| 241-SY-101 DS Tank | R, C | | | | | |
| 241-SY-102 DS Tank | R, C | | | | | |
| 241-SY-103 DS Tank | R, C | | | | | |
| 240-S-302 Catch Tank | R, C | | | | | |
| 241-S-302A Catch Tank | R, C | | | | | |
| 241-S-302B Catch Tank | R, C | | | | | |
| 241-SX-302 Catch Tank | R, C | | | | | |
| 244-S Receiver Tank | R, C | | | | | |
| Cribs and Drain Fields | | | | | | |
| 216-S-1 & -2 Crib | R, C | R | | | R | R |
| 216-S-5 Crib | R, C | R | | | | R |
| 216-S-6 Crib | R, C | R | | | | R |
| 216-S-7 Crib | R, C | R | | | | R |
| 216-S-9 Crib | R, C | R | | | | R |
| 216-S-13 Crib | R, C | R | | | | R |
| 216-S-20 Crib | R, C | R | | | | R |
| 216-S-22 Crib | R, C | R | | | | R |
| 216-S-23 Crib | R, C | R | | | | R |
| 216-S-25 Crib | R, C | R | | | | R |
| 216-S-26 Crib | R, C | R | | | | |
| 216-S-3 French Drain | R, C | R | | | | |
| Ponds, Ditches, and Trenches | | | | | | |
| 216-S-10P Pond | R, C | R | | | | R |
| 216-S-11 Pond | R, C | R | | | | R |
| 216-S-15 Pond | R, C | R | | | | |
| 216-S-16P Pond | R, C | R | | | | |
| 216-S-17 Pond | R, C | | | | R | |
| 216-S-19 Pond | R, C | | | R | | |

9 3 1 2 2 4 5 1 5 9 0

Table 4-3. Types of Data Available for Each Waste Site.

| Source Site | Inventory | Surface Radiological | External Radiation Monitoring | Waste, Soil, or Sediment Sampling | Biota Sampling | Borehole Geophysics |
|---|-----------|----------------------|-------------------------------|-----------------------------------|----------------|---------------------|
| 216-S-8 Trench | R, C | | | | | R |
| 216-S-12 Trench | R, C | | | | | |
| 216-S-14 Trench | R, C | | | | | R |
| 216-S-18 Trench | R, C | | | R | | |
| 216-S-10D Ditch | R, C | | | R | R | R |
| 216-S-16D Ditch | R, C | | | | | |
| 216-U-9 Ditch | R, C | | | | | |
| Septic Tanks and Associated Drain Fields | | | | | | |
| 2607-W6 Septic Tank | | R | | | | |
| 2607-WZ Septic Tank | | R | | | | |
| Sanitary Crib | | | | | | |
| Transfer Facilities, Diversion Boxes, and Pipelines | | | | | | |
| 216-S-172 Cont. Struct. | R | R | | | | |
| 2904-S-160 Cont. Struct. | R | R | | | | |
| 2904-S-170 Cont. Struct. | R | R | | | | |
| 2904-S-171 Cont. Struct. | R | R | | | | |
| 240-S-151 Diversion Box | R, C | | | | | |
| 240-S-152 Diversion Box | R, C | | | | | |
| 241-S-151 Diversion Box | R, C | | | | | |
| 241-S-152 Diversion Box | R, C | | | | | |
| 241-SX-151 Diversion Box | | | | | | |
| 241-SX-152 Diversion Box | R, C | | | | | |
| 241-S-A Valve Pit | | | | | | |
| 241-S-B Valve Pit | | | | | | |
| 241-S-C Valve Pit | | | | | | |
| 241-S-D Valve Pit | | | | | | |
| 241-SX-A Valve Pit | | | | | | |
| 241-SX-B Valve Pit | | | | | | |
| 241-SY-A Valve Pit | | | | | | |
| 241-SY-B Valve Pit | | | | | | |

9 3 1 2 0 4 5 1 5 9

Table 4-3. Types of Data Available for Each Waste Site.

| Source Site | Inventory | Surface Radiological | External Radiation Monitoring | Waste, Soil, or Sediment Sampling | Biota Sampling | Borehole Geophysics |
|------------------------|-----------|----------------------|-------------------------------|-----------------------------------|----------------|---------------------|
| Basins | | | | | | |
| 207-S Retention Basin | R, C | | | | | |
| 207-SL Retention Basin | R, C | | | | | |
| Burial Sites | | | | | | |
| 218-W-7 Burial Ground | R | | | | | |
| 218-W-9 Burial Ground | R, C | | | | | |
| Unplanned Releases | | | | | | |
| UN-200-W-10 | R | | | | | |
| UN-200-W-30 | | | | | | |
| UN-200-W-32 | R, C | | | | | |
| UN-200-W-34 | R, C | | | | | |
| UN-200-W-35 | R, C | | | | | |
| UN-200-W-41 | R, C | | | | | |
| UN-200-W-42 | R, C | | | | | |
| UN-200-W-43 | R, C | | | | | |
| UN-200-W-49 | R, C | | | | | |
| UN-200-W-50 | R, C | | | | | |
| UN-200-W-52 | R, C | | | | | |
| UN-200-W-56 | R | | | | | |
| UN-200-W-61 | R | | | | | |
| UN-200-W-69 | R, C | | | | | |
| UN-200-W-80 | R, C | R | | | | |
| UN-200-W-81 | R | | | | | |
| UN-200-W-82 | R, C | | | | | |
| UN-200-W-83 | R | | | | | |
| UN-200-W-108 | R, C | R | | | | |
| UN-200-W-109 | R, C | R | | | | |
| UN-200-W-114 | R, C | R | | | | |
| UN-200-W-116 | R | R | | | | |
| UN-200-W-123 | R, C | | | | | |

9 0 1 2 3 4 5 6 7 8 9

Table 4-3. Types of Data Available for Each Waste Site.

| Source Site | Inventory | Surface Radiological | External Radiation Monitoring | Waste, Soil, or Sediment Sampling | Biota Sampling | Borehole Geophysics |
|--------------------------|-----------|----------------------|-------------------------------|-----------------------------------|----------------|---------------------|
| UN-200-W-127 | R, C | | | | | |
| UN-216-W-25, Rad. Emiss. | R, C | R | | | | |
| UN-216-W-30 | | | | | | |
| (Radiation Emissions) | | | | | | |
| UPR-200-W-13 | R | | | | | |
| UPR-200-W-15 | R, C | | | | | |
| UPR-200-W-20 | R, C | | | | | |
| UPR-200-W-36 | R, C | | | | | |
| UPR-200-W-47 | R, C | | | | | |
| UPR-200-W-51 | R, C | | | | | |
| UPR-200-W-57 | | | | | | |
| UPR-200-W-59 | R | | | | | |
| UPR-200-W-87 | | | | | | |
| UPR-200-W-95 | R, C | | | | | |
| UPR-200-W-96, Spill | R, C | R | | | | |
| UPR-200-W-124 | R, C | | | | | |
| UPR-200-W-139 | R | | | | | |
| UPR-200-W-140 | R, C | | | | | |
| UPR-200-W-141 | R, C | | | | | |
| UPR-200-W-142 | R, C | | | | | |
| UPR-200-W-143 | R, C | | | | | |
| UPR-200-W-144 | R, C | | | | | |
| UPR-200-W-145 | R, C | | | | | |
| UPR-200-W-146 | R, C | | | | | |

R - Radionuclide - related data

C - Chemical - related data

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Table 4-4. Summary of Air Sampling Results 1985, 1986, and 1988 (pCi/m³). Page 1 of 2

| Year | Map Location | Site | Quarters Sampled | ⁹⁰ Sr | | | ¹³⁷ Cs | | |
|------|--------------|------------------------------|------------------|-------------------|-----------------|------------------------|-------------------|-----------------|------------------------|
| | | | | Quarter Maximum | Quarter Minimum | Annual average ± 2 SD* | Quarter Maximum | Quarter Minimum | Annual average ± 2 SD* |
| 1985 | N956 | 241-S and SX Tank Farms | 1,2,3,4 | 1.10 E-02 | 1.28 E-04 | 2.94 E-03 ± 1.08 E-02 | 1.42 E-03 | 4.05 E-04 | 9.66 E-04 ± 8.38 E-04 |
| 1986 | N956 | E of 241-S and SX Tank Farms | 1,2,3,4 | 2.96 E-03 | 1.49 E-04 | 9.12 E-04 ± 2.74 E-03 | 2.37 E-03 | -3.61 E-04 | 6.22 E-04 ± 2.41 E-03 |
| Year | Map Location | Site | Quarters Sampled | ²³⁹ Pu | | | U (total) | | |
| | | | | Quarter Maximum | Quarter Minimum | Annual average ± 2 SD* | Quarter Maximum | Quarter Minimum | Annual average ± 2 SD* |
| 1985 | N956 | 241-S and SX Tank Farms | 1,2,3,4 | 3.38 E-05 | 3.09 E-06 | 1.72 E-05 ± 3.13 E-05 | 8.90 E-04 | 3.22 E-05 | 2.76 E-04 ± 8.23 E-04 |
| 1986 | N956 | E of 241-S and SX Tank Farms | 1,2,3,4 | 2.61 E-05 | 8.42 E-06 | 1.44 E-05 ± 1.59 E-05 | 8.29 E-05 | 2.34 E-05 | 4.96 E-05 ± 5.14 E-05 |

4T-4a

DOE/RL-91-60
Draft A

Table 4-4. Summary of Air Sampling Results 1985, 1986, and 1988 (pCi/m³)

| Year | Site | Location | Quarter | ⁹⁰ Sr ± Error | ¹³⁷ Cs ± Error | ²³⁹ Pu ± Error | U-Total ± Error |
|---------|------|-----------------------------|---------|--------------------------|---------------------------|---------------------------|-----------------------|
| 1988 | N956 | E of 241-S and SX Tank Farm | 1 | 2.3 E-04 ± 1.2 E-04 | 1.1 E-03 ± 6.1 E-04 | 9.5 E-06 ± 4.8 E-06 | <-2.0 E-06 ± 1.9 E-05 |
| | | | 2 | < 6.8 E-06 ± 6.3 E-05 | < 5.5 E-04 ± 6.4 E-04 | < 9.3 E-07 ± 2.5 E-06 | <-1.1 E-05 ± 1.8 E-05 |
| | | | 3 | 9.7 E-05 ± 8.7 E-05 | < 7.0 E-04 ± 8.1 E-04 | 1.2 E-05 ± 6.2 E-06 | <-2.8 E-06 ± 1.9 E-05 |
| | | | 4 | < 3.8 E-05 ± 7.1 E-05 | <-1.9 E-04 ± 5.4 E-04 | 5.2 E-06 ± 3.7 E-06 | <-1.3 E-05 ± 1.8 E-05 |
| Average | | | | 9.3 E-05 ± 1.0 E-04 | 5.4 E-04 ± 5.5 E-04 | 6.9 E-06 ± 5.2 E-06 | -7.3 E-06 ± 5.8 E-06 |

Sources: Elder 1986, 1987, 1989.

4T-4b

DOE/RL-91-60
Draft A

**Table 4-5. Radiation and Dose Rate Surveys at the S Plant Aggregate Area
Waste Management Units.**

| Waste Management Unit | Waste Management Unit Type | c/min | Radiation Surveys dis/min | mrem/h | Survey Date | Radiation Type |
|--------------------------------------|----------------------------|--------------------|------------------------------|--------|-------------|-------------------|
| Plants, Buildings, and Storage Areas | | | | | | |
| 291-S | Stack Complex | NA | NA | NA | | |
| Tanks and Vaults | | | | | | |
| 241-S | Tank Farm | 1.32×10^7 | | | Jul/Aug-88 | δ |
| 241-S-101 | Single-Shell Tank | NA | NA | NA | | |
| 241-S-102 | Single-Shell Tank | NA | NA | NA | | |
| 241-S-103 | Single-Shell Tank | NA | NA | NA | | |
| 241-S-104 | Single-Shell Tank | NA | NA | NA | | |
| 241-S-105 | Single-Shell Tank | NA | NA | NA | | |
| 241-S-106 | Single-Shell Tank | NA | NA | NA | | |
| 241-S-107 | Single-Shell Tank | NA | NA | NA | | |
| 241-S-108 | Single-Shell Tank | NA | NA | NA | | |
| 241-S-109 | Single-Shell Tank | NA | NA | NA | | |
| 241-S-110 | Single-Shell Tank | NA | NA | NA | | |
| 241-S-111 | Single-Shell Tank | NA | NA | NA | | |
| 241-S-112 | Single-Shell Tank | NA | NA | NA | | |
| 241-SX | Tank Farm | 1.32×10^7 | -- | -- | Jul/Aug-88 | δ |

4T-5a

DOE/RL-91-60
Draft A

Table 4-5. Radiation and Dose Rate Surveys at the S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Waste Management Unit Type | c/min | Radiation Surveys dis/min | mrem/h | Survey Date | Radiation Type |
|-----------------------|----------------------------|-------|---------------------------|--------|-------------|----------------|
| 241-SX-101 | Single-Shell Tank | NA | NA | NA | | |
| 241-SX-102 | Single-Shell Tank | NA | NA | NA | | |
| 241-SX-103 | Single-Shell Tank | NA | NA | NA | | |
| 241-SX-104 | Single-Shell Tank | NA | NA | NA | | |
| 241-SX-105 | Single-Shell Tank | NA | NA | NA | | |
| 241-SX-106 | Single-Shell Tank | NA | NA | NA | | |
| 241-SX-107 | Single-Shell Tank | NA | NA | NA | | |
| 241-SX-108 | Single-Shell Tank | NA | NA | NA | | |
| 241-SX-109 | Single-Shell Tank | NA | NA | NA | | |
| 241-SX-110 | Single-Shell Tank | NA | NA | NA | | |
| 241-SX-111 | Single-Shell Tank | NA | NA | NA | | |
| 241-SX-112 | Single-Shell Tank | NA | NA | NA | | |
| 241-SX-113 | Single-Shell Tank | NA | NA | NA | | |
| 241-SX-114 | Single-Shell Tank | NA | NA | NA | | |
| 241-SX-115 | Single-Shell Tank | NA | NA | NA | | |
| 241-SY-101 | Double-Shell Tank | NA | NA | NA | | |
| 241-SY-102 | Double-Shell Tank | NA | NA | NA | | |
| 241-SY-103 | Double-Shell Tank | NA | NA | NA | | |

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**Table 4-5. Radiation and Dose Rate Surveys at the S Plant Aggregate Area
Waste Management Units.**

| Waste Management Unit | Waste Management Unit Type | c/min | Radiation Surveys dis/min | mrem/h | Survey Date | Radiation Type |
|-----------------------|----------------------------|-------|------------------------------|--------|-------------|-------------------|
| 240-S-302 | Catch Tank | NA | NA | NA | | |
| 241-S-302A | Catch Tank | NA | NA | NA | | |
| 241-S-302B | Catch Tank | NA | NA | NA | | |
| 241-SX-302 | Catch Tank | NA | NA | NA | | |
| 244-S | Receiver Tank | NA | NA | NA | | |
| Cribs and Drains | | | | | | |
| 216-S-1&2 | Cribs | -- | 150,000 | -- | Aug-91 | B |
| 216-S-3 | French Drain | NC | 20,000 | NC | Aug-91 | B |
| 216-S-5 | Crib | NC | NC | NC | Aug-91 | |
| 216-S-6 | Crib | NC | NC | NC | Aug-91 | |
| 216-S-7 | Crib | 150 | NC | NC | Aug-91 | Unknown |
| 216-S-9 | Crib | NC | NC | NC | Aug-91 | |
| 216-S-13 | Crib | NC | 4,000 | NC | Dec-91 | B |
| 216-S-20 | Crib | NC | NC | NC | Aug-91 | |
| 216-S-22 | Crib | NC | NC | NC | Aug-91 | |
| 216-S-23 | Crib | NC | NC | NC | Aug-91 | |
| 216-S-25 | Crib | 100 | NC | NC | Sep-91 | Unknown |
| 216-S-26 | Crib | NC | NC | NC | Dec-91 | |

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**Table 4-5. Radiation and Dose Rate Surveys at the S Plant Aggregate Area
Waste Management Units.**

| Waste Management Unit | Waste Management Unit Type | c/min | Radiation Surveys dis/min | mrem/h | Survey Date | Radiation Type |
|------------------------------|----------------------------|-------|------------------------------|--------|-------------|-------------------|
| Ponds, Ditches, and Trenches | | | | | | |
| 216-S-10P | Pond | NC | NC | NC | Jul-91 | |
| 216-S-11 | Pond | NC | NC | NC | Jan-92 | |
| 216-S-15 | Pond | NC | 20,000 | NC | Aug-91 | B |
| 216-S-16P | Pond | NC | NC | NC | Feb-91 | |
| 216-S-17 | Pond | NC | NC | NC | Jan-92 | |
| 216-S-19 | Pond | NC | NC | NC | Oct-91 | |
| 216-S-10D | Ditch | NC | NC | NC | Jan-92 | |
| 216-S-16D | Ditch | NC | NC | NC | Sep-84 | |
| 216-U-9 | Ditch | NA | NA | NA | | |
| 216-S-8 | Trench | -- | 20,000 | | Aug-91 | B |
| 216-S-12 | Trench | NC | NC | NC | Aug-91 | |
| 216-S-14 | Trench | NC | NC | Nc | Feb-71 | |
| 216-S-18 | Trench | NC | NC | NC | Oct-72 | |

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**Table 4-5. Radiation and Dose Rate Surveys at the S Plant Aggregate Area
Waste Management Units.**

| Waste Management Unit | Waste Management Unit Type | c/min | Radiation Surveys dis/min | mrem/h | Survey Date | Radiation Type |
|--|------------------------------------|-------|------------------------------|-----------------|-------------|-------------------|
| Septic Tanks and Associated Drain Fields | | | | | | |
| 2607-W6 | Septic Tank and Tile Field | NA | NA | NA | | |
| 2607-WZ | Septic Tank (2) and Drain Field | NA | NA | NA | | |
| -- | Sanitary Crib | NA | NA | NA | | |
| Transfer Facilities and Pipelines | | | | | | |
| 216-S-172 | Control Structure | -- | -- | 25 ^a | Unknown | Unknown |
| 2904-S-160 | Control Structure | 5,000 | -- | -- | Unknown | B, δ |
| 2904-S-170 | Control Structure | 200 | -- | -- | Unknown | B, δ |
| 2904-S-171 | Control Structure | 100 | -- | -- | Unknown | B, δ |
| 240-2-151 | Diversion Box | -- | -- | 25 ^a | | |
| 240-S-152 | Diversion Box | -- | -- | 25 ^a | | |
| 241-S-151 | Diversion Box | -- | -- | 25 ^a | | |
| 241-S-152 | Diversion Box | -- | -- | 25 ^a | | |
| 241-SX-151 | Diversion Box | -- | -- | 25 ^a | | |
| 241-SX-152 | Diversion Box | -- | -- | 25 ^a | | |
| 241-S-A | Valve Pit | -- | -- | 25 ^a | | |
| 352-S-B | Valve Pit | -- | -- | 25 ^a | | |

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Table 4-5. Radiation and Dose Rate Surveys at the S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Waste Management Unit Type | c/min | Radiation Surveys dis/min | mrem/h | Survey Date | Radiation Type |
|-----------------------|----------------------------|-------|------------------------------|------------------|-------------|-------------------|
| 241-S-C | Valve Pit | -- | -- | 25 ^a | | |
| 241-S-D | Valve Pit | -- | -- | 25 ^a | | |
| 241-SX-A | Valve Pit | -- | -- | 25 ^a | | |
| 241-SX-B | Valve Pit | -- | -- | 25 ^a | | |
| 241-SY-A | Valve Pit | -- | -- | 25 ^a | | |
| 241-SY-B | Valve Pit | -- | -- | 25 ^a | | |
| Basins | | | | | | |
| 207-S | Retention Basin | -- | 60,000 | -- | Jul-90 | Unknown |
| 207-SL | Retention Basin | NC | NC | NC | Jul-90 | |
| Burial Sites | | | | | | |
| 218-W-7 | Burial Ground | -- | -- | 3.5 ^a | Jul-90 | Unknown |
| 218-W-9 | Burial Ground | -- | 25,000 | -- | Jul-90 | Unknown |
| Unplanned Releases | | | | | | |
| UN-200-W-10 | Unplanned Release | NA | NA | NA | | |
| UN-200-W-30 | Unplanned Release | NA | NA | NA | | |
| UN-200-W-32 | Unplanned Release | -- | 30,000 | -- | 1991 | B |
| UN-200-W-34 | Unplanned Release | NA | NA | NA | | |
| UN-200-W-35 | Unplanned Release | NA | NA | NA | | |

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**Table 4-5. Radiation and Dose Rate Surveys at the S Plant Aggregate Area
Waste Management Units.**

| Waste Management Unit | Waste Management Unit Type | c/min | Radiation Surveys dis/min | mrem/h | Survey Date | Radiation Type |
|-----------------------|----------------------------|--------|------------------------------|--------|-------------|-------------------|
| UN-200-W-41 | Unplanned Release | NA | NA | NA | | |
| UN-200-W-42 | Unplanned Release | NA | NA | NA | | |
| UN-200-W-43 | Unplanned Release | NA | NA | NA | | |
| UN-200-W-49 | Unplanned Release | NA | NA | NA | | |
| UN-200-W-50 | Unplanned Release | NA | NA | NA | | |
| UN-200-W-52 | Unplanned Release | NA | NA | NA | | |
| UN-200-W-56 | Unplanned Release | NA | NA | NA | | |
| UN-200-W-61 | Unplanned Release | NA | NA | NA | | |
| UN-200-W-69 | Unplanned Release | NA | NA | NA | | |
| UN-200-W-80 | Unplanned Release | 60,000 | -- | -- | Unknown | Unknown |
| UN-200-W-81 | Unplanned Release | NA | NA | NA | | |
| UN-200-W-82 | Unplanned Release | NA | NA | NA | | |
| UN-200-W-83 | Unplanned Release | NA | NA | NA | | |
| UN-200-W-108 | Unplanned Release | NC | NC | NC | Oct-90 | |
| UN-200-W-109 | Unplanned Release | 6,000 | -- | -- | Oct-90 | Unknown |
| UN-200-W-114 | Unplanned Release | 450 | -- | -- | Oct-90 | Unknown |
| UN-200-W-116 | Unplanned Release | 200 | -- | -- | Oct-90 | Unknown |
| UN-200-W-123 | Unplanned Release | NA | NA | NA | | |

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**Table 4-5. Radiation and Dose Rate Surveys at the S Plant Aggregate Area
Waste Management Units.**

| Waste Management Unit | Waste Management Unit Type | c/min | Radiation Surveys dis/min | mrem/h | Survey Date | Radiation Type |
|-----------------------|----------------------------|--------|------------------------------|--------|-------------|-------------------|
| UN-200-W-127 | Unplanned Release | NA | NA | NA | | |
| UN-216-W-25 | Radiation Emissions | 40,000 | -- | -- | 1991 | B |
| UN-216-W-30 | Unplanned Release | NA | NA | NA | | |
| UPR-200-W-13 | Unplanned Release | NA | NA | NA | | |
| UPR-200-W-15 | Unplanned Release | NA | NA | NA | | |
| UPR-200-W-20 | Unplanned Release | NA | NA | NA | | |
| UPR-200-W-36 | Unplanned Release | NA | NA | NA | | |
| UPR-200-W-47 | Unplanned Release | NA | NA | NA | | |
| UPR-200-W-51 | Unplanned Release | NA | NA | NA | | |
| UPR-200-W-57 | Unplanned Release | NA | NA | NA | | |
| UPR-200-W-59 | Unplanned Release | NA | NA | NA | | |
| UPR-200-W-87 | Unplanned Release | NA | NA | NA | | |
| UPR-200-W-95 | Unplanned Release | NA | NA | NA | | |
| UPR-200-W-96 | Unplanned Release | 3,000 | -- | -- | Oct-90 | Unknown |
| UPR-200-W-124 | Unplanned Release | | | | | |
| UPR-200-W-139 | Unplanned Release | | | | | |
| UPR-200-W-140 | Unplanned Release | | | | | |
| UPR-200-W-141 | Unplanned Release | | | | | |

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**Table 4-5. Radiation and Dose Rate Surveys at the S Plant Aggregate Area
Waste Management Units.**

| Waste Management Unit | Waste Management Unit Type | c/min | Radiation Surveys dis/min | mrem/h | Survey Date | Radiation Type |
|-----------------------|----------------------------|-------|------------------------------|--------|-------------|-------------------|
| UPR-200-W-142 | Unplanned Release | NA | NA | NA | | |
| UPR-200-W-143 | Unplanned Release | NA | NA | NA | | |
| UPR-200-W-144 | Unplanned Release | NA | NA | NA | | |
| UPR-200-W-145 | Unplanned Release | NA | NA | NA | | |
| UPR-200-W-146 | Unplanned Release | NA | NA | NA | | |

NA = No data available

NC = No contamination detected

± = It was assumed that 1 mR/h was equivalent to 1 mrem/h

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Table 4-6. Thermoluminescent Results of External Radiation Monitoring,
1985 through 1988, TLDs (mrem/yr).

| TLD Number | Location | Max (a) mrem/year | Min (a) mrem/year | Total |
|------------|---------------------|----------------------|----------------------|-------|
| 0210 | E-122 Baseline Site | 164 | 100 | 125 |
| 0213 | 216-S-19 | 108 | 92 | 97 |

NOTE: (a) = Quarterly dose normalized to annual dose rate.

Source: Schmidt et al. 1991.

9 5 1 2 0 5 1 7 9 5

Table 4-7. Summary of Background Air Monitoring Results (1988).

| Site | Location | Quarter | ⁹⁰ Sr ± error | ¹³⁷ Cs ± error | ²³⁹ Pu ± error | U-Total ± error |
|---------|-------------------------|---------------------|--------------------------|---------------------------|---------------------------|-----------------------|
| N961 | Yakima Barricade | 1 | <-4.8 E-06 ± 6.4 E-05 | < 0.0 E+00 ± 3.9 E-04 | < 1.4 E-06 ± 2.2 E-06 | <-9.1 E-06 ± 1.8 E-05 |
| | | 2 | < 2.1 E-05 ± 8.7 E-05 | <-4.6 E-04 ± 6.1 E-04 | < 4.3 E-07 ± 2.0 E-06 | <-6.4 E-06 ± 1.9 E-05 |
| | | 3 | 1.7 E-04 ± 1.1 E-04 | 6.4 E-04 ± 3.9 E-04 | 5.3 E-06 ± 3.9 E-06 | <-1.1 E-05 ± 1.8 E-05 |
| | | 4 | 1.5 E-04 ± 1.3 E-04 | <-2.8 E-04 ± 5.7 E-04 | 1.9 E-05 ± 7.5 E-06 | <-8.7 E-06 ± 1.8 E-05 |
| Average | | 8.3 E-05 ± 9.3 E-05 | -2.8 E-05 ± 5.0 E-04 | 6.6 E-06 ± 9.1 E-06 | -8.7 E-06 ± 1.8 E-06 | |
| N981 | Wye Barricade | 1 | 1.2 E-04 ± 9.8 E-05 | < 2.8 E-05 ± 5.3 E-04 | < 4.7 E-07 ± 2.1 E-06 | <-7.0 E-06 ± 1.8 E-05 |
| | | 2 | < 3.4 E-05 ± 6.5 E-05 | <-1.2 E-04 ± 4.3 E-04 | < 2.1 E-06 ± 2.7 E-06 | <-1.1 E-05 ± 1.8 E-05 |
| | | 3 | 8.8 E-05 ± 8.0 E-05 | <-1.3 E-04 ± 5.0 E-04 | <-2.4 E-08 ± 2.4 E-06 | <-7.1 E-06 ± 1.9 E-05 |
| | | 4 | 1.2 E-04 ± 8.4 E-05 | <-1.1 E-04 ± 5.7 E-04 | < 1.1 E-06 ± 1.9 E-06 | < 2.4 E-06 ± 1.9 E-05 |
| Average | | 9.0 E-05 ± 4.2 E-05 | -8.0 E-05 ± 9.3 E-05 | 9.1 E-07 ± 1.0 E-06 | -5.7 E-06 ± 5.8 E-06 | |
| N982 | Hanford Townsite | 1 | 8.7 E-05 ± 8.3 E-05 | < 3.3 E-04 ± 4.0 E-04 | < 7.5 E-07 ± 1.9 E-06 | <-1.2 E-05 ± 1.7 E-05 |
| | | 2 | < 4.6 E-05 ± 6.9 E-05 | < 2.2 E-04 ± 5.1 E-04 | 2.2 E-05 ± 1.0 E-05 | <-1.4 E-05 ± 1.8 E-05 |
| | | 3 | 1.5 E-04 ± 1.0 E-04 | 7.6 E-04 ± 5.0 E-04 | <-5.3 E-08 ± 2.3 E-06 | < 3.9 E-06 ± 2.1 E-05 |
| | | 4 | 1.2 E-04 ± 8.8 E-05 | < 2.6 E-04 ± 4.2 E-04 | < 2.1 E-08 ± 2.0 E-06 | <-8.6 E-06 ± 1.8 E-05 |
| Average | | 1.0 E-04 ± 4.6 E-05 | 3.9 E-04 ± 2.6 E-04 | 5.7 E-06 ± 1.2 E-05 | -7.7 E-06 ± 8.2 E-06 | |
| N950 | Quality Assurance Blank | 1 | <-2.5 E-05 ± 6.4 E-05 | < 3.7 E-04 ± 4.3 E-04 | 1.7 E-05 ± 6.9 E-06 | <-1.5 E-05 ± 1.7 E-05 |
| | | 2 | < 6.3 E-05 ± 7.3 E-05 | <-2.6 E-05 ± 5.3 E-04 | 1.6 E-05 ± 7.2 E-06 | <-2.1 E-05 ± 1.7 E-05 |
| | | 3 | <-1.8 E-05 ± 6.1 E-05 | 4.6 E-04 ± 3.3 E-04 | < 1.4 E-06 ± 2.3 E-06 | <-1.7 E-05 ± 1.7 E-05 |
| | | 4 | < 3.8 E-05 ± 6.7 E-05 | <-2.4 E-04 ± 4.5 E-04 | 5.3E-06 ± 3.9 E-06 | <-1.7 E-05 ± 1.7 E-05 |
| Average | | 1.4 E-05 ± 4.3 E-05 | 1.4 E-04 ± 3.4 E-04 | 1.0 E-05 ± 8.2 E-06 | -1.7 E-05 ± 2.8 E-06 | |
| N951 | Quality Assurance Blank | 1 | <-1.4 E-05 ± 7.0 E-05 | <-1.3 E-04 ± 3.0 E-04 | < 1.9 E-06 ± 2.7 E-06 | <-1.4 E-05 ± 1.7 E-05 |
| | | 2 | < 1.4 E-05 ± 6.5 E-05 | <-2.1 E-04 ± 5.9 E-04 | <-5.7 E-07 ± 2.1 E-06 | <-2.4 E-05 ± 1.7 E-05 |
| | | 3 | 6.1 E-05 ± 1.0 E-04 | <-9.0 E-05 ± 5.3 E-04 | 1.1 E-05 ± 5.7 E-06 | <-2.1 E-05 ± 1.9 E-05 |
| | | 4 | < 4.2 E-05 ± 1.0 E-04 | <-3.2 E-04 ± 3.5 E-04 | <-1.2 E-06 ± 1.3 E-06 | <-1.8 E-05 ± 1.7 E-05 |
| Average | | 2.6 E-05 ± 3.8 E-05 | -1.9 E-04 ± 1.7 E-04 | 2.7 E-06 ± 5.9 E-06 | -1.9 E-05 ± 4.2 E-06 | |

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.

Source: Elder et al. 1989.

Table 4-8. Grid Soil Sampling Results for S Plant Aggregate Area, 1985, 1986, and 1988 (pCi/g dry weight). Page 1 of 3

| Year | Sampling Site | ⁵⁵ Mn ± error | ⁶⁰ Co ± error | ⁶⁰ Co ± error | ⁶⁵ Zn ± error | ⁸⁷ Sr ± error | ⁹³ Nb ± error | ⁹⁰ Zr ± error |
|------|-----------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1985 | 2W28 | - | - | 0.04 ± 0.03 | - | 0.68 ± 0.13 | - | - |
| | 2W29 | - | - | - | - | 1.18 ± 0.22 | - | - |
| | 2W33 | - | - | - | - | 0.98 ± 0.18 | - | - |
| | 2W34 | - | - | 0.05 ± 0.03 | 0.16 ± 0.09 | 1.27 ± 0.23 | - | - |
| 1986 | 2W28 | 0.04 ± 0.02 | N/A | N/A | N/A | 0.69 ± 0.13 | N/A | N/A |
| | 2W29 | N/A | N/A | N/A | N/A | 0.49 ± 0.10 | N/A | N/A |
| | 2W33 | N/A | N/A | 0.02 ± 0.02 | N/A | 0.51 ± 0.10 | N/A | N/A |
| | 2W34 | 0.02 ± 0.02 | N/A | N/A | 0.07 ± 0.05 | 1.55 ± 0.28 | 0.04 ± 0.04 | N/A |
| | 2W34b | N/A | N/A | N/A | N/A | 1.28 ± 0.24 | N/A | N/A |
| | 2WA | N/A | N/A | N/A | N/A | 0.23 ± 0.05 | N/A | N/A |
| 1988 | 2W28 | <8.5 E-5 ± 1.4 E-2 | N/A | <3.6 E-3 ± 1.4 E-2 | N/A | 1.6 E+0 ± 3.0 E-1 | <2.0 E-2 ± 1.6 E-2 | <7.5 E-3 ± 2.5 E-2 |
| | 2W29 | <7.9 E-3 ± 1.6 E-2 | N/A | <6.7 E-3 ± 1.7 E-2 | N/A | 8.1 E-1 ± 1.5 E-1 | <1.3 E-2 ± 2.2 E-2 | <2.6 E-2 ± 3.1 E-2 |
| | 2W32 | <3.7 E-3 ± 1.6 E-2 | N/A | <9.8 E-3 ± 1.6 E-2 | N/A | 3.2 E-1 ± 6.1 E-2 | <3.1 E-2 ± 2.1 E-2 | <1.4 E-2 ± 2.6 E-2 |
| | 2W33 | <1.3 E-2 ± 1.8 E-2 | N/A | <1.5 E-2 ± 1.8 E-2 | N/A | 4.9 E-1 ± 9.3 E-2 | <1.3 E-2 ± 2.4 E-2 | <2.5 E-2 ± 3.6 E-2 |
| | 2W34 | <8.4 E-4 ± 1.5 E-2 | N/A | 2.3 E-2 ± 1.5 E-2 | N/A | 6.1 E-1 ± 1.2 E-1 | <2.0 E-2 ± 1.6 E-2 | <4.4 E-4 ± 2.5 E-2 |
| | 2WA | 1.7 E-2 ± 1.6 E-2 | N/A | <3.5 E-3 ± 1.7 E-2 | N/A | 2.0 E-1 ± 3.9 E-2 | <1.1 E-2 ± 2.0 E-2 | <2.7 E-2 ± 3.1 E-2 |
| | 2WB | <3.8 E-3 ± 1.4 E-2 | N/A | <2.0 E-3 ± 1.5 E-2 | N/A | 3.3 E-1 ± 6.3 E-2 | <2.6 E-2 ± 2.0 E-2 | <7.3 E-3 ± 2.6 E-2 |
| | 2WC | <3.0 E-3 ± 1.3 E-2 | N/A | <1.1 E-3 ± 1.3 E-2 | N/A | 2.8 E-1 ± 5.5 E-2 | <1.2 E-2 ± 1.6 E-2 | <4.0 E-3 ± 2.1 E-2 |
| | 2WD | <4.2 E-3 ± 1.7 E-2 | N/A | <3.9 E-3 ± 1.5 E-2 | N/A | 2.7 E-1 ± 5.2 E-2 | <2.7 E-2 ± 2.1 E-2 | <1.3 E-2 ± 2.7 E-2 |
| | 2WE | <1.3 E-2 ± 1.6 E-2 | N/A | <3.3 E-3 ± 1.6 E-2 | N/A | 2.5 E-1 ± 4.8 E-2 | <5.5 E-4 ± 1.9 E-2 | <2.5 E-2 ± 3.2 E-2 |
| | 2WF | <2.9 E-3 ± 1.3 E-2 | N/A | <1.3 E-3 ± 1.2 E-2 | N/A | 1.1 E-1 ± 2.2 E-2 | <2.2 E-2 ± 1.6 E-2 | <1.0 E-2 ± 2.4 E-2 |
| | Detection Limit | 0.02 | 0.02 | 0.02 | 0.04 | 0.005 | 0.03 | 0.03 |

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Table 4-8. Grid Soil Sampling Results for S Plant Aggregate Area,
1985, 1986, and 1988 (pCi/g dry weight).

| Year | Sampling Site | ¹³⁶ Ru ± error | ¹³⁴ Cs ± error | ¹³⁷ Cs ± error | ¹⁴⁷ Eu ± error | ¹⁵² Eu ± error | ¹⁵⁵ Eu ± error |
|------|-----------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| 1985 | 2W28 | 0.60 ± 0.49 | 0.07 ± 0.04 | 21.00 ± 1.34 | 0.09 ± 0.08 | 0.11 ± 0.07 | - |
| | 2W29 | 0.95 ± 0.39 | - | 2.43 ± 0.23 | - | - | - |
| | 2W33 | - | 0.04 ± 0.04 | 1.91 ± 0.19 | - | - | - |
| | 2W34 | - | 0.06 ± 0.04 | 1.89 ± 0.20 | 0.15 ± 0.11 | - | 0.17 ± 0.12 |
| 1986 | 2W28 | N/A | 0.03 ± 0.03 | 3.68 ± 0.39 | 0.19 ± 0.10 | N/A | N/A |
| | 2W29 | N/A | 0.04 ± 0.03 | 1.54 ± 0.18 | N/A | N/A | N/A |
| | 2W33 | N/A | 0.03 ± 0.02 | 1.26 ± 0.14 | 0.14 ± 0.08 | N/A | N/A |
| | 2W34 | N/A | 0.06 ± 0.03 | 1.56 ± 0.18 | 0.10 ± 0.10 | N/A | N/A |
| | 2W34b | N/A | N/A | 2.25 ± 0.24 | 0.15 ± 0.10 | 0.06 ± 0.05 | N/A |
| | 2WA | N/A | 0.03 ± 0.02 | 0.46 ± 0.06 | N/A | 0.06 ± 0.05 | N/A |
| 1988 | 2W28 | < 2.2 E-2 ± 1.4 E-1 | N/A | 5.3 E+0 ± 5.4 E-1 | 1.0 E-1 ± 6.6 E-2 | < 4.1 E-3 ± 4.7 E-2 | < 5.4 E-2 ± 5.4 E-2 |
| | 2W29 | < 7.5 E-2 ± 1.2 E-1 | N/A | 1.4 E+0 ± 1.5 E-1 | 1.1 E-1 ± 6.8 E-2 | < 2.5 E-2 ± 5.1 E-2 | 6.8 E-2 ± 5.8 E-2 |
| | 2W32 | < 2.7 E-2 ± 1.3 E-1 | N/A | 6.6 E-1 ± 7.9 E-2 | 1.4 E-1 ± 6.7 E-2 | < 2.5 E-2 ± 5.5 E-2 | 7.2 E-2 ± 5.5 E-2 |
| | 2W33 | < 2.2 E-2 ± 1.6 E-1 | N/A | 1.7 E+0 ± 1.8 E-1 | < 2.1 E-2 ± 9.3 E-2 | 9.8 E-2 ± 6.3 E-2 | < 5.9 E-3 ± 8.0 E-2 |
| | 2W34 | < 3.4 E-2 ± 1.2 E-1 | N/A | 9.1 E-1 ± 1.0 E-1 | 1.4 E-1 ± 7.2 E-2 | < 1.4 E-2 ± 4.7 E-2 | < 4.3 E-2 ± 4.5 E-2 |
| | 2WA | 1.5 E-1 ± 1.2 E-1 | N/A | 4.2 E-1 ± 5.3 E-2 | 8.5 E-2 ± 7.0 E-2 | < 2.4 E-2 ± 5.7 E-2 | 6.5 E-2 ± 6.0 E-2 |
| | 2WB | < 2.7 E-2 ± 1.3 E-1 | N/A | 6.7 E-1 ± 7.8 E-2 | 7.8 E-2 ± 6.9 E-2 | < 7.7 E-3 ± 5.1 E-2 | < 3.1 E-2 ± 5.1 E-2 |
| | 2WC | < 1.1 E-2 ± 1.2 E-1 | N/A | 5.8 E-1 ± 6.8 E-2 | < 4.1 E-2 ± 6.5 E-2 | < 3.2 E-2 ± 4.9 E-2 | < 3.0 E-2 ± 3.9 E-2 |
| | 2WD | < 8.3 E-3 ± 1.3 E-1 | N/A | 7.3 E-1 ± 8.4 E-2 | < 3.9 E-2 ± 8.4 E-2 | < 2.1 E-2 ± 5.9 E-2 | < 1.6 E-2 ± 4.7 E-2 |
| | 2WE | < 5.3 E-2 ± 1.1 E-1 | N/A | 5.8 E-1 ± 7.3 E-2 | 7.7 E-2 ± 6.7 E-2 | < 2.7 E-2 ± 5.7 E-2 | < 4.2 E-2 ± 5.5 E-2 |
| | 2WF | < 2.7 E-2 ± 1.1 E-1 | N/A | 2.5 E-1 ± 4.0 E-2 | 1.0 E-1 ± 6.2 E-2 | < 4.6 E-2 ± 5.0 E-2 | 5.1 E-2 ± 4.4 E-2 |
| | Detection Limit | 0.17 | 0.02 | 0.02 | 0.11 | 0.05 | 0.05 |

9 6 1 9 9 6 1 9 6

Table 4-8. Grid Soil Sampling Results for S Plant Aggregate Area,
1985, 1986, and 1988 (pCi/g dry weight).

| Year | Sampling Site | ²³⁸ Pu ± error | ²³⁹ Pu ± error | ²⁴⁰ Pu ± error | U Total ± error | ¹³⁷ Ce ± error | ¹³⁵ Ce ± error |
|------|-----------------|---------------------------|---------------------------|---------------------------|-------------------|---------------------------|---------------------------|
| 1985 | 2W28 | N/A | 0.0011 ± 0.0005 | 0.01 ± 0.01 | 0.62 ± 0.19 | N/A | N/A |
| | 2W29 | N/A | 0.0100 ± 0.0017 | 0.06 ± 0.01 | 0.42 ± 0.14 | N/A | N/A |
| | 2W33 | N/A | 0.0040 ± 0.0009 | 0.08 ± 0.01 | 0.33 ± 0.11 | N/A | N/A |
| | 2W34 | N/A | 0.3560 ± 0.0338 | 0.17 ± 0.02 | 0.37 ± 0.12 | N/A | N/A |
| 1986 | 2W28 | N/A | 0.0020 ± 0.0008 | 0.02 ± 0.00 | 0.30 ± 0.10 | N/A | N/A |
| | 2W29 | N/A | 0.0047 ± 0.0011 | 0.05 ± 0.01 | 0.57 ± 0.19 | N/A | 0.27 ± 0.23 |
| | 2W33 | N/A | 0.0028 ± 0.0009 | 0.09 ± 0.01 | 0.47 ± 0.16 | N/A | N/A |
| | 2W34 | N/A | 0.3520 ± 0.0349 | 0.20 ± 0.02 | 0.50 ± 0.17 | N/A | N/A |
| | 2W34b | N/A | 0.6930 ± 0.0721 | 0.15 ± 0.02 | 0.26 ± 0.09 | N/A | N/A |
| | 2WA | N/A | N/A | 0.01 ± 0.00 | 0.47 ± 0.16 | N/A | N/A |
| 1988 | 2W28 | N/A | 1.8 E-3 ± 4.6 E-4 | 3.5 E-2 ± 4.0 E-3 | 2.7 E-1 ± 8.2 E-2 | N/A | N/A |
| | 2W29 | 4.8 E-1 ± 7.1 E-2 | 5.0 E-3 ± 9.1 E-4 | 1.2 E-1 ± 1.3 E-2 | 3.1 E-1 ± 9.4 E-2 | N/A | N/A |
| | 2W32 | 6.5 E-1 ± 8.9 E-2 | 1.0 E-3 ± 4.5 E-4 | 4.3 E-2 ± 5.1 E-3 | 2.6 E-1 ± 8.1 E-2 | N/A | N/A |
| | 2W33 | 6.5 E-1 ± 8.3 E-2 | 2.8 E-3 ± 6.5 E-4 | 1.4 E-1 ± 1.5 E-2 | 3.5 E-1 ± 1.1 E-1 | N/A | N/A |
| | 2W34 | 6.4 E-1 ± 9.3 E-2 | 3.9 E-3 ± 3.9 E-4 | 1.7 E-1 ± 1.7 E-2 | 2.4 E-1 ± 7.7 E-2 | N/A | N/A |
| | 2WA | 5.4 E-1 ± 7.3 E-2 | 1.0 E-3 ± 3.5 E-4 | 3.8 E-2 ± 4.4 E-3 | 2.1 E-1 ± 6.7 E-2 | N/A | N/A |
| | 2WB | 6.8 E-1 ± 8.6 E-2 | 1.4 E-3 ± 4.7 E-4 | 2.4 E-2 ± 2.9 E-3 | 3.0 E-1 ± 9.4 E-2 | N/A | N/A |
| | 2WC | 6.0 E-1 ± 7.9 E-2 | 7.9 E-4 ± 3.2 E-4 | 3.2 E-2 ± 3.7 E-3 | 3.4 E-1 ± 1.0 E-1 | N/A | N/A |
| | 2WD | 5.3 E-1 ± 7.1 E-2 | 1.3 E-3 ± 3.8 E-4 | 4.8 E-2 ± 5.3 E-3 | 2.8 E-1 ± 8.6 E-2 | N/A | N/A |
| | 2WE | 6.3 E-1 ± 8.3 E-2 | 6.4 E-4 ± 2.8 E-4 | 1.8 E-2 ± 2.2 E-3 | 2.9 E-1 ± 8.9 E-2 | N/A | N/A |
| | 2WF | 5.3 E-1 ± 7.5 E-2 | < 1.9 E-4 ± 2.4 E-4 | 7.7 E-3 ± 1.8 E-3 | 1.4 E-1 ± 4.8 E-2 | N/A | N/A |
| | Detection Limit | 5.0 E-1 ± 7.1 E-2 | 0.0006 | 0.0006 | 0.01 | 0.02 | 0.18 |

NOTE: ± error = counting error.
 - = indicates that radionuclide concentration is less than detectable.
 a = not analyzed.
 pCi/g = picocuries per gram.
 N/A = not available.

Negative values indicate concentrations at or near background levels of radioactivity.

Source: Elder et al. 1986, 1987, 1989.

Table 4-9. Summary of Fenceline Soil Sampling for the 241-S, -SX, -SY Tank Farms 1985, 1986, and 1988 (pCi/g dry weight).

| Year | Location | ⁵⁴ Mn ± Error | ⁹⁰ Sr ± Error | ⁹³ Zr ± Error | ¹⁰⁶ Ru ± Error | ¹³⁴ Cs ± Error | ¹³⁷ Cs ± Error | ¹⁴¹ Ce ± Error | ¹⁵² Eu ± Error | ¹⁵⁴ Eu ± Error |
|------|-----------------|--------------------------|--------------------------|--------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| 1985 | S-TF-SE | 0.029 ± 0.015 | 3.120 ± 0.569 | - | 0.187 ± 0.186 | 0.037 ± 0.018 | 12.200 ± 0.752 | - | - | - |
| | S-TF-W | - | 0.513 ± 0.099 | - | - | 0.048 ± 0.025 | 1.940 ± 0.140 | - | - | - |
| | S-TF-NE | - | 2.860 ± 0.525 | - | - | 0.045 ± 0.021 | 7.800 ± 0.487 | - | - | - |
| 1986 | S-TF-NE | N/A | 4.240 ± 0.777 | N/A | N/A | 0.055 ± 0.027 | 3.590 ± 0.381 | N/A | 0.131 ± 0.088 | N/A |
| | S-TF-SE | N/A | 2.250 ± 0.415 | N/A | N/A | 0.032 ± 0.023 | 7.190 ± 0.734 | N/A | N/A | N/A |
| | S-TF-W | N/A | 2.340 ± 0.424 | N/A | N/A | 0.038 ± 0.020 | 4.380 ± 0.454 | N/A | 0.118 ± 0.075 | N/A |
| 1988 | S-TF-NE | < 8.1 E-3 ± 1.9 E-2 | 1.9 E+0 ± 3.6 E-1 | < 7.8 E-3 ± 3.4 E-2 | < 1.6 E-2 ± 1.8 E-1 | < 9.9 E-3 ± 2.0 E-2 | 4.2 E+0 ± 4.3 E-1 | < 2.4 E-3 ± 3.4 E-2 | < 1.6 E-3 ± 9.1 E-2 | < 1.3 E-2 ± 5.6 E-2 |
| | S-TF-SE | < 6.8 E-3 ± 1.7 E-2 | 9.8 E+0 ± 1.8 E+0 | < 2.8 E-2 ± 3.0 E-2 | < 4.0 E-1 ± 3.0 E-1 | < 1.8 E-3 ± 2.9 E-2 | 3.7 E+1 ± 3.8 E+0 | < 4.4 E-2 ± 5.7 E-2 | < 4.4 E-3 ± 7.7 E-2 | < 2.9 E-2 ± 4.9 E-2 |
| | S-TF-W | < 8.0 E-3 ± 1.6 E-2 | 7.4 E-1 ± 1.4 E-1 | < 1.6 E-2 ± 3.1 E-2 | < 2.7 E-2 ± 1.9 E-1 | < 5.2 E-3 ± 1.9 E-2 | 3.3 E+0 ± 3.4 E-1 | < 5.0 E-3 ± 2.9 E-2 | < 7.5 E-2 ± 7.6 E-2 | < 2.6 E-2 ± 5.1 E-2 |
| | Detection Limit | 0.020 | 0.005 | 0.030 | 0.170 | 0.020 | 0.020 | N/A | 0.110 | 0.050 |

| Year | Location | ¹⁵⁵ Eu ± Error | ²³⁸ Pu ± Error | ²³⁹ Pu ± Error | Uranium ± Error | ⁵⁸ Co ± Error | ⁶⁰ Co ± Error | ⁶⁵ Zn ± Error | ⁹³ Nb ± Error |
|------|-----------------|---------------------------|---------------------------|---------------------------|-------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1985 | S-TF-SE | - | - | 0.039 ± 0.010 | 0.334 ± 0.111 | - | - | - | - |
| | S-TF-W | - | 0.0009 ± 0.0008 | 0.014 ± 0.003 | 0.279 ± 0.096 | 0.051 ± 0.021 | 0.025 ± 0.024 | - | - |
| | S-TF-NE | 0.104 ± 0.080 | - | 0.040 ± 0.005 | 0.373 ± 0.122 | - | 0.017 ± 0.016 | - | - |
| 1986 | S-TF-NE | N/A | 0.0009 ± 0.0005 | 0.012 ± 0.002 | 0.438 ± 0.144 | N/A | 0.035 ± 0.020 | N/A | N/A |
| | S-TF-SE | N/A | 0.0004 ± 0.0003 | 0.009 ± 0.002 | 0.387 ± 0.127 | N/A | N/A | N/A | N/A |
| | S-TF-W | N/A | 0.0013 ± 0.0006 | 0.020 ± 0.003 | 0.228 ± 0.076 | N/A | N/A | N/A | N/A |
| 1988 | S-TF-NE | < 1.8 E-2 ± 7.2 E-2 | 1.6 E-3 ± 6.5 E-4 | 2.2 E-2 ± 3.6 E-3 | 2.5 E-1 ± 8.1 E-2 | N/A | N/A | N/A | N/A |
| | S-TF-SE | < 9.9 E-3 ± 1.2 E-1 | 1.7 E-2 ± 2.2 E-3 | 4.9 E-2 ± 5.5 E-3 | 2.8 E-1 ± 9.0 E-2 | N/A | N/A | N/A | N/A |
| | S-TF-W | 7.0 E-2 ± 6.5 E-2 | 3.6 E-4 ± 2.2 E-4 | 9.9 E-3 ± 1.5 E-3 | 2.4 E-1 ± 7.8 E-2 | N/A | N/A | N/A | N/A |
| | Detection Limit | 0.050 | 0.0006 | 0.0006 | 0.010 | 0.020 | 0.020 | 0.040 | 0.030 |

NOTE: ± error = counting error.
 - = indicates that radionuclide concentration is less than detectable.
 a = not analyzed.
 pCi/g = picocuries per gram.
 N/A = not available.
 Negative values indicate concentrations at or near background levels of radioactivity.
 Source: Elder 1986, 1987, 1989.

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Table 4-10. Results of Surface Water Sampling (pCi/ml).

| RM28: 216-S10 Ditch | | | | |
|---------------------|---------|---------|---------|---------|
| Radionuclide | 1985 | | 1986 | |
| | Maximum | Minimum | Maximum | Minimum |
| Total beta | 0.106 | 0.008 | 0.036 | <DL |
| Total alpha | 0.007 | 0.001 | 0.012 | <DL |
| ¹³⁷ Cs | 0.121 | 0.043 | 0.127 | <DL |
| ⁹⁰ Sr | 0.030 | 0.020 | 0.040 | <DL |

| 1988 | | 1990 | | Detection Limit (DL) |
|---------|---------|---------|---------|----------------------|
| Maximum | Minimum | Maximum | Minimum | |
| <DL | <DL | <DL | <DL | 0.1 |
| <DL | <DL | <DL | <DL | 0.04 |
| <DL | <DL | <DL | <DL | 0.2 |
| <DL | <DL | <DL | <DL | 0.1 |

Sources: Elder et al 1986, 1987, 1989; Schmidt et al. 1991.

9 5 1 2 0 5 1 6 0 1

Table 4-11. Nonradiological Parameters for Water in the 216-S-10 Ditch.

| Year | Sample Location | Sample Number | Maximum pH | Minimum pH | Average pH | Maximum NO ₃ ppm | Minimum NO ₃ ppm | Average NO ₃ ppm |
|------|-----------------|---------------|------------|------------|------------|-----------------------------|-----------------------------|-----------------------------|
| 1986 | 216-S-10 Ditch | RM 28 | 8.6 | 7.1 | 7.9 | <DL | <DL | <DL |
| 1988 | 216-S-10 Ditch | RM 28 | 9.6 | 7.0 | 7.8 | <DL | <DL | <DL |
| 1990 | 216-S-10 Ditch | RM 28 | 9.21 | 7.56 | 8.15 | <DL | <DL | <DL |

NOTE: pH maximum and minimum are from weekly samples.

<DL = less than detection limit (~1.2 ppm).

Sources: Elder et al. 1987, 1989; Schmidt et al. 1991.

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Table 4-12. Summary of Vegetation Results for the S Plant Aggregate Area,
1985, 1986, and 1988 (pCi/g dry weight).

| Year | Sampling Site | ⁵⁸ Co ± error | ⁶⁰ Co ± error | ⁶⁵ Zn ± error | ⁸⁷ Sr ± error | ⁹³ Nb ± error | ⁹⁰ Zr ± error | ¹³⁴ Cs ± error | ¹³⁷ Cs ± error | ¹⁵² Eu ± error |
|------|---------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|---------------------------|---------------------------|---------------------------|
| 1985 | 2W28 | 0.194 ± 0.093 | - | 0.391 ± 0.209 | - | - | - | - | 2.090 ± 0.231 | - |
| | 2W29 | 0.097 ± 0.046 | 0.081 ± 0.043 | - | - | - | - | - | - | - |
| | 2W32 | - | - | 0.151 ± 0.084 | - | 0.068 ± 0.048 | - | - | 0.089 ± 0.063 | - |
| | 2W33 | - | 0.089 ± 0.056 | 0.236 ± 0.189 | - | - | - | 0.131 ± 0.059 | 0.313 ± 0.095 | 0.431 ± 0.274 |
| | 2W34 | - | 0.075 ± 0.036 | 0.168 ± 0.093 | - | - | - | - | 0.141 ± 0.048 | 0.171 ± 0.121 |
| | 2WA | 0.083 ± 0.048 | - | - | - | - | - | - | 0.090 ± 0.055 | - |
| | 2WB | - | - | - | - | - | 0.120 ± 0.115 | 0.038 ± 0.029 | 0.138 ± 0.059 | 0.174 ± 0.156 |
| | 2WC | - | - | - | - | - | - | - | 0.066 ± 0.044 | - |
| | 2WD | - | - | - | - | - | - | - | 0.123 ± 0.050 | - |
| | 2WE | - | 0.020 ± 0.018 | - | - | 0.101 ± 0.062 | - | - | - | - |
| | 2WF | - | 0.049 ± 0.028 | - | - | - | - | - | - | - |
| 1986 | 2W29 | N/A | N/A | N/A | N/A | N/A | N/A | 0.090 ± 0.027 | 0.205 ± 0.040 | 0.118 ± 0.060 |
| | 2W33 | N/A | N/A | N/A | N/A | N/A | N/A | 0.096 ± 0.025 | 0.279 ± 0.044 | 0.078 ± 0.062 |
| | 2W34 | N/A | 0.024 ± 0.023 | N/A | N/A | 0.073 ± 0.063 | N/A | 0.078 ± 0.034 | 0.336 ± 0.053 | N/A |
| | 2W34b | N/A | N/A | N/A | 1.010 ± 0.193 | N/A | N/A | N/A | 0.343 ± 0.077 | N/A |
| | 2WA | N/A | N/A | N/A | 0.147 ± 0.036 | 0.101 ± 0.043 | 0.097 ± 0.045 | 0.141 ± 0.032 | 0.299 ± 0.045 | N/A |

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Table 4-12. Summary of Vegetation Results for the S Plant Aggregate Area, 1985, 1986, and 1988 (pCi/g dry weight).

| Year | Sampling Site | ⁶⁰ Co ± error | ⁶⁰ Co ± error | ⁶⁵ Zn ± error | ⁹⁰ Sr ± error | ⁹³ Nb ± error | ⁹³ Zr ± error | ¹³⁴ Cs ± error | ¹³⁷ Cs ± error | ¹⁵² Eu ± error |
|------|-----------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|---------------------------|---------------------------|---------------------------|
| 1988 | 2W28 | N/A | 1.4 E-2 ± 1.4 E-2 | N/A | 5.8 E-1 ± 1.1 E-1 | < 5.8 E-3 ± 1.5 E-2 | N/A | N/A | 1.4 E+0 ± 1.4 E-1 | < 2.2 E-2 ± 6.1 E-2 |
| | 2W29 | N/A | 1.9 E-2 ± 1.5 E-2 | N/A | 4.2 E-1 ± 8.0 E-2 | < 1.3 E-2 ± 4.0 E-2 | N/A | N/A | 1.1 E+0 ± 1.2 E-1 | 1.1 E-1 ± 6.9 E-2 |
| | 2W32 | N/A | < 3.8 E-4 ± 3.5 E-2 | N/A | 3.8 E-1 ± 7.3 E-2 | 1.6 E-1 ± 1.3 E-1 | N/A | N/A | 5.1 E-1 ± 6.9 E-2 | < 4.7 E-3 ± 1.5 E-1 |
| | 2W33 | N/A | < 1.1 E-2 ± 1.6 E-2 | N/A | 3.5 E-1 ± 6.7 E-2 | < 2.4 E-2 ± 6.1 E-2 | N/A | N/A | 6.4 E-1 ± 7.6 E-2 | 1.0 E-1 ± 6.6 E-2 |
| | 2W34 | N/A | < 8.7 E-3 ± 1.9 E-2 | N/A | 2.9 E-1 ± 5.6 E-2 | < 4.9 E-2 ± 3.8 E-2 | N/A | N/A | 7.2 E-1 ± 9.0 E-2 | < 6.0 E-2 ± 8.3 E-2 |
| | 2WA | N/A | < 5.1 E-3 ± 1.8 E-2 | N/A | 2.2 E+0 ± 4.1 E-1 | < 6.7 E-4 ± 3.7 E-2 | N/A | N/A | 2.2 E-1 ± 3.4 E-2 | < 2.0 E-2 ± 7.8 E-2 |
| | 2WB | N/A | < 7.3 E-3 ± 2.4 E-2 | N/A | 2.0 E-1 ± 4.0 E-2 | < 4.6 E-2 ± 9.4 E-2 | N/A | N/A | 2.7 E-1 ± 4.5 E-2 | < 7.1 E-2 ± 1.0 E-1 |
| | 2WC | N/A | < 9.9 E-3 ± 1.3 E-2 | N/A | a | < 4.5 E-2 ± 5.6 E-2 | N/A | N/A | 1.5 E-1 ± 2.5 E-2 | < 2.4 E-2 ± 6.4 E-2 |
| | 2WD | N/A | < 3.2 E-3 ± 1.7 E-2 | N/A | 8.6 E-2 ± 1.8 E-2 | < 3.1 E-2 ± 6.6 E-2 | N/A | N/A | 4.2 E-2 ± 2.0 E-2 | < 6.3 E-2 ± 7.9 E-2 |
| | 2WE | N/A | 2.2 E-2 ± 2.0 E-2 | N/A | a | < 1.1 E-2 ± 7.3 E-2 | N/A | N/A | 1.4 E-1 ± 2.9 E-2 | < 9.4 E-2 ± 9.8 E-2 |
| | 2WF | N/A | < 8.7 E-4 ± 2.0 E-2 | N/A | a | < 8.0 E-3 ± 3.3 E-2 | N/A | N/A | 7.4 E-2 ± 2.4 E-2 | < 2.8 E-2 ± 8.4 E-2 |
| | Detection Limit | 0.03 | 0.03 | 0.06 | 0.005 | 0.05 | 0.05 | 0.03 | 0.03 | 0.17 |

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Table 4-12. Summary of Vegetation Results for the S Plant Aggregate Area, 1985, 1986, and 1988 (pCi/g dry weight).

| Year | Sampling Site | ¹⁵⁴ Eu ± error | ¹⁵³ Eu ± error | ²³⁸ Pu ± error | ²³⁹ Pu ± error | ¹⁰³ Ru ± error | ¹⁰⁶ Ru ± error | ⁹⁹ Tc ± error | ¹²⁹ I ± error |
|------|---------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|--------------------------|--------------------------|
| 1985 | 2W28 | 0.249 ± 0.229 | - | - | - | N/A | N/A | N/A | N/A |
| | 2W29 | - | - | - | - | N/A | N/A | N/A | N/A |
| | 2W32 | - | - | - | - | N/A | N/A | N/A | N/A |
| | 2W33 | - | - | - | - | N/A | N/A | N/A | N/A |
| | 2W34 | - | - | - | - | N/A | N/A | N/A | N/A |
| | 2WA | - | - | - | - | N/A | N/A | N/A | N/A |
| | 2WB | - | - | - | - | N/A | N/A | N/A | N/A |
| | 2WC | - | - | - | - | N/A | N/A | N/A | N/A |
| | 2WD | - | - | - | - | N/A | N/A | N/A | N/A |
| | 2WE | - | - | - | - | N/A | N/A | N/A | N/A |
| | 2WF | - | - | - | - | N/A | N/A | N/A | N/A |
| 1986 | 2W29 | N/A | N/A | N/A | N/A | 0.081 ± 0.057 | N/A | N/A | N/A |
| | 2W33 | N/A | N/A | N/A | N/A | 0.154 ± 0.060 | N/A | N/A | N/A |
| | 2W34 | N/A | N/A | N/A | N/A | 0.155 ± 0.084 | N/A | N/A | N/A |
| | 2W34b | N/A | N/A | N/A | N/A | 0.060 ± 0.053 | N/A | N/A | N/A |
| | 2WA | N/A | N/A | 0.0004 ± 0.0003 | 0.0053 ± 0.0014 | 0.259 ± 0.066 | 0.216 ± 0.144 | N/A | N/A |
| 1988 | 2W28 | <3.9 E-2 ± 5.0 E-2 | <1.0 E-2 ± 3.9 E-2 | • | • | N/A | N/A | <1.0 E+0 ± 1.8 E+0 | <5.5 E-2 ± 2.5 E-1 |
| | 2W29 | 6.6 E-2 ± 4.7 E-2 | <3.7 E-3 ± 4.7 E-2 | • | • | N/A | N/A | • | • |
| | 2W32 | <4.8 E-2 ± 1.1 E-1 | <6.0 E-2 ± 9.1 E-2 | • | • | N/A | N/A | • | • |
| | 2W33 | <3.0 E-2 ± 5.0 E-2 | <9.2 E-3 ± 3.7 E-2 | 1.6 E-3 ± 6.0 E-4 | 7.7 E-2 ± 9.4 E-3 | N/A | N/A | • | • |
| | 2W34 | <3.0 E-2 ± 6.4 E-2 | <1.2 E-2 ± 5.6 E-2 | • | • | N/A | N/A | • | • |
| | 2WA | <3.8 E-3 ± 6.0 E-2 | <2.4 E-2 ± 5.1 E-2 | • | • | N/A | N/A | • | • |

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Table 4-12. Summary of Vegetation Results for the S Plant Aggregate Area, 1985, 1986, and 1988 (pCi/g dry weight). Page 4 of 4

| Year | Sampling Site | ¹⁵⁴ Eu ± error | ¹⁵⁵ Eu ± error | ²³⁹ Pu ± error | ²³⁸ Pu ± error | ¹⁰³ Ru ± error | ¹⁰⁶ Ru ± error | ⁹⁹ Tc ± error | ¹²⁹ I ± error |
|------|-----------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|--------------------------|--------------------------|
| | 2WB | 7.6 E-2 ± 7.4 E-2 | <1.1 E-2 ± 5.6 E-2 | 1.5 E-3 ± 5.0 E-4 | 7.8 E-3 ± 1.4 E-3 | N/A | N/A | a | a |
| | 2WC | <2.7 E-3 ± 4.5 E-2 | <1.9 E-2 ± 3.5 E-2 | a | a | N/A | N/A | a | a |
| | 2WD | <1.8 E-2 ± 5.5 E-2 | <8.9 E-3 ± 4.1 E-2 | a | a | N/A | N/A | <1.0 E-0 ± 2.9 E+0 | <9.2 E-3 ± 2.6 E-1 |
| | 2WE | <4.5 E-2 ± 6.1 E-2 | <2.5 E-2 ± 5.4 E-2 | a | a | N/A | N/A | a | a |
| | 2WF | 5.7 E-2 ± 5.6 E-2 | <1.2 E-2 ± 4.4 E-2 | a | a | N/A | N/A | a | a |
| | Detection Limit | 0.08 | 0.07 | 0.0006 | 0.0006 | 0.030 | 0.260 | | |

NOTE: ± error = counting error.

- = indicates that radionuclide concentration is less than detectable.

a = not analyzed.

pCi/g = picocuries per gram.

N/A = not available.

Negative values indicate concentrations at or near background levels of radioactivity.

Source: Elder et al. 1986, 1987, 1989.

4T-12d

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Table 4-13. Grid Site Feces Results in the S Plant Aggregate Area for 1985 (pCi/g dry weight).

| Grid Site | Type | $^{54}\text{Mn} \pm \text{error}$ | $^{60}\text{Co} \pm \text{error}$ | $^{65}\text{Co} \pm \text{error}$ | $^{65}\text{Zn} \pm \text{error}$ |
|-----------|--------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| 2WC | Rabbit | - | 0.254 ± 0.218 | - | - |

| Grid Site | Type | $^{106}\text{Ru} \pm \text{error}$ | $^{134}\text{Cs} \pm \text{error}$ | $^{137}\text{Cs} \pm \text{error}$ | $^{152}\text{Eu} \pm \text{error}$ | $^{155}\text{Eu} \pm \text{error}$ |
|-----------|--------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|
| 2WC | Rabbit | - | - | 0.392 ± 0.171 | - | - |

NOTE: \pm error = counting error.

[-] = indicates that radionuclide concentration is less than detectable.

Source: Elder et al. 1986.

9 3 1 2 0 / 5 1 6 0 7

Table 4-14. Potential for Migration of Liquid Discharges to the Unconfined Aquifer. Page 1 of 2

| Waste Management Unit ^v | Range of Soil Column Pore Volumes (m ³) ^v | Liquid Effluent Volume Received (m ³) | Potential Migration to Unconfined Aquifer |
|------------------------------------|--|---|---|
| Cribs and Drains | | | |
| 216-S-1 and -2 Cribs | 2,007 to 6,020 | 160,000 | Yes |
| 216-S-5 Crib | 24,582 to 73,746 | 4,100,000 | Yes |
| 216-S-6 Crib | 11,706 to 35,117 | 4,470,000 | Yes |
| 216-S-7 Crib | 2,787 to 8,361 | 390,000 | Yes |
| 216-S-9 Crib | 5,017 to 15,050 | 50,300 | Yes |
| 216-S-13 Crib | 892 to 2,676 | 5,000 | Yes |
| 216-S-20 Crib | 2,007 to 6,020 | 135,000 | Yes |
| 216-S-22 Crib | 195 to 585 | 98 | No |
| 216-S-23 Crib | 2,007 to 6,020 | 34,100 | Yes |
| 216-S-25 Crib | 3,205 to 9,615 | 288,00 | Yes |
| 216-S-26 Crib | 2,341 to 7,023 | 164,000 | Yes |
| 216-S-3 French Drain | 111 to 334 | 4,200 | Yes |
| Ponds, Ditches, and Trenches | | | |
| 216-S-11 Pond | 36,422 to 109,265 | 2,230,000 | Yes |
| 216-S-15 Pond | 98 to 293 | 10 | No |
| 216-S-16P Pond | 752,715 to 2,258,146 | 40,700,000 | Yes |
| 216-S-17 Pond | 509,904 to 1,529,712 | 6,440,000 | Yes |
| 216-S-19 Pond | 84,984 to 254,952 | 1,330,000 | Yes |

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Table 4-14. Potential for Migration of Liquid Discharges to the Unconfined Aquifer. Page 2 of 2

| Waste Management Unit ^v | Range of Soil Column Pore Volumes (m ³) ^w | Liquid Effluent Volume Received (m ³) | Potential Migration to Unconfined Aquifer |
|------------------------------------|--|---|---|
| 216-S-10D Ditch | 7,525 to 22,575 | 4,340,000 | Yes |
| 216-S-16D Ditch | 6,689 to 20,067 | 400,000 | Yes |
| 216-S-8 Trench | 3,344 to 10,033 | 10,000 | Yes ^x |
| 216-S-12 Trench | 1,003 to 3,010 | 68 | No |

- ^v Waste Management Units 216-S-10P, 216-U-9, 216-S-14, and 216-S-18 do not have inventory data available and are omitted here.
- ^w Pore volume calculation: (waste unit section area) x (nominal depth to groundwater, assumed to be 60 m) x (porosity). Lower pore volume value reflects 0.10 porosity, higher pore volume reflects 0.3 porosity. Pore-volume calculation does not account for the ability of the soil to retain the liquid discharged.
- ^x The effluent volume received by these units exceeds the lower pore volume estimate but is below the high estimate. Given the high permeability of the soil column in general, it is likely that some of the discharge waste volume reached groundwater.

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | S-101 Curies | S-102 Curies | S-103 Curies | S-104 Curies | S-105 Curies | S-106 Curies | S-107 Curies | S-108 Curies |
|-----------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 1. Ac225 | 5E-09 | 4E-09 | 4E-17 | 6E-10 | 8E-10 | 2E-09 | 4E-10 | 4E-08 |
| 2. Ac227 | 3E-05 | 1E-05 | 2E-13 | 5E-06 | 5E-06 | 6E-05 | 6E-06 | 2E-04 |
| 3. Am241 | 1E+02 | 5E+01 | 2E-06 | 7E-04 | 6E-04 | 4E+00 | 7E+00 | 8E+02 |
| 4. Am242 | 2E-01 | 8E-02 | 2E-09 | 2E-06 | 3E-07 | 7E-03 | 1E-02 | 2E+00 |
| 5. Am242M | 2E-01 | 8E-02 | 2E-09 | 2E-06 | 3E-07 | 7E-03 | 1E-02 | 2E+00 |
| 6. Am243 | 9E-02 | 4E-02 | 1E-09 | 5E-07 | 8E-08 | 3E-03 | 5E-03 | 7E-01 |
| 7. At217 | 5E-09 | 4E-09 | 4E-17 | 6E-10 | 8E-10 | 2E-09 | 4E-10 | 3E-08 |
| 8. Bs137M | 2E+03 | 1E+04 | 7E-04 | 3E+02 | 6E+02 | 9E+02 | 1E+04 | 9E+00 |
| 9. Bi210 | 1E-12 | 9E-13 | 3E-21 | 2E-14 | 4E-13 | 3E-13 | 2E-13 | 3E-13 |
| 10. Bi211 | 1E-05 | 1E-05 | 2E-13 | 5E-06 | 5E-06 | 8E-06 | 6E-06 | 2E-06 |
| 11. Bi213 | 2E-09 | 4E-09 | 4E-17 | 6E-10 | 8E-10 | 1E-09 | 4E-10 | 4E-10 |
| 12. Bi214 | 6E-12 | 9E-12 | 2E-19 | 6E-14 | 1E-12 | 1E-12 | 1E-12 | 1E-12 |
| 13. C14 | 7E+01 | 3E+01 | 5E-07 | 1E+01 | 2E+01 | 3E+01 | 1E+01 | 4E+02 |
| 14. Cm242 | 2E-01 | 7E-02 | 2E-09 | 2E-06 | 2E-07 | 5E-03 | 1E-02 | 1E+00 |
| 15. Cm244 | 6E-01 | 2E-01 | 9E-09 | 5E-03 | 3E-03 | 4E-02 | 5E-02 | 5E+00 |
| 16. Cm245 | 3E-05 | 9E-06 | 3E-13 | 9E-08 | 5E-08 | 1E-06 | 2E-06 | 2E-04 |
| 17. Cs135 | 7E-01 | 3E-01 | 5E-09 | 8E-01 | 1E+00 | 2E+00 | 5E-02 | 4E+00 |
| 18. Cs137 | 1E+05 | 6E+04 | 7E-04 | 1E+05 | 1E+05 | 2E+05 | 1E+04 | 7E+05 |
| 19. Fr221 | 5E-09 | 4E-09 | 4E-17 | 6E-10 | 8E-10 | 2E-09 | 4E-10 | 4E-08 |
| 20. Fr223 | 4E-07 | 2E-07 | 3E-15 | 6E-08 | 8E-08 | 2E-07 | 8E-08 | 2E-06 |
| 21. I129 | 2E-01 | 8E-02 | 1E-09 | 4E-02 | 5E-02 | 1E-01 | 3E-02 | 1E+00 |
| 22. N693M | 3E+00 | 2E+00 | 5E-08 | 4E-02 | 7E-02 | 9E-01 | 6E-01 | 2E+01 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | S-101 Curies | S-102 Curies | S-103 Curies | S-104 Curies | S-105 Curies | S-106 Curies | S-107 Curies | S-108 Curies |
|------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 23. N163 | 4E-01 | 2E-02 | 5E-07 | 3E+02 | 3E+02 | 4E+02 | 5E-03 | 1E+03 |
| 24. NP237 | 2E-01 | 1E-01 | 2E-09 | 1E-01 | 1E-01 | 2E-01 | 1E-02 | 1E+00 |
| 25. NP239 | 9E-02 | 4E-02 | 1E-09 | 5E-07 | 8E-08 | 3E-03 | 5E-03 | 7E-01 |
| 26. Pa231 | 7E-05 | 3E-05 | 6E-13 | 8E-06 | 9E-06 | 2E-05 | 1E-05 | 4E-04 |
| 27. Pa233 | 2E-01 | 1E-01 | 2E-09 | 1E-01 | 1E-01 | 2E-01 | 1E-02 | 1E+00 |
| 28. Pa234M | 7E-15 | 1E-14 | 8E-23 | 7E-16 | 2E-13 | 2E-12 | 1E-15 | 8E-10 |
| 29. Pb209 | 5E-09 | 4E-09 | 4E-17 | 6E-10 | 8E-10 | 2E-09 | 4E-10 | 2E-08 |
| 30. Pb210 | 3E-12 | 9E-13 | 3E-21 | 2E-14 | 4E-13 | 4E-13 | 2E-13 | 1E-11 |
| 31. Pb211 | 3E-05 | 1E-05 | 2E-13 | 5E-06 | 5E-06 | 1E-05 | 6E-06 | 7E-05 |
| 32. Pb214 | 2E-11 | 9E-12 | 2E-19 | 7E-14 | 1E-12 | 2E-12 | 1E-12 | 5E-11 |
| 33. Po107 | 4E-11 | 1E-01 | 3E-09 | 6E-02 | 7E-02 | 2E-01 | 5E-02 | 2E+00 |
| 34. Po210 | 3E-12 | 9E-13 | 2E-20 | 2E-14 | 4E-13 | 4E-13 | 2E-13 | 2E-11 |
| 35. Po213 | 3E-09 | 4E-09 | 4E-17 | 6E-10 | 8E-10 | 2E-10 | 4E-10 | 3E-08 |
| 36. Po214 | 2E-11 | 1E-11 | 2E-19 | 8E-14 | 2E-12 | 2E-12 | 2E-12 | 1E-10 |
| 37. Po215 | 3E-05 | 1E-05 | 2E-13 | 5E-05 | 5E-06 | 1E-05 | 6E-06 | 2E-04 |
| 38. Po218 | 2E-11 | 9E-12 | 2E-19 | 7E-14 | 1E-12 | 2E-12 | 1E-12 | 1E-10 |
| 39. Pu238 | 3E-03 | 1E-03 | 2E-11 | 0 | 0 | 2E-04 | 2E-04 | 1E-02 |
| 40. Pu239 | 1E-05 | 3E-06 | 6E-14 | 0 | 0 | 2E-06 | 7E-06 | 8E-05 |
| 41. Pu240 | 1E-04 | 5E-05 | 1E-12 | 0 | 0 | 2E-05 | 2E-05 | 7E-04 |
| 42. Pu241 | 3E-05 | 1E-05 | 3E-13 | 0 | 0 | 2E-05 | 6E-05 | 1E-04 |
| 43. Ra223 | 3E-05 | 1E-05 | 2E-13 | 5E-06 | 5E-06 | 1E-05 | 6E-06 | 2E-04 |
| 44. Ra225 | 5E-09 | 4E-09 | 4E-17 | 6E-10 | 8E-10 | 2E-09 | 4E-10 | 4E-08 |
| 45. Ra226 | 2E-11 | 9E-12 | 2E-19 | 7E-14 | 1E-12 | 2E-12 | 1E-12 | 1E-10 |
| 46. Ru106 | 3E-02 | 5E-02 | 1E-09 | 3E-04 | 9E-05 | 1E-02 | 2E-02 | 4E-01 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | S-101 Curies | S-102 Curies | S-103 Curies | S-104 Curies | S-105 Curies | S-106 Curies | S-107 Curies | S-108 Curies |
|------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 47. Sb126 | 1E-06 | 9E-06 | 1E-08 | 6E-14 | 1E-13 | 4E-06 | 6E-08 | 2E-07 |
| 48. Sb126M | 1E-06 | 9E-06 | 1E-08 | 6E-14 | 1E-13 | 4E-06 | 6E-05 | 2E-07 |
| 49. Sb79 | 4E+00 | 1E+00 | 4E-08 | 7E-01 | 9E-01 | 2E+00 | 6E-01 | 2E+01 |
| 50. Sm151 | 3E+02 | 9E+02 | 1E-05 | 2E-04 | 2E-04 | 4E+01 | 8E+01 | 3E+03 |
| 51. Sm126 | 7E-01 | 7E-01 | 1E-08 | 6E-14 | 1E-13 | 3E-02 | 7E-02 | 3E+00 |
| 52. Sr90 | 1E+05 | 5E+04 | 1E-03 | 2E-07 | 1E+02 | 7E+03 | 7E+03 | 1E+06 |
| 53. Tc99 | 1E+02 | 5E+01 | 8E-07 | 3E+01 | 3E+01 | 7E+01 | 2E+01 | 8E+02 |
| 54. Th227 | 3E-05 | 1E-05 | 2E-13 | 5E-14 | 5E-14 | 1E-05 | 5E-06 | 2E-04 |
| 55. Th229 | 5E-09 | 4E-09 | 4E-17 | 5E-18 | 1E-17 | 2E-09 | 4E-10 | 4E-08 |
| 56. Th230 | 5E-10 | 7E-10 | 2E-17 | 1E-25 | 1E-24 | 3E-11 | 7E-11 | 3E-09 |
| 57. Th231 | 2E-14 | 3E-15 | 1E-23 | 2E-25 | 5E-23 | 1E-13 | 1E-14 | 2E-11 |
| 58. Th234 | 7E-15 | 1E-14 | 8E-23 | 9E-24 | 2E-21 | 2E-12 | 1E-15 | 4E-10 |
| 59. Tl207 | 3E-05 | 1E-05 | 2E-13 | 5E-06 | 5E-06 | 1E-05 | 6E-05 | 2E-04 |
| 60. U233 | 9E-08 | 1E-07 | 3E-15 | 5E-08 | 8E-08 | 1E-07 | 6E-08 | 2E-08 |
| 61. U234 | 9E-10 | 8E-10 | 1E-17 | 1E-14 | 9E-14 | 2E-10 | 7E-10 | 4E-10 |
| 62. U235 | 2E-15 | 1E-15 | 1E-23 | 5E-19 | 2E-16 | 3E-15 | 1E-14 | 2E-14 |
| 63. U238 | 3E-16 | 4E-18 | 8E-27 | 1E-17 | 4E-15 | 4E-14 | 2E-16 | 4E-13 |
| 64. Y90 | 1E+05 | 5E+04 | 2E-03 | 3E-07 | 2E+02 | 7E+03 | 7E+03 | 1E+06 |
| 65. Zr93 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 66. Ag | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 67. Al | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | S-101 Curies | S-102 Curies | S-103 Curies | S-104 Curies | S-105 Curies | S-106 Curies | S-107 Curies | S-108 Curies |
|------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 68. C2H3O3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 69. Ba | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 70. Bi | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 71. CoH507 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 72. Co3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 73. Ca | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 74. Ce | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 75. Cl | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 76. Ca | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 77. EDTA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 78. F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 79. Fl | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 80. HEDTA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 81. K | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 82. La | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 83. Mn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 84. NO2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 85. NO3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 86. Na | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 87. Ni | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 88. OH | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | S-101 Curies | S-102 Curies | S-103 Curies | S-104 Curies | S-105 Curies | S-106 Curies | S-107 Curies | S-108 Curies |
|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 89. Po4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 90. Pu | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 91. S103 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 92. SO4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 93. Sr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 94. Zro | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Curie | 3E+05 | 1E+05 | 4E-03 | 1E+05 | 1E+05 | 2E+05 | 3E+05 | 3E+06 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank S-109 Curies | Tank S-110 Curies | Tank S-111 Curies | Tank S-112 Curies |
|-----------|----------------------|----------------------|----------------------|----------------------|
| 1. Ac225 | 4E-08 | 5E-08 | 5E-08 | 2E-08 |
| 2. Ac227 | 9E-05 | 4E-04 | 3E-04 | 7E-05 |
| 3. Am241 | 4E+02 | 7E+02 | 2E+03 | 2E-02 |
| 4. Am242 | 6E-01 | 1E+00 | 3E+00 | 4E-01 |
| 5. Am242M | 6E-01 | 1E+00 | 3E+00 | 4E-01 |
| 6. Am243 | 3E-01 | 6E-01 | 1E+00 | 2E-01 |
| 7. At217 | 4E-08 | 5E-08 | 5E-08 | 2E-06 |
| 8. Bs137M | 7E+01 | 4E+01 | 6E+01 | 1E+02 |
| 9. Bi210 | 1E-13 | 8E-12 | 5E-12 | 1E-12 |
| 10. Bi211 | 1E-06 | 1E-04 | 3E-05 | 1E-05 |
| 11. Bi213 | 6E-10 | 1E-08 | 5E-09 | 4E-09 |
| 12. Bi214 | 6E-13 | 3E-11 | 2E-11 | 6E-12 |
| 13. C14 | 2E+02 | 8E+02 | 7E+02 | 2E+02 |
| 14. Cm242 | 5E-01 | 1E+00 | 2E+00 | 4E-01 |
| 15. Cm244 | 2E+00 | 5E+00 | 9E+00 | 1E+00 |
| 16. Cm245 | 6E-05 | 2E-04 | 4E-04 | 5E-05 |
| 17. Cs135 | 3E+00 | 6E+00 | 8E+00 | 1E+00 |
| 18. Cs137 | 5E+05 | 2E+06 | 1E+05 | 2E+05 |
| 19. Fr221 | 4E-08 | 5E-08 | 5E-08 | 2E-08 |
| 20. Fr223 | 1E-06 | 6E-06 | 4E-06 | 9E-07 |
| 21. I129 | 7E-01 | 3E+00 | 2E+00 | 5E-01 |
| 22. Nb93H | 1E+01 | 5E+01 | 4E+01 | 8E+00 |
| 23. Ni63 | 2E+02 | 7E+02 | 4E+03 | 2E+02 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank S-109 Curies | Tank S-110 Curies | Tank S-111 Curies | Tank S-112 Curies |
|------------|----------------------|----------------------|----------------------|----------------------|
| 24. Np237 | 6E-01 | 3E+00 | 2E+00 | 4E-01 |
| 25. Np239 | 3E-01 | 6E-01 | 1E+00 | 2E-01 |
| 26. Pa231 | 2E-04 | 1E-03 | 7E-04 | 2E-04 |
| 27. Pa233 | 6E-01 | 3E+00 | 2E+00 | 4E-01 |
| 28. Pa234M | 7E-03 | 1E-11 | 6E-12 | 1E-02 |
| 29. Pb209 | 4E-08 | 4E-08 | 5E-09 | 2E-06 |
| 30. Pb210 | 9E-12 | 3E-11 | 5E-11 | 6E-12 |
| 31. Pb211 | 9E-05 | 4E-04 | 3E-04 | 7E-05 |
| 32. Pb214 | 5E-11 | 1E-10 | 2E-10 | 3E-11 |
| 33. Pd107 | 1E+00 | 4E+00 | 4E+00 | 8E-01 |
| 34. Po210 | 9E-12 | 3E-11 | 5E-11 | 6E-12 |
| 35. Po213 | 4E-08 | 5E-08 | 5E-08 | 2E-08 |
| 36. Po214 | 6E-11 | 2E-10 | 3E-10 | 4E-11 |
| 37. Po215 | 9E-05 | 4E-04 | 3E-04 | 7E-05 |
| 38. Po218 | 5E-11 | 1E-10 | 2E-10 | 3E-11 |
| 39. Po230 | 2E-05 | 3E-02 | 2E-02 | 6E-06 |
| 40. Pu239 | 2E-04 | 3E-04 | 5E-05 | 2E-04 |
| 41. Pu240 | 5E-05 | 2E-03 | 1E-03 | 4E-05 |
| 42. Pu241 | 4E-04 | 2E-03 | 1E-04 | 3E-04 |
| 43. Ra223 | 9E-05 | 4E-04 | 3E-04 | 7E-05 |
| 44. Ra225 | 4E-08 | 5E-08 | 5E-08 | 2E-06 |
| 45. Ra226 | 5E-11 | 1E-10 | 2E-10 | 3E-11 |
| 46. Ru106 | 2E-01 | 8E-01 | 8E-01 | 1E-01 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank S-109 Curies | Tank S-110 Curies | Tank S-111 Curies | Tank S-112 Curies |
|------------|----------------------|----------------------|----------------------|----------------------|
| 47. Sb126 | 7E-08 | 1E-07 | 1E-07 | 9E-09 |
| 48. Sb126M | 7E-08 | 2E-07 | 1E-07 | 9E-09 |
| 49. Se79 | 1E+01 | 5E+01 | 4E+01 | 9E+00 |
| 50. Sm151 | 5E+03 | 8E+03 | 7E+03 | 1E+03 |
| 51. Sn126 | 4E+00 | 7E+00 | 6E+00 | 1E+00 |
| 52. Sr90 | 3E+05 | 7E+05 | 2E+06 | 3E+05 |
| 53. Tc99 | 4E+02 | 2E+03 | 1E+03 | 3E+02 |
| 54. Th227 | 9E-05 | 4E-04 | 3E-04 | 6E-05 |
| 55. Th229 | 4E-08 | 5E-08 | 5E-08 | 2E-08 |
| 56. Th230 | 4E-09 | 5E-09 | 5E-09 | 1E-09 |
| 57. Th231 | 3E-04 | 4E-12 | 2E-12 | 5E-04 |
| 58. Th234 | 7E-03 | 1E-11 | 6E-12 | 1E-02 |
| 59. Tl207 | 9E-05 | 4E-04 | 3E-04 | 7E-05 |
| 60. U233 | 3E-13 | 1E-07 | 1E-07 | 3E-13 |
| 61. U234 | 8E-14 | 1E-09 | 3E-09 | 4E-14 |
| 62. U235 | 4E-12 | 7E-15 | 5E-15 | 8E-12 |
| 63. U238 | 8E-11 | 2E-14 | 1E-14 | 2E-10 |
| 64. Y90 | 4E+05 | 7E+05 | 2E+05 | 3E+05 |
| 65. Zr93 | 0 | 0 | 0 | 0 |
| 66. Ag | 0 | 0 | 0 | 0 |
| 67. Al | 0 | 0 | 0 | 0 |
| 68. Ba | 0 | 0 | 0 | 0 |
| 69. Bi | 0 | 0 | 0 | 0 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank S-109 Curies | Tank S-110 Curies | Tank S-111 Curies | Tank S-112 Curies |
|------------|----------------------|----------------------|----------------------|----------------------|
| 70. C2H3O3 | 0 | 0 | 0 | 0 |
| 71. C6H5O7 | 0 | 0 | 0 | 0 |
| 72. CO3 | 0 | 0 | 0 | 0 |
| 73. Ca | 0 | 0 | 0 | 0 |
| 74. Ce | 0 | 0 | 0 | 0 |
| 75. Cl | 0 | 0 | 0 | 0 |
| 76. Cr | 0 | 0 | 0 | 0 |
| 77. EDTA | 0 | 0 | 0 | 0 |
| 78. F | 0 | 0 | 0 | 0 |
| 79. Fe | 0 | 0 | 0 | 0 |
| 80. HEDTA | 0 | 0 | 0 | 0 |
| 81. K | 0 | 0 | 0 | 0 |
| 82. La | 0 | 0 | 0 | 0 |
| 83. Mn | 0 | 0 | 0 | 0 |
| 84. NO2 | 0 | 0 | 0 | 0 |
| 85. NO3 | 0 | 0 | 0 | 0 |
| 86. Na | 0 | 0 | 0 | 0 |
| 87. Ni | 0 | 0 | 0 | 0 |
| 88. OH | 0 | 0 | 0 | 0 |
| 89. Po4 | 0 | 0 | 0 | 0 |
| 90. Pu | 0 | 0 | 0 | 0 |
| 91. S103 | 0 | 0 | 0 | 0 |
| 92. SO4 | 0 | 0 | 0 | 0 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank S-109 Curies | Tank S-110 Curies | Tank S-111 Curies | Tank S-112 Curies |
|-------------|----------------------|----------------------|----------------------|----------------------|
| 93. Sr | 0 | 0 | 0 | 0 |
| 94. Zro | 0 | 0 | 0 | 0 |
| Total Curie | 1E+06 | 3E+06 | 2E+06 | 8E+05 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank SX-101 Curies | Tank SX-102 Curies | Tank SX-103 Curies | Tank SX-104 Curies | Tank SX-105 Curies | Tank SX-106 Curies |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 1. Ac225 | 0 | 7E-16 | 3E-09 | 5E-11 | 1E-09 | 6E-08 |
| 2. Ac227 | 1E-29 | 7E-12 | 3E-05 | 2E-07 | 3E-05 | 2E-04 |
| 3. Am241 | 1E-23 | 2E-05 | 3E+01 | 8E-01 | 3E+01 | 1E+03 |
| 4. Am242 | 1E-26 | 7E-08 | 5E-02 | 1E-03 | 4E-02 | 2E+00 |
| 5. Am242M | 1E-26 | 7E-08 | 5E-02 | 1E-03 | 4E-02 | 2E+00 |
| 6. Am243 | 1E-26 | 2E-08 | 3E-02 | 6E-04 | 2E-02 | 1E+00 |
| 7. At217 | 0 | 7E-15 | 3E-09 | 5E-11 | 1E-09 | 6E-08 |
| 8. Bs137M | 2E-20 | 5E-03 | 2E+03 | 1E+01 | 1E+04 | 6E+02 |
| 9. Bi210 | 0 | 7E-20 | 4E-12 | 2E-14 | 1E-12 | 6E-13 |
| 10. Bi211 | 0 | 7E-12 | 5E-05 | 2E-07 | 3E-05 | 4E-05 |
| 11. Bi213 | 0 | 7E-16 | 3E-09 | 6E-11 | 1E-09 | 1E-05 |
| 12. Bi214 | 0 | 3E-18 | 1E-11 | 1E-13 | 5E-12 | 3E-11 |
| 13. C14 | 6E-24 | 7E-08 | 7E+01 | 4E-01 | 7E+01 | 6E+02 |
| 14. Cm242 | 2E-26 | 5E-08 | 5E-02 | 1E-03 | 4E-02 | 2E+00 |
| 15. Cm244 | 3E-26 | 1E-07 | 4E-01 | 4E-03 | 2E-01 | 7E+00 |
| 16. Cm245 | 1E-30 | 5E-12 | 2E-05 | 2E-07 | 8E-06 | 3E-04 |
| 17. Cs135 | 5E-25 | 2E-08 | 5E-01 | 5E-03 | 2E-01 | 4E+00 |
| 18. Cs137 | 2E-20 | 6E-03 | 1E+05 | 1E+03 | 5E+04 | 8E+05 |
| 19. Fr221 | 0 | 7E-16 | 3E-09 | 6E-11 | 1E-09 | 6E-08 |
| 20. Fr223 | 0 | 1E-13 | 7E-07 | 3E-09 | 5E-07 | 4E-05 |
| 21. I129 | 4E-26 | 2E-08 | 3E-01 | 1E-03 | 2E-01 | 2E+00 |
| 22. Nb93H | 1E-24 | 1E-06 | 3E+00 | 4E-02 | 3E+00 | 4E+01 |
| 23. Ni63 | 8E-25 | 1E-04 | 1E+02 | 2E-03 | 2E+00 | 6E+02 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank SX-101 Curies | Tank SX-102 Curies | Tank SX-103 Curies | Tank SX-104 Curies | Tank SX-105 Curies | Tank SX-106 Curies |
|------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 24. Np237 | 7E-26 | 4E-08 | 5E-01 | 2E-03 | 5E-02 | 2E+00 |
| 25. Np239 | 9E-27 | 2E-08 | 3E-02 | 6E-04 | 2E-02 | 1E+00 |
| 26. Pa231 | 4E-30 | 1E-11 | 1E-04 | 5E-07 | 8E-05 | 6E-04 |
| 27. Pa233 | 7E-26 | 4E-08 | 5E-01 | 2E-03 | 5E-02 | 2E+00 |
| 28. Pa234M | 0 | 2E-24 | 2E-16 | 2E-16 | 2E-15 | 8E-14 |
| 29. Pb209 | 0 | 7E-16 | 3E-09 | 5E-11 | 1E-09 | 6E-08 |
| 30. Pb210 | 2E-33 | 7E-20 | 3E-12 | 2E-14 | 1E-12 | 4E-12 |
| 31. Pb211 | 1E-29 | 7E-12 | 5E-05 | 2E-07 | 3E-05 | 2E-04 |
| 32. Pb214 | 0 | 3E-15 | 1E-11 | 1E-13 | 5E-12 | 2E-10 |
| 33. Pd107 | 9E-26 | 5E-08 | 4E-01 | 2E-03 | 3E-01 | 3E+00 |
| 34. Po210 | 0 | 3E-19 | 3E-12 | 2E-14 | 1E-12 | 2E-11 |
| 35. Po213 | 0 | 7E-16 | 3E-09 | 5E-11 | 1E-09 | 6E-08 |
| 36. Po214 | 0 | 4E-18 | 2E-11 | 2E-13 | 6E-12 | 3E-10 |
| 37. Po215 | 0 | 7E-12 | 5E-05 | 2E-07 | 3E-05 | 3E-04 |
| 38. Po218 | 0 | 3E-18 | 1E-11 | 1E-13 | 5E-12 | 2E-10 |
| 39. Pu238 | 8E-28 | 4E-10 | 4E-03 | 2E-05 | 1E-03 | 2E-02 |
| 40. Pu239 | 3E-30 | 1E-12 | 5E-05 | 6E-08 | 5E-05 | 6E-05 |
| 41. Pu240 | 4E-29 | 2E-11 | 3E-04 | 8E-07 | 1E-04 | 1E-03 |
| 42. Pu241 | 9E-30 | 8E-13 | 4E-04 | 2E-07 | 5E-04 | 2E-04 |
| 43. Ra223 | 1E-29 | 7E-12 | 5E-05 | 2E-07 | 3E-05 | 2E-04 |
| 44. Ra225 | 0 | 7E-16 | 3E-09 | 6E-11 | 1E-09 | 6E-08 |
| 45. Ra226 | 5E-36 | 3E-18 | 1E-11 | 1E-13 | 5E-12 | 2E-10 |
| 46. Ru106 | 3E-26 | 3E-08 | 7E-02 | 7E-04 | 1E-01 | 1E+00 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank SX-101 Curies | Tank SX-102 Curies | Tank SX-103 Curies | Tank SX-104 Curies | Tank SX-105 Curies | Tank SX-106 Curies |
|------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 47. Sb126 | 7E-25 | 1E-07 | 8E-06 | 1E-09 | 1E-05 | 6E-05 |
| 48. Sb126M | 7E-25 | 1E-07 | 8E-06 | 1E-09 | 1E-05 | 6E-05 |
| 49. Se79 | 6E-25 | 7E-07 | 5E+00 | 2E-02 | 4E+00 | 3E+01 |
| 50. Sm151 | 8E-22 | 1E-04 | 2E+02 | 1E+01 | 2E+02 | 1E+04 |
| 51. Sn126 | 7E-25 | 1E-07 | 1E-01 | 1E-02 | 1E-01 | 1E+01 |
| 52. Sr90 | 1E-20 | 2E-02 | 1E+04 | 6E+02 | 3E+04 | 1E+06 |
| 53. Tc99 | 4E-23 | 1E-05 | 2E+02 | 9E-01 | 1E+02 | 1E+03 |
| 54. Th227 | 1E-29 | 7E-12 | 4E-05 | 2E-07 | 3E-05 | 2E-04 |
| 55. Th229 | 5E-33 | 7E-15 | 3E-09 | 5E-11 | 1E-09 | 6E-08 |
| 56. Th230 | 9E-34 | 3E-16 | 1E-10 | 1E-11 | 2E-10 | 1E-08 |
| 57. Th231 | 0 | 5E-22 | 3E-14 | 5E-17 | 9E-14 | 2E-14 |
| 58. Th234 | 0 | 2E-24 | 2E-16 | 2E-16 | 2E-15 | 8E-14 |
| 59. Tl207 | 0 | 7E-12 | 5E-05 | 2E-07 | 3E-05 | 2E-04 |
| 60. U233 | 3E-31 | 8E-14 | 1E-07 | 5E-10 | 1E-07 | 7E-08 |
| 61. U234 | 3E-33 | 5E-15 | 5E-10 | 4E-12 | 2E-09 | 5E-10 |
| 62. U235 | 2E-39 | 5E-22 | 3E-15 | 4E-18 | 5E-14 | 5E-16 |
| 63. U238 | 4E-39 | 2E-25 | 2E-17 | 3E-21 | 6E-16 | 2E-19 |
| 64. Y90 | 1E-20 | 2E-02 | 1E+04 | 8E+02 | 3E+04 | 2E+06 |
| 65. Zr93 | 0 | 0 | 0 | 0 | 0 | 0 |
| 66. Ag | 0 | 0 | 0 | 0 | 0 | 0 |
| 67. Al | 0 | 0 | 0 | 0 | 0 | 0 |
| 68. Ba | 0 | 0 | 0 | 0 | 0 | 0 |
| 69. Bi | 0 | 0 | 0 | 0 | 0 | 0 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank SX-101 Curies | Tank SX-102 Curies | Tank SX-103 Curies | Tank SX-104 Curies | Tank SX-105 Curies | Tank SX-106 Curies |
|------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 70. C2H3O3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 71. C6H5O7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 72. CO3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 73. Ca | 0 | 0 | 0 | 0 | 0 | 0 |
| 74. Ce | 0 | 0 | 0 | 0 | 0 | 0 |
| 75. Cl | 0 | 0 | 0 | 0 | 0 | 0 |
| 76. Cr | 0 | 0 | 0 | 0 | 0 | 0 |
| 77. EDTA | 0 | 0 | 0 | 0 | 0 | 0 |
| 78. F | 0 | 0 | 0 | 0 | 0 | 0 |
| 79. Fe | 0 | 0 | 0 | 0 | 0 | 0 |
| 80. HEDTA | 0 | 0 | 0 | 0 | 0 | 0 |
| 81. K | 0 | 0 | 0 | 0 | 0 | 0 |
| 82. La | 0 | 0 | 0 | 0 | 0 | 0 |
| 83. Mn | 0 | 0 | 0 | 0 | 0 | 0 |
| 84. NO2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 85. NO3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 86. Na | 0 | 0 | 0 | 0 | 0 | 0 |
| 87. Ni | 0 | 0 | 0 | 0 | 0 | 0 |
| 88. OH | 0 | 0 | 0 | 0 | 0 | 0 |
| 89. Po4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 90. Pu | 0 | 0 | 0 | 0 | 0 | 0 |
| 91. S103 | 0 | 0 | 0 | 0 | 0 | 0 |
| 92. SO4 | 0 | 0 | 0 | 0 | 0 | 0 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank SX-101 Curies | Tank SX-102 Curies | Tank SX-103 Curies | Tank SX-104 Curies | Tank SX-105 Curies | Tank SX-106 Curies |
|-------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 93. Sr | 0 | 0 | 0 | 0 | 0 | 0 |
| 94. Zro | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Curie | 6E-20 | 5E-02 | 1E+05 | 2E+03 | 1E+05 | 4E+06 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank SX-107 Curies | Tank SX-108 Curies | Tank SX-109 Curies | Tank SX-110 Curies |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|
| 1. Ac225 | 2E-20 | 5E-17 | 2E-09 | 1E-17 |
| 2. Ac227 | 8E-15 | 6E-13 | 2E-05 | 4E-13 |
| 3. Am241 | 9E-14 | 1E-11 | 2E-05 | 6E-06 |
| 4. Am242 | 1E-16 | 2E-14 | 3E-09 | 8E-09 |
| 5. Am242M | 1E-16 | 2E-14 | 3E-08 | 8E-09 |
| 6. Am243 | 4E-17 | 5E-15 | 7E-09 | 5E-09 |
| 7. At217 | 2E-20 | 5E-17 | 2E-09 | 1E-17 |
| 8. Bs137M | 1E-04 | 2E-02 | 6E-02 | 5E-04 |
| 9. B1210 | 1E-24 | 4E-21 | 8E-14 | 2E-19 |
| 10. B1211 | 4E-16 | 6E-13 | 8E-06 | 4E-13 |
| 11. B1213 | 9E-22 | 5E-17 | 9E-10 | 1E-17 |
| 12. B1214 | 4E-24 | 1E-20 | 2E-13 | 3E-19 |
| 13. C14 | 1E-08 | 2E-06 | 4E+01 | 2E-06 |
| 14. Cm242 | 1E-16 | 1E-14 | 5E-07 | 7E-09 |
| 15. Cm244 | 2E-11 | 3E-09 | 4E-02 | 5E-08 |
| 16. Cm245 | 6E-16 | 4E-14 | 9E-07 | 1E-12 |
| 17. Cs135 | 3E-10 | 4E-08 | 1E+00 | 5E-10 |
| 18. Cs137 | 1E-04 | 2E-02 | 4E+05 | 3E-04 |
| 19. Fr221 | 2E-20 | 5E-17 | 2E-03 | 1E-17 |
| 20. Fr223 | 1E-16 | 8E-15 | 3E-07 | 3E-15 |
| 21. H129 | 4E-11 | 5E-09 | 1E-01 | 3E-09 |
| 22. Nb93H | 4E-10 | 5E-08 | 2E+00 | 8E-08 |
| 23. Ni63 | 2E-17 | 8E-13 | 6E+01 | 1E-10 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank SX-107 Curies | Tank SX-108 Curies | Tank SX-109 Curies | Tank SX-110 Curies |
|------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 24. Np237 | 6E-13 | 1E-09 | 8E-02 | 3E-09 |
| 25. Np239 | 4E-17 | 5E-15 | 1E-07 | 5E-09 |
| 26. Pa231 | 2E-14 | 1E-12 | 4E-05 | 1E-12 |
| 27. Pa233 | 6E-13 | 1E-19 | 8E-02 | 8E-09 |
| 28. Pa234M | 0 | 7E-17 | 1E-09 | 3E-25 |
| 29. Pb209 | 2E-20 | 5E-17 | 2E-09 | 1E-17 |
| 30. Pb210 | 3E-23 | 4E-21 | 2E-13 | 2E-19 |
| 31. Pb211 | 2E-04 | 8E-15 | 6E-13 | 4E-13 |
| 32. Pb214 | 9E-23 | 1E-20 | 5E-13 | 8E-19 |
| 33. Pd107 | 1E-10 | 7E-09 | 2E-01 | 7E-09 |
| 34. Po210 | 3E-23 | 4E-21 | 2E-13 | 2E-19 |
| 35. Po213 | 2E-20 | 5E-17 | 2E-09 | 1E-17 |
| 36. Po214 | 1E-22 | 1E-20 | 6E-13 | 9E-19 |
| 37. Po215 | 8E-15 | 6E-13 | 2E-05 | 4E-13 |
| 38. Po218 | 9E-23 | 1E-20 | 5E-13 | 8E-19 |
| 39. Pu238 | 0 | 0 | 0 | 1E-11 |
| 40. Pu239 | 0 | 0 | 0 | 1E-13 |
| 41. Pu240 | 0 | 0 | 0 | 5E-12 |
| 42. Pu241 | 0 | 0 | 0 | 1E-13 |
| 43. Ra223 | 7E-15 | 6E-13 | 2E-05 | 4E-13 |
| 44. Ra225 | 2E-20 | 5E-17 | 2E-08 | 1E-17 |
| 45. Ra226 | 9E-23 | 1E-20 | 5E-13 | 8E-19 |
| 46. Ru106 | 6E-13 | 3E-10 | 3E-02 | 1E-08 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank SX-107 Curies | Tank SX-108 Curies | Tank SX-109 Curies | Tank SX-110 Curies |
|------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 47. Sb126 | 6E-24 | 8E-16 | 1E-05 | 8E-16 |
| 48. Sb126M | 6E-24 | 8E-16 | 1E-08 | 8E-16 |
| 49. Se79 | 6E-10 | 8E-08 | 2E+00 | 8E-08 |
| 50. Sm151 | 3E-14 | 6E-12 | 6E-06 | 3E-12 |
| 51. Sn126 | 6E-24 | 8E-16 | 2E-13 | 8E-16 |
| 52. Sr90 | 6E-17 | 1E-10 | 2E-03 | 3E-03 |
| 53. Tc99 | 3E-08 | 3E-36 | 8E+01 | 3E-36 |
| 54. Th227 | 9E-23 | 2E-18 | 2E-13 | 3E-13 |
| 55. Th229 | 2E-28 | 2E-22 | 2E-17 | 1E-17 |
| 56. Th230 | 4E-30 | 5E-25 | 4E-21 | 3E-20 |
| 57. Th231 | 0 | 2E-23 | 8E-19 | 3E-21 |
| 58. Th234 | 0 | 3E-22 | 9E-18 | 3E-25 |
| 59. Tl207 | 8E-15 | 6E-13 | 2E-05 | 4E-13 |
| 60. U233 | 1E-19 | 8E-14 | 1E-13 | 5E-14 |
| 61. U234 | 2E-20 | 2E-15 | 3E-13 | 2E-15 |
| 62. U235 | 3E-31 | 4E-18 | 2E-15 | 3E-21 |
| 63. U238 | 3E-35 | 7E-17 | 4E-14 | 3E-25 |
| 64. Y90 | 6E-17 | 1E-10 | 2E-03 | 5E-03 |
| 65. Zr93 | 0 | 0 | 0 | 0 |
| 66. Ag | 0 | 0 | 0 | 0 |
| 67. Al | 0 | 0 | 0 | 0 |
| 68. Ba | 0 | 0 | 0 | 0 |
| 69. Bi | 0 | 0 | 0 | 0 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank SX-107 Curies | Tank SX-108 Curies | Tank SX-109 Curies | Tank SX-110 Curies |
|------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 70. C2H3O3 | 0 | 0 | 0 | 0 |
| 71. C6H5O7 | 0 | 0 | 0 | 0 |
| 72. Co3 | 0 | 0 | 0 | 0 |
| 73. Ca | 0 | 0 | 0 | 0 |
| 74. Ce | 0 | 0 | 0 | 0 |
| 75. Cl | 0 | 0 | 0 | 0 |
| 76. Cr | 0 | 0 | 0 | 0 |
| 77. EDTA | 0 | 0 | 0 | 0 |
| 78. F | 0 | 0 | 0 | 0 |
| 79. Fe | 0 | 0 | 0 | 0 |
| 80. HEDTA | 0 | 0 | 0 | 0 |
| 81. K | 0 | 0 | 0 | 0 |
| 82. La | 0 | 0 | 0 | 0 |
| 83. Mn | 0 | 0 | 0 | 0 |
| 84. No2 | 0 | 0 | 0 | 0 |
| 85. No3 | 0 | 0 | 0 | 0 |
| 86. Na | 0 | 0 | 0 | 0 |
| 87. Ni | 0 | 0 | 0 | 0 |
| 88. OH | 0 | 0 | 0 | 0 |
| 89. Po4 | 0 | 0 | 0 | 0 |
| 90. Pu | 0 | 0 | 0 | 0 |
| 91. S103 | 0 | 0 | 0 | 0 |
| 92. So4 | 0 | 0 | 0 | 0 |

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9 3 1 2 8 1 5 1 6 2 9

Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank SX-107 Curies | Tank SX-108 Curies | Tank SX-109 Curies | Tank SX-110 Curies |
|-------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 93. Sr | 0 | 0 | 0 | 0 |
| 94. Zro | 0 | 0 | 0 | 0 |
| Total Curie | | | | |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank SX-111 Curies | Tank SX-112 Curies | Tank SX-113 Curies | Tank SX-114 Curies | Tank SX-115 Curies |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 1. Ac225 | 2E-17 | 2E-10 | 2E-10 | 4E-18 | 4E-18 |
| 2. Ac227 | 3E-13 | 2E-06 | 1E-05 | 2E-13 | 4E-14 |
| 3. Am241 | 1E-07 | 1E-05 | 3E-05 | 6E-09 | 1E-12 |
| 4. Am242 | 3E-10 | 2E-08 | 6E-08 | 8E-12 | 2E-15 |
| 5. Am242M | 3E-10 | 2E-08 | 6E-08 | 8E-12 | 2E-15 |
| 6. Am243 | 2E-10 | 5E-09 | 2E-08 | 3E-12 | 1E-15 |
| 7. A217 | 2E-17 | 2E-10 | 2E-10 | 4E-18 | 4E-15 |
| 8. B2137M | 6E-04 | 2E-01 | 3E-01 | 1E-06 | 9E-04 |
| 9. Bi210 | 2E-20 | 6E-15 | 3E-13 | 3E-21 | 2E-22 |
| 10. Bi211 | 3E-13 | 2E-06 | 1E-05 | 2E-13 | 4E-14 |
| 11. Bi213 | 2E-17 | 2E-10 | 2E-10 | 4E-18 | 4E-18 |
| 12. Bi214 | 9E-20 | 2E-14 | 2E-12 | 1E-20 | 4E-22 |
| 13. C14 | 5E-07 | 4E+00 | 3E+01 | 2E-07 | 6E-08 |
| 14. Cm242 | 2E-10 | 1E-07 | 4E-03 | 7E-12 | 2E-15 |
| 15. Cm244 | 3E-09 | 4E-03 | 2E-02 | 2E-09 | 8E-11 |
| 16. Cm245 | 1E-13 | 7E-08 | 4E-07 | 4E-14 | 2E-15 |
| 17. Cs135 | 5E-09 | 1E-01 | 7E-01 | 6E-10 | 1E-09 |
| 18. Cs137 | 6E-04 | 4E+04 | 2E+05 | 3E-04 | 1E-03 |
| 19. Fr221 | 2E-17 | 2E-10 | 2E-10 | 4E-18 | 4E-18 |
| 20. Fr223 | 4E-15 | 3E-08 | 2E-07 | 3E-15 | 6E-16 |
| 21. I129 | 1E-09 | 1E-02 | 7E-02 | 1E-09 | 2E-10 |
| 22. Nb93M | 2E-08 | 1E-01 | 6E-01 | 2E-08 | 7E-10 |
| 23. Ni63 | 9E-07 | 3E+01 | 8E+01 | 1E-08 | 2E-06 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank SX-111 Curies | Tank SX-112 Curies | Tank SX-113 Curies | Tank SX-114 Curies | Tank SX-115 Curies |
|------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 24. Np237 | 2E-09 | 7E-03 | 2E-03 | 3E-10 | 8E-11 |
| 25. Np239 | 2E-10 | 5E-08 | 1E-03 | 3E-12 | 1E-15 |
| 26. Pa231 | 6E-13 | 4E-06 | 3E-05 | 6E-13 | 8E-14 |
| 27. Pa233 | 3E-09 | 7E-03 | 2E-03 | 3E-10 | 8E-11 |
| 28. Pa234M | 2E-23 | 3E-13 | 9E-03 | 1E-22 | 2E-21 |
| 29. Pb209 | 2E-17 | 2E-10 | 2E-10 | 4E-18 | 4E-18 |
| 30. Pb210 | 2E-20 | 6E-15 | 3E-13 | 3E-21 | 2E-22 |
| 31. Pb211 | 3E-13 | 2E-06 | 1E-05 | 2E-13 | 4E-14 |
| 32. Pb214 | 9E-20 | 2E-14 | 2E-12 | 1E-20 | 4E-22 |
| 33. Pd107 | 3E-09 | 2E-02 | 1E-01 | 3E-09 | 2E-10 |
| 34. Po210 | 2E-20 | 6E-15 | 3E-13 | 3E-21 | 2E-22 |
| 35. Po213 | 2E-17 | 2E-10 | 2E-10 | 4E-18 | 4E-18 |
| 36. Po214 | 1E-19 | 2E-14 | 3E-12 | 1E-20 | 5E-22 |
| 37. Po215 | 3E-13 | 2E-06 | 1E-05 | 2E-13 | 4E-14 |
| 38. Po218 | 9E-20 | 2E-14 | 2E-12 | 1E-20 | 4E-22 |
| 39. Pu238 | 4E-11 | 0 | 0 | 7E-12 | 5E-20 |
| 40. Pu239 | 9E-13 | 0 | 0 | 9E-14 | 6E-27 |
| 41. Pu240 | 4E-12 | 0 | 0 | 8E-13 | 1E-21 |
| 42. Pu241 | 4E-12 | 0 | 0 | 8E-13 | 1E-23 |
| 43. Ra223 | 3E-13 | 2E-06 | 1E-05 | 2E-13 | 4E-14 |
| 44. Ra225 | 2E-17 | 2E-10 | 2E-10 | 4E-18 | 4E-18 |
| 45. Ra226 | 9E-20 | 2E-14 | 2E-12 | 1E-20 | 4E-22 |
| 46. Ru106 | 4E-10 | 4E-03 | 2E-01 | 1E-10 | 2E-12 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank SX-111 Curies | Tank SX-112 Curies | Tank SX-113 Curies | Tank SX-114 Curies | Tank SX-115 Curies |
|------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 47. Sb126 | 2E-22 | 1E-14 | 1E-09 | 2E-22 | 9E-23 |
| 48. Sb126M | 2E-22 | 1E-14 | 1E-09 | 2E-22 | 9E-23 |
| 49. Sc79 | 4E-08 | 2E-01 | 1E+00 | 2E-08 | 5E-09 |
| 50. Sm151 | 4E-13 | 4E-06 | 1E-05 | 4E-13 | 8E-13 |
| 51. Sn126 | 2E-22 | 1E-15 | 2E-09 | 2E-22 | 9E-23 |
| 52. Sr90 | 1E-05 | 1E+02 | 2E+04 | 6E-07 | 4E-09 |
| 53. Tc99 | 2E-06 | 8E+00 | 5E+01 | 8E-07 | 1E-07 |
| 54. Th227 | 3E-13 | 2E-14 | 9E-14 | 3E-21 | 1E-18 |
| 55. Th229 | 2E-17 | 3E-18 | 3E-18 | 4E-26 | 1E-22 |
| 56. Th230 | 2E-20 | 1E-21 | 8E-18 | 1E-28 | 7E-25 |
| 57. Th231 | 6E-21 | 2E-22 | 7E-12 | 2E-29 | 4E-27 |
| 58. Th234 | 2E-23 | 4E-21 | 8E-11 | 2E-30 | 7E-26 |
| 59. Th207 | 3E-13 | 2E-06 | 1E-05 | 2E-13 | 4E-14 |
| 60. U233 | 8E-14 | 9E-10 | 2E-15 | 4E-16 | 5E-15 |
| 61. U234 | 7E-16 | 6E-12 | 8E-14 | 1E-17 | 3E-16 |
| 62. U235 | 6E-21 | 4E-17 | 4E-12 | 6E-23 | 1E-22 |
| 63. U238 | 2E-23 | 9E-10 | 8E-11 | 5E-24 | 2E-21 |
| 64. Y90 | 1E-05 | 1E+01 | 3E+01 | 6E-07 | 4E-09 |
| 65. Zr93 | 0 | 0 | 0 | 0 | 0 |
| 66. Ag | 0 | 0 | 0 | 0 | 0 |
| 67. Al | 0 | 0 | 0 | 0 | 0 |
| 68. Ba | 0 | 0 | 0 | 0 | 0 |
| 69. Bi | 0 | 0 | 0 | 0 | 0 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank SX-111 Curies | Tank SX-112 Curies | Tank SX-113 Curies | Tank SX-114 Curies | Tank SX-115 Curies |
|------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 70. C2H3O3 | 0 | 0 | 0 | 0 | 0 |
| 71. C6H5O7 | 0 | 0 | 0 | 0 | 0 |
| 72. CO3 | 0 | 0 | 0 | 0 | 0 |
| 73. Ca | 0 | 0 | 0 | 0 | 0 |
| 74. Ce | 0 | 0 | 0 | 0 | 0 |
| 75. Cl | 0 | 0 | 0 | 0 | 0 |
| 76. Cr | 0 | 0 | 0 | 0 | 0 |
| 77. EDTA | 0 | 0 | 0 | 0 | 0 |
| 78. F | 0 | 0 | 0 | 0 | 0 |
| 79. Fe | 0 | 0 | 0 | 0 | 0 |
| 80. HEDTA | 0 | 0 | 0 | 0 | 0 |
| 81. K | 0 | 0 | 0 | 0 | 0 |
| 82. La | 0 | 0 | 0 | 0 | 0 |
| 83. Mn | 0 | 0 | 0 | 0 | 0 |
| 84. NO2 | 0 | 0 | 0 | 0 | 0 |
| 85. NO3 | 0 | 0 | 0 | 0 | 0 |
| 86. Na | 0 | 0 | 0 | 0 | 0 |
| 87. Ni | 0 | 0 | 0 | 0 | 0 |
| 88. OH | 0 | 0 | 0 | 0 | 0 |
| 89. Po4 | 0 | 0 | 0 | 0 | 0 |
| 90. Pb | 0 | 0 | 0 | 0 | 0 |
| 91. SiO3 | 0 | 0 | 0 | 0 | 0 |
| 92. SO4 | 0 | 0 | 0 | 0 | 0 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank SX-111 Curies | Tank SX-112 Curies | Tank SX-113 Curies | Tank SX-114 Curies | Tank SX-115 Curies |
|-------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 93. Sr | 0 | 0 | 0 | 0 | 0 |
| 94. ZrO | 0 | 0 | 0 | 0 | 0 |
| Total Curie | 1E-03 | 4E+04 | 2E+05 | 3E-04 | 2E-03 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank SY-101 Curies | Tank SY-102 Curies | Tank SY-103 Curies |
|-----------|-----------------------|-----------------------|-----------------------|
| 1. Ac225 | 5E-08 | 5E-08 | 6E-08 |
| 2. Ac227 | 1E-04 | 2E-04 | 2E-04 |
| 3. Am241 | 8E+02 | 1E+03 | 1E+03 |
| 4. Am242 | 1E+00 | 2E+00 | 2E+00 |
| 5. Am242M | 1E+00 | 2E+00 | 2E+00 |
| 6. Am243 | 6E-01 | 9E-01 | 1E+00 |
| 7. At217 | 5E-08 | 5E-08 | 6E-08 |
| 8. Bsi37M | 7E+03 | 1E+03 | 2E+03 |
| 9. Bi210 | 2E-12 | 1E-12 | 1E-12 |
| 10. Bi211 | 5E-05 | 6E-05 | 9E-05 |
| 11. Bi213 | 2E-08 | 2E-08 | 2E-08 |
| 12. Bi214 | 5E-11 | 5E-11 | 8E-11 |
| 13. C14 | 3E+02 | 5E+02 | 6E+02 |
| 14. Cm242 | 1E+00 | 2E+00 | 2E+00 |
| 15. Cm244 | 3E+00 | 6E+00 | 7E+00 |
| 16. Cm245 | 1E-04 | 3E-04 | 3E-04 |
| 17. Cs135 | 2E+00 | 3E+00 | 3E+00 |
| 18. Cs137 | 4E+05 | 7E+05 | 8E+05 |
| 19. Fr221 | 5E-08 | 5E-08 | 6E-08 |
| 20. Fr223 | 2E-06 | 3E-06 | 3E-06 |
| 21. I129 | 8E-01 | 1E+00 | 2E+00 |
| 22. Nb93H | 3E+01 | 4E+01 | 4E+01 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank SY-101 Curies | Tank SY-102 Curies | Tank SY-103 Curies |
|------------|-----------------------|-----------------------|-----------------------|
| 23. Ni63 | 2E+01 | 6E+01 | 1E+00 |
| 24. Np237 | 1E+00 | 2E+00 | 2E+00 |
| 25. Np239 | 6E-01 | 9E-01 | 1E+00 |
| 26. Pa231 | 3E-04 | 5E-04 | 6E-04 |
| 27. Pa233 | 1E+00 | 2E+00 | 2E+00 |
| 28. Pa234M | 3E-10 | 5E-14 | 7E-14 |
| 29. Pb209 | 5E-08 | 5E-08 | 6E-08 |
| 30. Pb210 | 4E-12 | 3E-12 | 4E-12 |
| 31. Pb211 | 1E-04 | 2E-04 | 2E-04 |
| 32. Pb214 | 1E-10 | 2E-10 | 2E-10 |
| 33. Pd107 | 1E-00 | 3E+00 | 3E+00 |
| 34. Po210 | 9E-12 | 1E-11 | 1E-11 |
| 35. Po213 | 5E-03 | 5E-08 | 6E-08 |
| 36. Po214 | 1E-10 | 2E-10 | 3E-10 |
| 37. Po215 | 1E-04 | 2E-04 | 2E-04 |
| 38. Po218 | 1E-10 | 2E-10 | 2E-10 |
| 39. Pu238 | 1E-02 | 2E-02 | 2E-02 |
| 40. Pu239 | 3E-05 | 5E-05 | 6E-05 |
| 41. Pu240 | 5E-04 | 8E-04 | 1E-03 |
| 42. Pu241 | 1E-04 | 1E-04 | 2E-04 |
| 43. Ra223 | 1E-04 | 2E-04 | 2E-04 |
| 44. Ra225 | 5E-08 | 5E-08 | 6E-08 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank SY-101 Curies | Tank SY-102 Curies | Tank SY-103 Curies |
|------------|-----------------------|-----------------------|-----------------------|
| 45. Ra226 | 1E-10 | 2E-10 | 2E-10 |
| 46. Ru106 | 7E-01 | 9E-01 | 1E+00 |
| 47. Sb126 | 2E-05 | 7E-06 | 1E-05 |
| 48. Sb126M | 2E-05 | 7E-06 | 1E-05 |
| 49. Se79 | 2E+01 | 3E+01 | 3E+01 |
| 50. Sm151 | 1E+04 | 1E+04 | 1E+04 |
| 51. Sn126 | 9E+00 | 9E+00 | 1E+01 |
| 52. Sr90 | 8E+05 | 1E+06 | 1E+06 |
| 53. Tc99 | 5E+02 | 9E+02 | 1E+03 |
| 54. Th227 | 1E-04 | 2E-04 | 2E-04 |
| 55. Th229 | 5E-08 | 5E-08 | 6E-08 |
| 56. Th230 | 8E-09 | 8E-09 | 1E-08 |
| 57. Th231 | 2E-11 | 1E-14 | 2E-14 |
| 58. Th234 | 3E-10 | 6E-14 | 7E-14 |
| 59. Ti207 | 1E-04 | 2E-04 | 2E-04 |
| 60. U233 | 3E-08 | 9E-08 | 1E-07 |
| 61. U234 | 7E-10 | 5E-10 | 9E-10 |
| 62. U235 | 4E-13 | 5E-16 | 9E-16 |
| 63. U238 | 7E-12 | 3E-19 | 5E-19 |
| 64. Y90 | 8E+05 | 1E+06 | 2E+06 |
| 65. Zr93 | 0 | 0 | 0 |
| 66. Ag | 0 | 0 | 0 |

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**Table 4-15. TRAC Estimated Waste Tank Inventories
Data.**

| Component | Tank SY-101 Curies | Tank SY-102 Curies | Tank SY-103 Curies |
|------------|-----------------------|-----------------------|-----------------------|
| 67. Al | 0 | 0 | 0 |
| 68. Ba | 0 | 0 | 0 |
| 69. Bi | 0 | 0 | 0 |
| 70. C2H3O3 | 0 | 0 | 0 |
| 71. C6H5O7 | 0 | 0 | 0 |
| 72. CO3 | 0 | 0 | 0 |
| 73. Ca | 0 | 0 | 0 |
| 74. Ce | 0 | 0 | 0 |
| 75. Cl | 0 | 0 | 0 |
| 76. Cr | 0 | 0 | 0 |
| 77. EDTA | 0 | 0 | 0 |
| 78. F | 0 | 0 | 0 |
| 79. Fe | 0 | 0 | 0 |
| 80. HEDTA | 0 | 0 | 0 |
| 81. K | 0 | 0 | 0 |
| 82. La | 0 | 0 | 0 |
| 83. Mn | 0 | 0 | 0 |
| 84. NO2 | 0 | 0 | 0 |
| 85. NO3 | 0 | 0 | 0 |
| 86. Na | 0 | 0 | 0 |
| 87. Ni | 0 | 0 | 0 |
| 88. OH | 0 | 0 | 0 |

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Table 4-15. TRAC Estimated Waste Tank Inventories Data.

| Component | Tank SY-101 Curies | Tank SY-102 Curies | Tank SY-103 Curies |
|-------------|-----------------------|-----------------------|-----------------------|
| 89. Po4 | 0 | 0 | 0 |
| 90. Pu | 0 | 0 | 0 |
| 91. S103 | 0 | 0 | 0 |
| 92. SO4 | 0 | 0 | 0 |
| 93. Sr | 0 | 0 | 0 |
| 94. Zro | 0 | 0 | 0 |
| Total Curie | 2E+06 | 3E+06 | 4E+06 |

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Table 4-16. Summary of Tank Sampling Data.

| Tank 101-S | | | | | | |
|-----------------------|--------|-------------------------|---------------------------|--------------------------|----------------------------|----------------------------|
| Description | Date | Pu(g/l) | ¹³⁷ Cs(μCi/l) | ¹³⁴ Cs(μCi/l) | ^{89,90} Sr(μCi/l) | |
| Sludge | 6/4/75 | 5.97 X 10 ⁻³ | 2.95 X 10 ⁵ | - | 1.01 X 10 ⁶ | |
| Tank 102-S | | | | | | |
| Description | Date | Pu(g/g) | ¹³⁷ Cs(μCi/g) | ¹³⁴ Cs(μCi/g) | ^{89,90} Sr(μCi/g) | |
| Solids (top layer) | 4/75 | 5.2 X 10 ⁻⁷ | 17.3 | - | 19.2 | |
| Solids (bottom layer) | 4/75 | 7.5 X 10 ⁻⁷ | 6.6 | - | 0.5 | |
| Tank 105-S | | | | | | |
| Description | Date | Pu(g/l) | ¹³⁷ Cs(μCi/l) | | | |
| Liquid | 3/74 | - | 0.097 | | | |
| Solids | 3/74 | - | 56.3 | | | |
| Tank 106-S | | | | | | |
| Description | Date | Pu(g/l) | ¹³⁷ Cs(μCi/g)l | ¹³⁴ Cs(μCi/l) | ^{89,90} Sr(μCi/l) | |
| Liquid | 3/74 | - | 0.356 | - | - | |
| Solids | 6/4/75 | 2.71 X 10 ⁻⁵ | 200.0 | - | 0.69 | |
| Supernatant Liquid | 6/4/75 | 1.17 X 10 ⁻⁶ | 5.29 X 10 ⁵ | 2.02 X 10 ³ | 1.22 X 10 ³ | |
| Tank 107-S | | | | | | |
| Description | Date | Pu(g/l) | ¹³⁷ Cs(μCi/l) | ¹³⁴ Cs(μCi/l) | ^{89,90} Sr(μCi/l) | Total Organic Carbon (g/l) |
| Sludge | 7/1/74 | 7.20 X 10 ⁻² | 4.19 X 10 ⁴ | - | 4.84 X 10 ⁴ | - |
| Gelatinous Mixture | 8/78 | - | 2.26 X 10 ⁵ | - | - | 11.8 |
| Tank 108-S | | | | | | |
| Description | Date | Pu(g/l) | ¹³⁷ Cs(μCi/g) | | | |
| Liquid | 3/74 | - | 0.344 | | | |

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Draft A

Table 4-16. Summary of Tank Sampling Data.

| Tank 110-S | | | | | | | |
|----------------------------|------------------|------------------------------|--------------------------|--------------------------|----------------------------|--------------------------|------------------------------|
| Description | Date | Pu(g/l) | ¹³⁷ Cs(μCi/l) | ¹³⁴ Cs(μCi/l) | ^{89,90} Sr(μCi/l) | | |
| Sludge | 10/22/74 | 6.29 X 10 ⁻⁴ | 8.10 X 10 ⁻⁵ | 4.57 X 10 ⁻³ | 5.43 X 10 ⁻⁵ | | |
| Tank 111-S | | | | | | | |
| Description | Date | Pu(μCi/g) | ¹³⁷ Cs(μCi/g) | ¹³⁴ Cs(μCi/g) | ^{89,90} Sr(μCi/g) | ²⁴¹ Am(g/g) | Total Organic Carbon (g/l) |
| Salts | 2/2/78 - 6/27/78 | 1.10 X 10 ⁻⁷ | 129.0 | - | 13.0 | - | - |
| Core 1001-C | 2/2/78 - 6/27/78 | 3.60 X 10 ⁻¹⁰ g/g | 72.1 | 0.1 | 1.03 | 1.02 X 10 ⁻¹⁰ | 1.29 |
| Core 1003-C, 1004-C | 2/2/78 - 6/27/78 | 2.12 X 10 ⁻¹⁰ g/g | 180.0 | - | 1.2 | 4.03 X 10 ⁻¹¹ | 2.38 |
| Core 1009-C | 2/2/78 - 6/27/78 | 4.25 X 10 ⁻⁹ g/g | 109.0 | - | 1.71 | 4.23 X 10 ⁻¹¹ | 2.80 |
| Supernatant Liquid | 2/2/78 - 6/27/78 | 1.08 X 10 ⁻⁵ g/g | 6.82 X 10 ⁵ | 9.82 X 10 ² | 2.04 X 10 ⁴ | - | 6.0 |
| Supernatant of Core 1009-C | 2/2/78 - 6/27/78 | 8.95 X 10 ⁻⁶ g/g | 4.68 X 10 ⁵ | - | 2.51 X 10 ³ | - | 6.2 |
| Tank 101-SX | | | | | | | |
| Description | Date | Pu(g/l) | ¹³⁷ Cs(μCi/l) | ¹³⁴ Cs(μCi/l) | ^{89,90} Sr(μCi/l) | Sr(μCi/l) | Total Organic Carbon (g/l) |
| Liquid Supernatant | 1978 | 2.14 X 10 ⁻⁷ | 6.68 X 10 ⁵ | - | 5.17 X 10 ² | | |
| Supernatant | 7/80 | 2.55 X 10 ⁻⁶ | 4.27 X 10 ⁴ | - | - | | |
| Liquid | 4/26/89 | <0.3 | 2.85 X 10 ⁴ | - | 2.2 | 13.1 | 0.32 |
| Tank 102-SX | | | | | | | |
| Description | Date | Pu(g/l) | ¹³⁷ Cs(μCi/l) | ¹³⁴ Cs(μCi/l) | ^{89,90} Sr(μCi/l) | ⁶⁰ CO(μCi/l) | ^{154,155} Eu(μCi/l) |
| Liquids | 5/9/75 | - | 3.24 X 10 ⁵ | 1.66 X 10 ³ | - | - | 2.89 X 10 ² |
| Solids | 5/9/75 | 2.73 X 10 ⁻³ | 3.43 X 10 ⁴ | 3.11 X 10 ² | 1.09 X 10 ⁻⁵ | 6.55 X 10 ² | 4.7 X 10 ³ |
| Solids | 8/17/77 | 2.3 X 10 ⁻³ | 2.7 X 10 ⁵ | - | 1.3 X 10 ⁵ | - | - |

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Table 4-16. Summary of Tank Sampling Data.

| Tank 103-SX | | | | | | | | | |
|--------------------|----------|-------------------------|--------------------------|----------------------------|----------------------------|----------------------------|----------------------------|--------------------------|----------------------------|
| Description | Date | Pu(g/l) | ¹³⁷ Cs(μCi/l) | ¹³⁴ Cs(μCi/l) | ^{89,90} Sr(μCi/l) | Total Organic Carbon (g/l) | | | |
| Sludge | 4/11/75 | 9.73 X 10 ⁻³ | 2.29 X 10 ⁵ | 4.85 X 10 ³ | 2.63 X 10 ⁶ | 9.0 | | | |
| Supernatant Liquid | 4/11/75 | 2.23 X 10 ⁻⁶ | 2.96 X 10 ⁵ | 1.13 X 10 ³ | 1.87 X 10 ³ | - | | | |
| Supernatant Liquid | 10/10/77 | - | 3.4 X 10 ⁵ | 6.5 X 10 ² | 7.3 X 10 ³ | - | | | |
| Solid | 10/10/77 | 2.2 X 10 ⁻⁴ | 3.5 X 10 ⁵ | 6.4 X 10 ² | 1.5 X 10 ⁵ | 92.0 | | | |
| Tank 104-SX | | | | | | | | | |
| Description | Date | Pu(μCi/l) | ¹³⁷ Cs(μCi/l) | ¹³⁴ Cs(μCi/l) | ^{89,90} Sr(μCi/l) | ph | Total Organic Carbon (g/l) | | |
| Liquid | 5/14/88 | 0.7 ± 20% | 4.5 X 10 ⁵ | - | 3 X 10 ² ± 20% | 13.0 | 5.0 | | |
| Tank 106-SX | | | | | | | | | |
| Description | Date | Pu(g/gal) | ¹³⁷ Cs(μCi/l) | ¹³⁴ Cs(μCi/l) | ^{89,90} Sr(μCi/l) | ⁶⁰ Co(μCi/l) | ¹⁵⁴ Eu(μCi/l) | ¹⁵⁵ Eu(μCi/l) | Total Organic Carbon (g/l) |
| Supernatant | 4/18/78 | - | 3.8 X 10 ⁵ | 8.32 X 10 ² | 1.05 X 10 ⁵ | 2.03 X 10 ³ | 1.97 X 10 ³ | 4.46 X 10 ³ | 6.8 |
| Solid | 4/18/78 | 1.88 X 10 ⁷ | 1.62 X 10 ² | 0.350 | 38.5 | 0.934 | 1.06 | 2.68 | |
| Tank 111-SX | | | | | | | | | |
| Description | Date | Pu(g/l) | ¹³⁷ Cs(μCi/l) | ¹³⁴ Cs(μCi/l) | ^{89,90} Sr(μCi/l) | | | | |
| Sludge | 8/1/75 | 1.31 X 10 ⁻³ | 2.15 X 10 ⁵ | - | 3.38 X 10 ⁶ | | | | |
| Supernatant Liquid | 8/1/75 | <1.17 | 1.59 X 10 ⁵ | 5.92 X 10 ² | 80.3 | | | | |
| Tank 101-SY | | | | | | | | | |
| Description | Date | Pu(g/l) | ¹³⁷ Cs(μCi/l) | ^{89,90} Sr(μCi/l) | Total Organic Carbon (g/l) | | | | |
| Liquid | 11/88 | 0.16 | 3900 | 1.75 | 0.212 | | | | |
| Liquid | 11/88 | 5.94 | 7.7 X 10 ⁴ | 190 | 2.2 | | | | |
| Sludge: Wet | 11/18/90 | <3.9 X 10 ⁻³ | 434 | 13 | - | | | | |
| Sludge: Dry | 11/18/90 | <3.1 X 10 ⁻³ | 315 | 23 | - | | | | |
| Sludge: Loose | 11/18/90 | <7.3 X 10 ⁻³ | 469 | 98 | - | | | | |

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Table 4-16. Summary of Tank Sampling Data.

| Tank 103-SY | | | | | | | |
|-------------------------|---------|---------|--------------------------|----------------------------|------------------------|----------------------------|--|
| Description | Date | Pu(g/l) | ¹³⁷ Cs(μCi/l) | ^{89,90} Sr(μCi/l) | Am | Total Organic Carbon (g/l) | |
| Surface Sample: Slurry | 6/24/85 | 8.28 | 6.01 X 10 ⁻⁵ | 3.21 X 10 ⁻³ | <2.94 | 20.11 | |
| Solids | 6/24/85 | <1 | <1 | <1 | <1 | 6 | |
| Middle Sample: Filtrate | 7/2/85 | - | 4.15 X 10 ⁻⁵ | 6.85 X 10 ⁻³ | 7.15 | 9.43 | |
| Solids | 7/2/85 | <1 | <1 | <1 | - | 19 | |
| Slurry | 7/2/85 | 1.57 | 4.27 X 10 ⁻⁶ | 5.78 X 10 ⁻³ | 3.67 | 50.7 | |
| Bottom Sample: Filtrate | 7/2/85 | * | 8.13 X 10 ⁻⁵ | 3.93 X 10 ⁻³ | 1.01 X 10 ¹ | 17.35 | |
| Solids | 7/2/85 | * | <1 | * | * | 14 | |
| Slurry | 7/2/85 | * | 1.19 X 10 ⁻⁶ | 2.14 X 10 ⁻³ | 5.49 | 61.4 | |

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* Insufficient Sample

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Table 4-17. Candidate Contaminants of Potential Concern for the S Plant Aggregate Area.
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| RADIONUCLIDES | FISSION PRODUCTS | FISSION PRODUCTS |
|-------------------|--------------------|------------------------|
| Gross alpha | Iodine-131* | Tritium |
| Gross beta | Krypton-85 | Yttrium-90 |
| | Lanthanum | Zirconium-93 |
| | Lead-209 | Zirconium-95* |
| TRANSURANICS | Lead 210 | |
| Americium-241 | Lead 211 | HEAVY METALS |
| Americium-242 | Lead 212* | Aluminum |
| Americium-242m | Lead-214 | Barium |
| Americium-243 | Nickel 63 | Bismuth |
| Curium-242 | Niobium-93m | Cadmium |
| Curium-244 | Niobium-95* | Chromium |
| Curium-245 | Neodymium | Copper |
| Neptunium-237 | Polonium-210 | Iron |
| Neptunium-239 | Polonium-213* | Lanthanum |
| Plutonium | Polonium-214 | Lead |
| Plutonium-238 | Polonium-215 | Manganese |
| Plutonium-239/240 | Polonium-218 | Nickel |
| Plutonium-241 | Praseodymium | Silver |
| URANIUM | Promethium-147 | Strontium |
| Uranium | Protactinium-233* | Tin |
| Uranium-233 | Protactinium-234m* | Titanium |
| Uranium-234 | Radium | Uranium |
| Uranium-236 | Radium-223 | Vanadium |
| Uranium-236 | Radium-225 | Zinc |
| Uranium-238 | Radium-226 | |
| | Radium-228 | OTHER INORGANICS |
| FISSION PRODUCTS | Rhodium-106* | Acetate |
| Actinium-225 | Ruthenium-103* | Aluminum nitrate |
| Actinium-227 | Ruthenium-106 | Aluminum oxide |
| Antimony-126 | Samarium-151 | Ammonium fluoride |
| Antimony-126m | Selenium-79 | Ammonium hydroxide |
| Astifine-217* | Strontium-90 | Ammonium ion |
| Barium-135m* | Technetium-99 | Ammonium nitrate |
| Barium-137m | Tellurium-121* | Ammonium oxalate |
| Bismuth-210 | Tellurium-125m* | Boric acid |
| Carbon-14 | Tellurium-127* | Boron |
| Cerium-141 | Tellurium-129m* | Calcium |
| Cerium-144 | Thallium-207 | Carbon |
| Cesium-134 | Thallium-208 | Carbonate |
| Cesium-135 | Thorium-227 | Ceric ammonium nitrate |
| Cesium-137 | Thorium-229 | Ceric sulfate |
| Francium-221 | Thorium-230 | Chloride |
| Francium-223* | Thorium-231 | Chromic nitrate |
| Iodine-129 | Thorium-234 | |

9 3 1 9 3 6 5 1 5 4 4

Table 4-17. Candidate Contaminants of Potential Concern for the S Plant Aggregate Area.
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| | | |
|-----------------------------------|----------------------------|--|
| OTHER INORGANICS | OTHER INORGANICS | SEMIVOLATILE ORGANICS |
| Di (2-ethylhexyl) phosphoric acid | Sodium bismuthate | Bromonaphthalene |
| Ferrous ammonium sulfate | Sodium carbonate | Butylated hydroxy toluene |
| Ferrous sulfamate | Sodium dichromate | Citrate |
| Ferrous sulfate | Sodium fluoride | Ethylene diamine tetraacetate (EDTA) |
| Fluoride | Sodium hydroxide | Methyl isobutyl carbinol |
| Hydrazine | Sodium metasilicate | Methyl isopropyl diketone |
| Hydrochloric acid | Sodium nitrate | N-(2-hydroxyethyl) ethylenediaminetriacetate (HEDTA) |
| Hydrofluoric acid | Sodium nitrite | O-phenanthroline |
| Hydrogen | Sodium ruthenium tetroxide | Paraffin hydrocarbons |
| Hydroxylamine hydrochloride | Sulfamic acid | S-diphenyl carbazide |
| Hydroxyquinoline | Sulfamic acid Sulfate | Tri-iso-octylamine |
| Lead nitrate | Sulfuric acid | Tri-n-octylamine |
| Magnesium | Tetraphenyl boron | |
| Manganese oxide | Titanium chloride | |
| Mercuric nitrate | Tributyl phosphate | |
| Mercuric thiocyanate | Uranyl nitrate | |
| Mistron | Uranyl nitrate hexahydrate | |
| Molybdate - Citrate reagent | Xenon | |
| Nitrate | Zinc amalgam | |
| Nitric acid | Zirconium oxide | |
| Nitrogen | VOLATILE ORGANICS | |
| Nitrogen dioxide | Acetone | |
| Nitric oxide | Chloroform | |
| Oxalic acid | MIBK ("Hexone") | |
| Phosphate | Propane | |
| Potassium | Periodic acid | |
| Potassium dichromate | Tetrabromoethane | |
| Potassium fluoride | Xylene | |
| Potassium oxalate | | |
| Potassium permanganate | | |
| Ruthenium tetroxide | | |
| Silica | | |
| Silicon | | |
| Silver iodide | | |
| Silver nitrate | | |
| Sodium | | |
| Sodium aluminate | | |

* The radionuclide has a half-life of <1 year and if it is daughter product, the parent has a half-life of <1 year, or the buildup of the shortlived daughter would result in an activity of <1% of the parent radionuclides' initial activity.

9 0 1 2 3 4 5 6 7 8

Table 4-18. Contamination Types Expected at Each Waste Management Unit and Unplanned Release Types. Page 1 of 8

| Waste Management Unit or Unplanned Release | TRU | Fission Products | Uranium | Heavy Metals | Other Inorganics | Volatiles | Semi-volatiles |
|---|-----|------------------|---------|--------------|------------------|-----------|----------------|
| Plants, Buildings, and Storage Areas | | | | | | | |
| 291-S Stack Complex | S | K | S | S | S | K | S |
| Tanks and Vaults | | | | | | | |
| 241-S Tank Farm | K | K | K | K | K | S | S |
| 241-S-101 Single-Shell Tank | K | K | K | K | K | S | S |
| 241-S-102 Single-Shell Tank | K | K | K | K | K | S | S |
| 241-S-103 Single-Shell Tank | K | K | K | S | S | S | S |
| 241-S-104 Single-Shell Tank | K | K | K | S | S | S | S |
| 241-S-105 Single-Shell Tank | K | K | K | S | K | S | S |
| 241-S-106 Single-Shell Tank | K | K | K | S | K | S | S |
| 241-S-107 Single-Shell Tank | K | K | K | K | K | S | S |
| 241-S-108 Single-Shell Tank | K | K | K | S | S | S | S |
| 241-S-109 Single-Shell Tank | K | K | K | S | K | S | S |
| 241-S-110 Single-Shell Tank | K | K | K | K | K | S | S |
| 241-S-111 Single-Shell Tank | K | K | K | K | K | S | S |
| 241-S-112 Single-Shell Tank | K | K | K | S | K | S | S |
| 241-SX Tank Farm | K | K | K | S | K | S | S |
| 241-SX-101 Single-Shell Tank | K | K | K | S | K | S | S |
| 241-SX-102 Single-Shell Tank | K | K | K | K | K | S | S |

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Table 4-18. Contamination Types Expected at Each Waste Management Unit and Unplanned Release Types. Page 2 of 8

| Waste Management Unit or Unplanned Release | TRU | Fission Products | Uranium | Heavy Metals | Other Inorganics | Volatiles | Semi-volatiles |
|--|-----|------------------|---------|--------------|------------------|-----------|----------------|
| 241-SX-103 Single-Shell Tank | K | K | K | K | K | S | S |
| 241-SX-104 Single-Shell Tank | K | K | K | K | K | S | S |
| 241-SX-105 Single-Shell Tank | K | K | K | K | K | S | S |
| 241-SX-106 Single-Shell Tank | K | K | K | S | S | S | S |
| 241-SX-107 Single-Shell Tank | K | K | K | S | S | S | S |
| 241-SX-108 Single-Shell Tank | K | K | K | S | K | S | S |
| 241-SX-109 Single-Shell Tank | K | K | K | S | S | S | S |
| 241-SX-110 Single-Shell Tank | K | K | K | S | S | S | S |
| 241-SX-111 Single-Shell Tank | K | K | K | K | K | S | S |
| 241-SX-112 Single-Shell Tank | K | K | K | S | S | S | S |
| 241-SX-113 Single-Shell Tank | K | K | K | S | S | S | S |
| 241-SX-114 Single-Shell Tank | K | K | K | S | S | S | S |
| 241-SX-115 Single-Shell Tank | K | K | K | K | K | S | S |
| 241-SY Tank Farm | K | K | K | S | S | S | S |
| 241-SY-101 Double-Shell Tank | K | K | K | S | S | S | S |
| 241-SY-102 Double-Shell Tank | K | K | K | S | S | S | S |
| 241-SY-103 Double-Shell Tank | K | K | K | S | S | S | S |
| 240-S-302 Catch Tank | K | S | S | S | S | K | S |
| 241-S-302A Catch Tank | S | S | S | S | S | S | S |

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Table 4-18. Contamination Types Expected at Each Waste Management Unit and Unplanned Release Types. Page 3 of 8

| Waste Management Unit or Unplanned Release | TRU | Fission Products | Uranium | Heavy Metals | Other Inorganics | Volatiles | Semi-volatiles |
|--|-----|------------------|---------|--------------|------------------|-----------|----------------|
| 241-S-302B Catch Tank | S | S | S | S | S | S | S |
| 241-SX-302 Catch Tank | S | S | S | S | S | S | S |
| 244-S Receiver Tank | S | S | S | S | S | S | S |
| Cribs and Drains | | | | | | | |
| 216-S-1 & -2 Crib/UPR-200-W-36 | K | K | K | S | K | S | S |
| 216-S-5 Crib | K | K | K | S | K | S | S |
| 216-S-6 Crib | K | K | K | S | K | S | S |
| 216-S-7 Crib | K | K | K | S | K | S | S |
| 216-S-9 Crib | K | K | K | S | K | S | S |
| 216-S-13 Crib | K | K | K | S | K | S | S |
| 216-S-20 Crib | K | K | K | S | K | S | S |
| 216-S-22 Crib | K | K | K | S | K | - | - |
| 216-S-23 Crib | K | K | K | S | K | S | S |
| 216-S-25 Crib | K | K | K | S | K | S | S |
| 216-S-26 Crib | K | K | K | S | K | S | S |
| 216-S-3 French Drain | K | K | K | K | K | K | K |
| Ponds, Ditches, and Trenches | | | | | | | |
| 216-S-10P Pond | K | K | K | S | S | S | S |
| 216-S-11 Pond | K | S | S | S | K | S | S |

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Table 4-18. Contamination Types Expected at Each Waste Management Unit and Unplanned Release Types. Page 4 of 8

| Waste Management Unit or Unplanned Release | TRU | Fission Products | Uranium | Heavy Metals | Other Inorganics | Volatiles | Semi-volatiles |
|--|-----|------------------|---------|--------------|------------------|-----------|----------------|
| 216-S-15 Pond | S | K | S | S | K | K | S |
| 216-S-16P Pond | K | K | S | S | S | S | S |
| 216-S-17 Pond | K | S | S | S | S | S | S |
| 216-S-19 Pond | K | K | K | S | K | K | K |
| 216-S-10D Ditch | K | K | K | K | K | K | K |
| 216-S-16D Ditch | K | S | S | S | K | S | S |
| 216-U-9 Ditch | K | S | S | S | S | S | S |
| 216-S-8 Trench | K | K | K | S | K | S | S |
| 216-S-12 Trench | K | K | S | S | K | S | S |
| 216-S-14 Trench | S | S | S | S | S | K | S |
| 216-S-18 Trench | S | S | S | S | S | K | S |
| Septic Tanks and Associated Drain Fields | | | | | | | |
| 2607-W6 Septic Tank and Tile Field | - | - | - | - | - | - | - |
| 2607-WZ Septic Tanks | - | - | - | - | - | - | - |
| Sanitary Crib | - | - | - | - | - | - | - |
| Transfer Facilities, Diversion Boxes, and Pipelines | | | | | | | |
| 216-S-172 Cont. Structure | S | S | S | S | S | S | S |
| 2904-S-160 Cont. Structure | S | S | S | S | S | S | S |
| 2904-S-170 Cont. Structure | S | S | S | S | S | S | S |

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Table 4-18. Contamination Types Expected at Each Waste Management Unit and Unplanned Release Types. Page 5 of 8

| Waste Management Unit or Unplanned Release | TRU | Fission Products | Uranium | Heavy Metals | Other Inorganics | Volatiles | Semi-volatiles |
|--|-----|------------------|---------|--------------|------------------|-----------|----------------|
| 2904-S-171 Cont. Structure | S | S | S | S | S | S | S |
| 240-S-151 Diversion Box | S | S | S | S | S | S | S |
| 240-S-152 Diversion Box | S | S | S | S | S | S | S |
| 241-S-151 Diversion Box | S | S | S | S | S | S | S |
| 241-S-152 Diversion Box | S | S | S | S | S | S | S |
| 241-SX-151 Diversion Box | S | S | S | S | S | S | S |
| 241-SX-152 Diversion Box | S | S | S | S | S | S | S |
| 241-S-A Valve Pit | S | S | S | S | S | S | S |
| 241-S-B Valve Pit | S | S | S | S | S | S | S |
| 241-S-C Valve Pit | S | S | S | S | S | S | S |
| 241-S-D Valve Pit | S | S | S | S | S | S | S |
| 241-SX-A Valve Pit | S | S | S | S | S | S | S |
| 241-SX-B Valve Pit | S | S | S | S | S | S | S |
| 241-SY-A Valve Pit | S | S | S | S | S | S | S |
| 241-SY-B Valve Pit | S | S | S | S | S | S | S |
| Basins | | | | | | | |
| 207-S Retention Basin | S | K | S | S | S | S | S |
| 207-SL Retention Basin | K | K | K | K | K | K | K |

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Table 4-18. Contamination Types Expected at Each Waste Management Unit and Unplanned Release Types. Page 6 of 8

| Waste Management Unit or Unplanned Release | TRU | Fission Products | Uranium | Heavy Metals | Other Inorganics | Volatiles | Semi-volatiles |
|--|-----|------------------|---------|--------------|------------------|-----------|----------------|
| Burial Sites | | | | | | | |
| 218-W-7 Burial Ground | K | K | S | S | S | S | S |
| 218-W-9 Burial Ground | K | K | - | S | - | S | S |
| Unplanned Releases | | | | | | | |
| UN-200-W-10 | - | - | S | - | - | - | - |
| UN-200-W-30 | S | S | S | S | S | S | S |
| UN-200-W-32 | - | - | - | - | K | - | - |
| UN-200-W-34 | S | S | S | S | S | S | S |
| UN-200-W-35 | S | S | S | S | S | S | S |
| UN-200-W-41 | S | S | S | S | S | S | S |
| UN-200-W-42 | S | S | S | - | - | - | - |
| UN-200-W-43 | S | S | S | - | - | - | - |
| UN-200-W-49 | S | S | S | - | - | - | - |
| UN-200-W-50 | S | S | S | - | - | - | - |
| UN-200-W-52 | S | S | S | S | S | S | S |
| UN-200-W-56 | S | S | S | S | S | S | S |
| UN-200-W-61 | S | S | S | S | S | S | S |
| UN-200-W-69 | S | S | S | - | - | - | - |
| UN-200-W-80 | S | S | S | S | S | S | S |

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Table 4-18. Contamination Types Expected at Each Waste Management Unit and Unplanned Release Types. Page 7 of 8

| Waste Management Unit or Unplanned Release | TRU | Fission Products | Uranium | Heavy Metals | Other Inorganics | Volatiles | Semi-volatiles |
|--|-----|------------------|---------|--------------|------------------|-----------|----------------|
| UN-200-W-81 | S | S | S | - | - | - | - |
| UN-200-W-82 | S | S | S | S | S | S | S |
| UN-200-W-83 | S | S | S | - | - | - | - |
| UN-200-W-108 | S | S | S | S | S | S | S |
| UN-200-W-109 | S | S | S | S | S | S | S |
| UN-200-W-114 | S | S | S | - | - | - | - |
| UN-200-W-116 | S | S | S | - | - | - | - |
| UN-200-W-123 | S | S | S | S | S | S | S |
| UN-200-W-127 | S | S | S | S | S | S | S |
| UN-216-W-25 (Rad Emmission) | S | S | S | S | S | S | S |
| UN-216-W-30 | S | S | S | - | - | - | - |
| UPR-200-W-13 | S | S | S | S | S | S | S |
| UPR-200-W-15 | S | S | S | S | S | S | S |
| UPR-200-W-20 | S | S | S | S | S | S | S |
| UPR-200-W-36 | S | S | S | S | S | S | S |
| UPR-200-W-47 | S | S | S | S | S | S | S |
| UPR-200-W-51 | S | S | S | S | S | S | S |
| UPR-200-W-57 | - | - | - | - | - | - | - |
| UPR-200-W-59 | S | S | S | S | S | S | S |

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Table 4-18. Contamination Types Expected at Each Waste Management Unit and Unplanned Release Types. Page 8 of 8

| Waste Management Unit or Unplanned Release | TRU | Fission Products | Uranium | Heavy Metals | Other Inorganics | Volatiles | Semi-volatiles |
|--|-----|------------------|---------|--------------|------------------|-----------|----------------|
| UPR-200-W-87 | - | - | - | - | - | - | - |
| UPR-200-W-95 | S | S | S | S | S | S | S |
| UPR-200-W-96 Spill | K | S | S | S | S | S | S |
| UPR-200-W-124 | S | S | S | S | S | S | S |
| UPR-200-W-139 | S | S | S | S | S | S | S |
| UPR-200-W-140 | S | S | S | S | S | S | S |
| UPR-200-W-141 | S | S | S | S | S | S | S |
| UPR-200-W-142 | S | S | S | S | S | S | S |
| UPR-200-W-143 | S | S | S | S | S | S | S |
| UPR-200-W-144 | S | S | S | S | S | S | S |
| UPR-200-W-145 | S | S | S | S | S | S | S |
| UPR-200-W-146 | S | S | S | S | S | S | S |

K - Contaminant known to be present.

S - Contaminant suspected to be present.

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Table 4-19. Contaminants of Potential Concern for the S Plant Aggregate Area.

| | | |
|-------------------------|-------------------------|------------------------------|
| RADIONUCLIDES | FISSION PRODUCTS | OTHER INORGANICS |
| Gross alpha | Krypton-85 | Ammonium ion |
| Gross beta | Lead-209 | Boron |
| | Lead-210 | Fluoride |
| TRANSURANICS | Lead-211 | Nitrate/Nitrite |
| Americium-241 | Lead-212 | Uranium |
| Americium-242 | Lead-214 | |
| Americium-242m | Niobium-93m | VOLATILE ORGANICS |
| Americium-243 | Polonium-214 | Acetone |
| Curium-242 | Polonium-215 | Chloroform |
| Curium-244 | Polonium-218 | MIBK |
| Curium-245 | Promethium-147 | Xylene |
| Neptunium-237 | Protactinium-231 | |
| Neptunium-239 | Protactinium-234m | SEMIVOLATILE ORGANICS |
| Plutonium-238 | Radium-225 | Hydrazine |
| Plutonium-239/240 | Radium-226 | |
| Plutonium-241 | Radium-228 | |
| | Ruthenium-106 | |
| URANIUM | Samarium-151 | |
| Uranium-233 | Selenium-79 | |
| Uranium-234 | Strontium-90 | |
| Uranium-235 | Technetium-99 | |
| Uranium-236 | Thallium-207 | |
| Uranium-238 | Thallium-208 | |
| | Thorium-227 | |
| FISSION PRODUCTS | Thorium-229 | |
| Actinium-225 | Thorium-230 | |
| Actinium-227 | Thorium-231 | |
| Antimony-126 | Tritium | |
| Antimony-126m | Yttrium-90 | |
| Barium-137m | Zirconium-93 | |
| Bismuth-210 | | |
| Bismuth-211 | HEAVY METALS | |
| Bismuth-213 | Barium | |
| Bismuth-214 | Cadmium | |
| Carbon-14 | Chromium | |
| Cesium-134 | Copper | |
| Cesium-135 | Iron | |
| Cesium-137 | Lead | |
| Cobalt-60 | Manganese | |
| Europium-152 | Nickel | |
| Europium-154 | Silver | |
| Europium-155 | Titanium | |
| Francium-221 | Vanadium | |
| Iodine-129 | Zinc | |

9 0 1 2 3 4 5 6 7 8 9

Table 4-20. Soil-Water Distribution Coefficient K_d for Radionuclides^{1/} and Inorganics of Concern at S Plant Aggregate Area Waste Management Units. Page 1 of 2

| Element or Chemical | Recommended K_d for Hanford Site (Seme and Wood 1990) in mL/g | Conservative Default K_d ^{2/} (Seme and Wood 1990) in mL/g | MEPAS Default K_d pH 6-9 ^{2/} (Streng and Peterson 1989) in mL/g | Mobility Class |
|---------------------------|---|---|---|----------------|
| Actinium | - | - | 228 | low |
| Americium | 2 100 - 1000 (<1 @ pH 1-3) | 100 | 82 | low |
| Antimony | — | — | 2 | high |
| Barium | — | 50 | 530 | moderate |
| Bismuth | - | 20 | - | moderate |
| Boron | - | - | 0.19 | high |
| Cadmium | — | 15 | 14.9 | moderate |
| Carbon (¹⁴ C) | — | — | 0 | high |
| Cesium | 200 - 1,000 1 - 200 (acidic waste) | 50 | 51 | low |
| Chromium | - | 0 | 16.8 | moderate |
| Cobalt | 500 - 2000 | 10 | 1.9 | low |
| Copper | - | 15 | 41.9 | moderate |
| Curium | 100 - >2,000 | 100 | 82 | low |
| Cyanide | - | - | - | unknown |
| Europium | — | — | 228 | low |
| Fluoride | — | — | 0 | high |
| Francium | - | - | - | unknown |
| Iodine | <1 | 0 | 0 | high |
| Iron | — | 20 | 15 | moderate |
| Krypton | - | - | - | unknown |
| Lead | — | 30 | 234 | moderate |
| Manganese | — | 20 | 16.5 | moderate |
| Neptunium | $<1-5$ | 3 | 3 | high |
| Nickel | — | 15 | 12.2 | moderate |
| Niobium | — | — | 50 | moderate |
| Nitrate/nitric acid | — | — | 0 | high |
| Plutonium | 100 - 1,000 <1 at pH 1 - 3 | 100 | 10 | low |

9 3 1 2 3 4 5 1 6 5 5

Table 4-20. Soil-Water Distribution Coefficient K_d for Radionuclides^{a/} and Inorganics of Concern at S Plant Aggregate Area Waste Management Units. Page 2 of 2

| Element or Chemical | Recommended K_d for Hanford Site (Seme and Wood 1990) in mL/g | Conservative Default K_d ^{b/} (Seme and Wood 1990) in mL/g | MEPAS Default K_d pH 6-9 ^{c/} (Streng and Peterson 1989) in mL/g | Mobility Class |
|---------------------|--|---|---|----------------|
| Polonium | — | — | 5.9 | high |
| Promethium | - | - | - | unknown |
| Protactinium | — | — | 0 | high |
| Radium | — | 20 | 24.3 | moderate |
| Ruthenium | 20 - 700 (<2 at >1 M nitrate) | — | 274 | moderate |
| Samarium | — | — | 228 | low |
| Selenium | — | 0 | 5.91 | moderate |
| Silver | - | 20 | 0.4 | moderate |
| Strontium | 5 - 100 3 - 5 (acidic conditions) 200 - 500 (w/phosphate or oxalate) | 10 | 24.3 | moderate |
| Technetium | 0 - 1 | 0 | 3 | high |
| Thallium | — | — | 0 | high |
| Thorium | - | 50 | 100 | moderate |
| Titanium | - | - | - | unknown |
| Tritium | 0 | 0 | 0 | high |
| Uranium | — | 0 | 0 | high |
| Vanadium | — | — | 50 | moderate |
| Yttrium | — | — | 278 | low |
| Zinc | — | 15 | 12.7 | moderate |
| Zirconium | - | 30 | 50 | moderate |

^{a/} Radionuclides with half-lives of greater than 3 months.

^{b/} Average K_D s 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).

9 3 1 2 3 5 1 5 5 6

Table 4-21. Mobility of Inorganic Species in Soil.

| Highly mobile ($K_d < 5$) | |
|---------------------------------------|--------------|
| Antimony | Protactinium |
| Boron | Selenium |
| Carbon (as $^{14}\text{CO}_2$) | Silver |
| Fluoride | Sodium |
| Iodine | Technetium |
| Neptunium | Thallium |
| Nitrate | Tritium |
| | Uranium |
| Moderately mobile ($5 < K_d < 100$) | |
| Arsenic | Nickel |
| Barium | Niobium |
| Bismuth | Polonium |
| Cadmium | Radium |
| Cesium | Strontium |
| Chromium | Thorium |
| Copper | Vanadium |
| Iron | Zinc |
| Lead | Zirconium |
| Manganese | |
| Low mobility ($K_d > 100$) | |
| Actinium | |
| Americium | |
| Cesium | |
| Cobalt | |
| Curium | |
| Europium | |
| Mercury | |
| Plutonium | |
| Ruthenium | |
| Samarium | |
| Yttrium | |

9 0 1 2 3 4 5 6 5 7

Table 4-22. Physical/Chemical Properties of Organic Contaminants of Concern for S Plant Waste Management Units.

| Compound | Molecular Weight in g/mole | Water Solubility in mg/l | Vapor Pressure in mm Hg | Henry's Law Constant in atm-m ³ /mo | Soil/Organic Matter Partition Coef. K _{oc} in ml/g |
|-------------------------------|----------------------------|--------------------------|-------------------------|--|---|
| Acetone | 58.0 | miscible | 270 | 2.7 x 10 ⁻⁵ | 2.2 |
| Ammonia | 17.03 | insoluble | 7,470 | 3.3 x 10 ⁻⁴ | -- |
| Chloroform (Trichloromethane) | 119.39 | 9,300 | 208 | 3.4 x 10 ⁻³ | -- |
| Methyl/isobutyl ketone | 100.16 | 19,000 | 6 | 4.2 x 10 ⁻⁵ | 19 |
| Propane | 44.0 | 2,000 | 780 | 2.2 x 10 ⁻² | -- |
| Tributyl phophate | 266.3 | 280 | 15 | 1.0 x 10 ⁻³ | 6,000 |
| Xylene | 106.2 | 200 | 10 | 7.0 x 10 ⁻³ | 240 |

Source: Streng and Peterson (1989).

9 3 1 9 2 5 1 5 8

Table 4-23. Radiological Properties of Potential Radionuclides of Concern in S Plant Aggregate Area Waste Management Units. Page 1 of 2

| Radionuclide | Half-Life | Specific Activity ^{a/} in Ci/g | Principal Radiation of Concern ^{b/} |
|--------------------|-----------------------|---|--|
| ²²⁵ Ac | 10 d | 5.8×10^4 | α |
| ²²⁷ Ac | 21.8 yr | 7.2×10^1 | β, α |
| 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 |
| ^{137m} Ba | 2.6 min | 5.3×10^8 | γ |
| 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 |
| ²⁴² Cm | 163.2 d | 3.3×10^3 | α |
| ²⁴⁴ Cm | 18.1 yr | 8.1×10^1 | α |
| ²⁴⁵ Cm | 8,500 yr | 1.7×10^{-1} | α, γ |
| ⁶⁰ Co | 5.3 yr | 1.1×10^3 | γ |
| ¹³⁴ Cs | 2.06 yr | 1.3×10^3 | γ |
| ¹³⁵ Cs | 3×10^6 yr | 8.8×10^{-4} | β |
| ¹³⁷ Cs | 30 yr | 8.7×10^1 | γ |
| ¹⁵² Eu | 13.3 yr | 7.7×10^2 | β, γ' |
| ¹⁵⁴ Eu | 8.8 yr | 2.7×10^2 | β, γ' |
| ¹⁵⁵ Eu | 4.96 yr | 4.6×10^2 | β, γ |
| ²²¹ Fr | 4.8 min | 1.8×10^8 | α, γ |
| ¹²⁹ I | 1.6×10^7 yr | 1.7×10^{-4} | β |
| ⁸⁵ Kr | 10.7 yr | 2.8×10^6 | β, γ |
| ^{93m} Nb | 14.6 yr | 2.8×10^2 | γ' |
| ²³⁷ Np | 2.14×10^6 yr | 7.0×10^{-4} | α, γ |
| ²³⁹ Np | 2.35 d | 2.3×10^5 | β |
| ²³¹ Pa | 32,800 yr | 4.7×10^{-2} | α |
| ^{234m} Pa | 1.2 min | 6.7×10^8 | β, γ |
| 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 |

Table 4-23. Radiological Properties of Potential Radionuclides of Concern in S Plant Aggregate Area Waste Management Units. Page 2 of 2

| Radionuclide | Half-Life | Specific Activity ^{a/} in Ci/g | Principal Radiation of Concern ^{b/} |
|--------------------|----------------------------|---|--|
| ²¹² Pb | 10.6 hr | 1.4 x 10 ⁶ | β, γ ^{c/} |
| ²¹⁴ Pb | 26.8 min | 3.3 x 10 ⁷ | β, γ ^{c/} |
| ¹⁴⁷ Pm | 2.6 yr | 2.0 x 10 ⁷ | β |
| ²¹⁴ Po | 6 x 10 ⁻⁵ sec | 8.8 x 10 ¹⁴ | α |
| ²¹⁵ Po | 7.8 x 10 ⁻⁴ sec | 2.9 x 10 ¹³ | α |
| ²¹⁸ Po | 3.05 min | 2.8 x 10 ⁸ | α |
| ²³⁸ Pu | 87.7 yr | 1.7 x 10 ¹ | α |
| ²³⁹ Pu | 24,400 yr | 6.2 x 10 ⁻² | α |
| ²⁴⁰ Pu | 6,560 yr | 2.3 x 10 ⁻¹ | α |
| ²⁴¹ Pu | 14.4 yr | 1.0 x 10 ² | β |
| ²²⁵ Ra | 14.8 d | 3.9 x 10 ⁴ | β |
| ²²⁶ Ra | 1,600 yr | 9.9 x 10 ⁻¹ | α |
| ²²⁸ Ra | 6.7 yr | 1.2 x 10 ⁷ | β |
| ¹⁰⁶ Ru | 1.0 yr | 3.4 x 10 ³ | β, γ ^{c/} |
| ^{126m} Sb | 12.4 d | 1.3 x 10 ⁹ | β, γ |
| ⁷⁹ Se | <65,000 yr | 7.0 x 10 ⁻² | β |
| ¹⁵¹ Sm | 90 yr | 2.6 x 10 ¹ | β |
| ⁹⁰ Sr | 28.5 yr | 1.4 x 10 ² | β |
| ⁹⁹ Tc | 213,000 yr | 1.7 x 10 ⁻² | β |
| 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 |
| ²⁰⁷ Tl | 4.8 min | 1.9 x 10 ⁸ | β, γ |
| 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 | 2.342 x 10 ⁷ yr | 3.6 x 10 ⁰ | α, γ |
| ²³⁸ U | 4.5 x 10 ⁹ yr | 3.4 x 10 ⁻⁷ | α |
| ⁹⁰ Y | 6.41 hr | 5.4 x 10 ⁵ | β |
| ⁹³ Zr | 1.5 x 10 ⁶ yr | 2.6 x 10 ⁻³ | β |

^{a/} Calculated from half-life and atomic weight.

^{b/} α - alpha decay; β - negative beta decay; γ - release of gamma rays.

^{c/} Daughter radiation.

Table 4-24. Comparison of Radionuclide Relative Risks for Radionuclides of Concern at the S Plant Aggregate Area.

Page 1 of 2

| Radionuclide | Half-Life | 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 |
| ²⁴² Am | 16 hr | na | na | na | na |
| ^{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 |
| 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 |
| ²⁴² Cm | 163.2 d | na | na | na | na |
| 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 | (3.4 x 10 ⁻⁴) ^f |
| 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 |
| 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 |
| ^{93m} Nb | 14.6 yr | na | na | na | na |
| 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 | 2.35 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 |
| ²¹² Pb | 10.6 hr | 2.4 x 10 ⁻⁵ | 3.7 x 10 ⁻⁷ | 1.9 x 10 ⁻⁸ | 9.2 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 |
| 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 |
| ²³⁹ 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 |
| 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 |
| ²⁴¹ Pu | 14.4 yr | 1.5 x 10 ⁻⁴ | 2.5 x 10 ⁻⁷ | 1.3 x 10 ⁻⁸ | 0 |
| ²²⁵ Ra | 14.8 d | 8.2 x 10 ⁻⁴ | 3.4 x 10 ⁻⁶ | 1.8 x 10 ⁻⁷ | 8.0 x 10 ⁻⁶ |
| ²²⁶ Ra | 1,600 yr | 1.5 x 10 ⁻³ | 6.1 x 10 ⁻⁶ | 3.2 x 10 ⁻⁷ | 4.1 x 10 ⁻⁶ |
| ²²⁸ Ra | 5.75 yr | 3.4 x 10 ⁻⁴ | 5.1 x 10 ⁻⁶ | 2.7 x 10 ⁻⁷ | 5.6 x 10 ⁻¹³ |

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Table 4-24. Comparison of Radionuclide Relative Risks for Radionuclides of Concern at the S Plant Aggregate Area.

| Radionuclide | Half-Life | 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 |
|-------------------|--------------------------|---|--|--|---|
| ¹⁰⁶ Ru | 1.0 yr | 2.3 x 10 ⁻⁴ | 4.9 x 10 ⁻⁷ | 2.6 x 10 ⁻⁸ | 0 |
| ⁷⁹ Se | <65,000 yr | na | na | na | na |
| ¹⁵¹ Sm | 90 yr | na | na | na | na |
| ⁹⁰ Sr | 28.5 yr | 2.8 x 10 ⁻⁵ | 1.7 x 10 ⁻⁶ | 8.9 x 10 ⁻⁸ | 0 |
| ⁹⁹ Tc | 213,000 yr | 4.2 x 10 ⁻⁶ | 6.6 x 10 ⁻⁸ | 3.5 x 10 ⁻⁹ | 3.4 x 10 ⁻¹⁰ |
| ²²⁷ Th | 18.72 d | 2.5 x 10 ⁻³ | 2.5 x 10 ⁻⁷ | 1.3 x 10 ⁻⁸ | 6.6 x 10 ⁻⁶ |
| ²²⁹ Th | 7,340 yr | 3.9 x 10 ⁻² | 2.0 x 10 ⁻⁶ | 1.1 x 10 ⁻⁷ | 5.8 x 10 ⁻⁵ |
| ²³⁰ Th | 77,000 yr | 1.6 x 10 ⁻² | 1.2 x 10 ⁻⁶ | 6.5 x 10 ⁻⁸ | 5.9 x 10 ⁻⁷ |
| ²³¹ Th | 25.5 hr | 2.5 x 10 ⁻⁷ | 2.0 x 10 ⁻⁸ | 1.1 x 10 ⁻⁹ | 1.1 x 10 ⁻⁵ |
| ²³³ U | 159,000 yr | 1.4 x 10 ⁻² | 7.2 x 10 ⁻⁶ | 3.8 x 10 ⁻⁷ | 3.2 x 10 ⁻⁷ |
| ²³⁴ U | 244,500 yr | 1.4 x 10 ⁻² | 7.2 x 10 ⁻⁶ | 3.8 x 10 ⁻⁷ | 5.6 x 10 ⁻⁷ |
| ²³⁵ U | 7.0 x 10 ⁸ yr | 1.3 x 10 ⁻² | 6.6 x 10 ⁻⁶ | 3.5 x 10 ⁻⁷ | 9.7 x 10 ⁻⁵ |
| ²³⁸ U | 4.5 x 10 ⁹ yr | 1.2 x 10 ⁻² | 6.6 x 10 ⁻⁶ | 3.5 x 10 ⁻⁷ | 4.5 x 10 ⁻⁷ |
| ⁹⁰ Y | 64.1 hr | 2.8 x 10 ⁻⁵ | 1.6 x 10 ⁻⁷ | 8.6 x 10 ⁻⁹ | 0 |

^a Calculated from half-life and atomic weight.

^b Excess cancer risk associated with lifetime exposure to 1 pCi/m³ (10⁻¹² curies) per day in air (EPA 1991).

^c Excess cancer risk associated with lifetime exposure to 1 pCi (10⁻¹² curies) per day in drinking water (EPA 1991).

^d Excess cancer risk associated with lifetime exposure to 1 pCi/g (10⁻¹² curies/g) per day in soil (EPA 1991).

^e Excess cancer risk associated with lifetime exposure to surface soils containing 1 pCi/g of gamma-emitting radionuclides (EPA 1991).

^f External radiation risk from ^{137m}Ba, a short-lived decay product of ¹³⁷Cs.

na No information available.

9 0 1 2 3 4 5 6 7 8

Table 4-25. Potential Chronic Health Effects of Chemicals Detected or Disposed of at S Plant Aggregate Area Waste Management Units. Page 1 of 2

| Chemical | Tumor Site Inhalation Route; Oral Route [Weight of Evidence Group ^a] | Non-carcinogenic Chronic Health Effects Inhalation Route; Oral Route |
|--|--|--|
| INORGANIC CHEMICALS^b | | |
| Ammonium ion | NA; NA | decreased pulmonary function; degrades odor; taste of water |
| Barium | NA; NA | fetotoxicity; increased blood pressure |
| Boron | NA; NA | NA; testicular lesions |
| Cadmium | respiratory tract [B1]; NA | cancer; renal damage |
| Chromium | lung [A] - Cr(VI) only; NA | nasal mucosa atrophy; hepatotoxicity |
| Copper | NA; NA | NA; gastrointestinal irritation |
| Fluoride | NA; NA | NA; dental flurosis at high levels |
| Hydrazine | nasal cavity [B2]; liver [B2] | NA; NA |
| Lead | [B2] ^c ; [B2] | central nervous system (CNS) effects ^c ; CNS effects |
| Mercury | NA; NA | neurotoxicity; kidney effects |
| Nickel | respiratory tract [A]; NA | cancer; reduced weight gain |
| Nitrate/Nitrite | NA; NA | NA; methemoglobinemia in infants ^d |
| Uranium (soluble salts) | NA; NA | NA; body weight loss, nephrotoxicity |
| Zinc | NA; NA | NA; anemia |

9 3 1 2 0 5 1 6 6 3

Table 4-25. Potential Chronic Health Effects of Chemicals Detected or Disposed of at S Plant Aggregate Area Waste Management Units. Page 2 of 2

| Chemical | Tumor Site Inhalation Route; Oral Route [Weight of Evidence Group ^{a/}] | Non-carcinogenic Chronic Health Effects Inhalation Route; Oral Route |
|---------------------------------|---|--|
| ORGANIC CHEMICALS ^{b/} | | |
| Acetone | NA; NA | NA; kidney and liver effects |
| Chloroform | liver; kidney [B2] | NA; liver lesions |
| Methyl isobutyl ketone (MIBK) | NA; NA | liver and kidney effects; liver and kidney effects |
| Xylene | NA; NA | CNS effects, nose, throat, irritation; reduced weight gain |

^{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/} Only chemicals, inorganic or organic, with known health effects are presented.

^{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.

NA = Information not available.

9 3 1 2 8 5 1 6 6 4

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5.0 WASTE MANAGEMENT UNIT SCREENING POTENTIAL FOR HUMAN HEALTH IMPACT

This preliminary qualitative evaluation of potential human health concerns is intended to provide input to the S Plant Aggregate Area waste management unit recommendation process (Section 9.0). This process requires consideration of immediate impacts to human health and the environment. The approach that has been taken to identify potential health concerns related to individual waste management units and unplanned releases is as follows:

- Contaminants of potential concern are identified for each exposure pathway that is likely to occur within the S Plant Aggregate Area. Selection of contaminants was discussed in Section 4.2. Contaminants of potential concern were selected from the list of candidate contaminants of potential concern presented in Table 4-17. This table includes contaminants that are likely to be present in the environment based on occurrence in the liquid process wastes that were discharged to soils, and also contaminants that have been detected in environmental samples within the aggregate area but have not been identified as components of S Plant Aggregate Area waste streams.
- Exposure pathways potentially applicable to individual waste management units are identified based on the presence of the above contaminants of potential concern in wastes in the waste management units, consideration of known or suspected releases from those waste management units, and the physical and institutional controls affecting site access and use over the period of interest. The relationships between waste management units and exposure pathways are summarized in the conceptual model (Section 4.2).
- Estimates of relative hazard derived for the S Plant aggregate area waste management units are identified using the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Hazard Ranking System (HRS), modified Hazard Ranking system (mHRS), surface radiation survey data, and by Westinghouse Hanford Environmental Protection Group scoring. Other indicators of relative hazard, such as rate of release of contaminants, irreversible results of continuing residence of contaminants, etc., were not used because they generally require unit-specific data which are not available for most units.

The human health concerns and various hazard ranking scores listed above are used to establish whether or not a site is considered a "high" priority. In the data evaluation process, "high" priority sites are evaluated for the potential implementation of an interim remedial action. "Low" priority sites are evaluated to determine what type of additional investigation is necessary to establish a final remedy. Further detail is presented in Section 9.0.

The data used for this human health evaluation are presented in the earlier sections of this report. The types of data that have been assessed include site histories and physical descriptions (Section 2.0), descriptions of the physical environment of the study area

1 (Section 3.0), and a summary of the available chemical and radiological data for each waste
2 management unit (Section 4.0).
3

4 The quality and sufficiency of these data are assessed in Section 8.0. This information
5 is also used to identify applicable or relevant and appropriate requirements (Section 6.0).
6
7

8 **5.1 CONCEPTUAL FRAMEWORK FOR RISK-BASED SCREENING**

9

10 The range of potential human health exposure pathways at the S Plant Aggregate Area
11 was summarized in Section 4.2. The U.S. Environmental Protection Agency (EPA 1989b)
12 considers a human exposure pathway to consist of four elements: (1) a source and
13 mechanism for contaminant release, (2) a retention or transport medium (or media), (3) a
14 point of potential human contact, and (4) an exposure route (e.g., ingestion) at the contact
15 point. The probability of existence of a particular pathway is dependent upon the physical
16 and institutional controls affecting site access and use. In the absence of site access controls
17 and other land use restrictions, the identified potential exposure pathways could all occur.
18 For example, it could be hypothesized that an individual establish a residence within the
19 boundaries of the S Plant Aggregate Area, disrupt the soil surface and contact buried
20 contamination, and drill a well and withdraw contaminated groundwater for drinking water
21 and crop irrigation. However, within the 5- to 10-year period of interest associated with
22 identification and prioritization of remedial actions within the S Plant Aggregate Area,
23 unrestricted access and uncontrolled disruption of buried contaminants have a negligible
24 probability of occurrence.
25

26 For the purpose of identifying health hazards associated with S Plant Aggregate Area
27 waste management units, and prioritizing remediation actions for those units, an occupational
28 exposure scenario was determined to be the most appropriate. While work activities are
29 assumed to include occasional contact with surface soils, it is assumed that no contact with
30 buried contaminants will take place without proper protective measures.
31

32 Workers may be exposed via the following routes at the S Plant Aggregate Area:

- 33 • Ingestion of surface soils
- 34 • Inhalation of volatilized contaminants and resuspended particles
- 35 • Direct dermal contact with surface soils
- 36 • Direct exposure to radiation from surface soils and airborne resuspended particles
- 37
- 38
- 39
- 40
- 41

1 Since evaluation of migration in the saturated zone is not within the scope of a source
2 AAMS, ingestion of or contact with groundwater were not evaluated as exposure pathways.
3 However, since migration of waste constituents within the saturated zone will be addressed in
4 the 200 West Groundwater AAMS, contaminants likely to migrate to the water table, and
5 waste management units that have a high potential to impact groundwater will be identified.
6
7

8 **5.2 POTENTIAL EXPOSURE SCENARIOS AND HUMAN HEALTH CONCERNS**

9

10 The routes by which a Hanford Site worker could potentially be exposed to
11 contamination at the waste management units include ingestion, inhalation, direct contact with
12 soils, and direct exposure to radiation. To evaluate the potential for exposure at individual
13 waste management units, it is necessary to have data available for surface soils, air, and
14 radiation levels. Although samples have been collected from each of these media, only the
15 surface radiation survey data (contamination levels and dose rate) are specific to individual
16 waste management units. Therefore, only pathways associated with the surface radiological
17 contamination and external dose rates can be evaluated with confidence at this time. Potential
18 exposures by other pathways were evaluated based on available knowledge regarding
19 contaminants disposed to the waste management units and the integrity of engineered barriers.
20

21 **5.2.1 External Exposure**

22 External dose rate surveys, which are performed on a waste management unit basis,
23 were used as the measure of a unit's potential for impacting human health through direct
24 external radiation exposure. The contaminants of potential concern for this pathway are the
25 radionuclides that emit moderate to high energy penetrating gamma radiation. The measured
26 dose rates at S Plant Aggregate Area waste management units are presented in Table 5-1 from
27 the available survey data.
28
29

30 For 41 of the 78 S Plant Aggregate Area waste management units, no radiation survey
31 data are available. For the remaining 37 units that do have radiation survey data of some
32 type, 21 were reported as having no contamination detected.
33
34

35 Westinghouse Hanford manual WHC-CM-4-10, Section 7 (WHC 1988b) was used as
36 the basis for setting one of the criteria used to identify waste management units that can be
37 considered high priority sites. The manual indicates that waste management units with
38 radiation levels of 2mrem/h be posted with "Radiation Area" signs and undergo access controls
39 for the purpose of personnel protection. With the same objective in mind, the level of 2
40 mrem/h is recommended as one of the criteria for distinguishing high priority from lower
41 priority waste management units. The 216-S-8 Trench, 216-S-172 Control Structure, and the
42 218-W-7 Burial Ground were the only waste management units that exceeded the 2 mrem/h.
43 In the instances where results were reported in units of mR/h (milli Roentgen/h) it was
44 assumed that 1 mR/h is equivalent to 1 mrem/h.
45

1 High levels of radiation were reportedly associated with some of the unplanned releases
2 that are listed in Table 5-1. However, many of these releases occurred in the early years of
3 the Hanford Site and more recent survey data are not available. Some of the releases were
4 reportedly remediated by removing contaminated soil for disposal in burial grounds, paving or
5 covering the area with soil, or flushing the soil with water. The effectiveness of the various
6 remediation measures is not known, and confirmatory survey measurements are not available.
7 Thus, with the exception of unplanned releases located within engineered waste units, which
8 are routinely surveyed, information on the current radiological status of remediated unplanned
9 releases is deficient, and is identified as a data gap in Section 8.0.

12 5.2.2 Ingestion of Soil or Inhalation of Fugitive Dust

14 Radionuclides and nonradioactive contaminants of concern for the soil ingestion and
15 fugitive dust inhalation pathways are those that are nonvolatile, persistent in surface soils, and
16 have appreciable carcinogenic or toxic effects by ingestion or inhalation. However, little
17 information is available to evaluate the levels of specific radionuclides or nonradioactive
18 chemicals in surface soils. Surface radiological contamination surveys were performed at
19 many of the waste management units and provide measures of unit specific gross
20 contamination levels. Available gross activity survey data for the S Plant Aggregate Area
21 waste management units are provided in Table 5-1.

23 The Westinghouse Hanford Environmental Protection Group policies state that the
24 presence of any smearable alpha constitutes a potential threat to human health and qualifies a
25 waste management unit for a high remediation priority (Huckfeldt 1991). Waste management
26 units that exhibit elevated alpha readings in radiological surveys can be presumed to have
27 surface contamination, since alpha radiation cannot penetrate solids.

29 Westinghouse Hanford manual WHC-CM-4-10 (WHC 1988b) was also used to set
30 criteria for identifying waste management units that can be considered high remediation
31 priority sites. The manual indicates that waste management units with a level of 100 c/min
32 above background beta/gamma, and/or 20 c/min alpha, be posted with "Surface Contamination
33 Area" signs and undergo access controls for the purpose of personnel protection. With the
34 same objective in mind, the levels of 100 c/min above background beta/gamma and 20 c/min
35 alpha are recommended as two of the criteria for identifying high priority waste management
36 units. For those survey readings that are in units of dis/min, a conversion was made to c/min
37 assuming a survey detector efficiency of 10%.

39 It should be noted that these radiation readings may indicate transient conditions (e.g.,
40 presence of contaminated vegetation) and that routine stabilization of surface contamination is
41 carried out under the auspices of the Westinghouse Hanford Radiation Area Remedial Action
42 program.

44 Units subject to collapse of containment structures pose a potential threat of exposure
45 through release of contaminants to the surface. Three of the older cribs are open wooden
46 structures that could fail catastrophically, which could force contaminants from the buried crib

1 to the surface. Cribs 216-S-5, 216-S-7, and 216-S-20 all have a potential for collapse and are
2 believed to contain dispersible contaminants that would exceed reporting requirements if
3 released.
4

5.2.3 Inhalation of Volatiles

5
6
7
8 As summarized in Section 4.1, the distribution of volatile organics in soils is not well-
9 defined in the S Plant Aggregate Area. Although several semivolatile compounds, such as
10 bromonaphthalene and ethylene diamine tetracetate have been disposed in the cribs, no
11 information is available on whether these compounds are still available in the near surface
12 soil column for transport to the soil surface.
13

14 The primary volatile radionuclide of concern is tritium. Exposure to tritium (as tritiated
15 water vapor) and the potential for tritium release via radiolytic production of hydrogen from
16 aqueous radioactive wastes is of concern. The mode of disposal of this material cannot be
17 determined from available information.
18

5.2.4 Migration to Groundwater

19
20
21
22 Risks that could potentially occur due to migration of contaminants in groundwater to
23 existing or potential receptors will be addressed in the 200 West Groundwater Aggregate Area
24 Management Study (AAMS) and will not therefore be discussed in the S Plant AAMS Report.
25 However, the potential for individual units to impact groundwater has been discussed in
26 Section 4.1.
27

28 In addition to direct disposal of liquid wastes to the soil column, one unit is suspected
29 to be the source of subsurface contaminant migration. The sanitary crib is located about
30 24 m (80 ft) west of the southwest corner of the 241-SX Tank Farm. Approximately
31 22,600 L (161,200 gal) of liquid per day are said to be disposed of through the septic tank.
32 There is thus a significant flux of water through the vadose zone beneath the site. If lateral
33 migration from the Sanitary Crib has occurred, then it is possible that the septic tank
34 discharges are remobilizing contamination adsorbed onto the surface of soil particles. If this
35 is the case, then the septic system could be flushing contaminated water into the aquifer that
36 is more than 100 times the reportable quantity and quality standards.
37

5.3 ADDITIONAL SCREENING CRITERIA

38
39
40
41 In addition to determining human health concerns for a worker at each of the waste
42 management units, previously developed site ranking criteria were investigated for the
43 purpose of setting priorities for waste management units and unplanned releases. These
44 criteria are the CERCLA HRS scores (40 CFR 300) assigned during preliminary
45 assessment/site inspection (PA/SI) activities performed for the Hanford Site (DOE 1988), and

1 the rankings assigned by the Westinghouse Hanford Environmental Protection Group to
2 prioritize sites needing remedial actions for radiological control (Huckfeldt 1991).
3

4 Both of these ranking systems take into account some measure of hazard and
5 environmental mobility, and are thus appropriate to consider for waste unit prioritization. The
6 HRS evaluates units based on their relative risk, taking into account the population at risk, the
7 hazard potential of the substances at the facility, the potential for contamination of the
8 environment, the potential risk of fire and explosion, and the potential for injury associated
9 with humans or animals that come into contact with the waste management unit inventory.
10 The HRS is thus appropriate to consider for screening waste management units.
11

12 The PA/SI screening was performed using the EPA's HRS and mHRS. The HRS (40
13 CFR 300) is a site ranking methodology that was designed to determine whether sites should
14 be placed on the CERCLA National Priority List (NPL) based on chemical contamination
15 history. The EPA has established the criteria for placement on the NPL to be a score of 28.5
16 or greater. The mHRS is a ranking system developed by the Pacific Northwest Laboratory
17 (PNL) for DOE that uses the basic methodology of the HRS; however, it more accurately
18 predicts the impacts from radionuclides. The mHRS takes into account concentration, half-
19 life, and other chemical-specific parameters that are not considered by the HRS. The mHRS
20 has not been accepted by EPA as a ranking system.
21

22 Many of the S Plant Aggregate Area waste management units were ranked in the
23 preliminary assessment/site inspection using both the HRS and mHRS. For those waste
24 management units that were not ranked in the preliminary assessment/site inspection, unit
25 type and discharge history were evaluated in comparison with ranked units for the purpose of
26 setting priorities. If a waste management unit that has been ranked exhibits similar
27 characteristics (e.g., construction, waste type, and volume), the value for the ranked unit was
28 applied to the unit without an HRS or mHRS score. If no ranked waste management units
29 exhibit similar characteristics, then the unit was not ranked; however, a high or low score was
30 determined qualitatively through evaluation of unit configuration and contamination history.
31

32 Table 5-1 lists the HRS and mHRS rankings, as well as scores that were assigned for
33 unranked waste management units, based on their similarity to ranked units in terms of type,
34 construction, and quantity of waste disposed. If no similar waste management units were
35 available for comparison, the units were not ranked but were assigned a qualitative indicator
36 of migration potential.
37

38 For the HRS ranking, 10 units of the 78 S Plant Aggregate Area waste management
39 units were given a score of 28.5 or greater. For the mHRS ranking, 9 units were given
40 a score of 28.5 or greater (all of which had HRS scores greater than 28.5). Eleven units
41 received a qualitative "high" score and 35 units received a qualitative "low" score. Each of
42 the units that received a qualitative "high" HRS and mHRS score (2 cribs, 2 ditches, 2 ponds,
43 an unplanned release, 3 control facilities, and the retention basin) was given such a rating
44 based on their discharge history of large quantities of hazardous materials, that potentially
45 could have been transported to the groundwater. The units that received qualitative "low"
46 scores (the septic tank, the pond, the trench, 2 burial grounds, and 30 unplanned releases)

1 were given that ranking because there is no known history of liquid hazardous material
2 disposal that could affect groundwater beneath the S Plant Aggregate Area. Three sites did
3 not receive a ranking, although investigated in the preliminary assessment/site inspection,
4 because of insufficient data. These were denoted as "ENS" according to the terminology used
5 in the preliminary assessment/site inspection.
6

7 5.4 SUMMARY OF SCREENING RESULTS

8

9 The screening process was used to sort sites as either high priority or low priority.
10 Table 5-1 lists the S Plant Aggregate Area waste management units that exceeded one or
11 more of the screening criteria identified in the preceding sections. In total, 32 units were
12 identified as high priority.
13

14 Radiation survey results (dose rate and/or contamination) were available for 41 of the
15 76 waste management units. Twenty-one were reported as having no detectable results.
16 The remaining 14 units had survey results that exceeded one or more of the criteria
17 (2 mrem/h, 100 c/min beta/gamma, and 20 c/min alpha).
18

19 For the HRS scores, 10 waste management units were given scores of 28.5 or greater.
20 For the mHRS, 9 units received a score of 28.5 or greater. Eleven units received qualitative
21 "high" scores. Some of the sites were designated as high priority for 2 or more of the
22 criteria, hence only 34 total sites are designated high priority. Two of the 78 sites were
23 assigned Westinghouse Hanford Environmental Protection Group scores of 7 or greater.
24 Scoring values of 9, and 10 were assigned to 216-S-1 and 216-S-2 Cribs, and 216-S-7 Crib,
25 respectively.

Table 5-1. Hazard Ranking Scores for the S Plant Aggregate Area.

| Waste Management Unit | Waste Management Unit Type | HRS Rating | mHRS Rating | c/min | Radiation Surveys dis/min | mrem/h | Environmental Protection Score | High Priority |
|-------------------------------------|----------------------------|------------|-------------|--------|------------------------------|--------|--------------------------------|---------------|
| Cribs and Drains | | | | | | | | |
| 216-S-1&2 | Cribs | 55.36 | 57.73 | 35,000 | -- | -- | 9 | Yes |
| 216-S-5 | Crib | 47.81 | 30.75 | NC | NC | NC | | Yes |
| 216-S-6 | Crib | 47.81 | 42.14 | NC | NC | NC | | Yes |
| 216-S-7 | Crib | 57.88 | 59.63 | NC | NC | NC | 10 | Yes |
| 216-S-9 | Crib | 50.33 | 39.23 | NC | NC | NC | | Yes |
| 216-S-13 | Crib | 1.45 | 1.45 | NC | NC | NC | | No |
| 216-S-20 | Crib | 50.33 | 43.70 | NC | NC | NC | | Yes |
| 216-S-22 | Crib | 1.03 | 0.82 | NC | NC | NC | | No |
| 216-S-23 | Crib | 1.03 | 1.14 | NC | NC | NC | | No |
| 216-S-25 | Crib | High | High | NC | NC | NC | | Yes |
| 216-S-26 | Crib | High | High | NC | NC | NC | | Yes |
| 216-S-3 | French Drain | 47.81 | 49.97 | NC | NC | NC | | Yes |
| Ponds, Ditches, and Trenches | | | | | | | | |
| 216-S-10P | Pond | High | High | NC | NC | NC | | Yes |
| 216-S-11 | Pond | 45.30 | 17.70 | NC | NC | NC | | Yes |
| 216-S-15 | Pond | 1.03 | 0.71 | NC | NC | NC | | No |
| 216-S-16P | Pond | High | High | NA | NA | NA | | Yes |
| 216-S-17 | Pond | 47.81 | 42.14 | 1,000 | -- | -- | | Yes |
| 216-S-19 | Pond | Low | Low | NC | NC | NC | | No |
| 216-S-10D | Ditch | High | High | NC | NC | NC | | Yes |

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Table 5-1. Hazard Ranking Scores for the S Plant Aggregate Area.

| Waste Management Unit | Waste Management Unit Type | HRS Rating | mHRS Rating | c/min | Radiation Surveys dis/min | mrem/h | Environmental Protection Score | High Priority |
|--|--------------------------------|-------------------|-------------------|-------|------------------------------|------------------------|--------------------------------|---------------|
| 216-S-16D | Ditch | 47.81 | 42.14 | NC | NC | NC | | Yes |
| 216-U-9 | Ditch | High | High | NA | NA | NA | | Yes |
| 216-S-8 | Trench | 2.07 | 2.29 | -- | -- | 0.6 - 2.6 ^W | | Yes |
| 216-S-12 | Trench | 1.03 | 0.82 | NC | NC | NC | | No |
| 216-S-14 | Trench | 1.03 | 0.71 | NC | NC | NC | | No |
| 216-S-18 | Trench | Low | Low | NC | NC | NC | | No |
| Septic Tanks and Associated Drain Fields | | | | | | | | |
| 2607-W6 | Septic Tank & Tile Field | -- ^V | -- ^V | NA | NA | NA | | No |
| 2607-WZ | Septic Tanks (2) & Drain Field | Low | Low | NA | NA | NA | | No |
| -- | Sanitary Crib | -- ^V | -- ^V | NA | NA | NA | | No |
| Transfer Facilities, Diversion Boxes, and Pipelines | | | | | | | | |
| 2904-S-160 | Control Structure | High ^d | High ^d | NA | NA | NA | | Yes |
| 2904-S-170 | Control Structure | High ^d | High ^d | NA | NA | NA | | Yes |
| 2904-S-171 | Control Structure | High ^d | High ^d | NA | NA | NA | | Yes |
| Basins | | | | | | | | |
| 207-S | Retention Basin | High ^d | High ^d | NA | NA | NA | | NA |
| Burial Sites | | | | | | | | |
| 218-W-7 | Burial Ground | Low ^d | Low ^d | -- | -- | 3.5 ^W | | Yes |
| 218-W-9 | Burial Ground | Low ^d | Low ^d | -- | 25,000 | -- | | Yes |

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Table 5-1. Hazard Ranking Scores for the S Plant Aggregate Area.

| Waste Management Unit | Waste Management Unit Type | HRS Rating | mHRS Rating | c/min | Radiation Surveys dis/min | mrem/h | Environmental Protection Score | High Priority |
|-----------------------|----------------------------|-------------------|-------------------|-----------------|------------------------------|--------|--------------------------------|---------------|
| Unplanned Releases | | | | | | | | |
| UN-200-W-32 | Unplanned Release | Low ^d | Low ^d | -- | 30,000 | -- | | Yes |
| UN-200-W-34 | Unplanned Release | High ^d | High ^d | -- | -- | 1 | | Yes |
| UN-200-W-35 | Unplanned Release | Low ^d | Low ^d | NA | NA | NA | | No |
| UN-200-W-41 | Unplanned Release | Low ^d | Low ^d | NA | NA | NA | | No |
| UN-200-W-42 | Unplanned Release | 0.80 | -- | NA | NA | NA | | No |
| UN-200-W-43 | Unplanned Release | 0.80 | -- | NA | NA | NA | | No |
| UN-200-W-49 | Unplanned Release | 0.90 | -- | NA | NA | NA | | No |
| UN-200-W-50 | Unplanned Release | 1.00 | -- | NA | NA | NA | | No |
| UN-200-W-52 | Unplanned Release | Low ^d | Low ^d | NA | NA | NA | | No |
| UN-200-W-56 | Unplanned Release | 1.00 | -- | NA | NA | NA | | No |
| UN-200-W-61 | Unplanned Release | 1.00 | -- | NA | NA | NA | | No |
| UN-200-W-69 | Unplanned Release | Low ^d | Low ^d | 500- 100,000 | -- | -- | | Yes |
| UN-200-W-80 | Unplanned Release | 1.20 | -- | 60,000 | -- | -- | | Yes |
| UN-200-W-81 | Unplanned Release | 1.10 | -- | 500- 100,000 | -- | -- | | Yes |
| UN-200-W-82 | Unplanned Release | Low ^d | Low ^d | NA | NA | NA | | No |
| UN-200-W-83 | Unplanned Release | ENS | -- | NA | NA | NA | | No |
| UN-200-W-108 | Unplanned Release | Low ^d | Low ^d | NC | NC | NC | | No |
| UN-200-W-109 | Unplanned Release | Low ^d | Low ^d | 6,000 | -- | -- | | Yes |
| UN-200-W-114 | Unplanned Release | Low ^d | Low ^d | 450 | -- | -- | | Yes |

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Table 5-1. Hazard Ranking Scores for the S Plant Aggregate Area.

| Waste Management Unit | Waste Management Unit Type | HRS Rating | mHRS Rating | Radiation Surveys | | | Environmental Protection Score | High Priority |
|-----------------------|----------------------------|------------------|------------------|-------------------|---------|--------|--------------------------------|---------------|
| | | | | c/min | dis/min | mrem/h | | |
| UN-200-W-116 | Unplanned Release | Low ^w | Low ^w | 200 | -- | -- | | Yes |
| UN-200-W-123 | Unplanned Release | Low ^w | Low ^w | NA | NA | NA | | No |
| UN-200-W-127 | Unplanned Release | Low ^w | Low ^w | NA | NA | NA | | No |
| UN-216-W-25 | Radiation Emissions | Low ^w | Low ^w | 40,000 | -- | -- | | Yes |
| UN-216-W-30 | Unplanned Release | Low ^w | Low ^w | -- | 3,500 | -- | | Yes |
| UPR-200-W-13 | Unplanned Release | Low ^w | Low ^w | NA | NA | NA | | No |
| UPR-200-W-15 | Unplanned Release | Low ^w | Low ^w | NA | NA | NA | | No |
| UPR-200-W-20 | Unplanned Release | Low ^w | Low ^w | NA | NA | NA | | No |
| UPR-200-W-36 | Unplanned Release | Low ^w | Low ^w | NA | NA | NA | | No |
| UPR-200-W-47 | Unplanned Release | Low ^w | Low ^w | NA | NA | NA | | No |
| UPR-200-W-51 | Unplanned Release | Low ^w | Low ^w | NA | NA | NA | | No |
| UPR-200-W-57 | Unplanned Release | ENS | -- | NA | NA | NA | | No |
| UPR-200-W-59 | Unplanned Release | Low ^w | Low ^w | NA | NA | NA | | No |
| UPR-200-W-87 | Unplanned Release | ENS | -- | NA | NA | NA | | No |
| UPR-200-W-95 | Unplanned Release | 0.70 | -- | NA | NA | NA | | No |
| UPR-200-W-96 | Unplanned Release | 1.00 | -- | 3,000 | -- | -- | | Yes |
| UPR-200-W-124 | Unplanned Release | Low ^w | Low ^w | NA | NA | NA | | No |
| UPR-200-W-139 | Unplanned Release | Low ^w | Low ^w | NA | NA | NA | | No |
| UPR-200-W-140 | Unplanned Release | Low ^w | Low ^w | NA | NA | NA | | No |
| UPR-200-W-141 | Unplanned Release | Low ^w | Low ^w | NA | NA | NA | | No |
| UPR-200-W-142 | Unplanned Release | Low ^w | Low ^w | NA | NA | NA | | No |
| UPR-200-W-143 | Unplanned Release | Low ^w | Low ^w | NA | NA | NA | | No |
| UPR-200-W-144 | Unplanned Release | Low ^w | Low ^w | NA | NA | NA | | No |

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Table 5-1. Hazard Ranking Scores for the S Plant Aggregate Area.

| Waste Management Unit | Waste Management Unit Type | HRS Rating | mHRS Rating | Radiation Surveys | | | Environmental Protection Score | High Priority |
|-----------------------|----------------------------|------------|-------------|-------------------|---------|--------|--------------------------------|---------------|
| | | | | c/min | dis/min | mrem/h | | |
| UPR-200-W-145 | Unplanned Release | Low* | Low* | NA | NA | NA | No | |
| UPR-200-W-146 | Unplanned Release | Low* | Low* | NA | NA | NA | No | |

NA = No data available.

NC = No contamination detected.

ENS = Classification given in PA/SI when sufficient information was not available for scoring.

- * Unit was not qualitatively ranked because there was no similarity to other ranked units and available data on the unit was insufficient.
- * For the purpose of performing a ranking analysis, it was assumed that 1mR/hr was equivalent to 1 mrem/hr.
- * A high value is given to those units for which no similarities to other ranked sites exist and a qualitative investigation indicates a "high" score.
- * A low value is given to those units for which no similarities to other ranked sites exist and a qualitative investigation indicates a "low" score.

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1 **6.0 IDENTIFICATION OF POTENTIALLY APPLICABLE OR RELEVANT**
2 **AND APPROPRIATE REQUIREMENTS**
3 **FOR THE S PLANT AGGREGATE AREA**
4
5

6 **6.1 INTRODUCTION**
7

8 The Superfund Amendments and Reauthorization Act (SARA) of 1986 amended the
9 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
10 requiring that all applicable or relevant and appropriate requirements (ARARs) be employed
11 during implementation of a hazardous waste site cleanup. "Applicable" requirements are
12 defined by the U.S. Environmental Protection Agency (EPA) in "CERCLA Compliance with
13 Other Laws Manual" (OSWER Directive 9234.1-01, August 8, 1988) as:
14

15 cleanup standards, standards of control, and other substantive environmental protection
16 requirements, criteria, or limitations promulgated under federal or state law that
17 specifically address a hazardous substance, pollutant, contaminant, remedial action,
18 location, or other circumstance at a CERCLA site.
19

20 A separate set of "relevant and appropriate" requirements that must be evaluated
21 include:
22

23 cleanup standards, standards of control, and other substantive environmental protection
24 requirements, criteria, or limitations promulgated under federal or state law that while
25 not "applicable" to a hazardous substance, pollutant, contaminant, remedial action,
26 location, or other circumstance at a CERCLA site, address problems or situations
27 sufficiently similar to those encountered at the CERCLA site that their use is well suited
28 to the particular site.
29

30 "To-be-Considered Materials" (TBCs) are nonpromulgated advisories or guidance issued
31 by federal or state governments that are not legally binding and do not have the status of
32 potential ARARs. However, in many circumstances, TBCs will be considered along with
33 potential ARARs and may be used in determining the necessary level of cleanup for
34 protection of health or the environment.
35

36 The following sections identify potential ARARs to be used in developing and assessing
37 various remedial action alternatives at the S Plant Aggregate Area. Specific requirements
38 pertaining to hazardous and radiological waste management, remediation of contaminated
39 soils, surface water protection, and air quality will be discussed.
40

41 The potential ARARs focus on federal or state statutes, regulations, criteria, and
42 guidelines. The specific types of potential ARARs evaluated include:
43

- 44 • Contaminant-specific;
- 45 • Location-specific; and
- 46

- Action-specific.

Contaminant-specific potential ARARs are usually health or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical contaminant values that are generally recognized by the regulatory agencies as allowable to protect human health and the environment. In the case of the S Plant Aggregate Area, contaminant-specific potential ARARs address chemical constituents and/or radionuclides. The potential contaminant-specific ARARs that were evaluated for the S Plant Aggregate Area are discussed in Section 6.2.

Location-specific potential ARARs are restrictions placed on the concentration of hazardous substances, or the conduct of activities, solely because they occur in specific locations. The location-specific potential ARARs that were evaluated for the S Plant Aggregate Area are discussed in Section 6.3.

Action-specific potential ARARs apply to particular remediation methods and technologies, and are evaluated during the detailed screening and evaluation of remediation alternatives. The potential action-specific ARARs that were evaluated for the S Plant Aggregate Area are discussed in Section 6.4.

The TBC requirements are other federal and state criteria, advisories, and regulatory guidance that are not promulgated regulations, but are to be considered in evaluating alternatives. Potential TBCs include U.S. Department of Energy (DOE) Orders that carry out authority granted under the Atomic Energy Act. All DOE Orders are potentially applicable to operations at the S Plant Aggregate Area. Specific TBC requirements are discussed in Section 6.5.

Potential contaminant- and location-specific ARARs will be refined during the AAMS process. Potential action-specific ARARs are briefly discussed in this section, and will be further evaluated upon final selection of remedial alternatives. The points at which these potential ARARs must be achieved and the timing of the ARARs evaluations are discussed in Sections 6.6 and 6.7, respectively.

6.2 CONTAMINANT-SPECIFIC REQUIREMENTS

A contaminant-specific requirement sets concentration limits in various environmental media for specific hazardous substances, pollutants, or contaminants. Based on available information, some of the currently known or suspected contaminants that may be present in the S Plant Aggregate Area are outlined in Table 4-18. The currently identified potential federal and state contaminant-specific ARARs are summarized below.

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6.2.1 Federal Requirements

Federal contaminant-specific requirements are specified in several statutes, codified in the U.S. Code (USC), and promulgated in the Code of Federal Regulations (CFR), as follows:

6.2.1.1 Clean Water Act. Federal Water Quality Criteria (FWQC) are developed under the authority of the Clean Water Act to serve as guidelines to the states for determining receiving water quality standards. Different FWQC are derived for protection of human health and protection of aquatic life. The human health FWQC are further subdivided according to how people are expected to use the water (e.g., drinking the water versus consuming fish caught from the water). SARA 121(d)(2) states that remedial actions shall attain FWQC where they are relevant and appropriate, taking into account the designated or potential use of the water, the media affected, the purpose of the criteria, and current information. Many more substances have FWQC than maximum contaminant levels (MCLs) issued under the Safe Drinking Water Act (see discussion below); consequently, EPA and other state agencies rely on these criteria more than MCLs, even though these criteria can only be considered relevant and appropriate and not applicable.

FWQC would not be considered at S Plant Aggregate Area, as no natural surface water bodies exist in the S Plant Aggregate Area. The only existing man-made surface water bodies at S Plant Aggregate Area are waste management units.

6.2.1.2 Safe Drinking Water Act. Under the authority of the Safe Drinking Water Act, MCLs apply when the water may be used for drinking. At present, EPA and the State of Washington apply MCLs as the standards for groundwater contaminants at CERCLA sites that could be used as drinking water sources. Groundwater contamination and application of MCLs as potential ARARs are addressed under a separate AAMS specific to groundwater.

6.2.1.3 Resource Conservation and Recovery Act. RCRA addresses the generation and transportation of hazardous waste, and waste management activities at facilities that treat, store, or dispose of hazardous wastes. Subtitle C (Hazardous Waste Management) mandates the creation of a cradle-to-grave management and permitting system for hazardous wastes. RCRA defines hazardous wastes as "solid wastes" (even though the waste is often liquid in physical form) that may cause or significantly contribute to an increase in mortality or serious illness, or that poses a substantial hazard to human health or the environment when improperly managed. In Washington State, RCRA is implemented by EPA and the authorized state agency, the Washington State Department of Ecology (Ecology).

RCRA is potentially applicable or relevant and appropriate to the S Plant Aggregate Area. The extensive permitting requirements under RCRA would only apply to a waste management unit that is an identified hazardous waste TSD facility, and to hazardous waste management activities that occurred outside an area of contamination. If a waste management unit is not a RCRA TSD facility and if remediation occurs on site, then the RCRA permitting requirements would not have to be satisfied. However, other substantive requirements necessary to protect human health and the environment would constitute potential ARARs.

1 Two key contaminant-specific potential ARARs have been adopted under the federal
2 hazardous waste regulations: the Toxicity Characteristic Leaching Procedure (TCLP)
3 designation limits promulgated under 40 CFR Part 261; and the hazardous waste land disposal
4 restrictions for constituent concentrations promulgated under 40 CFR Part 268.
5

6 The TCLP designation limits define when a waste is hazardous, and are used to
7 determine when more stringent management standards apply than would be applied to typical
8 solid wastes. Thus, the TCLP contaminant-specific potential ARARs can be used to
9 determine when RCRA waste management standards may be required. The TCLP limits are
10 presented in Table 6-1.
11

12 The land disposal restrictions are numerical limits derived by EPA by reviewing
13 available technologies for treating hazardous wastes. Until a prohibited waste can meet the
14 numerical limits, it can be prohibited from land disposal. Two sets of limits have been
15 promulgated: limits for constituent concentrations in waste extract, which uses the TCLP test
16 to obtain a leached sample of the waste; and limits for constituent concentrations in waste,
17 which addresses the total contaminant concentration in the waste. The land disposal
18 restrictions limits are presented in Table 6-1 (see Section 6.4.1.2 for a further discussion on
19 applying the land disposal restriction limits).
20

21 **6.2.1.4 Clean Air Act.** The Clean Air Act establishes National Primary and Secondary
22 Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), National Emission Standards for
23 Hazardous Air Pollutants (NESHAP)(40 CFR Part 61), and New Source Performance
24 Standards (NSPS)(40 CFR Part 60).
25

26 In general, new and modified stationary sources of air emissions must undergo a pre-
27 construction review to determine whether the construction or modification of any source, such
28 as a CERCLA remedial program, will interfere with attainment or maintenance of NAAQS or
29 fail to meet other new source review requirements including NESHAP and NSPS. However,
30 the process applies only to "major" sources of air emissions (defined as emissions of 250 tons
31 per year). The S Plant Aggregate Area would not constitute a major source.
32

33 Section 112 of the Clean Air Act directs EPA to establish standards at the level that
34 provides an ample margin of safety to protect the public health from hazardous air pollutants.
35 The NESHAP standards for radionuclides are directly applicable to DOE facilities under
36 Subpart H of Section 112 that establishes a 10 mrem/year facility-wide standard during
37 cleanup of the site. Further, if the maximum individual dose added by a new construction or
38 modification during remediation exceeds 1 percent of the NESHAP standard (0.1 mrem/yr), a
39 report meeting the substantive requirements of an application for approval of construction
40 must be prepared.
41
42

1 **6.2.2 State of Washington Requirements**
2

3 Potential state contaminant-specific requirements are specified in several statutes,
4 codified in the Revised Code of Washington (RCW) and promulgated in the Washington
5 Administrative Code (WAC).
6

7 **6.2.2.1 Model Toxics Control Act.** The Model Toxics Control Act (Ecology, 1991)
8 authorized Ecology to adopt cleanup standards for remedial actions at hazardous waste sites.
9 These regulations are considered potential ARARs for soil, groundwater, and surface water
10 cleanup actions. The processes for identifying, investigating, and cleaning up hazardous
11 waste sites are defined and cleanup standards are set for groundwater, soil, surface water, and
12 air in Chapter 173-340 WAC.
13

14 Under the Model Toxics Control Act regulations, cleanup standards may be established
15 by one of three methods.
16

- 17 • Method A may be used if a routine cleanup action, as defined in WAC
18 173-340-200, is being conducted at the site or relatively few hazardous substances
19 are involved for which cleanup standards have been specified by Tables 1, 2, or 3
20 of WAC 173-340-720 through -745.
21
- 22 • Under Method B, a risk level of 10^{-6} is established and a risk calculation based on
23 contaminants present is determined.
24
- 25 • Method C cleanup standards represent concentrations that are protective of human
26 health and the environment for specified site uses. Method C cleanup standards
27 may be established where it can be demonstrated that such standards comply with
28 applicable state and federal laws, that all practical methods of treatment are used,
29 that institutional controls are implemented, and that one of the following
30 conditions exist: (1) Method A or B standards are below background
31 concentrations; (2) Method A or Method B results in a significantly greater threat
32 to human health or the environment; (3) Method A or Method B standards are
33 below technically possible concentrations, or (4) the site is defined as an industrial
34 site for purposes of soil remediation.
35

36 Table 1 of Method A addresses groundwater, so it is not considered to be an ARAR for
37 S Plant Aggregate Area (groundwater will be addressed in the 200 West Groundwater AAMS
38 report). Table 2 of Method A is intended for non-industrial site soil cleanups, and Table 3 of
39 Method A is intended for industrial site soil cleanups. Method A industrial soil cleanup
40 standards for preliminary contaminants of concern are provided as potential ARARs in
41 Table 6-1.
42

43 In addition to Method A, Method B and Method C cleanup standards may also be
44 considered potential ARARs for the S Plant Aggregate Area. Method B and Method C
45 cleanup standards can be calculated on a case-by-case basis in concert with Ecology.
46 Method B and Method C should be used where Method A standards do not exist or cannot be

1 met, or where routine cleanup actions cannot be implemented at a specific waste management
2 unit.

3
4 **6.2.2.2 State Hazardous Waste Management Act and Dangerous Waste Regulations.**

5 The State of Washington is a RCRA-authorized state for hazardous waste management, and
6 has developed state-specific hazardous waste regulations under the authority of the State
7 Hazardous Waste Management Act. Generally, state hazardous waste regulations parallel the
8 federal regulations. The state definition of a hazardous waste incorporates the EPA
9 designation of hazardous waste that is based on the compound being specifically listed as
10 hazardous, or on the waste exhibiting the properties of reactivity, ignitability, corrosivity, or
11 toxicity as determined by the TCLP.

12
13 In addition, Washington State identifies other waste as hazardous. Three unique criteria
14 are established: toxic dangerous waste; persistent dangerous waste; and carcinogenic
15 dangerous waste. These additional designation criteria may be imposed by Ecology as
16 potential ARARs, for purposes of determining acceptable cleanup standards and appropriate
17 waste management standards.

18
19 **6.2.2.3 Ambient Air Quality Standards and Emission Limits for Radionuclides (Chapter**
20 **173-480 WAC).** These Ecology ambient air quality standards specify maximum accumulated
21 dose limits to members of the public.

22
23 **6.2.2.4 Monitoring and Enforcement of Air Quality and Emission Standards for**
24 **Radionuclides (WAC 246-247).** These permitting requirements by the Washington State
25 Department of Health adopt the Ecology standards for maximum accumulated dose limits to
26 members of the public.

27
28 **6.2.2.5 Controls for New Sources of Toxic Air Pollutants (Chapter 173-460 WAC).** In
29 accordance with regulations recently promulgated by Ecology in Chapter 173-460 WAC, any
30 new emission source will be subject to Toxic Air Pollutant emission standards. The
31 regulations establish allowable ambient source impact levels (ASILs) for hundreds of organic
32 and inorganic compounds. Ecology's ASILs may constitute potential ARARs for cleanup
33 activities that have a potential to affect air. ASILs for preliminary contaminants of concern
34 are provided in Table 6-1.

35
36 **6.2.2.6 Water Quality Standards.** Washington State has promulgated various numerical
37 standards related to surface water and groundwater contaminants. These are included
38 principally in the following regulations:

- 39
40 • **Public Water Supplies (Chapter 248-54 WAC).** This regulation establishes
41 drinking water standards for public water supplies. The standards essentially
42 parallel the federal drinking water standards (40 CFR Parts 141 and 143).
43

- 1 • **Water Quality Standards for Ground Waters of the State of Washington**
2 **(Chapter 173-200 WAC).** This regulation establishes contaminant standards for
3 protecting existing and future beneficial uses of groundwater through the reduction
4 or elimination of the discharge of contaminants to the state's groundwater.
5
- 6 • **Water Quality Standards for Surface Waters of the State of Washington**
7 **(Chapter 173-201 WAC and Proposed Chapter 173-203/173-201A WAC).**
8 Ecology has adopted numerical ambient water quality criteria for six conventional
9 pollutant parameters for various surface water classes (WAC 173-201-045): (1)
10 fecal coliform bacteria; (2) dissolved oxygen; (3) total dissolved gas; (4)
11 temperature; (5) pH; and (6) turbidity. In addition, toxic, radioactive, or
12 deleterious material concentrations shall be below those of public health
13 significance or which may cause acute or chronic toxic conditions to the aquatic
14 environment or which may adversely affect any water use. Numerical criteria
15 currently exist for a limited number of toxic substances (WAC 173-201-047).
16 Ecology has initiated rulemaking to modify and incorporate additional numerical
17 criteria for toxic substances and for radioactive substances, and to reclassify
18 certain waters of the state.

19
20 Under the state Water Quality Standards, the criteria and classifications do not
21 apply inside an authorized mixing zone surrounding a wastewater discharge. In
22 defining mixing zones, Ecology generally follows guidelines contained in "Criteria
23 for Sewage Works Design." Although water quality standards can be exceeded
24 inside the mixing zone, state regulations will not permit discharges that cause
25 mortalities of fish or shellfish within the zone or that diminish aesthetic values.
26

27 These water quality standards do not constitute ARARs for purposes of establishing
28 cleanup standards for the S Plant Aggregate Area. Groundwater is being addressed under a
29 separate study in which pertinent groundwater-related potential ARARs will be covered. No
30 surface water bodies exist within the S Plant Aggregate Area, so there will be no need to
31 achieve ambient water quality standards during remediation activities.
32

33 The numerical water quality standards cited above may become potential ARARs if
34 selected remedial actions could result in discharges to groundwater or surface water (e.g., if
35 treated wastewaters are discharged to the soil column or the Columbia River). Determining
36 appropriate standards for such discharges will depend on the type of remediation performed
37 and will have to be established on a case-by-case basis as remedial actions are defined.
38
39

40 **6.2.3 National Pollutant Discharge Elimination System (Chapter 173-220 WAC and** 41 **40 CFR Part 122) and Water Quality Standards** 42

43 National Pollutant Discharge Elimination System (NPDES) regulations govern point
44 source discharges into navigable waters. Limits on the concentrations of contaminants and
45 volumetric flowrates that may be discharged are determined on a case-by-case basis and
46 permitted under this program. No point source discharges have been identified. The EPA

1 implements this program in Washington State for federal facilities; however, assumption of
2 the NPDES program by the state is likely within five years.

3
4
5 **6.3 LOCATION-SPECIFIC REQUIREMENTS**

6
7 Location-specific potential ARARs are restrictions placed on the concentration of
8 hazardous substances or the conduct of activities solely because they are in specific locations.
9 Some examples of special locations include floodplains, wetlands, historic places, and
10 sensitive ecosystems or habitats.

11
12 Table 6-2 lists various location-specific standards and indicates which of these may be
13 potential ARARs. Potential ARARs have been identified as follows:

- 14
15 • **Floodplains.** Requirements for protecting floodplains are not ARARs for
16 activities conducted within the S Plant Aggregate Area. However, remedial
17 actions selected for cleanup may require projects in or near floodplains (e.g.,
18 construction of a treatment facility outfall at the Columbia River). In such cases,
19 location-specific floodplain requirements may be potential ARARs.
- 20
21 • **Wetlands, Shorelines, and Rivers and Streams.** Requirements related to
22 wetlands, shorelines, and rivers and streams are not ARARs for activities
23 conducted within the S Plant Aggregate Area. However, remedial actions selected
24 for cleanup may require projects on a shoreline or wetland, or discharges to
25 wetlands (e.g., construction of a treatment facility outfall at the Columbia River).
26 In such cases, location-specific shoreline and wetlands requirements may be
27 potential ARARs.
- 28
29 • **Threatened and Endangered Species Habitats.** As discussed in Section 3.6,
30 various threatened and endangered species inhabit portions of the Hanford Site
31 and may occur in the S Plant Aggregate Area (American peregrine falcon, bald
32 eagle, white pelican, and sandhill crane). Therefore, critical habitat protection for
33 these species would constitute a potential ARAR.
- 34
35 • **Wild and Scenic Rivers.** The Columbia River Hanford Reach is currently
36 undergoing study pursuant to the federal Wild and Scenic Rivers Act. Pending
37 results of this study, actions that may impact the Hanford Reach may be restricted.
38 This requirement would not be an ARAR for remedial activities within the S Plant
39 Aggregate Area. However, Wild and Scenic Rivers Act requirements may be
40 potential ARARs for actions taken as a result of S Plant cleanup efforts that could
41 affect the Hanford Reach.
- 42
43

1 **6.4 ACTION-SPECIFIC REQUIREMENTS**
2

3 Action-specific potential ARARs are requirements that are triggered by specific
4 remedial actions at the site. These remedial actions will not be fully defined until a remedial
5 approach has been selected. However, the universe of action-specific ARARs defined by a
6 preliminary screening of potential remedial action alternatives will help focus the selection
7 process. Potential action-specific ARARs are outlined below. (Note that contaminant- and
8 location-specific potential ARARs discussed above will also include provisions for action-
9 specific potential ARARs to be applied once the remedial action is selected.)
10

11
12 **6.4.1 Federal Requirements**
13

14 **6.4.1.1 Comprehensive Environmental Response, Compensation, and Liability Act.**

15 CERCLA, and regulations adopted pursuant to CERCLA contained in the National
16 Contingency Plan (40 CFR Part 300), include selection criteria for remedial actions. Under
17 the criteria, excavation and off-site land disposal options are least favored when on-site
18 treatment options are available. Emphasis is placed on alternatives that permanently treat or
19 immobilize contamination. Selected alternatives must be protective of human health and the
20 environment, which implies that federal and state ARARs be met. However, a remedy may
21 be selected that does not meet all potential ARARs if the requirement is technically
22 impractical, if its implementation would produce a greater risk to human health or the
23 environment, if an equivalent level of protection can otherwise be provided, if state standards
24 are inconsistently applied, or if the remedy is only part of a complete remedial action which
25 attains potential ARARs.
26

27 CERCLA gives state cleanup standards essentially equal importance as federal standards
28 in guiding cleanup measures in cases where state standards are more stringent. State
29 standards pertain only if they are generally applicable, were passed through formal means,
30 were adopted on the basis of hydrologic, geologic, or other pertinent considerations, and do
31 not preclude the option of land disposal by a state-wide ban. Most importantly, CERCLA
32 provides that cleanup of a site must ensure that public health and the environment are
33 protected. Selected remedies should meet all potential ARARs, but issues such as
34 cost-effectiveness must be weighed in the selection process.
35

36 **6.4.1.2 Resource Conservation and Recovery Act.** RCRA, and regulations adopted
37 pursuant to RCRA, describe numerous action-specific requirements that may be potential
38 ARARs for cleanup activities. The primary regulations are promulgated under 40 CFR
39 Parts 262, 264, and 265, and include such action-specific requirements as:
40

- 41 • Packaging, labeling, placarding, and manifesting of off-site waste shipments;
- 42
- 43 • Inspecting waste management areas to ensure proper performance and safe
44 conditions;
- 45

- 1 • Preparation of plans and procedures to train personnel and respond to
2 emergencies;
- 3
- 4 • Management standards for containers, tanks, incinerators, and treatment units;
- 5
- 6 • Design and performance standards for land disposal facilities; and
- 7
- 8 • Groundwater monitoring system design and performance.
- 9

10 Many of these requirements will depend on the particular remediation activity
11 undertaken, and will have to be identified as remediation proceeds.

12
13 One key potential area of action-specific RCRA ARARs are the 40 CFR Part 268 land
14 disposal restrictions. In addition to the contaminant-specific constituent concentration limits
15 established in the land disposal restrictions (as previously discussed in Section 6.2.1.3), EPA
16 has identified best demonstrated available treatment technologies (BDATs) for various waste
17 streams. EPA could require the use of BDATs prior to allowing land disposal of wastes
18 generated during remediation. EPA's imposition of the land disposal restrictions and BDAT
19 requirements will depend on various factors.

20
21 Applicability to CERCLA actions is based on determinations of waste
22 "placement/disposal" during a remediation action. According to OSWER Directive 9347.3-
23 05FS, EPA concludes that Congress did not intend in situ consolidation, remediations, or
24 improvement of structural stability to constitute placement or disposal. Placement or disposal
25 would be considered to occur if:

- 26
- 27 • Wastes from different units are consolidated into one unit (other than a land
28 disposal unit within an area of contamination);
- 29
- 30 • Waste is removed and treated outside a unit and redeposited into the same or
31 another unit (other than a land disposal unit within an area of contamination); or
- 32
- 33 • Waste is picked up from a unit and treated within the area of contamination in an
34 incinerator, surface impoundment, or tank and then redeposited into the unit
35 (except for in situ treatment).
- 36

37 Consequently, the requirement to use BDAT would not apply under the land disposal
38 restrictions standards unless placement or disposal had occurred. However, remediation
39 actions involving excavation and treatment could trigger the requirements to use BDAT for
40 wastes subject to the land disposal restrictions standards. In addition, the agencies could
41 consider BDAT technologies to be relevant and appropriate when developing and evaluating
42 potential remediation technologies.

43
44 Two additional components of the land disposal restrictions program should be
45 considered with regard to an excavate and treat remedial action. First, a national capacity
46 variance was issued by EPA for contaminated soil and debris for a two-year period ending

1 May 8, 1992 (54 FR 26640). Second, a series of variances and exemptions may be applied
2 under an excavate and treat scenario. These include:

- 3
4 • A no-migration petition;
5
6 • A case-by-case extension to an effective date;
7
8 • A treatability variance; and
9
10 • Mixed waste provisions of a federal Facilities Compliance Act (when enacted).
11

12 The applicability and relevance of each of these options will vary based on the specific
13 details of a S Plant Aggregate Area excavate and treat option. An analysis of these variances
14 can be developed once engineering data on the option becomes available.
15

16 The effect of the land disposal restrictions program on mixed waste management is
17 significant. Currently, limited technologies are available for effective treatment of these waste
18 streams and no commercially available treatment facilities exist except for liquid scintillation
19 counting fluids used for laboratory analysis and testing. The EPA recognized that inadequate
20 capacity exists and issued a national capacity variance until May 8, 1992, to allow for the
21 development of such treatment capacity.
22

23 Lack of treatment and disposal capacity also presents implications for storage of these
24 materials. Under 40 CFR 268.50, mixed wastes subject to land disposal restrictions may be
25 stored for up to one year. Beyond one year, the owner/operator has the burden of proving
26 such storage is for accumulating sufficient quantities for treatment. On August 29, 1991,
27 EPA issued a mixed waste storage enforcement policy providing some relief from this
28 provision for generators of small volumes of mixed wastes. However, the policy was limited
29 to facilities generating less than 28 m³ (1,000 ft³) of land disposal-prohibited waste per year.
30 Congress is considering amendments to RCRA postponing the storage prohibition for another
31 five years; however, final action on these amendments has not occurred.
32

33 **6.4.1.3 Clean Water Act.** Regulations adopted pursuant to the Clean Water Act under the
34 NPDES mandate use of best available treatment technologies prior to discharging
35 contaminants to surface waters. NPDES requirements would not be ARARs for actions
36 conducted only within the S Plant Aggregate Area. However, NPDES requirements could
37 constitute potential ARARs for cleanup actions which would result in discharge of treated
38 wastewaters to the Columbia River, and associated treatment systems could be required to
39 utilize best available treatment technologies.
40

41 42 **6.4.2 State of Washington Requirements**

43
44 **6.4.2.1 Hazardous Waste Management.** As discussed in Section 6.4.1.2, there are various
45 requirements addressing the management of hazardous wastes that may be potential action-
46 specific ARARs. Pertinent Washington regulations appear in Chapter 173-303 WAC and

1 generally parallel federal management standards. Determination of potential ARARs will be
2 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 standards
6 may be potential ARARs for disposal of cleanup wastes within the S Plant Aggregate Area.
7 Solid waste standards include such requirements as:
8

- 9 • Inspecting waste management areas to ensure proper performance and safe
10 conditions;
- 11 • Management standards for incinerators and treatment units;
- 12 • Design and performance standards for landfills; and
- 13 • Groundwater monitoring system design and performance.
14

15
16
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. Implementing
24 regulations appear principally at Chapters 173-216, 173-220, and 173-240 WAC.
25

26 The Water Pollution Control Act requirements for groundwater could be potential
27 ARARs for actions conducted within the S Plant Aggregate Area if such actions would result
28 in discharge of liquid contaminants to the soil column. In this event, Ecology may require
29 use of all known, available, and reasonable treatment technologies to treat the liquid
30 discharges prior to soil disposal.
31

32 The Water Pollution Control Act requirements for surface water would not be ARARs
33 for actions conducted only within the S Plant Aggregate Area. However, these requirements
34 could constitute potential ARARs for cleanup actions which would result in discharge of
35 treated wastewaters to the Columbia River and associated treatment systems could be required
36 to demonstrate they meet all known, available, and reasonable treatment technologies.
37

38 **6.4.2.4 Air Quality Management.** The Toxic Air Pollutant regulations for new air emission
39 sources, promulgated in Chapter 173-460 WAC, require use of best available control
40 technology for air toxics. The Toxic Air Pollutant regulations may be potential ARARs for
41 cleanup actions at the S Plant Aggregate Area that could result in emissions of toxic
42 contaminants to the air. Ecology may require the use of best available control technology for
43 air toxics, to treat such air emissions.
44
45

6.5 OTHER CRITERIA AND GUIDANCE TO BE CONSIDERED

In addition to the potential ARARs presented, other federal and state criteria, advisories, guidance, and similar materials are "to be considered" (TBC) in determining the appropriate degree of remediation for the S Plant Aggregate Area. A myriad of resources may be potentially evaluated. The following represents an initial assessment of pertinent TBC provisions.

6.5.1 Health Advisories

The EPA Office of Drinking Water publishes advisories identifying contaminants for which health advisories have been issued.

6.5.2 International Commission of Radiation Protection/National Council on Radiation Protection

The International Commission of Radiation Protection and the National Council on Radiation Protection have a guidance standard of 100 mrem/yr whole body dose of gamma radiation. These organizations also issue recommendations on other areas of interest regarding radiation protection.

6.5.3 EPA Proposed Corrective Actions for Solid Waste Management Units

In the July 27, 1990, federal register (55 FR 30798), EPA published proposed regulations for performing corrective actions (cleanup activities) at solid waste management units associated with RCRA facilities. The proposed 40 CFR Part 264 Subpart S include requirements that would be TBCs for determining an appropriate level of cleanup at the S Plant Aggregate Area. In particular, EPA included an appendix, "Appendix A - Examples of Concentrations Meeting Criteria for Action Levels", which presented recommended contaminant concentrations warranting corrective action. These contaminant-specific TBCs are included in Table 6-1 for the preliminary contaminants of concern.

6.5.4 DOE Standards for Radiation Protection

A number of DOE Orders exist which could be TBCs. DOE Orders that establish potential contaminant-specific or action-specific standards for the remediation of radioactive wastes and materials are discussed below.

6.5.4.1 DOE Order 5400.5 - DOE Standards for Radiation Protection of the Public and Environment. DOE Order 5400.5 establishes the requirements for DOE facilities to protect the environment and human health from radiation including soil and air contamination. The purpose of the Order is to establish standards and requirements for operations of the DOE and

1 DOE contractors with respect to protection of members of the public and the environment
2 against undue risk from radiation.

3
4 The Order mandates that the exposure to members of the public from a radiation source
5 as a consequence of routine activities shall not exceed 100 mrem from all exposure sources
6 due to routine DOE activities. In accordance with the Clean Air Act, exposures resulting
7 from airborne emissions shall not exceed 10 mrem to the maximally exposed individual at the
8 facility boundary. DOE Order 5400.5 provides Derived Concentration Guide values for
9 releases of radionuclides into the air or water. Derived Concentration Guide values are
10 calculated so that, under conditions of continuous exposure, an individual would receive an
11 effective dose equivalent of 100 mrem/year. Because dispersion in air or water is not
12 accounted for in the Derived Concentration Guide, actual exposures of maximally exposed
13 individuals in unrestricted areas are considerably below the 100 mrem/year level.

14
15 DOE Order 5400.5 also provides for establishment of soil cleanup levels through a site-
16 specific pathway analysis such as the allowable residual contamination level method. The
17 calculation of allowable residual contamination level values for radionuclides is dependent on
18 the physical characteristics of the site, the radiation dose limit determined to be acceptable,
19 and the scenarios of human exposure judged to be possible and to result in the upper-bound
20 exposure.

21
22 **6.5.4.2 DOE Order 5820.2A - Radioactive Waste Management.** DOE Order 5820.2A
23 applies to all DOE contractors and subcontractors performing work that involves management
24 of waste containing radioactivity. This Order requires that wastes be managed in a manner
25 that assures protection of the health and safety of the public, operating personnel, and the
26 environment. DOE Order 5820.2A establishes requirements for management of high-level,
27 transuranic, and low-level wastes as well as wastes containing naturally occurring or
28 accelerator produced radioactive material, and for decommissioning of facilities. The
29 requirements applicable to the S Plant Aggregate Area remediation activities include those
30 related to transuranic waste and low-level radioactive waste. These are summarized below.

31
32 **6.5.4.2.1 Management of Transuranic Waste.** Transuranic waste resulting from the S
33 Plant Aggregate Area remedial action must be managed to protect the public and worker
34 health and safety, and the environment, and performed in compliance with applicable
35 radiation protection standards and environmental regulations. Practical and cost-effective
36 methods must be used to reduce the volume and toxicity of transuranic waste.

37
38 Transuranic waste must be certified in compliance with the Waste Isolation Pilot Plant
39 (WIPP) Acceptance Criteria, placed in interim storage, if required, and sent to the WIPP.
40 Any transuranic waste that the DOE has determined, with the concurrence of the EPA
41 Administrator, does not need the degree of isolation provided by a geologic repository or
42 transuranic waste that cannot be certified or otherwise approved for acceptance at the WIPP
43 must be disposed of by alternative methods. Alternative disposal methods must be approved
44 by DOE Headquarters and comply with NEPA requirements and EPA/state regulations.
45

1 **6.5.4.2.2 Management of Low-Level Radioactive Waste.** The requirements for
2 management of low-level radioactive waste presented in DOE Order 5820.2A are relevant to
3 the remedial alternative of removal and disposal of S Plant Aggregate Area wastes.
4 Performance objectives for this option shall ensure that external exposure to the radioactive
5 material released into surface water, groundwater, soil, plants, and animals does not result in
6 an effective dose greater than 25 mrem/yr to the public. Releases to the environment shall be
7 at levels as low as reasonably achievable. An inadvertent intruder after the institutional
8 control period of 100 years is not to exceed 100 mrem/yr for continuous exposure or 500
9 mrem for a single acute exposure. A performance assessment is to be prepared to
10 demonstrate compliance with the above performance objectives.
11

12 Other requirements under DOE Order 5820.2A which may affect remediation of the S
13 Plant Aggregate Area include waste volume minimization, waste characterization, waste
14 acceptance criteria, waste treatment, and shipment. The low-level radioactive waste may be
15 stored by appropriate methods prior to disposal to achieve the performance objectives
16 discussed above. Disposal site selection, closure/post-closure, and monitoring requirements
17 are also discussed in this Order.
18
19

20 **6.6 POINT OF APPLICABILITY**

21 A significant factor in the evaluation of remedial alternatives for the S Plant Aggregate
22 Area will be the determination of the point at which compliance with identified ARARs must
23 be achieved (i.e., the point of a specific ARAR's applicability). These points of applicability
24 are the boundaries at which the effectiveness of a particular remedial alternative will be
25 assessed.
26
27

28 For most individual radioactive species transported by either water or air, Ecology and
29 Health standards generally require compliance at the boundaries of the Hanford Site. The
30 assumed point of compliance for radioactive species is the point where a member of the
31 public would have unrestricted access to live and conduct business, and, consequently, to be
32 maximally exposed. Although Health is responsible for monitoring and enforcing the air
33 standards promulgated by Ecology, and generally recognizes the site boundary as the point of
34 applicability, Ecology has recently indicated that compliance may be required at the point of
35 emission.
36

37 The point at which compliance with identified ARARs must be achieved will be a
38 significant factor in evaluating appropriate remedial alternatives in the S Plant Aggregate
39 Area. Applicability of ARARs at the point of discharge, at the boundary of the disposal unit,
40 at the boundary of the AAMS, at the boundary of the Hanford Site, and/or at the point of
41 maximum exposure will need to be determined.
42
43

1 **6.7 ARARs EVALUATION**

2
3 Evaluation of ARARs is an iterative process that will be conducted at multiple points
4 throughout the remedial process:

- 5
6 • When the public health evaluation is conducted to assess risks at the S Plant
7 Aggregate Area, the contaminant-specific ARARs and advisories and location-
8 specific ARARs will be identified more comprehensively and used to help
9 determine the cleanup goals; and
10
11 • During detailed analysis of alternatives, all the ARARs and advisories for each
12 alternative will be examined to determine what is needed to comply with other
13 laws and to be protective of public health and the environment.
14

15 Following completion of the investigation, the remedial alternative selected must be able
16 to attain all ARARs unless one of the six statutory waivers provided in Section 121 (d)(4)(A)
17 through (f) of CERCLA is invoked. Finally, during remedial design, the technical
18 specifications of construction must ensure attainment of ARARs. The six reasons ARARs can
19 be waived are as follows:

- 20
21 • The remedial action is an interim measure, where the final remedy will attain
22 ARARs upon completion.
23
24 • Compliance will result in greater risk to human health and the environment than
25 will other options.
26
27 • Compliance is technically impracticable.
28
29 • An alternative remedial action will attain the equivalent performance of the
30 ARAR.
31
32 • For state ARARs, the state has not consistently applied (or demonstrated the
33 intention to consistently apply) the requirements in similar circumstances.
34
35 • For CERCLA-financed actions under Section 104, compliance with the ARAR
36 will not provide a balance between the need for protecting public health, welfare,
37 and the environment at the facility, and the need for fund money to respond to
38 other sites (this waiver is not applicable at the Hanford Site).

Table 6-1. Potential Contaminant-Specific ARARs and TBCs for Preliminary Inorganic and Organic Contaminants of Concern.

| INORGANIC CHEMICALS | RCRA TCLP Designation Limits | RCRA Land Ban Limits Nonwastewater | | MTCA Method A Cleanup Levels Industrial Soil | WCAA Toxic Air Pollutants ASIL | RCRA Corrective Action Levels (Proposed) (1) | |
|--|------------------------------|------------------------------------|--------------|---|--------------------------------|--|---------------|
| | in mg/L | CCWE in mg/L | CCW in mg/kg | in mg/kg | in $\mu\text{g}/\text{m}^3$ | Air in $\mu\text{g}/\text{m}^3$ | Soil in mg/kg |
| Barium | 100 | 100 | — | — | — | — | — |
| Cadmium | 1.0 | 1.0 | — | 10 | .00056 | .0006 | 40 |
| Chromium | 5.0 | 5.0 | — | 500 | .000083 | .00009 | 40 |
| Copper | — | — | — | — | 3.3 | — | — |
| Fluoride | — | — | — | — | 8.3 | — | — |
| Lead | 5 | 5.0 | — | 1,000 | — | — | — |
| Iron | — | — | — | — | 2.7 | — | — |
| Manganese | — | — | — | — | — | — | — |
| Nickel | — | 134 | — | — | — | — | 2000 |
| Nitrite | — | — | — | — | — | — | — |
| Silver | 5.0 | 5.0 | — | — | 0.3 | — | 200 |
| Titanium | — | — | — | — | — | — | — |
| Uranium | — | — | — | — | 0.7 | — | — |
| Vanadium | — | — | — | — | — | — | — |
| Zinc | — | — | — | — | — | — | — |
| ORGANIC CHEMICALS | | | | | | | |
| Acetone | — | 160 | .59 | — | 5927.4 | — | 8000 |
| Chloroform | 6 | 5.6 | — | — | 0.043 | 0.04 | 100 |
| Hydrazine | — | — | — | — | — | 0.0002 | 0.2 |
| MIBK ("Hexone") | — | 33 | .33 | — | 682.7 | 70 | 4000 |
| Xylene | — | 0.15 | 28 | 20 | 1448.6 | 1000 | 200,000 |
| 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 = Toxic Characteristic Leaching Procedure WCAA = Washington State Clean Air Act | | | | mg/L = milligrams per liter mg/kg = milligrams per kilogram $\mu\text{g}/\text{m}^3$ = 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." | | | |

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Table 6-2. Potential Location-Specific ARARs.

| Location | Requirement | Prerequisite | Citation | ARAR |
|--|---|--|---|--------------------------------|
| GEOLOGICAL: | | | | |
| 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.

| Location | Requirement | Prerequisite | Citation | ARAR |
|-----------------------|--|---|---|--------------------------------|
| SURFACE WATER: | | | | |
| 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.

| Location | Requirement | Prerequisite | Citation | ARAR |
|-------------------------------|--|---|---|---|
| GROUNDWATER: | | | | |
| 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. |
| DRINKING WATER SUPPLY: | | | | |
| Drinking water supply well. | New solid waste disposal areas prohibited within 1,000 feet upgradient, or 90 days travel time, of drinking water supply well. | New solid waste disposal within 1,000 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. |

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Table 6-2. Potential Location-Specific ARARs.

| Location | Requirement | Prerequisite | Citation | ARAR |
|---|---|---|---|--------------------------------------|
| AIR: | | | | |
| 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. |
| SENSITIVE ENVIRONMENTS: | | | | |
| 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. |
| | Actions within critical habitats must conserve endangered/threatened species. | Activities where endangered or threatened species exist. | 50 CFR Parts 200 and 402. | Potential ARAR. |
| Parks. | 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. |
| | 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. |
| Wilderness areas. | Actions within designated wilderness areas must ensure area is preserved and not impaired. | Activities within designated wilderness areas. | 16 USC 1131 <u>et seq</u> ; 50 CFR 35.1 <u>et seq</u> | 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 <u>et seq</u> ; 50 CFR Part 27 | Not ARAR. Not a wildlife refuge. |

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Table 6-2. Potential Location-Specific ARARs.

| Location | Requirement | Prerequisite | Citation | ARAR |
|---------------------------------------|--|---|---|--|
| 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 332-650 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. |
| 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. |
| | 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. |
| Public lands. | 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 archaeologic properties and resources, and minimize harm to national landmarks. | Activities that could affect historic or archaeologic 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 archaeologic sites. |

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Table 6-2. Potential Location-Specific ARARs.

| Location | Requirement | Prerequisite | Citation | ARAR |
|-------------------------|--|--|-----------------|---|
| 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)/5,000 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

1
2
3
4 Previous sections identified contaminants of concern at the S Plant Aggregate Area,
5 potential routes of exposure, and applicable or relevant and appropriate requirements
6 (ARARs). Section 7.0 identifies preliminary remedial action objectives (RAOs) and develops
7 preliminary remedial action alternatives consistent with reducing the potential hazards of this
8 contamination and satisfying ARARs. The overall objective of this section is to identify
9 viable and innovative remedial action alternatives for media of concern at the S Plant
10 Aggregate Area.

11
12 The process of identifying viable remedial action alternatives consists of several steps.
13 In Section 7.1, RAOs are first identified. Next, in Section 7.2, general response actions are
14 determined along with specific treatment, resource recovery, and containment technologies
15 within the general response categories. Specific process options belonging to each technology
16 type are identified, and these process options are subsequently screened based on their
17 effectiveness, implementability, and cost (Section 7.3). The combining of process options
18 into alternatives occurs in Section 7.4. Here the alternatives are described and diagrammed.
19 Criteria are then identified in Section 7.5 for preliminary screening of alternatives that may be
20 applicable to the waste management units and unplanned release sites identified in the S Plant
21 Aggregate Area. Figure 7-1 is a matrix summarizing the development of the remedial action
22 alternatives starting with media-specific RAOs.

23
24 Because of uncertainty regarding the nature and extent of contamination at the S Plant
25 Aggregate Area waste sites, recommendations for remedial alternatives are general and cover
26 a broad range of actions. Remedial action alternatives will be considered and more fully
27 developed in future focused feasibility studies. The *Hanford Past-Practice Strategy*
28 (Thompson 1991) is used to focus the range of remedial action alternatives that will be
29 evaluated in focused studies. In general, the *Hanford Past-Practice Strategy* remedial
30 investigation (RI)/feasibility study (FS) and the Resource Conservation Recovery Act
31 (RCRA)/Corrective Measures Studies are defined as the combination of interim remedial
32 measures (IRMs), limited field investigations (LFIs) for final remedy selection where interim
33 actions are not clearly justified, and focused or aggregate area feasibility/treatability studies
34 for further evaluation of treatment alternatives. After completion of an IRM, data will be
35 evaluated including concurrent characterization and monitoring data to determine if a final
36 remedy can be selected.

37
38 A secondary purpose of the evaluation of preliminary remedial action alternatives is the
39 identification of additional information needed to complete the evaluation. This information
40 may include field data needs and treatability tests of selected technologies. Additional data
41 will be developed for most sites or waste groups during future data gathering activities (e.g.,
42 LFIs, characterization supporting IRMs, or treatability studies). These data may be used to
43 refine and supplement the RAOs and proposed alternatives identified in this initial study. Data
44 needs are defined in Section 8.0. Alternatives involving technologies that are not
45 well-demonstrated under the conditions of interest are identified in Sections 7.3 and 7.5.

1 These technologies may require bench-scale and pilot-scale treatability studies. The intent is
2 to conduct treatability studies for promising technologies early in the RI/FS process.
3 Conclusions regarding the feasibility of some individual technologies may change after new
4 data become available.
5

6 The bias-for-action philosophy of addressing contamination at the Hanford Site requires
7 an expedited process for implementing remedial actions. Implementation of general response
8 actions may be accomplished using an observational or "learn-as-you-go" approach. This
9 observational approach is an iterative process of data acquisition and refinement of the
10 conceptual model. Data needs are determined by the model, and data collected to fulfill these
11 needs are used as additional input to the model. Use of the observational approach while
12 conducting response actions in the 200 Area will allow integrating these actions with longer
13 range objectives of final remediation of similar areas and the entire 200 Area. Site
14 characterization and remediation data will be collected concurrently with the use of LFI's,
15 IRMs, and treatability testing. The knowledge gained through these different activities will
16 be applied to similar areas. The overall goal of this approach is convergence on an
17 appropriate response action as early as possible while continuing to obtain valuable
18 characterization information during remediation phases.
19
20

21 7.1 PRELIMINARY REMEDIAL ACTION OBJECTIVES

22
23 The RAOs are remediation goals for protection of human health and the environment
24 that specify the contaminants and media of concern, exposure pathways, and allowable
25 contaminant levels. The RAOs discussed in this section are considered to be preliminary and
26 may change or be refined as new data are acquired and evaluated.
27

28 The fundamental objective of the corrective action process at the S Plant Aggregate
29 Area is to protect environmental resources and/or human receptors from the potential threats
30 that may exist because of known or suspected contamination. Specific interim and final
31 RAOs will depend in part on current and reasonable potential future land use in the S Plant
32 Aggregate Area and the 200 Area.
33

34 Potential future land use will affect the risk-based cleanup objectives, potential ARARs,
35 and point of compliance. The RAOs for protecting human health for residential or
36 agricultural land use would be based on risk assessment exposure scenarios requiring cleanup
37 to lower contaminant levels than for recreational or industrial land uses. It is important that
38 potential future land use and the RAOs be clearly defined and agreed upon by the U.S.
39 Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and Washington
40 State Department of Ecology (Ecology) before further and more detailed evaluation of
41 remedial actions. The Hanford Site Remedial Action Environmental Impact Statement is
42 intended to resolve the land use issues. A Record of Decision for this environmental impact
43 statement is expected in the spring of 1994.
44

1 To focus remedial actions with a bias for action through implementing IRMs,
2 preliminary RAOs are identified for the 200 Area and S Plant Aggregate Area. The overall
3 objective for the 200 Area is as follows:
4

5 Reduce the risk of harmful effects to the environment and human users of the area by
6 reducing the toxicity, mobility, or volume of contaminants from the source areas to
7 meet ARARs or risk-based levels that will allow industrial use of the area (this is a
8 potential final RAO, and an interim action objective based on current use of the 200
9 Area).
10

11 The RAOs are further developed in Table 7-1 for media of concern and applicable
12 exposure pathways (see Sections 4.1 and 4.2) for the S Plant Aggregate Area. The media of
13 concern for the S Plant Aggregate Area include:
14

- 15 • Radiation contaminated soils that could result in direct exposure or inhalation
- 16
- 17 • Contaminated soils that are or could contribute to groundwater contamination
- 18
- 19 • Vadose zone vapors that could cause ambient air impacts or contribute to the
20 lateral and vertical migration of contaminants in the soil and to the groundwater
- 21
- 22 • Biota that could mobilize radionuclides or chemical contaminants and could
23 thereby degrade the integrity of other controls, such as caps.
24

25 Waste materials currently stored in single-shell tanks that contribute or may contribute
26 contaminants to environmental media will not be addressed by this aggregate area
27 management study (AAMS) program but rather by the single-shell tank program. In addition,
28 groundwater as an exposure medium is not addressed in this source AAMS report but will be
29 addressed in the 200 West Groundwater Aggregate Area Management Study Report.
30

31
32 **7.2 PRELIMINARY GENERAL RESPONSE ACTIONS**
33

34 General response actions represent broad classes of remedial measures that may be
35 appropriate to achieve both interim and final RAOs at the S Plant Aggregate Area, and are
36 presented in Table 7-2. The following are the general response actions followed by a brief
37 description for the S Plant Aggregate Area:
38

- 39 • No action (applicable to specific facilities)
- 40
- 41 • Institutional controls
- 42
- 43 • Waste removal and treatment or disposal
- 44
- 45 • Waste containment
46

- 1 • In situ waste treatment
- 2
- 3 • Combinations of the above actions.
- 4

5 No action is included for evaluations as required by the National Environmental Policy
6 Act and National Contingency Plan [40 CFR 300.68 (f)(1)(v)] to provide a baseline for
7 comparison with other response actions. The no action alternative may be appropriate for
8 some facilities and sources of contamination if risk assessments determine acceptable natural
9 resource or human health risks posed by those sources or facilities and no exceedances of
10 contaminant-specific ARARs occur.

11
12 Institutional controls involve the use of physical barriers or access restrictions to reduce
13 or eliminate public exposure to contamination. Considering the nature of the S Plant
14 Aggregate Area and the 200 Area as a whole, institutional controls will likely be an integral
15 component of all interim remedial alternatives. Many access and land use restrictions are
16 currently in place at the Hanford Site and will remain in place during implementation of
17 remedial actions. Institutional controls may also be important for final remedial measures
18 alternatives. The decisions regarding future long-term land use at the 200 Area will be
19 important in determining whether institutional controls will be a part of the remedial measures
20 alternative, and the type of controls required.

21
22 Waste removal and treatment or disposal involves excavation of contamination sources
23 for eventual treatment and/or disposal either on a small- or large-scale basis. One approach
24 being considered for large-scale waste removal is macro-engineering, which is based on high
25 volume excavation using conventional surface mining technologies. Waste removal on a
26 macro-engineering scale would be used over large areas such as groups of waste management
27 units, operable units, or operational areas as a final remedial action. Waste removal on a
28 small scale would be conducted for individual waste management units on a selective basis.
29 Small-scale waste removal could be conducted as either an interim or final remedial action.
30 One potential problem with off-site disposal is the lack of an alternate disposal location that
31 will decrease the potential human exposure over the long time required for many of the
32 contaminants. Waste removal actions may not be needed, or only be required on a small
33 scale, to protect human health or the environment for industrial uses of the 200 Area.

34
35 Waste treatment involves the use of biological, thermal, physical, or chemical
36 technologies. Typical treatment options include biological land farming, thermal processing,
37 soil washing, and fixation/solidification/stabilization. Some treatment technologies may be
38 pilot tested at the highest priority facilities. Waste treatment could be conducted either as an
39 interim or final action and may be appropriate in meeting RAOs for all potential future land
40 uses.

41
42 Waste containment includes the use of capping technologies (i.e., capping and grouting)
43 to minimize the driving force for downward or lateral migration of contaminants. Capping
44 also provides a radiation exposure barrier and barrier to direct exposure. In addition, these
45 barriers provide long-term stability with relatively low maintenance requirements.
46 Containment actions may be appropriate for either interim or final remedial actions.

1
2 In situ waste treatment includes thermal, chemical, physical, and biological technology
3 types, of which there are several specific process options including in situ vitrification, in situ
4 grouting or stabilization, soil flushing, and in situ biotreatment. The distinguishing feature of
5 in situ treatment technologies is the ability to attain RAOs without removing the wastes. The
6 final waste form generally remains in place. This feature is advantageous when exposure
7 during excavation would be significant or when excavation is technically impractical. In situ
8 treatment can be difficult because the process conditions may not be easily controlled.
9

10 In the next section, specific process options within these technology groups are
11 evaluated.
12

13 14 7.3 TECHNOLOGY SCREENING 15

16 In this section, potentially applicable technology types and process options are
17 identified. These process options are then screened using effectiveness, implementability, and
18 relative cost as criteria to eliminate those process options that would not be feasible at the
19 site. The remaining applicable processes are then grouped into remedial alternatives in
20 Sections 7.4.
21

22 The effectiveness criteria focuses on: (1) the potential effectiveness of process options
23 in handling the areas or volumes of media and meeting the remedial action objectives; (2) the
24 potential impacts to human health and the environment during the construction and
25 implementation phase; and (3) how proven and reliable the process is with respect to the
26 contaminants and conditions at the site. This criteria also concentrates on the ability of a
27 process option to treat a contaminant type (organics, inorganics, metals, radionuclides, etc.)
28 rather than a specific contaminant (nitrate, cyanide, chromium, plutonium, etc.).
29

30 The implementability criteria places greater emphasis on the institutional aspects of
31 implementability, such as the ability to obtain necessary permits for offsite actions, the
32 availability of treatment, storage, and disposal services, and the availability of necessary
33 equipment and skilled workers to implement the technology. It also focuses on the process
34 option's developmental status, whether it is an experimental or established technology.
35

36 The relative cost criteria is an estimate of the overall cost of a process, including capital
37 and operating costs. At this stage in the process, the cost analysis is made on the basis of
38 engineering judgement, and each process is evaluated as to whether costs are high, medium,
39 or low relative to other process options.
40

41 A process option is rated effective if it can handle the amount of area or media
42 required, if it does not impact human health or the environment during the construction and
43 implementation phases, and if it is a proven or reliable process with respect to the
44 contaminants and conditions at the site. Also a process option is considered more effective if
45 it treats a wide range of contaminants rather than a specific contaminant. An example of a
46 very effective process option would be vitrification because it treats inorganics, metals, and

1 radionuclides. On the other hand, chemical reduction may only treat chromium (VI), making
2 it a less useful option.
3

4 An easily implemented process option is one that is an established technology, uses
5 readily available equipment and skilled workers, uses treatment, storage, and disposal services
6 that are readily available, and has few regulatory constraints. Preference is given to
7 technologies that are easily implemented.
8

9 Preference is given to lower cost options, but cost is not an exclusionary criteria. A
10 process option is not eliminated based on cost alone.
11

12 Results of the screening process are shown in Table 7-3. Brief descriptions are given of
13 the process options, followed by comments regarding the evaluation criteria. The last column
14 of the table indicates whether the process option is rejected or carried forward for possible
15 alternative formation. The table first lists technologies that address soil RAOs. Next,
16 technologies pertaining to biota RAOs are presented. All the biota-specific technologies
17 happen to be technologies that were listed for soil RAOs. Air RAOs are dealt with as soil
18 remediation issues because the air contamination is a result of the contaminants in the soil:
19 addressing and remediating the air pathways would be unnecessary and ineffective as long as
20 there is soil contamination. If the soil is remediated, the source of the air contamination
21 would be removed.
22

23 The conclusions column of Table 7-3 indicates that no action, monitoring, 3 institutional
24 process options, and 16 other process options are retained for further development of
25 alternatives. These options are carried forward into the development of preliminary
26 alternatives.
27

28 29 7.4 PRELIMINARY REMEDIAL ACTION ALTERNATIVES

30
31 This section develops and describes several remedial alternatives considered applicable
32 to disposal sites that contain hazardous chemicals, radionuclides, and volatile organic
33 compounds (VOCs). These alternatives are not intended as recommended actions for any
34 individual site, but are intended only to provide potential options applicable to most sites
35 where multiple contaminants are present. Selection of actual remedial alternatives that should
36 be applied to the individual sites would be partly based on future expedited or interim actions
37 and LFIs, as recommended in Section 9.0 of this report. Selection of proper alternatives
38 would be conducted within the framework of the *Hanford Past-Practice Strategy* (Thompson
39 1991) and the strategy outlined in Section 9.4.
40

41 The remedial alternatives are developed in Section 7.4.1. Then, in Section 7.4.2
42 through Section 7.4.7, the remedial action alternatives are described. Detailed evaluations and
43 costs are not provided because site-specific conditions must be further investigated before
44 meaningful evaluations could be conducted.
45

1
2 **7.4.1 Development of Remedial Alternatives**
3

4 Potentially feasible remedial technologies were described and evaluated in Section 7.3.
5 Some of those technologies have been proven to be effective and constructible at industrial
6 waste sites, while other technologies are in the developmental stages. EPA guidance on
7 feasibility studies for uncontrolled waste management units recommends that a limited
8 number of candidate technologies be grouped into "Remedial Alternatives." For this study,
9 technologies were combined to develop remedial alternatives and provide at least one
10 alternative for each of the following general strategies:

- 11
- 12 • No action
 - 13
 - 14 • Institutional controls
 - 15
 - 16 • Removal, above-ground treatment, and disposal
 - 17
 - 18 • Containment
 - 19
 - 20 • In situ treatment.
 - 21

22 The alternatives are intended to treat all or a major component of the S Plant Aggregate
23 Area contaminated waste management units or unplanned releases. Consistent with the
24 development of RAOs and technologies, alternatives were developed based on treating classes
25 of compounds (radionuclides, heavy metals, inorganics, and organics) rather than specific
26 contaminants. At a minimum, the alternative must be a complete package. For example,
27 disposal of radionuclide-contaminated soil must be combined with excavation and backfilling
28 of the excavated site.
29

30 One important factor in the development of the preliminary remedial action alternatives
31 is the fact that radionuclides, heavy metals, and some inorganic compounds cannot be
32 destroyed. Rather, these compounds must be physically immobilized, contained, isolated, or
33 chemically converted to less mobile forms to satisfy RAOs. Organic compounds can be
34 destroyed, but may represent a smaller portion of the overall contamination at the S Plant
35 Aggregate Area. Both no action and institutional controls are required as part of the
36 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) RI/FS
37 guidance. The purpose of including both of these alternatives is to provide decision makers
38 with information on the entire range of available remedial actions.
39

40 For the containment alternative, an engineered multimedia cover, with or without
41 vertical barriers (depending on the specifics of the remediation) was selected. Two
42 alternatives were selected to represent the excavation and treatment strategy. One of these
43 deals with disposal of transuranic (TRU) contaminated soils. Finally, three in situ alternatives
44 were identified. One deals with vapor extraction for VOCs, one with stabilization of soils
45 and the other with vitrification of soils.
46

1 It is recognized that this does not represent an exhaustive list of all applicable
2 alternatives. However, these do provide a reasonable range of remedial actions that are likely
3 to be evaluated in future feasibility studies. The remedial action alternatives are summarized
4 as follows:

- 5
- 6 • No action
- 7
- 8 • Institutional controls
- 9
- 10 • Engineered multimedia cover with or without vertical barriers (containment)
- 11
- 12 • In situ grouting or stabilization of soil (in situ treatment)
- 13
- 14 • Excavation, above-ground treatment, and disposal of soil (removal, treatment and
15 disposal)
- 16
- 17 • In situ vitrification of soil (in situ treatment)
- 18
- 19 • Excavation, treatment, and geologic disposal of soil with TRU radionuclides
20 (removal, treatment and disposal)
- 21
- 22 • In situ soil vapor extraction of VOCs (in situ treatment).
- 23

24 These alternatives, with the exception of no action and institutional controls, were
25 developed because they satisfy a number of RAOs simultaneously and use technologies that
26 are appropriate for a wide range of contaminant types. For example, constructing an
27 engineered multimedia cover can effectively contain radionuclides, heavy metals, inorganic
28 compounds, and organic compounds simultaneously. It satisfies the RAOs of protecting
29 human health and the environment from exposures from contaminated soil, bio-mobilization,
30 and airborne contaminants. In situ soil vapor extraction is more contaminant-specific than the
31 other alternatives, but it addresses a contaminant class (VOCs) that is not readily treated using
32 the other options, such as in situ stabilization. It is possible that some waste management
33 units may require a combination of the identified alternatives to completely address all
34 contaminants.

35
36 The use of contaminant-specific remedial technologies was avoided because there
37 appear to be few, if any, waste management units where a single contaminant has been
38 identified. It is possible to construct alternatives that include several contaminant-specific
39 technologies, but the number of combinations of technologies would result in an
40 unmanageable number of alternatives. Moreover, the possible presence of unidentified
41 contaminants may render specific alternatives unusable. Alternatives may be refined as more
42 contamination data are acquired. For now, the alternatives will be directed at remediating the
43 major classes of compounds (radionuclides, heavy metals, inorganics, and organics).

44
45 In all alternatives except the no-action alternative, it is assumed that monitoring and
46 institutional controls are required, although they may be temporary. These features are not

1 explicitly mentioned, and details are purposely omitted until a more detailed evaluation may
2 be performed in subsequent studies.
3

4 In the next sections, the preliminary remedial action alternatives are described in more
5 detail, with the exception of the no-action and institutional control options.
6
7

8 **7.4.2 Alternative 1--Engineered Multimedia Cover with or without Vertical Barriers** 9

10 Alternative 1 consists of an engineered multimedia cover. Vertical barriers such as
11 grout curtains or slurry walls may be used in conjunction with the cover. Figure 7-2 shows a
12 schematic diagram of an engineered multimedia cover without the vertical barriers. If the
13 affected area includes either a naturally-occurring or engineered depression, then imported
14 backfill would be placed to control runoff and run-on water. The engineered cover itself may
15 consist of clay, gravel, sand, asphalt, soil, and/or synthetic liners. A liquid collection layer
16 could also be included. The specific design of the cover and vertical barriers would be the
17 subject of a focused feasibility study which may be supported by performance testing. The
18 barrier would be designed to minimize infiltration of surface water by enhancing the
19 evapotranspiration mechanism. The covered area may be fenced, and warning signs may be
20 posted.
21

22 Alternative 1 would provide a permanent cover over the affected area. The cover would
23 accomplish the following: minimize or eliminate the migration of precipitation into the
24 affected soil; reduce the migration of windblown dust that originated from contaminated
25 surface soils; reduce the potential for direct exposure to contaminated soils; and reduce the
26 volatilization of VOCs and tritium to the atmosphere. If vertical barriers are included, they
27 would limit the amount of lateral migration of contaminants.
28
29

30 **7.4.3 Alternative 2--In Situ Grouting or Stabilization of Soil** 31

32 Radioactive and hazardous soil would be grouted in this alternative using in situ
33 injection methods to significantly reduce the leachability of hazardous contaminants,
34 radionuclides and/or VOCs from the affected soil. Grouting may also be used to fill voids,
35 such as in cribs, thereby reducing subsidence. Another variation of this alternative would be
36 to stabilize the soil using in-situ mixing of soil with stabilizing compounds such as
37 pozzolanics or fly ash.
38

39 Figure 7-3 shows a schematic diagram of the in situ grout injection process. Grouting
40 wells would be installed and screened throughout the affected vertical zones. Specially
41 formulated cement grout (determined by treatability studies) would be injected and allowed to
42 cure. In-situ stabilization would be conducted in a similar manner, except a cutting-head tool
43 would be used to mix the contaminated soil with stabilizing compounds fed into the soil.
44

45 Alternative 2 would provide a combination of immobilization and containment of heavy
46 metal, radionuclide, and inorganic contamination. Thus, this alternative would reduce

1 migration of precipitation into the affected soil; reduce the migration of windblown dust that
2 originated from contaminated surface soils; reduce the potential for direct exposure to
3 contaminated soils; and reduce the volatilization of VOCs.
4
5

6 **7.4.4 Alternative 3--Excavation, Soil Treatment, and Disposal**

7

8 Under Alternative 3, radioactive and hazardous soil would be excavated using
9 conventional techniques, with special precautions to minimize fugitive dust generation. The
10 soil would be treated above ground. Several treatment options could be selected from the
11 physical, chemical, and thermal treatment process options screened in Section 7.3. For
12 example, thermal desorption with off gas treatment could be used if organic compounds are
13 present; soil washing could be used to remove contaminated silts and sands or specific
14 compounds; and stabilization could be used to immobilize radionuclides and heavy metals.
15 The specific treatment method would depend on site-specific conditions (determined in part
16 through bench-scale testing). The treated soil would be backfilled into the original excavation
17 or landfilled. Soil treatment by-products may require additional processing or treatment.
18 Figure 7-4 shows a schematic diagram of this alternative.
19

20 Alternative 3 would be effective in treating a full range of contamination, depending on
21 the type of treatment processes selected. Attainment of soil RAOs would depend on the
22 depth to which the soil was excavated. If near surface soil was treated, airborne
23 contamination, direct exposure to contaminated soil, and bio-mobilization of contamination
24 would be minimized. Because of practical limits on deep excavation, deep contamination
25 may not be removed and would be subject to migration into groundwater. Alternative 3 could
26 be used in conjunction with Alternative 1 (multimedia cap) to reduce this possibility.
27
28

29 **7.4.5 Alternative 4--In Situ Vitrification of Soil**

30

31 In this alternative, the contaminated soil in a subject site would be immobilized by in
32 situ vitrification. Figure 7-5 shows a schematic diagram of the alternative. Import fill would
33 initially be placed over the affected area to reduce exposures to the remediation workers from
34 surface contamination. High power electrodes would be used to vitrify the contaminated soil
35 under the site to a depth below where contamination is present. A large fume hood would be
36 constructed over the site before the start of the vitrification process to collect and treat
37 emissions. After completion of the vitrification, the site would be built back to original grade
38 with imported backfill. Fences and warning signs may be placed around the vitrified
39 monolith to minimize disturbance and potential exposure.
40

41 In situ vitrification would be effective in treating radionuclides, heavy metals, and
42 inorganic contamination and may also destroy organic contaminants. This would reduce the
43 potential for exposures by leaching to groundwater, windblown dust and direct dermal
44 contact. However, this alternative would not reduce the mass or toxicity of the radionuclides
45 present onsite. Also, in situ vitrification may be limited to depths of less than about 100 feet,
46 which may not be adequate to immobilize deep contamination.

1
2 **7.4.6 Alternative 5--Excavation, Above-Ground Treatment, and Geologic Disposal of**
3 **Soil with TRU Radionuclides**
4

5 Figure 7-6 shows a schematic diagram of Alternative 5. Special excavation procedures
6 would have to be used to minimize fugitive dust. Non-TRU "overburden" may have to be
7 removed, temporarily stored, and returned to the excavation after the TRU soil was removed.
8 Imported backfill would be used to restore the site to original grade. The excavated TRU soil
9 would be vitrified or stabilized by an above-ground treatment plant. The vitrified or
10 stabilized soil would then be shipped to a TRU waste repository. Long-term storage may be
11 required until a suitable facility could be sited and constructed. An engineered multimedia
12 cover (Alternative 1) could be installed over the completed site to reduce exposure to any
13 remaining contaminated, non-TRU soils.
14

15 For Alternative 5, soil containing TRU radionuclides at concentrations exceeding 100
16 nCi/g would be excavated, treated, and disposed. Thus, potential exposure to and migration
17 of TRU-wastes would be minimized. Potential exposure to other contaminants would be
18 determined by other remedial alternatives implemented. At sites containing TRU and
19 non-TRU wastes, the use of Alternative 5 alone may not satisfy all RAOs.
20

21
22 **7.4.7 Alternative 6--In Situ Soil Vapor Extraction for VOCs**
23

24 Figure 7-7 shows a schematic diagram of a representative soil vapor extraction system.
25 The soil vapor extraction system would consist of venting wells, manifold piping, condensed
26 water collectors, high efficiency particulate air (HEPA) filters, and a catalytic oxidizer. The
27 condensed water may contain VOCs and radionuclides, so it may have to be disposed of as
28 radioactive mixed waste. The vented air may contain radionuclide-containing dust particles,
29 so HEPA filters would be installed to remove the particulate radionuclides. The vented
30 vapors would be treated by the catalytic incinerator to provide at least 95% destruction.
31 Because there are few sites in the S Plant Aggregate Area, the potential use of soil vapor
32 extraction in this aggregate area would be limited.
33

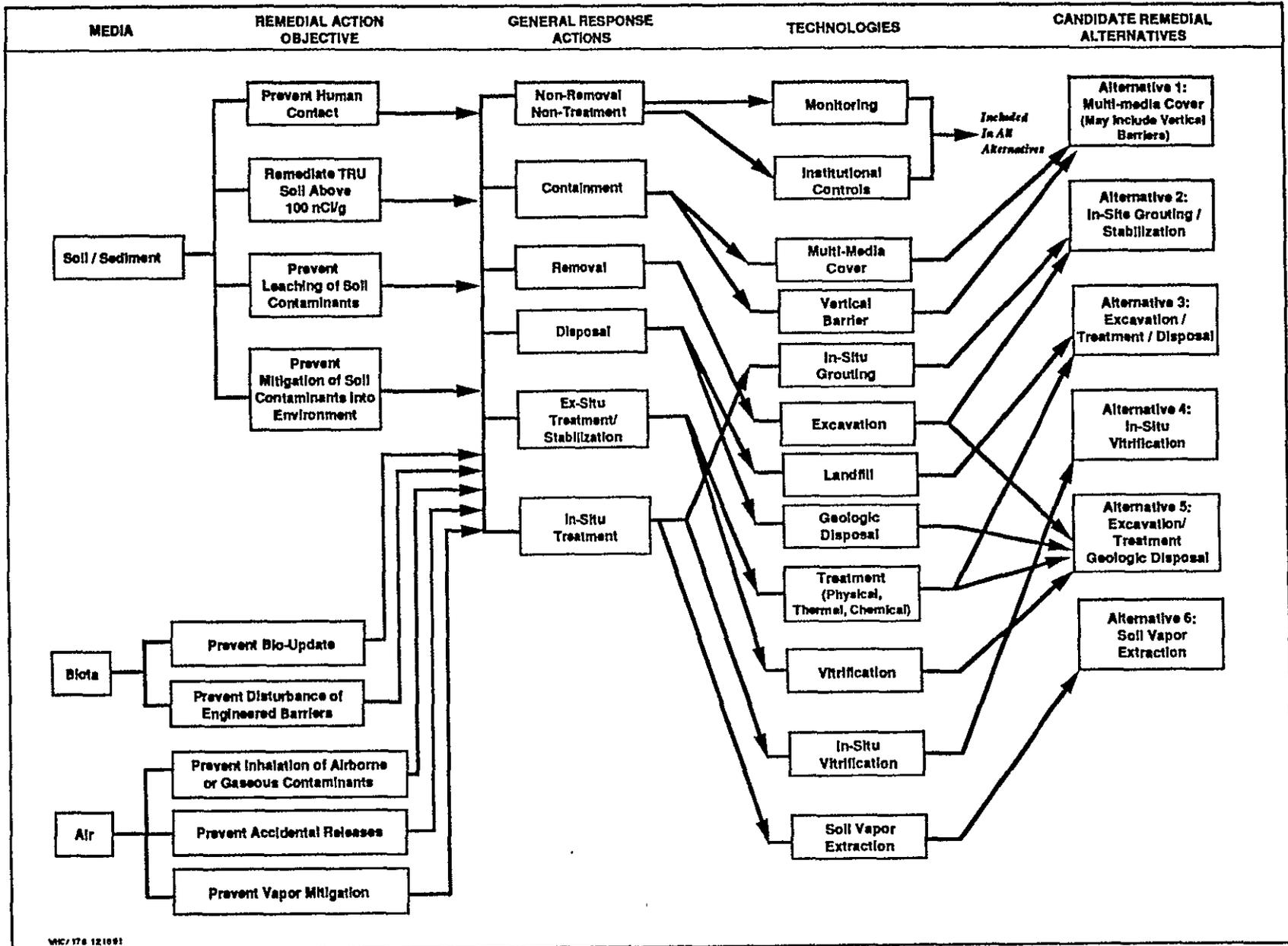
34 In situ soil vapor extraction is a proven technology for removal of VOC from the
35 vadose zone soils. Soil vapor extraction would reduce downward migration of the VOC
36 vapors through the vadose zone, and thereby minimize potential cross-media migration into
37 the groundwater. Soil vapor extraction would reduce upward migration of VOC through the
38 soil column into the atmosphere, and thereby minimize inhalation exposures to the
39 contaminants. In some cases the radionuclides were discharged to the disposal sites with
40 VOCs (e.g., hexone). Removal of the VOC by implementing soil vapor extraction could
41 reduce the mobility of the radionuclides, and thereby reduce the potential for downward
42 migration of the radionuclides. Finally, soil vapor extraction would enhance partitioning of
43 the VOC off of the soil and into the vented air stream, resulting in the permanent removal
44 and destruction of the VOC. Alternative 6 may be used in conjunction with other alternatives
45 if contaminants other than VOCs are present. However, because of the limited number of S
46 Plant sites that contain VOCs, the use of soil vapor extraction will not be extensive.

1
2 **7.5 PRELIMINARY REMEDIAL ACTION ALTERNATIVES APPLICABLE TO**
3 **WASTE MANAGEMENT UNITS AND UNPLANNED RELEASE SITES**
4

5 The purpose of this section is to discuss which preliminary remedial action alternatives
6 could be used to remediate each S Plant Aggregate Area waste management unit or unplanned
7 release site. The criteria used for deciding this are as follows:
8

- 9 • Installing an engineered multimedia cover with or without vertical barriers
10 (Alternative 1) could be used on any site where contaminants may be leached or
11 mobilized by surface water infiltration or if surface/near-surface contamination
12 exists.
13
- 14 • In situ grouting or stabilization (Alternative 2) could be used on any waste
15 management unit or unplanned release site that contain heavy metals,
16 radionuclides, and/or other inorganic compounds. In situ grouting could also be
17 effective in filling voids for subsidence control.
18
- 19 • Excavation and soil treatment (Alternative 3) could be used at most waste
20 management units or unplanned release sites that contain radionuclides, heavy
21 metals, other inorganics compounds, and/or semi-volatile organic compounds.
22

7E-1

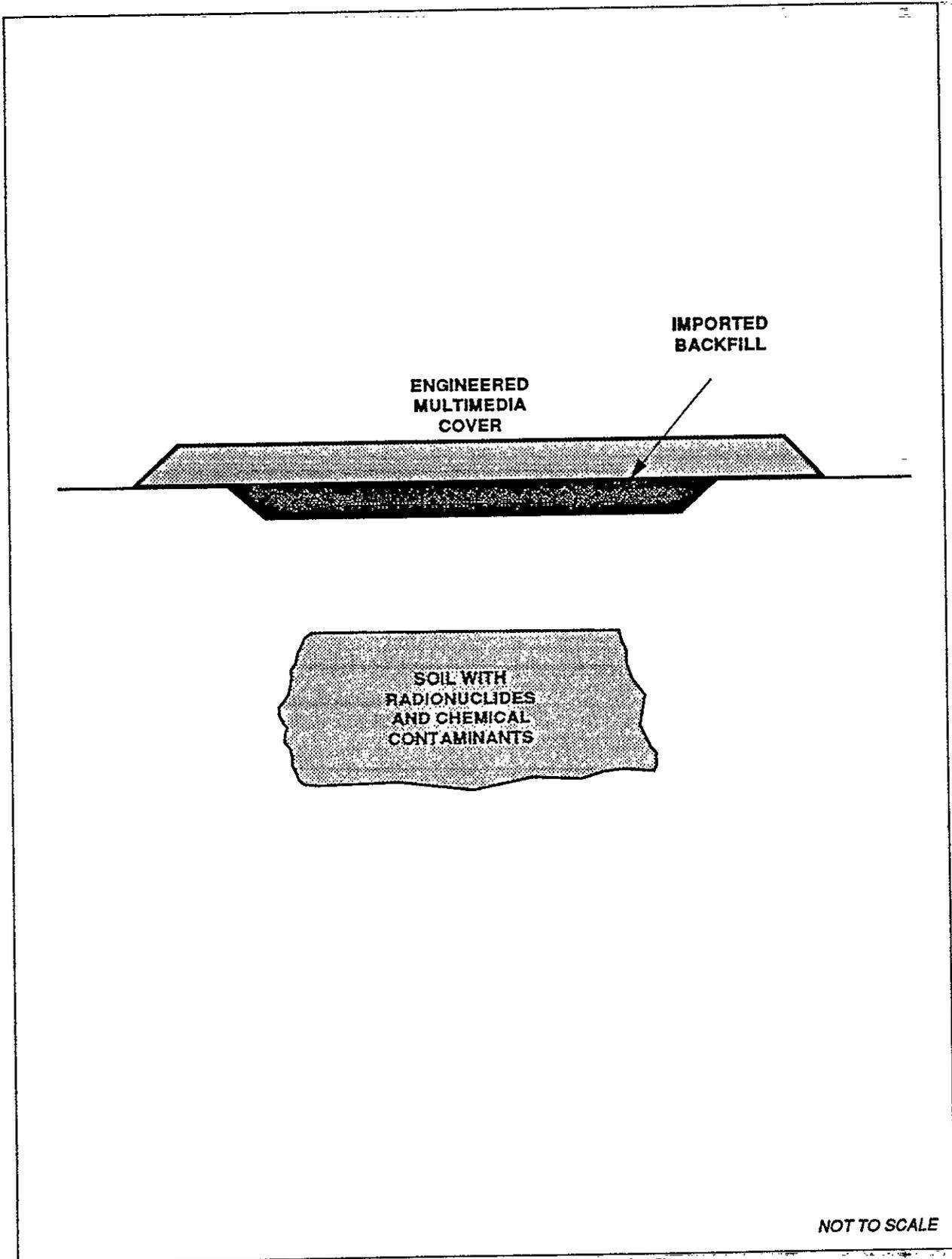


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Figure 7-1. Development of Candidate Remedial Alternatives for S Plant.

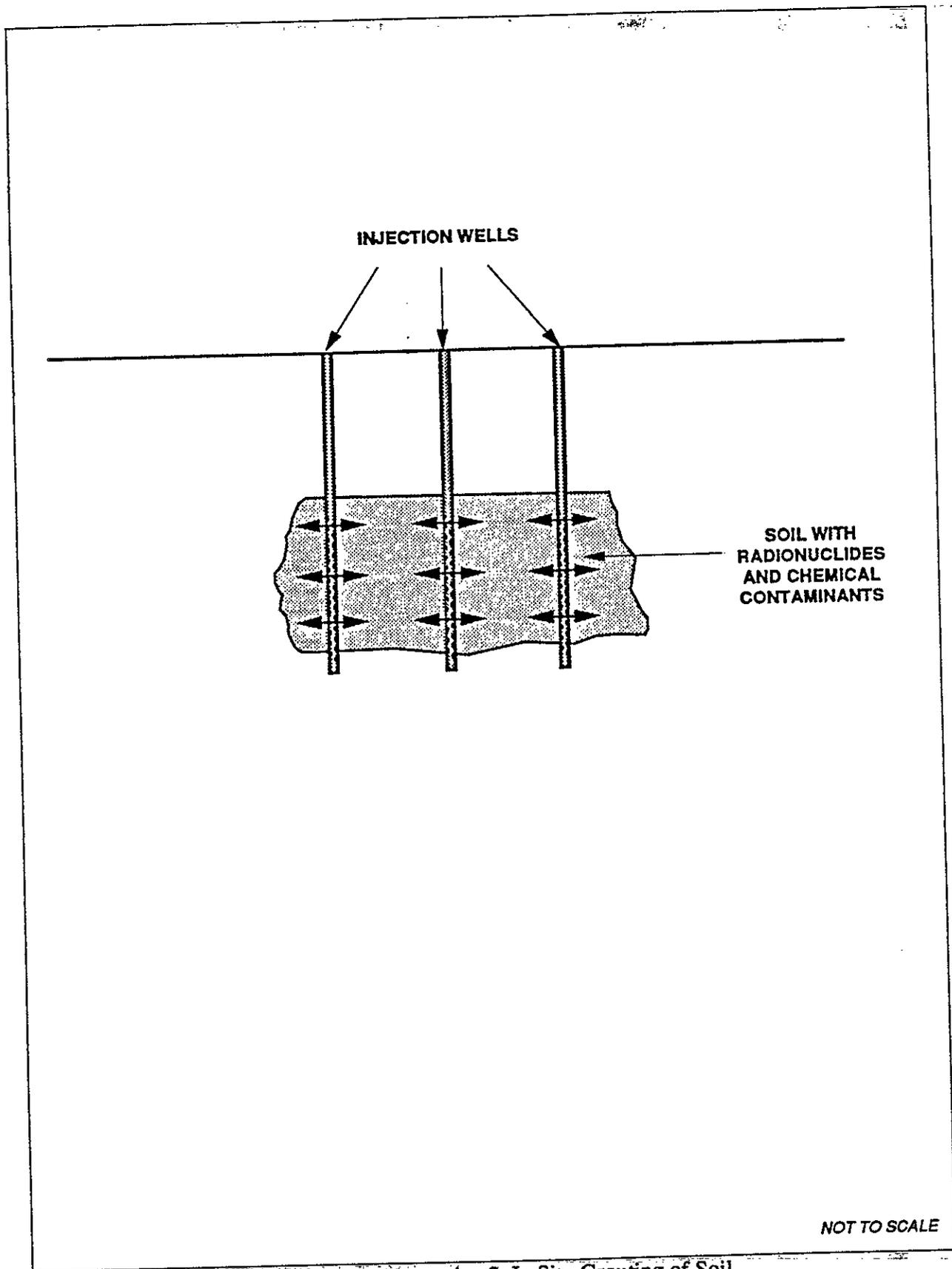
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Figure 7-2. Alternative 1: Multi-Media Cover.

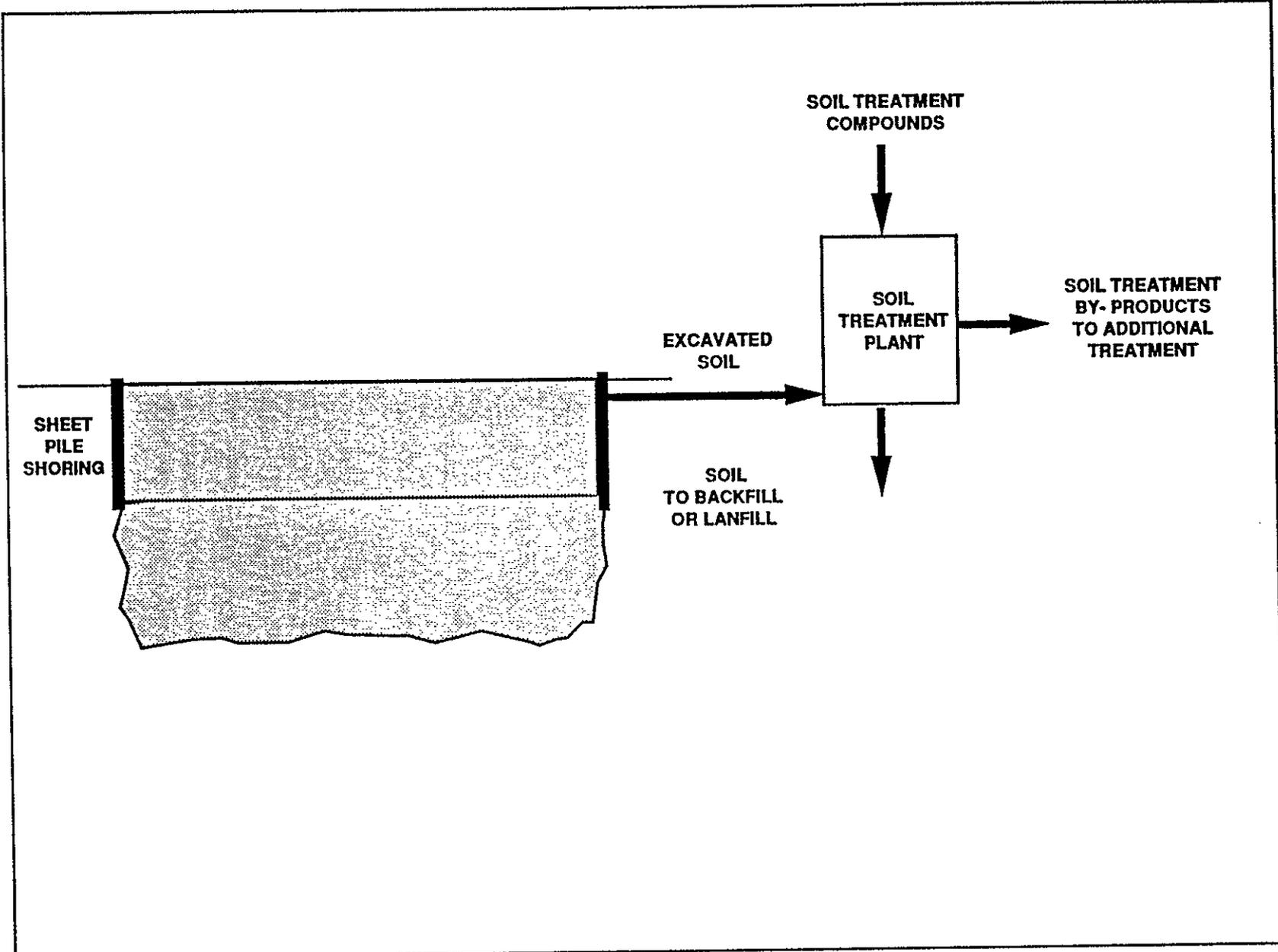


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Figure 7-3. Alternative 2: In Situ Grouting of Soil.

7F-4



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Figure 7-4. Alternative 3: Excavation, Treatment and Disposal.

9 3 1 2 9 7 5 1 7 1 6

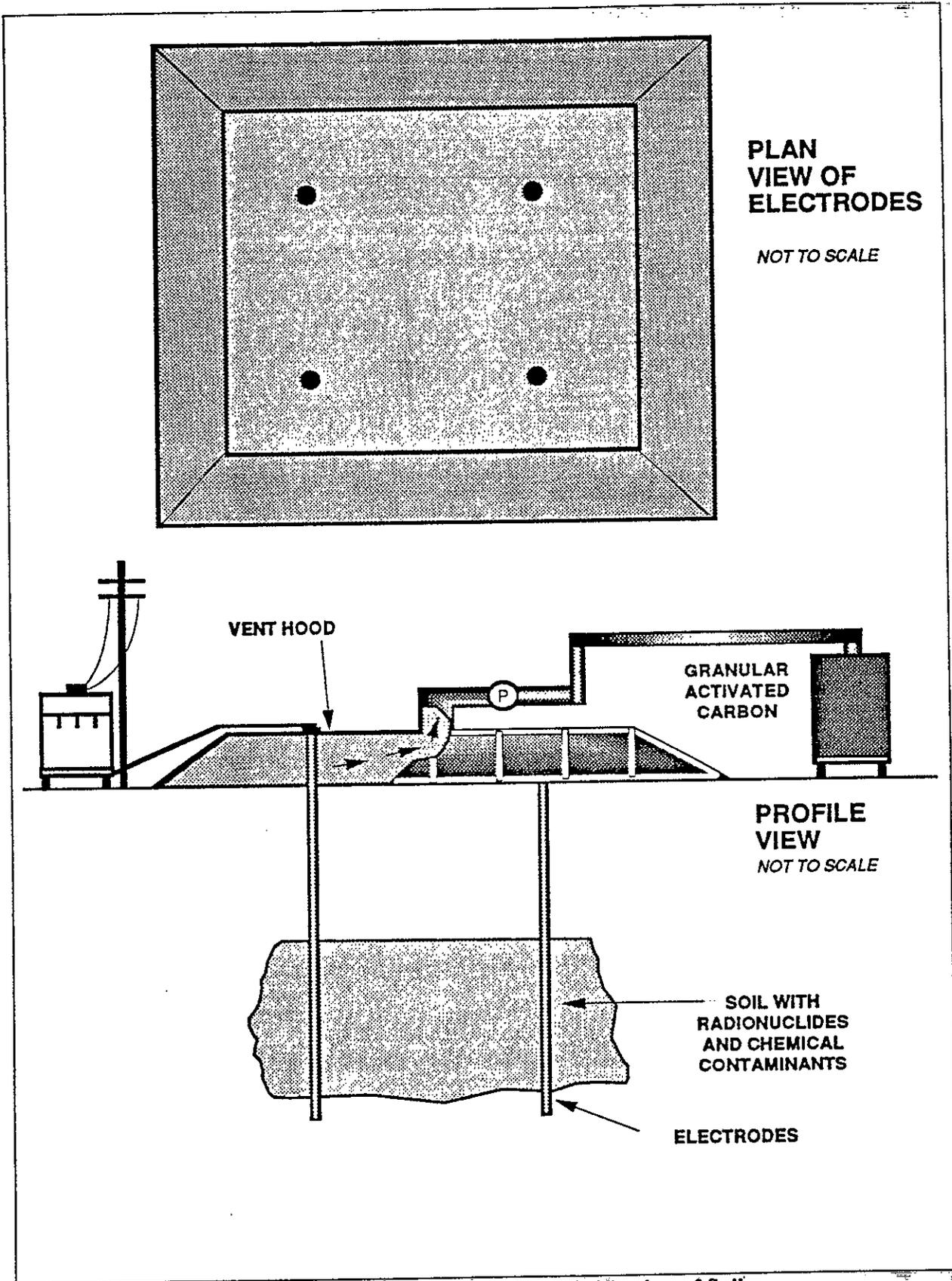
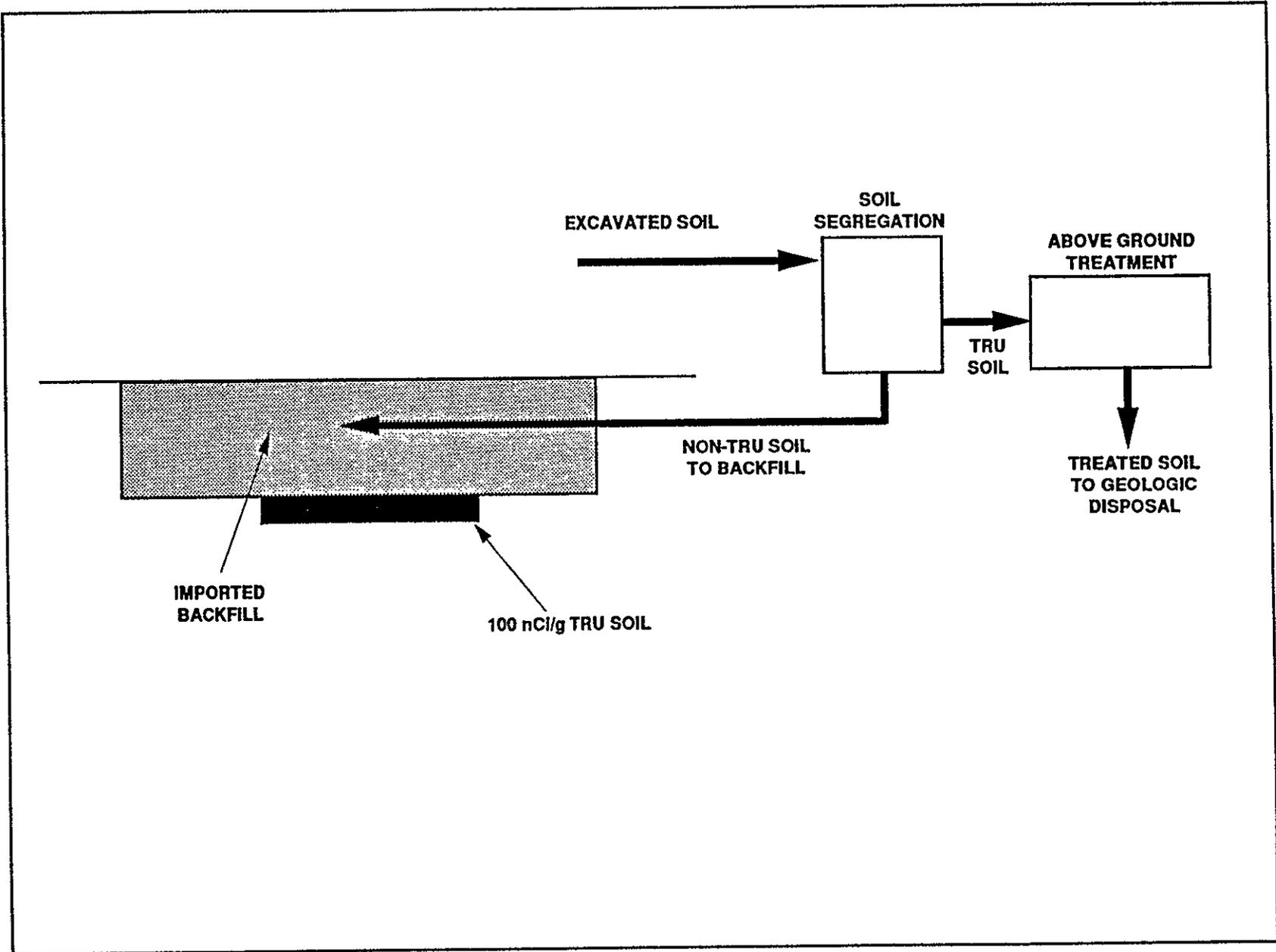


Figure 7-5. Alternative 4: In Situ Vitirification of Soil.

7F-6



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Figure 7-6. Alternative 5: Excavation, Treatment, and Geologic Disposal of Soil with TRU Radionuclides.

7F-7

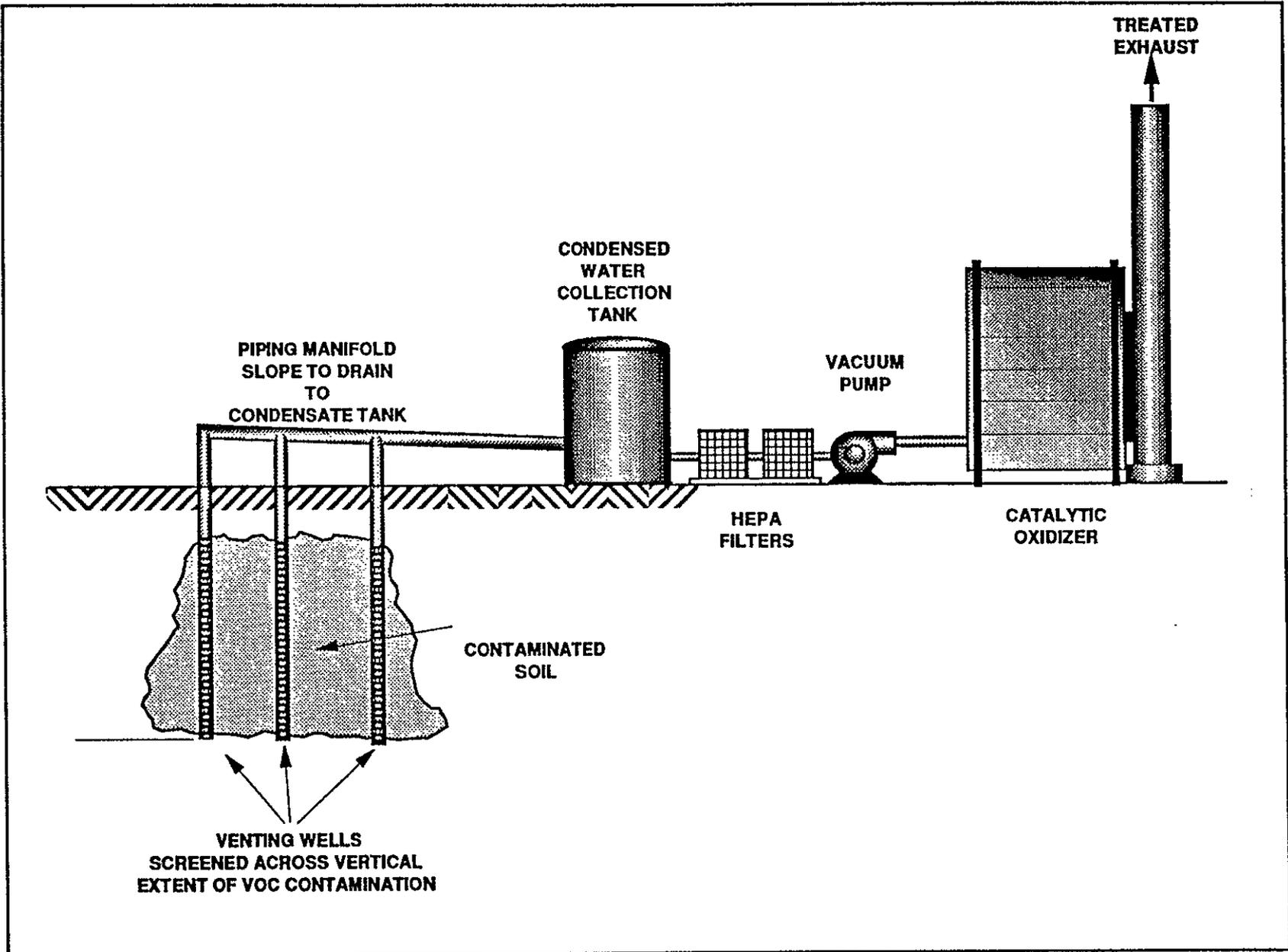


Figure 7-7. Alternative 6: Soil Vapor Extration for Volatile Organic Compounds (VOCs).

Table 7-1. Preliminary Remedial Action Objectives and General Response Actions.

| Environmental Media | Remedial Action Objectives | | General Response Actions |
|---------------------|---|--|--|
| | Human Health | Environmental Protection | |
| 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 ground water that would cause ground water 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 ground water, surface water, air, or biota contamination with constituents at concentrations exceeding ARARs. | <ul style="list-style-type: none"> No Action Institutional Controls 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 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. | |

Note: (1) No General Response Actions are required for the air because soil remediation will eliminate the air contamination source.

7F-1

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Table 7-2. Preliminary Remedial Action Technologies.

| 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 |
| | Containment | Monitoring | Monitoring | NA |
| | | | Capping | 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 |
| | | | Membranes/Sealants/ Wind Breaks/Wetting Agents | 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 | |

7T-2a

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Table 7-2. Preliminary Remedial Action Technologies.

| Media | General Response Action | Technology Type | Process Option | Contaminants Treated |
|-------|-------------------------|----------------------|---|---------------------------|
| | | Chemical Treatment | Chemical Reduction | M |
| | | | Hydrolysis | I,O |
| | | 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 Treatment | O |
| | | | Anaerobic Treatment | 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 |

7T-2b

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Table 7-2. Preliminary Remedial Action Technologies.

| Media | General Response Action | Technology Type | Process Option | Contaminants Treated |
|-------|-------------------------|-----------------------|---|----------------------|
| | | | Grouting | I,M,R |
| | | | Fixation/Solidification/ Stabilization | I,M,R,O |
| | | Biological Treatment | Aerobic Treatment | O |
| | | | Anaerobic Treatment | O |
| Biota | No Action | No Action | No Action | NA |
| | Institutional Controls | Land Use Restrictions | Deed Restrictions | NA |
| | | Access Controls | Signs/Fences | NA |
| | | | Entry Control | NA |
| | | Monitoring | Monitoring | NA |
| | Excavation | Excavation | Standard Construction Equipment | I,M,R,O |
| | Disposal | Landfill Disposal | Landfill Disposal | I,M,R,O |
| | Containment | Capping | Multimedia Capping | 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

Table 7-3. Screening of Process Options.

| Technology Type | Process Option | Description | Effectiveness | Implementability | Relative Cost | Conclusions |
|---------------------------|-------------------|--|--|--|---------------|---|
| SOIL 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 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 fences 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 | Multimedia | 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. |

7T-3a

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Table 7-3. Screening of Process Options.

| 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. | Easily implemented. Commonly used practice 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. | Easily implemented. Commonly used practice 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 pore water. | Effective in blocking lateral movement of all types of soil contamination. | Difficult to implement. 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. | Easily implemented. Commonly used practice, 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. | Easily implemented. Equipment and workers are readily available. | Low | Retained because of potential effectiveness and implementability. |

7T-3b

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Table 7-3. Screening of Process Options.

| Technology Type | Process Option | Description | Effectiveness | Implementability | Relative Cost | Conclusions |
|-------------------|----------------------------|--|--|---|---------------|---|
| Thermal Treatment | Above-ground Vitrification | Conversion of soil to glassified 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 | Destruction of 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 currently 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. |
| | Thermal Desorption | Organics removal by volatilization or destruction at 150 to 400°C (300 to 800°F) by heating contaminated soil followed by off gas treatment. | Potentially effective in destroying or desorbing 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. |

7T-3c

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Table 7-3. Screening of Process Options.

| 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. | Implementable. 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. | Potentially effective in treating heavy metal soil contaminants. Radioactivity will not be reduced. | Difficult to implement. Virtually untested for 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. | Effective on compounds generally classified as reactive. Limited effectiveness on stable compounds. Radioactivity will not be reduced. | Difficult to implement. Common industrial process. Soil treatment not well demonstrated. | Medium | Rejected because of limited effectiveness and because it is unproven unproven for soils. |
| Physical Treatment | Soil Washing | Leaching of waste constituents from contaminated soil using a washing solution. | Potentially effective. Effectiveness depends on contaminants and soil conditions. | Implementable. Treatability tests are necessary. Well developed technology and commercially available. | Medium | Retained because of potential effectiveness and implementability. |

7T-3P

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Table 7-3. Screening of Process Options.

| Technology Type | Process Option | Description | Effectiveness | Implementability | Relative Cost | Conclusions |
|-----------------|---------------------------------------|---|---|---|---------------|---|
| | Solvent Extraction | Extraction of contaminants from soil by use of 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. Treatability studies 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. |
| | 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. | Implementable. 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. |

7T-3e

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Table 7-3. Screening of Process Options.

| Technology Type | Process Option | Description | Effectiveness | Implementability | Relative Cost | Conclusions |
|----------------------|--------------------------------|---|--|--|---------------|---|
| Biological Treatment | Aerobic Biological Treatment | Microbial degradation under aerobic conditions | 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 reactor parameters. | Medium | Rejected because of limited applicability and difficult implementation. |
| | Anaerobic Biological Treatment | Microbial degradation under anaerobic conditions | 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 reactor parameters. | 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 contamination is moved 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. |

7T-3f

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Table 7-3. Screening of Process Options.

| Technology Type | Process Option | Description | Effectiveness | Implementability | Relative Cost | Conclusions |
|---------------------------|---------------------|---|--|---|---------------|---|
| | Geologic Repository | Put the contaminated soil in a safe geologic repository. | Effective for long-term storage of radionuclides. Does not reduce the soil contamination. 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 TRU 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. |

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Table 7-3. Screening of Process Options.

| Technology Type | Process Option | Description | Effectiveness | Implementability | Relative Cost | Conclusions |
|----------------------------|--------------------|---|--|---|---------------|--|
| 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. |
| 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. |

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Table 7-3. Screening of Process Options.

| Technology Type | Process Option | Description | Effectiveness | Implementability | Relative Cost | Conclusions |
|------------------------------|---|--|--|---|---------------|---|
| | 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. |
| In Situ Biological Treatment | In Situ Aerobic Biological Treatment | 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. |
| | In Situ Anaerobic Biological Treatment | Microbial growth utilizing organic contaminants as substrate is enhanced by addition of nutrients. | Effective for certain volatile and complex chlorinated 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. |

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Table 7-3. Screening of Process Options.

| Technology Type | Process Option | Description | Effectiveness | Implementability | Relative Cost | Conclusions |
|----------------------------|-------------------|--|---|--|---------------|---|
| 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. | Effective if implementation is continued. 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. | Easily implemented. Restrictions on future land use required. | Low | Retained to be used in conjunction with other process options. |
| | Entry Control | Install a guard/monitoring system to eliminate people from coming in contact with the contamination. | Very effective in limiting access to contaminated areas. | Easily implemented. Equipment and personnel are readily available. | Low | Retained to be used in conjunction with other process options. |
| Monitoring | Monitoring | Biota sampling and testing for contaminants. | Effective in tracking the contaminant levels, but does not reduce the contamination levels. | Easily implemented. Standard Technology. | Low | Retained to be used in conjunction with other process options. |
| Capping | Multimedia | Fine soils over synthetic membrane or other layers and covered with soil; applied over contaminated areas. | Effective in reducing the uptake of contaminants. Likely to hold up over final. | Easily implemented. Restrictions on future land use will also be necessary. | Medium | Retained because of potential effectiveness and implementability. |

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Table 7-3. Screening of Process Options.

| Technology Type | Process Option | Description | Effectiveness | Implementability | Relative Cost | Conclusions |
|-----------------|-------------------------------|--|---|--|---------------|---|
| Excavation | Standard Excavating Equipment | Remove affected biota and load it onto process system equipment. | Effective in removing 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 onsite landfill. | Effective in moving the contamination to a more secure place but does not reduce the biota contamination. | Easily implemented if sufficient storage is available in an offsite landfill area. | Medium | Retained because of potential effectiveness and implementability. |

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Table 7-4. Preliminary Remedial Action Alternatives for Waste Management Units and Unplanned Releases.

| Waste Management Unit or Unplanned Release | Alt. 1 With or Without Vertical Barriers | Alt. 2 In Situ Grouting or Stabilization | Alt. 3 Excavation & Treatment | Alt. 4 In Situ Vitrification | Alt. 5 Excavation, Treatment, & Geological Disposal of TRU Soil | Alt. 6 In Situ Soil Vapor Extraction for VOCs |
|--|--|---|--|------------------------------------|--|---|
| Cribs and Drains | | | | | | |
| 216-S-1 & -2 Cribs/UPR-200-W-36 | • | • | | • | | |
| 216-S-5 Crib | • | • | • | • | • | |
| 216-S-6 Crib | • | • | • | • | • | |
| 216-S-7 Crib | • | • | • | • | • | |
| 216-S-9 Crib | • | • | • | • | • | |
| 216-S-13 Crib | • | • | • | • | • | |
| 216-S-20 Crib | • | • | • | • | • | |
| 216-S-22 Crib | • | • | • | • | • | |
| 216-S-23 Crib | • | • | • | • | • | |
| 216-S-3 French Drain | • | • | • | • | • | |
| Ponds, Ditches, and Trenches | | | | | | |
| 216-S-10P Pond | • | | • | • | • | |
| 216-S-11 Pond | • | | • | • | • | |
| 216-S-15 Pond | • | • | • | • | • | |
| 216-S-16P Pond | • | • | • | • | • | |

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Table 7-4. Preliminary Remedial Action Alternatives for Waste Management Units and Unplanned Releases.

| Waste Management Unit or Unplanned Release | Alt. 1 With or Without Vertical Barriers | Alt. 2 In Situ Grouting or Stabilization | Alt. 3 Excavation & Treatment | Alt. 4 In Situ Vitrification | Alt. 5 Excavation, Treatment, & Geological Disposal of TRU Soil | Alt. 6 In Situ Soil Vapor Extraction for VOCs |
|---|--|---|--|------------------------------------|--|---|
| 216-S-17 Pond | . | . | . | . | . | |
| 216-S-19 Pond | . | . | . | . | . | |
| 216-S-10D Ditch | . | | . | . | . | . |
| 216-S-16D Ditch | . | . | . | . | . | . |
| 216-U-9 Ditch | . | . | . | . | . | . |
| 216-S-8 Trench | | . | . | | . | |
| 216-S-12 Trench | | . | . | . | . | . |
| 216-S-14 Trench | | . | . | . | . | . |
| 216-S-18 Trench | . | . | . | . | . | . |
| Septic Tanks and Associated Drain Fields | | | | | | |
| 2607-W6 Septic Tank and Tile Field | | | | | | |
| 2607-WZ Septic Tank | | | | | | |
| Sanitary Crib | . | . | . | . | . | |

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Table 7-4. Preliminary Remedial Action Alternatives for Waste Management Units and Unplanned Releases.

| Waste Management Unit or Unplanned Release | Alt. 1 With or Without Vertical Barriers | Alt. 2 In Situ Grouting or Stabilization | Alt. 3 Excavation & Treatment | Alt. 4 In Situ Vitrification | Alt. 5 Excavation, Treatment, & Geological Disposal of TRU Soil | Alt. 6 In Situ Soil Vapor Extraction for VOCs |
|--|--|---|--|------------------------------------|--|---|
| Transfer Facilities, Diversion Boxes, and Pipelines | | | | | | |
| 2904-S-160 Control Structure | • | | • | | • | |
| 2904-S-170 Control Structure | • | | • | | • | |
| 2904-S-171 Control Structure | • | | • | | • | |
| Basins | | | | | | |
| 207-S Retention Basin | • | • | • | | | |
| Burial Sites | | | | | | |
| 218-W-7 Burial Ground | • | • | • | | | |
| 218-W-9 Burial Ground | • | • | • | • | • | • |
| Unplanned Releases | | | | | | |
| UN-200-W-10 | | • | • | | | |
| UN-200-W-30 | • | • | • | | | |
| UN-200-W-32 | • | • | • | | | |
| UN-200-W-34 | • | • | • | | | |
| UN-200-W-35 | • | • | • | | | |
| UN-200-W-41 | • | • | • | | | |

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Table 7-4. Preliminary Remedial Action Alternatives for Waste Management Units and Unplanned Releases.

| Waste Management Unit or Unplanned Release | Alt. 1 With or Without Vertical Barriers | Alt. 2 In Situ Grouting or Stabilization | Alt. 3 Excavation & Treatment | Alt. 4 In Situ Vitrification | Alt. 5 Excavation, Treatment, & Geological Disposal of TRU Soil | Alt. 6 In Situ Soil Vapor Extraction for VOCs |
|--|--|---|--|------------------------------------|--|---|
| UN-200-W-42 | . | | . | | | |
| UN-200-W-43 | . | . | . | | | |
| UN-200-W-49 | . | . | . | | | |
| UN-200-W-50 | . | . | . | | | |
| UN-200-W-52 | . | . | | | | |
| UN-200-W-56 | . | | | | | |
| UN-200-W-61 | . | . | . | | | |
| UN-200-W-69 | . | . | . | | | |
| UN-200-W-80 | . | . | . | | | |
| UN-200-W-81 | . | . | . | | | |
| UN-200-W-82 | . | . | . | | | |
| UN-200-W-83 | . | . | . | | | |
| UN-200-W-108 | . | . | . | | | |
| UN-200-W-109 | . | . | . | | | |
| UN-200-W-114 | . | . | . | | | |
| UN-200-W-116 | . | . | . | | | |

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Table 7-4. Preliminary Remedial Action Alternatives for Waste Management Units and Unplanned Releases.

| Waste Management Unit or Unplanned Release | Alt. 1 With or Without Vertical Barriers | Alt. 2 In Situ Grouting or Stabilization | Alt. 3 Excavation & Treatment | Alt. 4 In Situ Vitrification | Alt. 5 Excavation, Treatment, & Geological Disposal of TRU Soil | Alt. 6 In Situ Soil Vapor Extraction for VOCs |
|--|--|---|--|------------------------------------|--|---|
| UN-200-W-123 | . | . | . | | | |
| UN-200-W-127 | . | . | . | | | |
| UN-216-W-25 Radiation Emission | . | . | . | | | |
| UN-216-W-30 | . | . | . | | | |
| UPR-200-W-13 | . | . | . | | | |
| UPR-200-W-15 | . | . | . | | | |
| UPR-200-W-20 | . | . | . | | | |
| UPR-200-W-36 | . | . | . | | | . |
| UPR-200-W-47 | . | . | . | | | |
| UPR-200-W-51 | . | . | . | | | |
| UPR-200-W-57 | . | . | . | | | |
| UPR-200-W-59 | | | | | | |
| UPR-200-W-87 | . | . | . | | | |
| UPR-200-W-95 | . | . | . | | | |
| UPR-200-W-96 Spill | . | . | . | | | |
| UPR-200-W-124 | . | . | . | | | |

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Table 7-4. Preliminary Remedial Action Alternatives for Waste Management Units and Unplanned Releases.

| Waste Management Unit or Unplanned Release | Alt. 1 With or Without Vertical Barriers | Alt. 2 In Situ Grouting or Stabilization | Alt. 3 Excavation & Treatment | Alt. 4 In Situ Vitrification | Alt. 5 Excavation, Treatment, & Geological Disposal of TRU Soil | Alt. 6 In Situ Soil Vapor Extraction for VOCs |
|--|--|---|--|------------------------------------|--|---|
| UPR-200-W-139 | • | • | • | | | |
| UPR-200-W-140 | • | • | • | | | |
| UPR-200-W-141 | • | • | • | | | |
| UPR-200-W-142 | • | • | • | | | |
| UPR-200-W-143 | • | • | • | | | |
| UPR-200-W-144 | • | • | • | | | |
| UPR-200-W-145 | • | • | • | | | |
| UPR-200-W-146 | • | • | • | | | |

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8.0 DATA QUALITY OBJECTIVES

1
2
3
4 As described in Section 1.2.2, this aggregate area management study (AAMS process, as
5 part of the *Hanford Past-Practice Strategy* (Thompson 1991), is designed to focus the
6 remedial investigation (RI) feasibility study (FS) process toward comprehensive cleanup or
7 closure of all contaminated areas at the earliest possible date and in the most effective
8 manner. The fundamental principle of the *Hanford Past Practice Strategy* is a "bias for
9 action" that emphasizes the maximum use of existing data to expedite the RI/FS process as
10 well as allow decisions about work that can be done at the site early in the process, such as
11 expedited response actions (ERAs), interim remedial measures (IRMs), limited field
12 investigations (LFIs), and focused feasibility studies (FFS). The data have already been
13 described in previous sections (2.0, 3.0, and 4.0). Remediation alternatives are described in
14 Section 7.0. However, data, whether existing or newly acquired, can only be used for these
15 purposes if it meets the requirements of data quality as defined by the data quality objective
16 (DQO) process developed by the U.S. Environmental Protection Agency (EPA) for use at
17 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites
18 (EPA 1987). This section implements the DQO process for this, the scoping phase, in the
19 S Plant Aggregate Area.
20

21 In the guidance document for DQO development (EPA 1987), the process is described as
22 involving three stages which have been used in the organization of the following sections:
23

- 24 • Stage 1--Identify decision types (Section 8.1)
- 25 • Stage 2--Identify data uses and needs (Section 8.2)
- 26 • Stage 3--Design a data collection program (Section 8.3).

8.1 DECISION TYPES (Stage 1)

31
32 Stage 1 of the DQO process is undertaken to identify:
33

- 34 • The decision makers (thus data users) relying on the data to be developed (Section
35 8.1.1),
36
- 37 • The data available to make these decisions (Section 8.1.2),
38
- 39 • The quality of these available data (Section 8.1.3),
40
- 41 • The conceptual model into which these data must be incorporated (Section 8.1.4), and
42
- 43 • The objectives and decisions that must evolve from the data (Section 8.1.5).
44
45

1 These issues serve to define, from various sides, the types of decisions that will be made
2 on the basis of the S Plant AAMS.
3
4

5 8.1.1 Data Users 6

7 The data users for the S Plant AAMS [and subsequent investigations such as LFIs,
8 RI/FSs, and Resource Conservation and Recovery Act (RCRA) Facility, Investigations (RFI)]
9 are the following:
10

- 11 • The decision makers for policies and strategies on remedial action at the Hanford Site.
12 These are the signatories of the *Hanford Federal Facility Agreement and Consent*
13 *Order* (Tri-Party Agreement) (Ecology et al. 1990) including the U.S. Department of
14 Energy (DOE), EPA, and the Washington State Department of Ecology (Ecology).
15

16 Nominally these responsibilities are assigned to the heads of these agencies (the Secretary
17 of Energy for DOE, the Administrator of EPA, and the Director of Ecology), although the
18 political process requires that more local policy-makers (such as the Regional Administrator
19 of EPA and the head of the U.S. Department of Energy, Richland Operations Office
20 (DOE/RL) and, to a great extent, technical and policy-assessment staff of these agencies will
21 have a major say in the decisions to be evolved through this process.
22

- 23 • Unit managers of Westinghouse Hanford and potentially other Hanford Site contractors
24 who will be tasked with implementing remedial activities at the S Plant Aggregate
25 Area. Staff of these contractors will have to make the lower level (tactical) decisions
26 about appropriate scheduling of activities and allocation of resources (funding,
27 personnel, and equipment) to accomplish the AAMS recommendations.
28
- 29 • Concerned members of the wide community involved with the Hanford Site. These
30 may include:
 - 31 - Other state (Washington, Oregon, and other states) and federal agencies,
 - 32 - Affected Indian tribes,
 - 33 - Special interest groups, and
 - 34 - The general public.
35
36

37 These groups will be involved in the decision process through the implementation of the
38 Community Relations Plan (CRP) (Ecology et al. 1989), and will apply their concerns
39 through the "primary" data users, the signatories of the Tri-Party Agreement.
40

41 The needs of these users will have a pivotal role in issues of data quality. Some of this
42 influence is already imposed by the guidance of the Tri-Party Agreement.
43
44

8.1.2 Available Information

The *Hanford Past-Practice Strategy* specifies a "bias for action" which intends to make the maximal use of existing data on an initial basis for decisions about remediation. This emphasis can only be implemented if the existing data are adequate for the purpose.

Available data for the S Plant Aggregate Area are presented in Sections 2.0, 3.0, and 4.0 and in Topical Reports prepared for this study. As described in Section 1.2.2, these data should address several issues:

- Issue 1: Facility and process descriptions and operational histories for waste sources (Sections 2.2, 2.3, and 2.4)
- Issue 2: Waste disposal records defining dates of disposal, waste types, and waste quantities (Section 2.4)
- Issue 3: Sampling events of waste effluents and affected media (Section 4.1)
- Issue 4: Site conditions including the site physiography, topography, geology, hydrology, meteorology, ecology, demography, and archaeology (Section 3.0)
- Issue 5: Environmental monitoring data for affected media including air, surface water, sediment, soil, groundwater and biota (Section 4.1, except that groundwater data is presented in the separate 200 West Groundwater Aggregate Area Management Study Report, AAMSR).

A major requirement for adequate characterization of many of these issues is identification of chemical and radiological constituents associated with the sites, with a view to determine the contaminants of concern there and the extent of their distribution in the soils beneath each of the waste management units in the S Plant Aggregate Area. There was found to be a limited amount of data in this regard. The data reported for the various waste management units in the S Plant Aggregate Area (See Section 4.1 and Tables 4-1, 4-2, and 4-3) have been found to describe:

- Inventory: generally estimated from chemical process data and emphasizing radionuclides (Issues 1 and 2). These data are especially limited regarding reconstruction of early operations activities, and even the most recent data are based on very few sampling events, possibly non-representative of the long-term activity of the waste management units. In some cases (e.g., for 216-U-15 Trench) even the location of the facility is not adequately understood.
- Surface radiological surveys: undifferentiated radiation levels, without identification of radionuclides present, presented in terms of extent of radiation and maximal levels (Issue 5). These historical data are extremely difficult to relate to the present-day distribution and nature of the radioactive contamination they purport to measure

1 because of the lack of radionuclide identification and the likelihood that changes have
2 occurred (at least to surface soils) since the time of these surveys.

- 3
4 • External radiation monitoring: similar to the surface radiological surveys but provide
5 even less information because with a fixed-point thermoluminescent dosimeter (TLD)
6 no spatial distribution is provided. In addition, data are also available for some TLDs
7 placed at points not associated with specific waste management units. TLD data again
8 do not differentiate radionuclide species.
9
- 10 • Waste, soil, or sediment sampling--these include waste sampling in SSTs (in the 241-S
11 and SX Tank Farms), wastes in the 207-SL Retention Basin; sediments from the
12 216-S-10D Ditch were collected and analyzed for radionuclide contamination, and soil
13 samples in the vicinity of the 216-S-1 and 2 Cribs were collected and analyzed for
14 radionuclides. The quality of these data is apparently good, but changes at the release
15 sites (e.g., cleanup activities) since the time of the sampling makes the data again
16 generally inapplicable to determination of the present-day distribution of
17 contamination.

18
19 There is also a set of data of soil sampling and analysis that was conducted for several
20 years on a grid pattern, and cannot be assigned to a particular waste management unit.
21 These data would indicate impacts of historical operations at the Hanford Site, and in
22 the vicinity of the grid points, but the impacts cannot be ascribed to a particular unit
23 and so do not assist in decision making on a unit-by-unit basis.

- 24
25 • Biota sampling--only in the 216-S-10D Ditch. These data could assist assessment of
26 bio-uptake and bio-transfer pathways from this unit (Issue 5).

27
28 There are also analytical data for grid-point samples of vegetation which cannot be
29 assigned to a specific waste management unit.

- 30
31 • Borehole geophysics: these data, for a number of units discharged to the soil column
32 (cribs, trenches, and ditches) and the single-shell tanks, were designed to detect the
33 presence of radionuclides (by their gamma-ray radiation) in the subsurface and to
34 indicate whether these materials are migrating vertically (Issue 5). A list of these
35 surveys that have been conducted in the S Plant Aggregate Area is included in the
36 Data Package Topical Report prepared for this study (Chamness et al. 1991). These
37 data are limited by the method's inability to identify specific radionuclides and thus to
38 differentiate naturally-occurring radioactive materials from possible releases.
39 Variations in quality control further limit their comparability and possible use for
40 estimation of concentrations.

41
42 Besides these historic data, additional borehole geophysical data will be available
43 through the Radionuclide Logging System (RLS), being carried out at the time of this
44 report and in support of the AAMS process. Like the previous (gross gamma) logging
45 conducted at waste management units in the S Plant Aggregate Area, the RLS depends
46 on gamma rays and cannot detect some species of radionuclides. However, unlike the

1 gross gamma surveys, the RLS is designed to identify individual radionuclide species
2 through their characteristic gamma ray photon energy levels. It should thus be able to
3 differentiate naturally-occurring radionuclides from those resulting from releases. It
4 will also (like gross gamma logging) determine the vertical extent of the presence of
5 the radionuclides. It will be conducted in about ten wells located in the S Plant
6 Aggregate Area and will be available with completion of the AAMS process.
7

8 Based on the above summary, the data are considered to be of varying quality. These
9 data have not been validated, a process generally required for risk assessment or final ROD
10 purposes. Most of the data are based on field methods, which are generally applicable only
11 for screening purposed and can be used to focus future activities (e.g., sampling and analysis
12 plans).
13

14 They are considered to be deficient in one or more of the following ways:

- 15
- 16 • The methods are unable to differentiate the various radionuclides which may have
17 been present at the time of the survey.
18
 - 19 • The release locations have been changed (especially by remediation activities) since
20 the time of the survey or sampling, and it is likely that contaminant distributions have
21 changed.
22
 - 23 • The survey or sampling has been done at a location different from the waste
24 management unit or release, and so would not be representative of the concentrations
25 in the zone of the release. This deficiency applies to horizontal and vertical
26 differences in location: the borehole geophysics data may be at the correct depths, but
27 the distance of the borehole from the waste management unit can severely attenuate
28 the gamma-radiation which is used to indicate contamination; surface sampling and
29 surveys similarly cannot establish subsurface contaminant concentrations or even
30 disprove the possible presence of some radioactive constituents (particularly
31 alpha-emitting transuranic elements, TRUs).
32
 - 33 • There has been virtually no measurement of non-radioactive hazardous constituents in
34 the sampling and analysis of media in the S Plant Aggregate Area.
35

36 As a result of these deficiencies, the data are not considered to be usable for input to a
37 quantitative risk assessment or for comparison to ARARs.
38

39 In addition to these data, there are also data regarding site conditions (Issue 2) that do not
40 directly relate to the presence of environmental releases, but which will assist in the
41 assessment of its potential migration if present. These data are generally summarized in the
42 Topical Reports prepared for this AAMS. Those include the following:
43

- 44 • *S Plant Geologic and Geophysics Data Package for the 200 AAMS* (Chamness et al.
45 1991), which contains tables of wells in which borehole geophysics have been
46 conducted, the types and dates of the tests, and a reference to indicate the physical

1 location of the logs. The package also includes a list of the data available from the
2 drilling of each well located in the S Plant Aggregate Area, such as the logs available
3 (driller's or geologist's; indication of their physical location; grain size, carbonate,
4 moisture, and chemical/radiological analyses; lists of depths, dates, elevation, and
5 coordinates for all wells); and copies of the boring logs and well completion (as-built)
6 summaries for a selection of wells in the S Plant Aggregate Area.
7

- 8 • *Geologic Setting of the 200 West Area: An Update* (Lindsey et al. 1991) includes
9 descriptions of regional stratigraphy, structural geology, and local (200 West Area)
10 stratigraphy, with revised structure and isopach maps of the various unconsolidated
11 strata found beneath the 200 West Area.
12

13 The data in these topical reports was obtained for the Aggregate Area study based on a
14 review of driller's and geologist's logs for wells drilled in the S Plant Aggregate Area. A
15 selection of 15 of those logs was made which best represented the geologic structures below
16 the Aggregate Area and are presented in Chamness et al (1991). Lindsay et al (1991) then
17 used these wells (and others from other Aggregate Areas in the 200 West Area) to develop
18 cross-sections, structure maps, and isopach maps, which were in turn adapted to the specific
19 needs of this report and presented in Section 3. Only existing logs were used; no new wells
20 were drilled as part of this study. The quality of the data varies among the logs according to
21 the time they were drilled and the scope of the study they were supporting, but generally
22 these data are sufficient for the general geological characterization of the site. Issues
23 involving the potential of contaminant migration at specific sites, based on stratigraphic
24 concerns, may not be fully addressed through any existing borings or wells because
25 appropriate borings may not be located in close proximity; these issues should be addressed
26 during subsequent field investigations at locations where contaminant migration is considered
27 likely.
28

29 Another class of data that was gathered in the general area of the 200 West Area, and
30 therefore potentially appropriate to the S Plant Aggregate Area, is the result of a set of studies
31 that were performed for the Basalt Waste Isolation Project (BWIP) (DOE 1988), in the
32 attempt to site a high-level radioactive waste geologic repository in the basalt beneath and in
33 the vicinity of the Hanford Site. The proposed Reference Repository Site included the 200
34 West Area and some distance beyond it, mainly to the west. For this siting project, a number
35 of geologic techniques were used, and some of the data generated by the drilling program
36 have been used for the stratigraphic interpretation presented in Section 3.4 (all the wells
37 denoted with an alias "BH-.." were drilled for the BWIP project) and a number of the figures
38 used in this and other sections of Section 3.0. The program also included a number of
39 geophysical studies, using the following techniques:
40

- 41 • Gravity
- 42
- 43 • Magnetism
- 44
- 45 • Seismic reflection
- 46

- 1 • Seismic refraction
2
3 • Magnetotellurics.
4

5 These data, as presented in Section 1.3.2.2.3 of DOE (1988), were reviewed for their
6 relevance to the present S Plant (source area) AAMS. The limitations of these studies include
7 the following aspects:
8

- 9 • Most of the studies covered a regional scale with lines or coverages that may have
10 crossed the S Plant Aggregate Area (or even the 200 West Area) only in passing.
11 Some of the surveys (e.g., the grid of gravity stations) specifically avoided the 200
12 West Area ("due to restricted access").
13
14 • Many of the techniques are more sensitive to the basalt than to the suprabasalt
15 sediments of specific interest in the AAMS program, and even less sensitive to the
16 features which are closer to the surface, as is applicable to the source area AAMS.
17 Basalt is by nature much denser than the unconsolidated sediments (and thus also has
18 a characteristic seismic signature) and has more consistent magnetic properties. In
19 addition, the analysis of the data emphasized the basalt features which were apparent
20 in the data. All this is appropriate to a study of the basalt, but does not make the
21 studies applicable to the present study.
22
23 • Even when features potentially due to shallow sediments are identified, they are
24 interpreted either very generally (e.g., "erosional features in the Hanford and (or)
25 Ringold Formations") or as complications (e.g., "shallow sediment velocity variations
26 causing stacking velocity correction errors"). There are only a very few features that
27 are interpreted as descriptive of the structure of the suprabasalt sediments.
28
29 • Lastly, some of the anomalies that are interpreted in terms of a sedimentary
30 stratigraphic cause (e.g., "erosion of Middle Ringold") do not bear up under the more
31 detailed stratigraphic interpretation carried out under the Topical Reports for the
32 AAMS (Lindsey et al. 1991, Chamness et al. 1991).
33

34 However, these data will be reviewed in more detail for the purposes of the 200 West
35 Groundwater AAMS, since deeper features (including in the basalt) are of more concern for
36 that study.
37

38 Other data, presented in Sections 2.0, 3.0, and 4.0, are broader-scale rather than
39 site-specific like the contaminant concentrations are. These include topography, meteorology,
40 surface hydrology, environmental resources, and human resources, and contaminant
41 characteristics. These data are generally of acceptable quality for the purposes of planning
42 remedial actions in the S Plant Aggregate Area.

1 **8.1.3 Evaluation of Available Data**
2

3 EPA (1987) has specified indicators of data quality, the five "PARCC" parameters
4 (precision, accuracy, representativeness, completeness, and comparability), which can be used
5 to evaluate the existing data and to specify requirements for future data collection.
6

- 7 • Precision: the reproducibility of the data
- 8
- 9 • Accuracy: the lack of a bias in the data.
- 10

11 Much of the existing data are of limited precision and accuracy due to the analytical
12 methods that have been used historically. The gross gamma borehole geophysical
13 logging in particular is limited by methodological problems although reproducibility
14 has been generally observed in the data. Conditions that have contributed to lack of
15 precision and/or accuracy include: improvements in analytical instrumentation and
16 methodology making older data incompatible; effects of background levels
17 (particularly regarding radioactivity and inorganics); and lack of quality control on
18 data acquisition.
19

20 The limitations in precision and accuracy in existing data are mainly due to the
21 progress of analytical methodologies and quality assurance (QA) procedures since the
22 time they were collected. The *Hanford Past Practice Investigation Strategy*
23 (Thompson 1991) recommends that existing data be used to the maximum extent
24 possible, at two levels: first to formulate the conceptual model, conduct a qualitative
25 risk assessment, and prepare work plans, but also as an initial data set that can be the
26 basis for a fully-qualified data set through a process of review, evaluation, and
27 confirmation.
28

- 29 • Representativeness: the degree to which the appropriate environmental parameters or
30 media have been sampled.
- 31

32 This parameter highlights a shortcoming of most of the historical data. Limitations
33 include the observation only of gross gamma radiation rather than differentiating it by
34 radionuclide (e.g., through spectral surveying methods as are being used by the RLS
35 program), the analysis of samples only for radionuclides rather than for chemicals and
36 radionuclides, and the failure to sample (especially in the subsurface) for the full
37 potential extent of contaminant migration.
38

39 The data are incomplete primarily because of the lack of subsurface sampling for
40 extent of contamination. This is because no subsurface investigation has been initiated
41 on the waste management units in the S Plant Aggregate Area yet. The lack of these
42 data is also caused by concerns to limit the potential exposure to radioactivity of
43 workers who would have to drill in contaminated areas and the possible release or
44 spread of contamination through these intrusive procedures. The result of this data
45 gap is that none of the sites can be demonstrated to have contamination either above

1 or below levels of regulatory concern, and a full quantitative risk assessment cannot be
 2 conducted.
 3

4 In addition, in many cases it has been necessary to use general data (i.e., from
 5 elsewhere in the 200 West Area or even from the vicinity of the 200 Areas) rather
 6 than data specific to a particular waste management unit. For most purposes of
 7 characterization for transport mechanisms, this procedure is acceptable given the
 8 screening level of the present study. For example, while it is appropriate to use a
 9 limited number of boring logs to characterize the stratigraphy in the Aggregate Area
 10 (Chamness et al. 1991, Lindsey et al. 1991), the later, waste management unit-specific,
 11 field sampling plans will require detailed consideration of more of the logs of wells
 12 drilled in the immediate vicinity, whatever their quality, as a starting point to
 13 conceptually model the geology specifically beneath that unit.
 14

- 15 • Completeness: the fraction of samples that are considered "valid."

16 None of the data that have been previously gathered in the U Plant Aggregate Area
 17 has been "validated" in the EPA Contract Laboratory Program (CLP) sense, although
 18 varying levels of quality control have been applied to the sampling and analysis
 19 procedures. The best indication of the validity of the data is the reproducibility of the
 20 results, and this indicates that validity (completeness) is one of the less significant
 21 problems with the data.
 22

- 23 • Comparability--the confidence that can be placed in the comparison of two data sets
 24 (e.g., separate samplings).
 25

26 With varying levels of quality control and varying procedures for sample acquisition
 27 and analysis, this parameter is also generally poorly met. Much of this is due to the
 28 more recent development of QA procedures.
 29

30 While these limitations cannot in most cases be quantified (and some such as
 31 representativeness are specifically only qualitative), most of the data gathered in the S Plant
 32 Aggregate Area can be cited as failing one or more of the PARCC parameters. As discussed
 33 in Section 8.1.2, the data are considered to be deficient in completeness, (the appropriate
 34 media, constituents, or locations were generally not sampled or analyzed). These data should,
 35 however, be used to the maximum extent to develop work plans for site field investigations,
 36 prioritize the various units, and to determine, to the extent possible, where and whether
 37 contamination is present.
 38

39 In addition to these site-specific data, there are also a limited number of non site-specific
 40 sampling events that are being developed to determine background levels of naturally
 41 occurring constituents (Hoover and LeGore 1991). These data can be used to differentiate the
 42 effect of the environmental releases from naturally occurring background levels.
 43
 44

1 **8.1.4 Conceptual Models**
2

3 The initial conceptual model of the sites in the S Plant Aggregate Area is presented and
4 described in Section 4.2 (Figure 4-23). The model is based on best estimates of where
5 contaminants were discharged and their potential for migration from release points. The
6 conceptual model is designed to be conservatively inclusive in the face of a lack of data.
7 This means that a migration pathway was included if there is any possibility of contamination
8 travelling on it, historically or at present. In most cases there may not be a significant flux of
9 such contamination migration for many of the pathways shown on the figure.
10

11 The one pathway in Figure 4-23 that has transported large amounts of water is
12 undoubtedly the releases to soil from the 216-S-10D Ditch, through the vadose zone into the
13 unconfined aquifer. Contamination can be demonstrated to have been present in the ditch
14 according to results of sediment sampling. If significant levels of dissolved constituents were
15 present in the ditch, the large quantities of water would have contributed to their mobilization
16 and transport to the aquifer. The 216-S-16P and 216-S-17 Ponds have received and may have
17 discharged even larger amounts of water through the vadose zone into the unconfined aquifer.
18 However, there is little information about the contamination that actually has been transported
19 along these pathways. The pathway from some of the cribs leading to adsorption of
20 transuranic elements on vadose-zone soils is possibly more significant. These and other
21 pathways can be traced on the conceptual model. All are possible; only a few are likely
22 because of the conservatism inherent in including all conceivable pathways. More
23 importantly, even if a pathway carries significant levels of a contaminant, it still may not have
24 carried contamination to the ultimate receptors, human or ecological. This can only be
25 assessed by sampling at the exposure point on this pathway, or sampling at some other point
26 and extrapolation to the exposure point, to indicate the dosage to the receptors.
27

28 There are, therefore, significant uncertainties in the contaminant levels in the contaminant
29 migration pathways shown on the conceptual model, yet almost none of these pathways has
30 been sampled to determine whether any contamination still exists in any of the locations
31 implicated from the conceptual model, and if so which constituents, how much, and to what
32 extent.
33
34

35 **8.1.5 Aggregate Area Management Study Objectives and Decisions**
36

37 The specific objectives of the S Plant AAMS are listed in Section 1.3. They include (in
38 part) the following:
39

- 40 • Assemble site data (as described in Section 8.1.2)
- 41
- 42 • Develop a site conceptual model (see Section 8.1.4)
- 43
- 44 • Identify contaminants of concern and their distribution (Section 5.0)
- 45

- 1 • Identify preliminary applicable, or relevant and appropriate, requirements (ARARs)
2 Section 6.0
3
4 • Define preliminary remedial action objectives and screen potential remedial
5 technologies to prepare preliminary remedial action alternatives (Section 7.0)
6
7 • Recommend expedited, interim, or limited actions (Section 9.0), and
8
9 • Define and prioritize workplan activities with emphasis on supporting early cleanup
10 actions and records of decision.
11

12 The decisions that will have to be made on the basis of this AAMS can best be described
13 according to the *Hanford Past-Practice Strategy* (Thompson 1991) flow chart (Figure 1-2 in
14 Section 1.0) that must be conducted on a site-by-site basis. Decisions are shown on the flow
15 chart as diamond-shaped boxes, and include:

- 16
17 • Is an ERA justified?
18
19 • Is less than 6 months' response needed (is the ERA time critical)?
20
21 • Are data sufficient to formulate the conceptual model and perform a qualitative risk
22 assessment?
23
24 • Is an IRM justified?
25
26 • Can the remedy be selected?
27
28 • Can additional required data be obtained by LFI?
29
30 • Are data (from field investigations) sufficient to perform risk assessment?
31
32 • Can an Operable Unit/Aggregate Area Record of Decision (ROD) be issued?
33

34 (The last two questions will only be asked after additional data are obtained through field
35 investigations, and so are DQO issues only in assessing scoping for those investigations.)
36

37 Most of these decisions are actually a complicated mixture of many smaller questions, and
38 will be addressed in Section 9.0 in a more detailed flowchart for assessing the need for
39 remediation or investigation.
40

41 Similarly, the tasks that will need to be performed after the AAMS that drive the data
42 needs for the study are found in the rectangular boxes on the flow chart. These include:

- 43
44 • ERA (if justified)
45

- 1 • Definition of threshold contamination levels, and formulation of conceptual model,
2 performance of qualitative risk assessment, and FS screening (IRM preliminaries)
3
- 4 • FFS for IRM selection
5
- 6 • Determination of minimum data requirements for IRM path
7
- 8 • Negotiation of Scope of Work, relative priority, and incorporation into integrated
9 schedule, performance of LFI
10
- 11 • Determination of minimum data needs for risk assessment and final Remedy Selection
12 (preparation of RI/FS pathway).
13

14 These stages of the investigation must be considered in assessing data needs (Section
15 8.2.1).
16

17 **8.2 DATA USES AND NEEDS (Stage 2 of the DQO Process)**

18 Stage 2 of the DQO development process (EPA 1987) defines data uses and specifies the
19 types of data needed to meet the project objectives. These data uses and needs are based on
20 the Stage 1 results, but must be more specific. The elements of this stage of the DQO
21 process include:
22

- 23 • Identifying data uses (Section 8.2.1)
24
- 25 • Identifying data types (Section 8.2.2.1)
26
- 27 • Identifying data quality needs (Section 8.2.2.2)
28
- 29 • Identifying data quantity needs (Section 8.2.2.3)
30
- 31 • Evaluating sampling/analysis options (Section 8.2.2.4)
32
- 33 • Reviewing data quality parameters (Section 8.2.2.5)
34
- 35 • Summarizing data gaps (Section 8.2.3).
36
37

38
39 Stage 2 is developed on the basis of the conceptual model and the project objectives.
40 These following sections discuss these issues in greater detail.
41
42

1 8.2.1 Data Uses
2

3 For the purposes of the remediation in the S Plant Aggregate Area, most data uses fall
4 into one or more of four general categories:

- 5
- 6 • Site characterization
 - 7
 - 8 • Public health evaluation and human health and ecological risk assessments
 - 9
 - 10 • Evaluation of remedial action alternatives
 - 11
 - 12 • Worker health and safety.
 - 13

14 Site characterization refers to a process that includes determining and evaluating the
15 physical and chemical properties of any wastes and contaminated media present at a site, and
16 evaluating the nature and extent of contamination. This process normally involves the
17 collection of basic geologic, hydrologic, and meteorologic data but more importantly for the
18 S Plant Aggregate Area waste management units, data on specific contaminants and sources
19 that can be incorporated into the conceptual model to indicate the relative significance of the
20 various pathways. Site characterization is not an end in itself, as stressed in the *Hanford*
21 *Past-Practice Strategy* (Thompson 1991), but rather the data must work toward the ultimate
22 objectives of assessing the need for remediation (according to risk assessment methods, either
23 qualitative or quantitative) and providing appropriate means of remediation (through an FFS,
24 FS, or CMS). The understanding of the site characterization, based on existing data, is
25 presented in Sections 2.0, 3.0, and 4.0, and summarized in the conceptual model
26 (Section 4.2).
27

28 Data required to conduct a public health evaluation, and human health and ecological risk
29 assessments at the sites in the S Plant Aggregate Area include the following: input
30 parameters for various performance assessment models (e.g., the Multimedia Environmental
31 Pollutant Assessment System); site characteristics; and contaminant data required to evaluate
32 the threat to public and environmental health and welfare through exposure to the various
33 media. These needs usually overlap with site characterization needs. An extensive discussion
34 of risk assessment data uses and needs is presented in the *Risk Assessment Guidance for*
35 *Superfund* (EPA 1989b). The main deficiency in the data available for waste management
36 units in the S Plant Aggregate Area is that a quantitative assessment of contaminant
37 concentrations for purposes of risk assessment cannot be performed. The present
38 understanding of site risks is presented in the selection of concern (Section 5.0). Quantitative
39 risk assessments will be conducted at the Hanford Site with a methodology under
40 development, and the data needs for this methodology will be considered in developing site
41 specific sampling and analysis plans.
42

43 Data collected to support evaluation of remedial action alternatives for ERAs, IRMs,
44 FFSs, or the full RI/FS, include site screening of alternatives, feasibility-level design, and
45 preliminary cost estimates. Once an alternative is selected for implementation, much of the
46 data collected during site investigations (LFI or RI) can also be used for the final engineering

1 design. Generally, collection of information during the investigations specifically for use in
2 the final design is not cost effective because many issues must be decided about appropriate
3 technologies before effective data gathering can be undertaken. It is preferable to gather such
4 specific information during a separate predesign investigation or at the time of remediation
5 (i.e., the "observational approach" of the *Hanford Past-Practice Strategy* [Thompson 1991]).
6 Based on the existing data, broad remedial action technologies and objectives have been
7 identified in Section 7.0.

8
9 The worker health and safety category includes data collected to establish the required
10 level of protection for workers during various investigation activities. These data are used to
11 determine if there is concern for the personnel working in the vicinity of the aggregate area.
12 The results of these assessments are also used in the development of the various safety
13 documents required for field work (see Health and Safety Plan, Appendix B).

14
15 It should be noted that each of these data use categories (site characterization, risk
16 assessment needs, remedial actions, and health and safety) will be required at each decision
17 point on the *Hanford Past-Practice Strategy* (Thompson 1991) flow chart, as discussed at the
18 end of Section 8.1.5. To the extent possible, however, not all sites will be investigated to the
19 same degree but only those with the highest priority. These results will then be extended to
20 the other, analogous sites which have similar geology and disposal histories (see
21 Section 9.2.3).

22
23 The existing data can presently be used for two main purposes:

- 24 • Development of site-specific sampling plans (site characterization use)
- 25 • Screening for health and safety (worker health and safety use).

26
27
28
29 Table 8-1 presents a summary of the availability of existing data for these two uses.

30
31 For the purposes of developing sampling plans, existing information is available for:

- 32 • The location of sites: many of the sites have surface expressions, markers, or have
33 been surveyed in the past. The unplanned releases in particular are lacking in this
34 information.
- 35 • Possible contamination found at the sites: these data can be derived from the
36 inventories for the sites (mainly for the cribs and other disposal facilities) as well as
37 from the limited sampling that has been done at the 216-S-10D Ditch.
- 38 • The likely depth of contaminants: this information is mainly obtained from the gross
39 gamma borehole logging for many of the sites.

40
41
42
43
44 Two types of information are available for the purposes of worker health and safety, and
45 will be used to develop health and safety documents:

- Levels of surface radiation: derived from the on-going periodic radiological surveys performed under the Environmental Surveillance program (Schmidt et al. 1991). Table 8-1 shows where surveys have indicated no detectable levels of surface radiation and so no additional survey is required before surface activities can be conducted.
- Expected maximum contaminant levels -- these data can be used mainly on the results of subsurface soil sampling.

Table 8-1 also presents a first expression of the data needs for the individual waste management units in the S Plant Aggregate Area, which must be addressed for remediation approaches to be developed.

8.2.2 Data Needs

The data needs for the S Plant Aggregate Area are discussed in the following sections according to the categories of types of data (Section 8.2.2.1), quality (8.2.2.2), quantity (8.2.2.3), options for acquiring the data (8.2.2.4), and appropriate DQO (PARCC) parameters (8.2.2.5). These considerations are summarized for each category of waste management unit site in the S Plant Aggregate Area (Section 8.2.3).

8.2.2.1 Data Types. Data use categories described in Section 8.2.1 define the general purpose of collecting additional data. Based on the intended uses, a concise statement regarding the data types needed can be developed. Data types specified at this stage should not be limited to chemical parameters, but should also include necessary physical parameters such as bulk density and moisture. Since environmental media and source materials are interrelated, data types used to evaluate one media may also be useful to characterize another media.

Identifying data types by media indicates that there are overlapping data needs. Data objectives proposed for collection in the site investigations at sites in the S Plant Aggregate Area are discussed in Section 8.3 to provide focus to investigatory methods that may be employed. The data type requirements for the preliminary remedial action alternatives developed in Section 7.4 are summarized in Table 8-2.

8.2.2.2 Data Quality Needs. The various tasks and phases of a CERCLA investigation may require different levels of data quality. Important factors in defining data quality include selecting appropriate analytical levels and validating and identifying contaminant levels of concern as described below. The Westinghouse Hanford document, *A Proposed Data Quality Strategy for Hanford Site Characterization*, will be used to help define these levels (McCain and Johnson 1990).

1 Chemical and radionuclide laboratory analysis will be one of the most important data
2 types, and is required at virtually all the sites in the S Plant Aggregate Area. In general,
3 increased accuracy, precision, and lower detection limits are obtained with increasing cost and
4 time. Therefore, the analytical level used to obtain data should be commensurate with the
5 intended use. Table 8-3 defines five analytical levels associated with different types of
6 characterization efforts. While the bulk of the analysis during LFIs/RIs will be screening
7 level (DQO Level I or II), these data will require confirmation sampling and analysis to allow
8 final remedial decisions through quantitative risk assessment methods. Individual DQO
9 analytical PARCC parameters for Level III or IV analytical data associated with each
10 contaminant anticipated in the S Plant Aggregate Area (as developed in Section 5) are
11 presented in Table 8-4. These parameters will be used for the development of site-specific
12 sampling and analysis plans and quality assurance plans for investigations and remediations in
13 the aggregate area.

14
15 Before laboratory or even field data can be used in the selection of the final remedial
16 action, they must first be validated. Exceptions are made for initial evaluations of the sites
17 using existing data, which may not be appropriate for validation but will be used for
18 screening based on the *Hanford-Past Practice Strategy* (Thompson 1991). Other screening
19 data (e.g., estimates of contaminant concentration inferred from field analyses) may also be
20 excepted. Validation involves determining the usability and quality of the data. Once data are
21 validated, they can be used to successfully complete the remedial action selection process.
22 Activities involved in the data validation process include the following:

- 23 • Verification of chain-of-custody and sample holding times
- 24 • Confirmation that laboratory data meet Quality Assurance/Quality Control (QA/QC)
- 25 criteria
- 26 • Confirmation of the usability and quality of field data, which includes geological logs,
- 27 hydrologic data, and geophysical surveys
- 28
- 29 • Proper documentation and management of data so that they are usable.
- 30
- 31
- 32
- 33

34 Validation may be performed by qualified Westinghouse Hanford personnel from the
35 Office of Sample Management (OSM), other Westinghouse Hanford organizations, or a
36 qualified independent participant subcontractor. Data validation of laboratory analyses will be
37 performed in accordance with *A Proposed Data Quality Strategy for Hanford Site*
38 *Characterization* (McCain and Johnson 1990) and standards set forth by Westinghouse
39 Hanford.

40
41 To accomplish the second point, all laboratory data must meet the requirements of the
42 specific QA/QC parameters as set up in the Quality Assurance Project Plan (QAPP) for the
43 project before it can be considered usable. The QA/QC parameters address laboratory
44 precision and accuracy, method blanks, instrument calibration, and holding times.
45

1 The usability of field data must be assessed by a trained and qualified person. The
2 project geohydrologist/geophysicists will review the geologic logs, hydrologic data,
3 geophysical surveys, and results of physical testing, on a daily basis, and senior technical
4 reviews will be conducted periodically throughout the project.
5

6 Data management procedures are also necessary for the validation. Data management
7 includes proper documentation of field activities, sample management and tracking, and
8 document and inventory control. Specific consistent procedures are discussed in the Data
9 Management Plan (Appendix D).
10

11 **8.2.2.3 Data Quantity Needs.** The number of samples that need to be collected during an
12 investigation can be determined by using several approaches. In instances where data are
13 lacking or are limited (such as for contamination in the vadose zone soils), a phased sampling
14 approach will be appropriate. In the absence of any available data, an approach or rationale
15 will need to be developed to justify the sampling locations and the numbers of samples
16 selected. Specific locations and numbers of samples will be determined based on data
17 collected during screening activities. For example, the number and location of beta/gamma
18 spectrometer probe locations can be based on results of surface geophysical and radiation
19 surveys. These may help locate some subsurface features (such as the 218-W-9 Burial
20 Ground), which may not be adequately documented. Details of any higher DQO level
21 subsurface soil sampling scheme will depend on results of screening investigations such as
22 geophysics surveys, surface radiation surveys, and beta/gamma spectrometer probe surveys.
23 In situations where and when available data are more complete, statistical techniques may be
24 useful in determining the additional data required.
25

26 **8.2.2.4 Sampling and Analysis Options.** Data collection activities are structured to obtain
27 the needed data in a cost-effective manner. Developing a sampling and analysis approach that
28 ensures that appropriate data quality and quantity are obtained with the resources available
29 may be accomplished by using field screening techniques and focusing the higher DQO level
30 analyses on a limited set of samples at each site. The investigations on sites in the S Plant
31 Aggregate Area should take advantage of this approach for a comprehensive characterization
32 of the site in a cost-effective manner.
33

34 A combination of lower level (Levels I, II, and III) and higher level analytical data
35 (Levels IV and V) should be collected. For instance, at least one of the samples collected
36 from each source (including contaminated surface soil at unplanned release locations) should
37 be analyzed at DQO Level IV or V and validated to provide high quality data to confirm the
38 less expensive but more extensive lower level analyses. This approach would provide the
39 certainty necessary to determine contaminants present near the sources. Samples collected
40 from the other media (i.e., subsurface soils, sediments) will be analyzed by *Test Methods for*
41 *Evaluating Solid Wastes* (EPA 1986), Contract Laboratory Program (EPA 1988; EPA 1989a),
42 *Methods for Chemical Analysis of Water and Wastes* (EPA 1983), or *Prescribed Procedures*
43 *for Measurement of Radioactivity in Drinking Water* (EPA 1980a).
44

1 **8.2.2.5 Data Quality Parameters.** The PARCC parameters are indicators of data quality.
2 Ideally, the end use of the data collected should define the necessary PARCC parameters.
3 Once the PARCC requirements have been identified, then appropriate analytical methods can
4 be chosen to meet established goals and requirements. Definitions of the PARCC parameters
5 are presented in Section 8.1.3.
6

7 In general the precision and accuracy objectives are governed by the capabilities of the
8 available methodologies and in most cases these are more than adequate for the needs of the
9 investigations. Chemical analyses can usually attain parts per billion detection range in soils
10 and water, and this level is adequate to the needs of the risk assessment for most analytes.
11 Radiological analyses reach similar levels. Some constituents (e.g., arsenic) would require
12 analysis to much lower levels, but this is impossible because of the limitations of analytical
13 methods and the effects of natural background levels. In addition, risk assessment is
14 conventionally computed only to a single digit of precision and uses conservative
15 assumptions, which reduce the impact of measurements with lower accuracy.
16

17 For other measurements, such as physical parameters, the precision and accuracy
18 capabilities of existing measurement technologies are sufficient for the evaluation methods
19 used to produce characterization data, so the objectives are based on the limitations of the
20 analysis methodologies.
21

22 Representativeness is maintained by fitting the sampling program to the governing aspects
23 of the sources and transport processes of the site, as demonstrated in the site conceptual
24 model (Section 4.2). Initial sampling should concentrate on sources, which are fairly well-
25 understood, and on representative locations of anticipated transport mechanisms. If necessary,
26 following activities can focus on aspects or locations that were not anticipated but were
27 demonstrated by the more general results.
28

29 Completeness is generally attained by specifying redundancy on critical samples and
30 maintaining quality control on their acquisition and analysis. As with representativeness, the
31 initial sampling program may lead to modifications of which samples should be considered
32 critical during subsequent sampling activities.
33

34 Comparability will be met through the use of Westinghouse Hanford standard procedures
35 generally incorporated into the *Environmental Investigation and Site Characterization Manual*
36 (WHC 1988c).
37

38 **8.2.3 Data Gaps**

39 Considering the data needs developed in the subsections of Section 8.2.2, and the data
40 available to meet these needs as presented in Section 8.1.2, it is apparent that a number of
41 data gaps can be identified. These are summarized, on a waste management unit category
42 basis, in Table 8-5, and should be the focus of LFIs on a waste management unit category
43 basis, using the analogue sites approach. These contaminant concentration data are the
44
45

1 highest priority because of the need to assess the need for remediation and appropriate
2 remedial actions for each site.
3

4 In addition to these data needs specifically addressing contamination problems at sites
5 included for consideration in this aggregate area, there are general data needs that will be
6 required for characterization of the possible transport pathways, as presented in the conceptual
7 model, at locations away from the individual units. These general, non-site-specific needs
8 include characterizing of the following:
9

- 10 • Geologic stratigraphy, particularly for possible perched water zones
- 11
- 12 • Air transport of contamination
- 13
- 14 • Ecological impacts and transport mechanisms (bio-uptake, bio-concentration, secondary
15 receptors through predation)
- 16
- 17 • Potential releases from process effluent lines between facilities and to waste disposal
18 sites.
- 19

20 All of these needs will have to be addressed in the data collection program (Section 8.3).
21

22 **8.3 DATA COLLECTION PROGRAM (Stage 3 of the DQO Process)**

23
24

25 The data collection program is Stage 3 of the process to develop DQOs. Conducting an
26 investigation with a mixture of screening and higher-level data is a common method for
27 optimizing the quantity and quality of the data collected. It would be very inefficient and
28 overly expensive to specify beforehand all the types of samples and analyses that will yield
29 the most complete and accurate understanding of the contamination and physical behavior of
30 the site. Data adequate to achieve all the goals and objectives for remedial action decisions
31 are obtained at a lower cost by using the information obtained in the field to focus the
32 ongoing investigation and remediation process.
33

34 Initial sampling should collect new data believed most necessary to confirm and refine the
35 conceptual model particularly at priority sites. Sampling may then be extended to further
36 reduce uncertainty, to fill in remaining data gaps, to collect more detailed information for
37 certain points where such information is required, or to conduct any needed treatability
38 studies or otherwise support the data needs of the remedial action selection process. An
39 alternative of extrapolating the data from a limited number of sites to other analogous ones
40 will also be used. The need for subsequent investigation phases will be assessed throughout
41 the investigation and remediation activities as data become available. Assessing completeness
42 of the investigation data through a formal statistical procedure may not be possible, given the
43 complexity and uncertainty of the parameters required to describe the site and the time to
44 make decisions. Rather, the use of engineering judgement is considered sufficient to the
45 decision process.
46

1 **8.3.1 General Rationale**
2

3 The general rationale for the investigation of sites in the S Plant Aggregate Area is to
4 collect needed data that are not available. Because of the size of the aggregate area, the
5 complexity of past operations, and the number of unplanned releases and waste management
6 units, a large amount of new information will be required such as the specific radionuclides
7 and chemicals present, their spatial distribution and form, and the presence of special
8 migration pathways (such as perched groundwater systems).
9

10 The following work plan approach will be used for LFIs and RI/FS in the S Plant
11 Aggregate Area. The results are described in Sections 8.3.2 and 8.3.3 in a general form.
12

- 13 • Existing data as described in Sections 2.0, 3.0, and 4.0 should be used to the
14 maximum extent possible. Although existing data are not validated fully, the data are
15 still useful in developing a preliminary conceptual model (Section 4.2) and in helping
16 to focus and guide the planning of investigations, expedited actions, and interim
17 measures.
18
- 19 • Additional data at validated and screening levels should be collected to obtain the
20 maximum amount of useful information for the amount of time and resources invested
21 in the investigation.
22
- 23 • Data should be collected to support the intended data uses identified in Section 8.2.1.
24
- 25 • Nonintrusive sampling (e.g., geophysical surveys, surface radiation surveys, soil gas,
26 and spectral gamma probe surveys), and surficial and source sampling should be
27 conducted early in any investigation effort to identify necessary interim response
28 actions (i.e., additional ERAs or IRMs).
29
- 30 • Data collected from initial investigation activities should be used to confirm and refine
31 the conceptual model (Section 4.2), refine the analyte constituents of concern, and
32 provide information to conduct interim response actions or risk assessment activities.
33
- 34 • Additional investigation activities are proposed to support (if needed) quantitative
35 baseline risk assessments for final cleanup actions and further refine the conceptual
36 model.
37
- 38 • Field investigation techniques should be used to minimize the amount of hazardous or
39 mixed waste generated. Any waste generated will be in accordance with EII 4.2,
40 "Interim Control of Unknown Suspected Hazardous and Mixed Waste" (WHC 1988c).
41
42

8.3.2 General Strategy

The overall objective of any field investigation (LFI, IRM, or RI) of the sites in the S Plant Aggregate Area will be to gather additional information to support risk assessment and remedial action selection according to the *Hanford-Past Practice Strategy* (Thompson 1991) flow chart discussed in Section 8.1.5. The general approach or strategy for obtaining this additional information is presented below.

- Analytical parameter selection should be based on verifying overall conditions and then narrowed to specific constituents of concern, in consideration with regulatory requirements and site conditions. Periodic analyses of the long list of parameters should be conducted to verify that the list of constituents of concern has not changed, either because new constituents are identified or some of those considered as a potential concern do not appear to be significant.
- Similarly, investigations should work from a screening level (DQO Levels I or II, e.g., surface radiation surveys) to successively more specific sampling and analysis methodologies (e.g., beta/gamma spectral probes, then DQO Level III or IV soil sampling and analysis), without time consuming remobilizations.
- Dangerous and radioactive wastes may be generated during the field investigation. While efforts should be made to minimize these wastes, any waste generated will be handled in accordance with EII 4.2, "Interim Control of Unknown Suspected Hazardous and Mixed Waste" (WHC 1988c). The analyses of samples for constituents of concern analytes will allow wastes generated to be adequately designated.

8.3.3 Investigation Methodology

Initial field investigations (mainly LFIs, but also associated with IRMs at appropriate sites and possibly some RIs) may include some or all of the following integrated methodologies:

- Source Investigation (Section 8.3.3.1)
- Geological Investigation (Section 8.3.3.2)
- Surface Water Sediment Investigation (Section 8.3.3.3)
- Soil Investigation (Section 8.3.3.4)
- Air Investigation (Section 8.3.3.5)
- Ecological Investigation (Section 8.3.3.6)
- Geophysical Stratigraphic Survey (Section 8.3.3.7)

- 1 • Process Effluent Pipeline Integrity Assessment (Section 8.3.3.8)
- 2
- 3 • Geodetic Survey (Section 8.3.3.9).
- 4

5 Each investigation methodology is briefly outlined in the following sections. Specific
6 survey methods (such as electromagnetics or ground-penetrating radar) have not been
7 recommended to allow flexibility in the development of field sampling plans which can be
8 sensitive to very local conditions. A summary of the applicable methods for each waste
9 management unit is presented in Table 8-6. In addition, some of the data needs must be
10 addressed on an area-wide basis (e.g., stratigraphy interpretation). More detailed descriptions
11 and specific methods and instrumentation will be included in site-specific work plans,
12 sampling and analysis plans, and field sampling plans for LFIs/IRMs at waste management
13 units that require these investigations.

14
15 These investigations are presented in the approximate priority of their need, with the
16 source investigation first because of its importance to the decisions about remedial action on a
17 site-by-site basis. The other investigations are of lower priority, and will be conducted
18 according to the need to determine whether contamination has been transported beyond the
19 immediate vicinity of the waste management units. To some extent, this need will depend on
20 the results of the source investigation.

21
22 **8.3.3.1 Source Investigation.** The purpose of source investigation activities in the S Plant
23 Aggregate Area is to characterize the known waste management units and unplanned releases
24 that exist in the area and that may contribute to contamination of surface soil, vadose zone,
25 surface water, sediment, air, and biota. The completeness of the characterization effort will
26 be assessed according to the needs of risk assessment and remedial action selection, which
27 will also determine what levels of the various contaminants of concern comprise
28 "contamination."

29
30 Source sampling should be conducted at waste management units or unplanned release
31 locations where the available data indicate that dangerous, mixed, or radioactive wastes may
32 be present. Activities which are proposed to be performed during the source investigations
33 include the following:

- 34
- 35 • Compile and evaluate additional existing data for the purpose of: verifying locations,
36 specifications of engineered facilities, and pipelines, and waste stream characteristics;
37 assessment of the construction and condition of boreholes/wells that exist in the
38 operable unit and their suitability for use for investigation activities, QA/QC
39 information, and raw data regarding radiological and hazardous substances monitoring;
40 and integrating any additional environmental modeling data into the conceptual model.
41 This has been done (on an aggregate area basis) in this report; the process will be
42 extended to site-specific planning and on-going assessments of the
43 investigation/remediation as it is carried out.
- 44
- 45 • Conduct surface radiological survey of suspected or known source areas to verify
46 locations and nature of surface and subsurface radiological contamination. Conditions

1 at specific sources within a waste management unit should also be noted in order to
2 plan sampling/remediation activities and worker health and safety.
3

- 4 • Conduct nonintrusive surface geophysical surveys at specific waste management units
5 such as the 218-W-9 Burial Ground (Section 2.3.9.1), and unplanned release locations
6 to verify locations and physical characteristics of source locations. Data generated
7 from these activities can be used in planning intrusive source sampling activities.
8
- 9 • Conduct beta/gamma spectrometer probe survey to screen for near-surface
10 contamination and to confirm the absence or presence of some specific radionuclides,
11 which may be of particular concern. Existing boreholes will be used to the maximum
12 extent, but new boreholes may be needed at many locations (to be decided based on
13 screening results). Logging will be done both by NaI detectors or pR meters for rapid
14 screening as well as the RLS high purity germanium logging system. Westinghouse
15 Hanford will develop an EII Procedure for the beta/gamma spectrometer probe survey.
16 The beta/gamma spectrometer probe survey serves two purposes depending on the
17 source conditions: to confirm absence of contamination in the near-surface soils, and
18 to serve as a screening tool to choose locations and quantities of vadose zone soil
19 borings. The RLS procedure could demonstrate "assay quality" data for radionuclide
20 concentrations, but will probably continue to require supporting Level IV soil analysis
21 data to allow a risk assessment before final remedial decisions. The need to conduct
22 this survey will be based (at least in part) on the screening results of the surface
23 survey and on information about site burial.
24
- 25 • Soil gas surveys should be conducted at waste management units such as catch tanks
26 or where VOCs are suspected, as a screening method to identify compounds such as
27 solvents and degreasers that may have been used in separate processes or during
28 construction activities. The soil gas survey should not be considered conclusive that
29 VOCs at lower concentrations may not be present. Data from the soil gas survey can
30 be used to help locate surface and near-surface samples and vadose zone borings.
31
- 32 • Collect surface and near-surface samples of contaminated soils and/or waste materials
33 at selected locations. Specific sampling sites will be chosen to assess particular
34 facilities or releases. Additional sampling sites may be specified based on results from
35 nonintrusive investigations.
36
- 37 • Wipe samples should be collected as part of the investigations of surface
38 contamination or building (piping or pavement) surfaces. The wipe sample locations
39 can be chosen based on visual observations and a surface radiation survey conducted
40 during a site walkthrough. The methodology may be limited by the presence of soil,
41 rough concrete, or paving and so may not be heavily used except as confirmation
42 following removal of loose contamination.
43

44 **8.3.3.2 Geologic Investigation.** A geologic investigation should be performed to better
45 characterize the vadose zone and the nature of unsaturated soils that make up this system.
46 The geologic investigation will include the following tasks:

- 1 • Borings may be advanced into zones where an accurate interpolation of the subsurface
2 stratigraphy is important to understanding migration pathways in the vadose zone. An
3 investigation of the Plio-Pleistocene layer, which may be causing perched water zones,
4 may be especially valuable.
5
- 6 • Geologic data collected during the ongoing vadose zone soil (Section 8.3.3.4) and
7 other (deeper) investigations (e.g., geologic and geophysical logs from groundwater
8 well installations for groundwater AAMs) will be compared, compiled, and evaluated.
9

10 **8.3.3.3 Surface Water Sediment Investigation.** A surface water sediment investigation
11 should be conducted. The investigation will include:

- 12 • Radiation survey along ditches, trenches, and ponds for health and safety purposes and
13 to locate areas of elevated radiation for selection of specific sediment sampling
14 locations.
15
- 16 • Sampling of sediment in any ditches, ponds, and trenches that still contain water. This
17 will probably be limited to the 216-S-10D Ditch.
18

19 **8.3.3.4 Soil Investigation.** The purpose of soil investigations is to determine physical and
20 chemical properties of the soil and to determine the nature, type, and extent of soil
21 contamination associated with waste management units and unplanned releases to allow
22 initiation of interim remedial actions and to assess the quantitative risk at other sites.
23 Sampling will include:
24

- 25 • Samples of vadose zone soil will be collected and analyzed for constituents of concern
26 when wells are drilled for other studies (i.e., groundwater investigations) in the
27 vicinity of a waste management unit or unplanned release with reported liquid
28 disposals or spills. Organic vapor (at sites with suspected VOCs) and radiation
29 sampling should also be performed with samples selected by onsite screening.
30
- 31 • Data collected during this investigation will be evaluated to further understand the
32 contribution of contaminants to the vadose zone from specific waste management units
33 and/or unplanned releases and to better define the hydrology and water quality in the
34 vadose zone system through moisture content profiles and tracking of specific
35 contaminants.
36

37 **8.3.3.5 Air Investigation.** Air investigations (on an aggregate area scale) should consist of
38 on-site particle sampling as part of the health and safety program. In addition, high-volume
39 air samplers should be placed in appropriate locations on site based on evaluation of existing
40 meteorological data. The purpose of these samplers will be to determine if any migration of
41 airborne contaminants occurs.
42

43 **8.3.3.6 Ecological Investigation.** Ecological investigation activities, on an aggregate area
44 scale, should include a literature search and data review, and a site walkthrough. These
45 activities are intended to identify potential biota concerns which need to be addressed in the
46

1 site investigation. Particular emphasis should be given to identifying potential exposure
2 pathways to biota that migrate offsite or that introduce contaminants into the food web.
3

4 **8.3.3.7 Geophysical Stratigraphic Survey.** A geophysical survey of subsurface stratigraphy
5 should be conducted across the aggregate area to help characterize the geology and
6 hydrogeology of the vadose zone. Of particular interest are perched water zones and the
7 caliche layer (an important aquitard) in the Plio-Pleistocene Unit.
8

9 **8.3.3.8 Process Effluent Pipeline Integrity Assessment.** An assessment of process effluent
10 pipeline integrity should be conducted early in site investigation activities to look for potential
11 leaks and therefore possible areas of contamination. Initially, as part of this effort, drawings
12 of the process lines and encasements within the aggregate area (Section 2.3.7) should be
13 reviewed and their construction, installation, and operation evaluated. Specific lines will then
14 be selected for integrity assessment with emphasis on lines serving the waste management
15 units that have received large volumes of liquid (e.g., cribs). Investigation of operating high
16 level waste transfer lines will be deferred to their respective programs. Results of the
17 integrity assessments will be evaluated and additional sampling activities may be
18 recommended for subsequent studies.
19

20 **8.3.3.9 Geodetic Survey.** Geodetic surveys will be conducted after the installation and
21 completion of each investigation activity. The survey will be to locate the horizontal
22 locations of surface and near-surface soil samples; corners of geophysics, soil gas, and
23 beta/gamma probe surveys; and surface water and sediment sample locations. Horizontal and
24 vertical locations of all vadose zone soil borings and perched zone wells will be surveyed.
25 The geodetic survey should be conducted by a professional surveyor licensed in the state of
26 Washington and should be referenced to both historic (e.g., Hanford coordinates) and current
27 coordinate datums (e.g., North American Datum of 1983 - NAD-83), both vertical and
28 horizontal.
29

30 **8.3.4 Data Evaluation and Decision Making**

31
32
33 Data will be evaluated as soon as results (e.g., soil gas, radiation screening, drilling
34 results) become available for use in restructuring and focusing the investigation activities.
35 Data reports will be developed that summarize and interpret new data. This includes
36 groundwater sampling and RLS borehole logging as part of the AAMS. Data will be used to
37 refine the conceptual model, further assess potential contaminant-specific ARARs, develop the
38 quantitative risk assessment, and assess remedial action alternatives.
39

40 The objectives of data evaluation are:

- 41
- 42 • To reduce and integrate data to ensure that data gaps are identified and that the goals
43 and objectives of the S Plant AAMS are met
- 44
- 45 • To confirm that data are representative of the media sampled and that QA/QC criteria
46 have been met.

9 3 1 2 9 5 1 7 6 4

Table 8-1. Uses of Existing Data for S Plant Aggregate
Area Waste Management Units.

| Waste Management Unit | Type of Unit | Development of Sampling Plans | | | Health & Safety | |
|-------------------------------------|--------------|-------------------------------|------------------|---------------|-----------------|---------------------|
| | | Location | Possible Contam. | Depth Contam. | Surface Rad. | Expected Max. Level |
| Tanks and Vaults | | | | | | |
| 240-S-302 | Catch Tank | * | * | * | * | |
| Cribs and Drains | | | | | | |
| 216-S-1 & 2 | Cribs | * | * | * | * | |
| 216-S-5 | Crib | * | * | * | * | |
| 216-S-6 | Crib | * | * | * | * | |
| 216-S-7 | Crib | * | * | * | * | |
| 216-S-9 | Crib | * | * | * | * | |
| 216-S-13 | Crib | * | * | * | * | |
| 216-S-20 | Crib | * | * | * | * | |
| 216-S-22 | Crib | * | * | * | * | |
| 216-S-23 | Crib | * | * | * | * | |
| 216-S-25 | Crib | * | * | * | * | |
| 216-S-26 | Crib | * | * | * | * | |
| 216-S-3 | French Drain | * | * | * | * | |
| Ponds, Ditches, and Trenches | | | | | | |
| 216-S-10P | Pond | * | * | * | * | |
| 216-S-11 | Pond | * | * | * | * | |
| 216-S-15 | Pond | * | * | * | * | |
| 216-S-17 | Pond | * | * | * | * | |
| 216-S-19 | Pond | * | * | | * | |
| 216-S-10D | Ditch | * | * | * | * | |
| 216-S-16D | Ditch | * | * | | * | |
| 216-S-8 | Trench | * | * | * | * | |
| 216-S-12 | Trench | * | * | * | * | |
| 216-S-14 | Trench | * | * | * | * | |
| 216-S-18 | Trench | * | * | | * | |

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Table 8-1. Uses of Existing Data for S Plant Aggregate
Area Waste Management Units.

| Waste Management Unit | Type of Unit | Development of Sampling Plans | | | Health & Safety | |
|---|----------------------------------|-------------------------------|------------------|---------------|-----------------|---------------------|
| | | Location | Possible Contam. | Depth Contam. | Surface Rad. | Expected Max. Level |
| Septic Tanks and Associated Drain Fields | | | | | | |
| 2607-W6 | Septic Tank/Tile Field | * | | | * | |
| 2607-WZ | Septic Tanks (2) and Drain Field | * | | | * | |
| Unnumbered | Sanitary Crib | * | | | * | |
| Transfer Facilities and Pipelines | | | | | | |
| 216-S-172 | Control Structure | * | * | | * | |
| 2904-S-160 | Control Structure | * | * | | * | |
| 2904-S-170 | Control Structure | * | * | | * | |
| 2904-S-171 | Control Structure | * | * | | * | |
| 240-S-151 | Diversion Box | * | * | | | |
| 240-S-152 | Diversion Box | * | * | | | |
| Basins | | | | | | |
| 207-SL | Retention Basin | * | | | * | |
| Burial Sites | | | | | | |
| 218-W-7 | Burial Ground | * | | | * | |
| 218-W-9 | Burial Ground | * | | | * | |

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Table 8-2. Data Needs for Preliminary Remedial Action Technologies
S Plant Aggregate Area.

| Alternative | Physical Attribute | Chemical/Radiochemical Attribute |
|--|--|---|
| 1. Multimedia Cover (plus possible vertical barriers) | <ul style="list-style-type: none"> areal extent depth of contamination structural integrity (collapse potential) run-off/run-on potential cover properties (permeability) | <ul style="list-style-type: none"> surface radiation biologic transport potential |
| 2. In Situ Grouting/ Stabilization | <ul style="list-style-type: none"> areal extent depth particle size hydraulic properties (permeability/porosity) stratigraphy borehole spacing grout/additive mix parameters | <ul style="list-style-type: none"> solubility reactivity leachability from grout medium |
| 3. Excavation, Soil Treatment, and Disposal | <ul style="list-style-type: none"> areal extent^v depth^v particle size silt-size (dust) content excavation stability | <ul style="list-style-type: none"> toxicity/radioactivity levels of contaminants solubility/reactivity soil chemistry (relative affinity) concentrations in PM-10 fraction spent solvent treatment/disposal options |
| 4. In Situ vitrification | <ul style="list-style-type: none"> areal extent depth soil/waste conductivity thermal properties moisture contact voids | <ul style="list-style-type: none"> volatility reactivity leachability/integrity off-gas treatment waste disposal options |
| 5. Excavation, Above Ground Treatment, and Geologic Disposal | <ul style="list-style-type: none"> areal extent^v depth^v mineralogy of soil/waste particle size silt-size (dust) content excavation stability treatment parameters | <ul style="list-style-type: none"> concentrations of TRU toxicity/radioactivity levels of contaminants concentrations in PM-10 fraction reactivity leachability/integrity of final waste form |

9 5 1 2 8 ' 5 1 7 6 7

Table 8-2. Data Needs for Preliminary Remedial Action Technologies
S Plant Aggregate Area.

| Alternative | Physical Attribute | Chemical/Radiochemical Attribute |
|----------------------------------|---|--|
| 6. In Situ Soil Vapor Extraction | <ul style="list-style-type: none">• areal extent• depth• locations/depth of highest concentrations (vapors, adsorbed)• stratigraphy• soil permeability/porosity• voids | <ul style="list-style-type: none">• volatility of constituents (Henry's Law Constant)• non-volatile organics• levels• volatile radionuclides (Radon)• treatability (catalytic oxidization) |

* May be obtained during remediation using the observational approach recommended by the *Hanford Past Practice Investigation Strategy* (Thompson 1991)

9 3 1 2 8 5 1 7 6 8

Table 8-3. Analytical Levels for the S Plant Aggregate Area.

| Level | Description |
|------------------|--|
| <u>LEVEL I</u> | 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. |
| <u>LEVEL II</u> | 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. |
| <u>LEVEL III</u> | Laboratory analysis using methods other than the Contract Laboratory Program (CLP) Routine Analytical Services (RAS). This level is used primarily in support of engineering studies using standard EPA-approved procedures. Some procedures may be equivalent to CLP RAS without the CLP requirements for documentation. |
| <u>LEVEL IV</u> | Contract Laboratory Program (CLP) Routine Analytical Services (RAS). 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. |
| <u>LEVEL V</u> | Nonstandard methods. Analyses which may require method modification and/or development are considered Level V by CLP Special Analytical Services (SAS). |

9 3 1 2 9 5 1 7 4 9

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

| | Soil/Sediment | | | | Water | | | |
|----------------------|---------------|-----|-----------|-----|-----------|-----|-----------|-----|
| | Practical | | Practical | | Practical | | Practical | |
| RADIONUCLIDES | | | | | | | | |
| 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 |
| Gamma Scan | D3699 M | TBD | ±30 | ±25 | D3649 M | TBD | ±25 | ±25 |
| ²²³ Ac | 907.0 M | TBD | ±30 | ±25 | 907.0 | TBD | ±25 | ±25 |
| ²²⁷ Ac | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ²⁴¹ Am | Am-01 | TBD | ±30 | ±25 | Am-03 | TBD | ±25 | ±25 |
| ²⁴² Am | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ^{242m} Am | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ²⁴³ Am | Am-01 | TBD | ±30 | ±25 | Am-03 | TBD | ±25 | ±25 |
| ^{137m} Ba | D3649 M | TBD | ±30 | ±25 | D3649 M | TBD | ±25 | ±25 |
| ²¹⁰ Bi | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ²¹¹ Bi | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ²¹³ Bi | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ²¹⁴ Bi | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ¹⁴ C | C-01 M | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ²⁴² Cm | 907.0 M | TBD | ±30 | ±25 | 907.0 | TBD | ±25 | ±25 |
| ²⁴⁴ Cm | 907.0 M | TBD | ±30 | ±25 | 907.0 | TBD | ±25 | ±25 |
| ²⁴⁵ Cm | 907.0 M | TBD | ±30 | ±25 | 907.0 | TBD | ±25 | ±25 |
| ⁶⁰ Co | D3649 M | TBD | ±30 | ±25 | D3649 M | TBD | ±25 | ±25 |
| ¹³⁴ Cs | D3649 M | TBD | ±30 | ±25 | D3649 M | TBD | ±25 | ±25 |
| ¹³⁵ Cs | 901.0 M | TBD | ±30 | ±25 | 901.0 | TBD | ±25 | ±25 |
| ¹³⁷ Cs | D3649 M | TBD | ±30 | ±25 | D3649 M | TBD | ±25 | ±25 |
| ¹⁵² Eu | D3649 M | TBD | ±30 | ±25 | D3649 M | TBD | ±25 | ±25 |
| ¹⁵⁴ Eu | D3649 M | TBD | ±30 | ±25 | D3649 M | TBD | ±25 | ±25 |
| ¹⁵⁵ Eu | D3649 M | TBD | ±30 | ±25 | D3649 M | TBD | ±25 | ±25 |
| ²²¹ Fr | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |

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Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

| | Soil/Sediment | | | | Water | | | |
|-----------------------|---------------|-----|-----|-----|-----------|-----|-----|-----|
| | Practical | | | | Practical | | | |
| RADIONUCLIDES | | | | | | | | |
| ³ H | 906.0 M | TBD | ±30 | ±25 | 906.0 | 300 | ±25 | ±25 |
| ¹²⁹ I | 902.0 M | TBD | ±30 | ±25 | 902.0 | TBD | ±25 | ±25 |
| ⁴⁰ K | D3649 M | TBD | ±30 | ±25 | D3649 M | TBD | ±25 | ±25 |
| ⁸⁵ Kr | Kr-01 | TBD | +30 | +25 | Kr-01 | TBD | +25 | +25 |
| ^{93m} Nb | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ⁵⁹ Ni | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ⁶³ Ni | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ²³⁷ Np | 907.0 M | TBD | ±30 | ±25 | 907.0 | TBD | ±25 | ±25 |
| ²³⁹ Np | D35649 M | TBD | ±30 | ±25 | D3649 M | TBD | ±25 | ±25 |
| ²³¹ Pa | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ^{234m} Pa | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ²⁰⁹ Pb | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ²¹⁰ Pb | Pb-01 M | TBD | ±30 | ±25 | Pb-01 | TBD | ±25 | ±25 |
| ²¹¹ Pb | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ²¹² Pb | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ²¹⁴ Pb | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ²¹⁴ Po | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ²¹⁵ Po | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ²¹⁸ Po | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ¹⁴⁷ Pr | Pm-01 | TBD | +30 | +25 | Pm-01 | TBD | ±25 | ±25 |
| Pu | Pu-02 | TBD | ±30 | ±25 | Pu-10 | TBD | ±25 | ±25 |
| ²³⁸ Pu | Pu-02 | TBD | ±30 | ±25 | Pu-10 | TBD | ±25 | ±25 |
| ^{239/240} Pu | Pu-02 | TBD | ±30 | ±25 | Pu-10 | TBD | ±25 | ±25 |
| ²⁴¹ Pu | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| Ra | Ra-04 | TBD | +30 | +25 | Ra-05 | TBD | +25 | +25 |
| ²²⁵ Ra | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |

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Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

| | Soil/Sediment | | | | Water | | | |
|----------------------|---------------|-----|-----------|-----|-------|-----|-----------|-----|
| | | | Practical | | | | Practical | |
| RADIONUCLIDES | | | | | | | | |
| ²²⁶ Ra | Ra-04 | TBD | ±30 | ±25 | Ra-05 | TBD | ±25 | ±25 |
| ²²⁸ Ra | Ra-04 | TBD | ±30 | ±25 | Ra-05 | TBD | ±25 | ±30 |
| ¹⁰⁶ Ru | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ¹²⁶ Sb | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ^{126m} Sb | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ⁷⁹ Se | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ¹⁵¹ Sm | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ⁹⁰ Sr | Sr-02 | TBD | ±30 | ±25 | Sr-02 | TBD | ±25 | ±25 |
| ⁹⁹ Tc | Tc-01 M | TBD | ±30 | ±25 | Tc-01 | TBD | ±25 | ±25 |
| ²²⁷ Th | 00-06 | TBD | ±30 | ±25 | 00-07 | TBD | ±25 | ±25 |
| ²²⁹ Th | 00-06 | TBD | ±30 | ±25 | 00-07 | TBD | ±25 | ±25 |
| ²³⁰ Th | 00-06 | TBD | ±30 | ±25 | 00-07 | TBD | ±25 | ±25 |
| ²³¹ Th | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ²⁰⁷ Tl | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |
| ²⁰⁸ Tl | D3649M | TBD | +30 | +25 | D3649 | TBD | +25 | +25 |
| U | U-04 | TBD | ±30 | ±25 | U-04 | TBD | ±25 | ±25 |
| ²³³ U | U | TBD | ±30 | ±25 | 908.0 | TBD | ±25 | ±25 |
| ²³⁴ U | U | TBD | ±30 | ±25 | 908.0 | TBD | ±25 | ±25 |
| ²³⁵ U | U | TBD | ±30 | ±25 | 908.0 | TBD | ±25 | ±25 |
| ²³⁶ U | U | TBD | ±30 | ±25 | 908.0 | TBD | ±25 | ±25 |
| ²³⁸ U | U | TBD | ±30 | ±25 | 908.0 | TBD | ±25 | ±25 |
| ⁹⁰ Y | Sr-02 | TBD | ±30 | ±25 | Sr-02 | TBD | ±25 | ±25 |
| ⁹³ Zr | TBD | TBD | ±30 | ±25 | TBD | TBD | ±25 | ±25 |

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Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

| | Soil/Sediment | | | | Water | | | |
|-------------------|---------------|-----------|-----|-----|-------|-----------|-----|-----|
| | | Practical | | | | Practical | | |
| INORGANICS | | | | | | | | |
| Ammonium | 350.1m | 0.4 | ±25 | ±30 | 350.1 | 400 | ±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 |
| 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 |
| 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 |
| Silver | 6010 | 2 | ±25 | ±30 | 272.2 | 10 | ±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. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

| | Soil/Sediment | | | | Water | | | |
|-----------------|---------------|-------|-----|-----|-----------|-----|-----|-----|
| | Practical | | | | Practical | | | |
| ORGANICS | | | | | | | | |
| Acetone | 8240 | 0.1 | ±25 | ±30 | 8240 | 100 | ±20 | ±25 |
| Chloroform | 8240 | 0.005 | ±25 | ±30 | 8240 | 5 | ±20 | ±25 |
| Hydrazine | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| MIBK | 8240 | 0.5 | ±25 | ±30 | 8240 | 5 | ±20 | ±25 |
| Xylene | 8240 | 0.005 | +25 | +30 | 8240 | 5 | +20 | +25 |

TBD - To Be Determined

M - method modified to include extraction from the solid medium, extraction method is matrix and laboratory-specific

RPD - Relative Percent Difference

Prescribed Procedures for Measurement of Radioactivity in Drinking Water (EPA 1980a)

Test Methods for Evaluation Solid Waste (SW 846) Third Edition (EPA 1986)

Methods for Chemical Analysis of Water and Waste (EPA 1983)

Radionuclide Method for the Determination of Uranium in Soil and Air (EPA 1980b)

EML Procedures Manual (DOE/EML 1990)

Eastern Environmental Radiation Facility RadioChemistry Procedures Manual (EPA 1984)

High-Resolution Gamma-Ray Spectrometry of Water (ASTM 1985)

Precision and accuracy are goals. Since these parameters are highly matrix dependent they could vary greatly from the goals listed.

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Table 8-5. Data Gaps by Site Category.

| Site Category | Identified Data Gaps |
|---|--|
| Tanks and Vaults | <ul style="list-style-type: none">• Contaminant concentrations in waste management units other than single-shell tanks• Distribution of contaminants in subsurface soils released in leaks• Constituents concentrations in related surface contamination |
| Cribs and Drains | <ul style="list-style-type: none">• Contaminant concentrations in cribs• Contaminant concentrations in soils beneath cribs• Specific constituents (especially organic chemicals)• Distribution and vertical/lateral extent of contamination |
| Ponds, Ditches, and Trenches | <ul style="list-style-type: none">• Distribution/extent of subsurface contamination• Buried contaminant concentrations in stabilized portions/units |
| Septic Tanks and Associated Drain Fields | <ul style="list-style-type: none">• Actual discharge levels• Possible discharge and presence/level of non-sanitary wastes (e.g., laboratory drains) |
| Transfer Facilities, Diversion Boxes, and Pipelines | <ul style="list-style-type: none">• Contamination constituents and concentrations• Direct radiation levels in facilities• Constituents/concentrations in related surface contamination• Integrity of transfer lines |
| Unplanned Releases | <ul style="list-style-type: none">• Surface soil constituents and concentrations• Buried contamination constituents and concentrations |

9 5 1 2 8 / 5 1 7 7 5

Table 8-6. Applicable Characterization Investigation Methods at S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Surface Radiation Survey | Subsurface Spectral Geophysics | Surface Geophysics | Soil Gas Survey | Surface Soil Sampling | Wipe Samples | Surface Water Sediment Sampling | Subsurface Soil Sampling | Perched Zone Monitoring Wells | Remarks |
|--|--------------------------|--------------------------------|--------------------|-----------------|-----------------------|--------------|---------------------------------|--------------------------|-------------------------------|---------|
| Plants, Buildings, and Storage Areas | | | | | | | | | | |
| 291-S Stack Complex | X | X | | | | X | | | | |
| Tanks and Vaults | | | | | | | | | | |
| 240-S-302 Catch Tank (and Pump Pit) | | X | | X | | | | X | | |
| Cribs and Drains | | | | | | | | | | |
| 216-S-1 & -2 Crib/UN-200-W-139 (2 is 1's overflow) | X | A | | | X | | | X | | |
| 216-S-5 Crib (low potential condensate) | X | X | | | X | | | X | | |
| 216-S-6 Crib (high potential condensate) | X | X | | | X | | | X | X | |
| 216-S-7 Crib | | A | | | | | | A | X | |
| 216-S-9 Crib | | A | | | | | | A | | |
| 216-S-13 Crib | | A | | | | | | A | | |
| 216-S-20 Crib | | A | | | X | | | X | | |
| 216-S-22 Crib | | A | | | | | | A | | |
| 216-S-23 Crib | | A | | | | | | A | | |
| 216-S-25 Crib | X | A | | | | | | X | X | |
| 216-S-26 Crib | | A | | | | | | X | | |
| 216-S-3 French Drain | | A | | | | | | X | | |

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Table 8-6. Applicable Characterization Investigation Methods at S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Surface Radiation Survey | Subsurface Spectral Geophysics | Surface Geophysics | Soil Gas Survey | Surface Soil Sampling | Wipe Samples | Surface Water Sediment Sampling | Subsurface Soil Sampling | Perched Zone Monitoring Wells | Remarks |
|---|--------------------------|--------------------------------|--------------------|-----------------|-----------------------|--------------|---------------------------------|--------------------------|-------------------------------|---------|
| Ponds, Ditches, and Trenches | | | | | | | | | | |
| 216-S-10P Pond (waste came via 216-S-10D) | | X | | | X | | | X | | |
| 216-S-11 Pond (waste came via 216-S-10D) | | X | | | X | | | X | | |
| 216-S-15 Pond | X | X | | X | X | | | X | | |
| 216-S-16P Pond | X | X | | | X | | | X | | |
| 216-S-17 Pond | X | X | | | X | | | X | | |
| 216-S-19 Pond | | X | | X | X | | | X | | |
| 216-S-10D Ditch (trench since 1984) | X | X | X | | X | | X | X | X | |
| 216-S-16D Ditch | | X | | | | | | X | | |
| 216-U-9 Ditch/UN-200-W-139 | X | X | | | X | | | X | | |
| 216-S-8 Trench | | X | X | | X | | | X | | |
| 216-S-12 Trench/UN-200-W-30 | | X | X | | | | | X | | |
| 216-S-14 Trench | | | | X | | | | X | | |
| 216-S-18 Trench | | | | | | | | X | | |
| Septic Tanks and Drain Fields | | | | | | | | | | |
| 2607-W6 Septic Tank and Tile Field | X | X | X | X | | | | X | | |
| 2607-WZ Septic Tanks (2) and Drain Field | X | X | X | X | | | | X | | |
| Sanitary Crib | X | X | | | | | | X | | |

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Table 8-6. Applicable Characterization Investigation Methods at S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Surface Radiation Survey | Subsurface Spectral Geophysics | Surface Geophysics | Soil Gas Survey | Surface Soil Sampling | Wipe Samples | Surface Water Sediment Sampling | Subsurface Soil Sampling | Perched Zone Monitoring Wells | Remarks |
|--|--------------------------|--------------------------------|--------------------|-----------------|-----------------------|--------------|---------------------------------|--------------------------|-------------------------------|---------------------------|
| Transfer Facilities, Diversion Boxes, and Pipelines | | | | | | | | | | |
| 2904-S-160 Control Structure | | | | | | X | | X | | |
| 2904-S-170 Control Structure | | | | | | X | | X | | |
| 2904-S-171 Control Structure | | | | | | X | | X | | |
| 216-S-172 Control Structure | | | | | | X | | X | | Wipe samples in structure |
| 240-S-151 Diversion Box | | | | | | X | | X | | Wipe sample |
| 240-S-152 Diversion Box | | | | | | X | | X | | |
| Basins | | | | | | | | | | |
| 207-S Retention Basin/UPR-200-W-13, -15, -95 | | X | | | X | | X | X | | |
| 207-SL Retention Basin | | A | | | | | X | X | | |
| Burial Sites | | | | | | | | | | |
| 218-W-7 Burial Ground | | | | | | | | X | | |
| 218-W-9 Burial Ground | | X | X | | X | | | X | | |
| Unplanned Releases | | | | | | | | | | |
| UN-200-W-10 Unplanned Release | X | | | | X | | | | | |
| UN-200-W-30 Unplanned Release | | | | | | | | | | Same as 216-S-12 |
| UN-200-W-32 Unplanned Release | | | | | | | | X | | |
| UN-200-W-34 Unplanned Release | X | | | | X | | | X | | |

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Table 8-6. Applicable Characterization Investigation Methods at S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Surface Radiation Survey | Subsurface Spectral Geophysics | Surface Geophysics | Soil Gas Survey | Surface Soil Sampling | Wipe Samples | Surface Water Sediment Sampling | Subsurface Soil Sampling | Perched Zone Monitoring Wells | Remarks |
|--------------------------------|--------------------------|--------------------------------|--------------------|-----------------|-----------------------|--------------|---------------------------------|--------------------------|-------------------------------|--------------------------|
| UN-200-W-35 Unplanned Release | X | | | | X | | | X | | |
| UN-200-W-41 Unplanned Release | | | | | | | | | | No further investigation |
| UN-200-W-42 Unplanned Release | X | | | | X | | | | | |
| UN-200-W-43 Unplanned Release | X | | | | X | | | | | |
| UN-200-W-49 Unplanned Release | X | | | | X | | | | | |
| UN-200-W-50 Unplanned Release | X | | | | X | | | | | |
| UN-200-W-52 Unplanned Release | X | X | | | X | | | X | | |
| UN-200-W-56 Unplanned Release | X | | | | X | | | | | |
| UN-200-W-61 Unplanned Release | | | | | X | | | | | |
| UN-200-W-69 Unplanned Release | | | | | X | | | | | |
| UN-200-W-80 Unplanned Release | X | | | | X | | | | | |
| UN-200-W-81 Unplanned Release | | | | | X | | | | | |
| UN-200-W-82 Unplanned Release | | | | | X | | | | | |
| UN-200-W-83 Unplanned Release | X | | | | X | | | | | |
| UN-200-W-108 Unplanned Release | | X | | | X | | | X | X | |
| UN-200-W-109 Unplanned Release | | X | | | X | | | X | | |
| UN-200-W-114 Unplanned Release | | | | | X | | | | | |
| UN-200-W-116 Unplanned Release | | | | | X | | | | | |
| UN-200-W-123 Unplanned Release | X | | | | X | | | | | |

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Table 8-6. Applicable Characterization Investigation Methods at S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Surface Radiation Survey | Subsurface Spectral Geophysics | Surface Geophysics | Soil Gas Survey | Surface Soil Sampling | Wipe Samples | Surface Water Sediment Sampling | Subsurface Soil Sampling | Perched Zone Monitoring Wells | Remarks |
|----------------------------------|--------------------------|--------------------------------|--------------------|-----------------|-----------------------|--------------|---------------------------------|--------------------------|-------------------------------|----------------------------|
| UN-200-W-127 Unplanned Release | X | X | | | X | | | X | | |
| UN-216-W-30 Unplanned Release | X | | | | X | | | | | |
| UPR-216-W-25 Radiation Emissions | X | | | | | X | | | | |
| UPR-200-W-13 Unplanned Release | | | | | | | | | | Same as 207-S |
| UPR-200-W-15 Unplanned | | | | | | | | | | Same as 207-S |
| UPR-200-W-20 Unplanned Release | X | X | | | X | | | X | | |
| UPR-200-W-36 Unplanned Release | | | | | | | | | | Same as 216-S-1 & -2 cribs |
| UPR-200-W-47 Unplanned Release | X | | | | X | | | X | | |
| UPR-200-W-51 Unplanned Release | X | | | | X | | | | | |
| UPR-200-W-57 Unplanned Release | X | | | | X | X | | | | |
| UPR-200-W-59 Unplanned Release | X | | | | X | | | | | No further investigation |
| UPR-200-W-87 Unplanned Release | | | | | X | | | | | |
| UPR-200-W-95 Unplanned Release | | | | | | | | | | Same as 216-S-207 |
| UPR-200-W-96 Unplanned Release | | | | | X | | | X | | |
| UPR-200-W-124 Unplanned Release | X | X | | | X | | | X | | |
| UPR-200-W-139 Unplanned Release | X | | | | | | | X | | |
| UPR-200-W-140 Unplanned Release | | X | | | | | | X | | |
| UPR-200-W-141 Unplanned Release | | X | | | | | | X | | |

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Table 8-6. Applicable Characterization Investigation Methods at S Plant Aggregate Area Waste Management Units.

| Waste Management Unit | Surface Radiation Survey | Subsurface Spectral Geophysics | Surface Geophysics | Soil Gas Survey | Surface Soil Sampling | Wipe Samples | Surface Water Sediment Sampling | Subsurface Soil Sampling | Perched Zone Monitoring Wells | Remarks |
|---------------------------------|--------------------------|--------------------------------|--------------------|-----------------|-----------------------|--------------|---------------------------------|--------------------------|-------------------------------|---------|
| UPR-200-W-142 Unplanned Release | | X | | | | | | X | | |
| UPR-200-W-143 Unplanned Release | | X | | | | | | X | | |
| UPR-200-W-144 Unplanned Release | | X | | | | | | X | | |
| UPR-200-W-145 Unplanned Release | | X | | | | | | X | | |
| UPR-200-W-146 Unplanned Release | | X | | | | | | X | | |

X = Investigation at each individual site.

A = Investigation at representative of several analogous sites.

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9.0 RECOMMENDATIONS

1
2
3
4 The purpose of the Aggregate Area Management Study Report (AAMSR) is to compile
5 and evaluate the existing body of knowledge to support the *Hanford Past Practice Strategy*
6 (Thompson 1991) decision making process. A primary task in achieving this purpose is to
7 assess each waste management unit and unplanned release within the S Plant Aggregate Area
8 to determine the most expeditious path for remediation within the statutory requirements of
9 Comprehensive Environmental Response, Compensation, and Liability Act (CERLA) and
10 Resource Conservation Recovery Act (RCRA). The existing body of pertinent knowledge
11 regarding S Plant Aggregate Area waste management units and unplanned releases has been
12 summarized and evaluated in the previous sections of this study. A data evaluation process
13 has been established that uses the existing data to develop preliminary recommendations on
14 the appropriate remediation path for each site. This data evaluation process is a refinement of
15 the *Hanford Past Practice Strategy* (Figure 1-2) and establishes criteria for selecting
16 appropriate *Hanford Past Practice Strategy* paths (expedited response action [ERA]; interim
17 remedial measures [IRM]; limited field investigation [LFI]; and final remedy selection) for
18 individual waste management units and unplanned releases within the 200 Areas. A
19 discussion of the criteria for path selection and the results of the data evaluation process are
20 provided in Sections 9.1. and 9.2, respectively. Figure 9-1 provides a flowchart of the data
21 evaluation process that will be discussed. Table 9-1 provides a summary of the results of the
22 data evaluation assessment of each unit. Table 9-2 provides the results of the decisional
23 matrix each unit followed.

24
25 This section presents recommended assessment paths for the waste management units
26 and unplanned releases at the S Plant Aggregate Area. These recommendations are only
27 proposed at this time and are subject to adjustment and change. Factors that may affect
28 development of final recommendations include, but are not limited to, comments and advice
29 from the U.S. Environmental Protection Agency (EPA), Washington State Department of
30 Ecology (Ecology), or U.S. Department of Energy (DOE); identification and development of
31 new information; and modification of the criteria used in the assessment path decision-making
32 process. Changes in recommendations will be addressed, and more detail on recommended
33 assessment paths for waste management units and unplanned releases will be included in
34 work plans as they are developed for the actual investigation and remediation activities.

35
36 A majority of waste management units and unplanned releases do not have information
37 regarding the nature and extent of contamination necessary for quantitative or qualitative risk
38 assessment, especially with regard to hazardous constituents, and were recommended for
39 additional investigation (e.g., LFI). Several units and releases assessed within the ERA path
40 were recommended for actions that fall within the scope of existing operational programs.
41 Wooden cribs with collapse potential and sites with elevated levels of surface radionuclide
42 contamination are addressed by the Radiation Area Remedial Action (RARA) Program.
43

1 Waste management units and unplanned releases which are addressed entirely by other
2 programs were not subjected to the data evaluation process. This includes units and
3 unplanned release which are within the scope of the Single-Shell Tank Program, Surplus
4 Facilities Program, and Defense Waste Management Program.
5

6 A majority of facilities addressed included in the data evaluation fall within the scope of
7 the Single-Shell Tank Program. The activities associated with closure of the 200-RO-4
8 Operable Unit single-shell tank sites have separate *Hanford Federal Facility Agreement and*
9 *Consent Order* (Tri-Party Agreement) milestones and any recommendations for disposition of
10 these units and associated unplanned released will be developed as part of the ongoing
11 program addressing the single-shell tanks. The Defense Waste Management Program will
12 completely address the active 216-S-25 and -26 Cribs, and the active 207-SL Retention Basin.
13

14 A discussion of the four decision-making paths shown in Figure 9-1: ERA, IRM, LFI,
15 and final remedy selection, is provided in Section 9.1. Section 9.2 provides a discussion of
16 the waste management units grouped under each of these paths. A discussion of regrouping
17 and prioritization of the waste management units is provided in Section 9.3.
18 Recommendations for redefining operable unit boundaries and prioritizing operable units for
19 work plan development are also provided in Section 9.3. No additional aggregate area-based
20 field characterization activities are recommended to be undertaken as a continuation of the
21 AAMS. All recommendations for future characterization needs (see Section 8.0) will be more
22 fully developed and implemented through the remedial investigation/feasibility study (RI/FS)
23 RCRA facility investigation/corrective measures study (RFI/CMS) work plans. Sections 9.4
24 and 9.5 provide recommendations for focused feasibility and treatability studies, respectively.
25
26

27 9.1 DECISION MAKING CRITERIA

28
29 The criteria used for assessing the most expeditious remediation process path are based
30 primarily on urgency for action and whether site data are adequate to proceed along a given
31 path (Figure 9-1). All units and unplanned releases that are not completely addressed under
32 other Hanford Site programs are assessed in the data evaluation process. All of the units and
33 releases that are addressed in the data evaluation process are initially evaluated as candidates
34 for an ERA. Sites where a release has occurred or is imminent are considered candidates for
35 ERAs. Conditions that might trigger an ERA are the determination of an unacceptable health
36 or environmental risk or a short time frame available to mitigate the problem (Thompson
37 1991). As a result, candidate ERA units were evaluated against a set of criteria to determine
38 whether potential for exposure to unacceptable health or environmental risks exists. Units
39 and unplanned releases that are recommended for ERAs will undergo a formal evaluation
40 following the selection process outlined in WHC (1991b).
41

42 Waste management units and unplanned releases that are not recommended for an ERA
43 continue through the data evaluation process. Sites continuing through the process that
44 potentially pose a high risk (refer to Section 5.0), become candidates for an IRM. The
45 criteria used to determine a potential for high risk, thereby indicating a high priority site, were
46 the Hazard Ranking System (HRS) score used for nominating waste management units for

1 CERCLA cleanup (40 CFR 300), the modified Hazard Ranking System (mHRS) scores,
2 surface radiation survey data, and rankings by the Environmental Protection Program
3 (Huckfeldt 1991b). Units and unplanned releases with HRS or mHRS scores greater than
4 28.5 (the CERCLA cleanup criterion) were designated as candidate IRM sites. Units and
5 unplanned releases that did not have a HRS score were compared to similar sites to establish
6 an estimated HRS score. Sites with surface contamination greater than 2 mR/h exposure rate,
7 100 c/min beta/gamma above background or alpha greater than 20 c/min were also designated
8 as candidate IRM sites. In addition, surface contamination sites which had an Environmental
9 Protection Program ranking of greater than 7 were also designated as candidate IRM sites.
10 The candidate IRM sites are listed in Table 5-1, which summarizes the high priority sites.
11 Candidate IRM sites were then further evaluated to determine if an IRM is appropriate for the
12 site. Candidate IRM sites that did not meet the IRM criteria were placed into the final
13 remedy selection path.
14

15 For certain units and unplanned releases, it was recognized that remedial actions could
16 be undertaken under an existing operational or other Hanford Site program (e.g., Single-Shell
17 Tank, RARA, or Surplus Facility Programs). As a result, recommendations were made that
18 remedial actions be undertaken (partially or completely) outside the 200 AAMS past practice
19 program. Units or unplanned releases that could be addressed only in part by another
20 program (e.g., surface contamination cleanup under the RARA Program) remained in the
21 200 AAMS data evaluation process for further consideration. If it cannot be demonstrated
22 that these sites will be addressed under the operational program within a time frame
23 compatible with the past practice program, they will be readdressed by the 200 AAMS
24 process.

25 Units and unplanned releases recommended for complete disposition under another
26 program (e.g., single-shell tanks and associated structures under the Single-Shell Tank
27 program) were not considered in the 200 AAMS data evaluation process.
28

29
30 Specific criteria used to develop initial recommendations for ERAs, LFIs, and IRMs for
31 units and unplanned releases within the S Plant Aggregate Area are provided in Sections 9.1.1
32 and 9.1.2. Units and unplanned releases not initially addressed under an ERA, LFI or IRM
33 will be evaluated under the final remedy selection path discussed in Section 9.1.3.
34
35

36 9.1.1 Expedited Response Action Pathway 37

38 Candidate ERA sites are evaluated to determine if they pose an unacceptable health or
39 environmental risk and if there exists a short time frame to mitigate the problem. All units
40 and unplanned releases other than those recommended for complete disposition under another
41 Hanford program are assessed against the ERA criteria. The *Hanford Past-Practice Strategy*
42 describes conditions that might trigger abatement actions for candidate waste management
43 unit or unplanned release under an ERA. Generally, these conditions would rely on a
44 determination of, or suspected, existing or future unacceptable health or environmental risk,
45 and a short time-frame available to mitigate the problem. Conditions include, but are not
46 limited to:

- 1 • Actual or potential exposure to nearby human populations, biota, or the food chain
2 from hazardous substances and radioactive or mixed waste contaminants
- 3
- 4 • Actual or potential contamination of drinking water supplies or sensitive
5 ecosystems
- 6
- 7 • Threats of release of hazardous substances and radioactive or mixed waste
8 contaminants
- 9
- 10 • High levels of hazardous substances and radioactive or mixed waste contaminants
11 in soils that pose or may pose a threat to human health or the environment, or
12 have the potential for migration
- 13
- 14 • Weather conditions that may increase the potential for release or migration of
15 hazardous substances and radioactive or mixed waste contaminants
- 16
- 17 • The availability of other appropriate federal or state response mechanisms to
18 respond to the release
- 19
- 20 • Time required to develop and implement a final remedy.
- 21
- 22 • Further degradation of the medium which may occur if a response action is not
23 expeditiously initiated
- 24
- 25 • Risks of fire or explosion or potential for exposure as a result of an accident or
26 failure of a container or handling system
- 27
- 28 • Other situations or factors that may pose threats to human health or welfare or the
29 environment.
- 30

31 These conditions were used as the initial screening criteria to identify candidate waste
32 management units and unplanned releases for ERAs. Candidate waste management units and
33 releases that did not meet these conditions were not assessed through the ERA evaluation
34 path. Additional criteria for further, detailed screening of ERA candidates were developed
35 based on the conditions outlined in the *Hanford Past-Practice Strategy*. Qualification of these
36 criteria for further screening were developed. These screening criteria are shown in
37 Figure 9-1 and are described below.

38
39 The next criterion used to assess each ERA candidate is whether a driving force to an
40 exposure pathway exists or is likely to exist. Units or unplanned releases with contamination
41 that is migrating or is likely to significantly migrate to a medium that can result in exposure
42 and harm to humans required additional assessment under the ERA process. Units or
43 unplanned releases where contamination could migrate and, therefore, potentially require
44 significantly more extensive remedial action if left unabated were also assessed in the ERA
45 path.

1 Waste management units and unplanned releases with a driving force were assessed to
2 determine if unacceptable health or environmental risk and a short time frame is available to
3 mitigate the problem exists from the release. The criteria used to determine unacceptability
4 are based on the quantity and concentration of the release. If the release or imminent release
5 is greater than 100 times the CERCLA reportable quantity for any constituent, the unit or
6 unplanned release remains in consideration for an ERA. If the release or imminent release
7 contains hazardous constituents at concentrations that are 100 times the most applicable
8 standard, the unit or unplanned release continues to be considered for an ERA. In some
9 cases, engineering judgment was used to estimate the quantity and concentration of a
10 postulated release. Standards applied include Model Toxics Control Act standards for
11 industrial sites and DOE and Westinghouse Hanford radiation criteria (refer to Section 6.0).
12 The application of these standards does not signify they are recognized as applicable or
13 relevant and appropriate requirements (ARARs).
14

15 If a release is unacceptable with respect to health or environmental risk, a technology
16 must be readily available to control the release for a unit or unplanned release to be
17 considered for an ERA. An example that would require substantial technology development
18 before implementation of cleanup would be a tritium release since no established treatment
19 technology is available to separate low concentrations of tritium from water.
20

21 The next step in the ERA evaluation path involves determining whether implementation
22 of the available technology would have adverse consequences that would offset the benefits of
23 an ERA. Examples of adverse consequences include: 1) use of technologies that result in
24 risks to cleanup personnel that are much greater than the risks of the release; 2) the ERA
25 would foreclose future remedial actions; and 3) the ERA would prevent or greatly hinder
26 future data collection activities. If adverse consequences are not expected, the site remains in
27 consideration for an ERA.
28

29 The final criterion is to determine if the candidate ERA is within the scope of an
30 operational program. Maintenance and operation of active waste management facilities are
31 within the scope of activities administered by the Defense Waste Management Program.
32 Active facilities include the 216-S-25 and 216-S-26 Cribs and the 207-SL Retention Basin.
33 Generally, active facilities will not be included in past practice investigations unless operation
34 is discontinued prior to initiation of the investigation. The Surplus Facilities and RCRA
35 Closures programs are responsible for safe and cost-effective surveillance, maintenance, and
36 decommissioning of surplus facilities and RCRA closures at the Hanford Site. The Surplus
37 Facilities Program is also responsible for RARA activities that include surveillance,
38 maintenance, decontamination, and/or stabilization of inactive burial grounds, cribs, ponds,
39 trenches, and unplanned release sites.
40

41 If the proposed ERA will not address all the contamination present, the unit or
42 unplanned release continues through the process to be evaluated under a second path. For
43 example, surface contamination cleanup under the RARA Program may not address
44 subsurface contamination and, therefore, additional investigation may be needed.
45

1 Final decision regarding whether ERAs are justified in the aggregate area will be made
2 between DOE, EPA, and Ecology based, at least in part, on the recommendations provided in
3 this section, results of the final selection process outlined in WHC (1991b), and availability of
4 resources.
5
6

7 **9.1.2 Limited Field Investigation and Interim Remedial Measure Paths**

8

9 High priority waste management units and unplanned release sites were evaluated to
10 determine if sufficient need and information exists such that an IRM could be pursued. An
11 IRM is desired for high priority units and unplanned releases where extensive characterization
12 is not necessary to reach defensible cleanup decisions. Implementation of IRMs at waste
13 management units and unplanned releases with minimal characterization is expected to rely on
14 observational data acquired during remedial activities. Successful execution of this strategy is
15 expected to reduce both time and cost for cleanup of units and unplanned releases without
16 impacting the effectiveness of the implemented action.
17

18 The initial step in the IRM evaluation path is to categorize the units. The exposure
19 pathways of interest are similar for each site in a category; therefore, it is effective to
20 evaluate candidate units as a group. The groupings used in Section 2.3 (e.g., cribs; tanks and
21 vaults; etc.) will continue to be used to group the units for IRM assessment. This grouping
22 approach is especially effective in reducing characterization requirements. As is being done
23 in the 100 Area using the observational approach, the LFIs can be used to characterize a
24 representative unit or units in detail to develop a remedial alternative for the group of units.
25 Observational data obtained during implementation of the remedial alternative could be used
26 to meet unit specific needs.
27

28 Data adequacy is assessed in the next step. The existing data are evaluated to
29 determine if: 1) existing data were sufficient to develop a conceptual model and qualitative
30 risk assessment; 2) the IRM will work for this pathway; 3) implementing the IRM will have
31 adverse impacts on the environment, future remediation activities or data collection efforts;
32 4) the benefits of implementing the IRM are greater than the costs. If data are not adequate
33 an assessment was made to determine if an LFI might provide enough data to perform an
34 IRM. If an LFI would not collect sufficient data to perform an IRM, the unit was addressed
35 in the final remedy selection path.
36

37 The final step in the IRM evaluation process is to assess if the IRM will work without
38 significant adverse consequences. This includes: will the IRM be successful? will it create
39 significant adverse environmental impacts (e.g., environmental releases)? will the costs
40 outweigh the benefits? will it preclude future cleanup or data collection efforts? and will the
41 risks of the cleanup be greater than the risks of no action? Units where remediation is
42 considered to be possible without adverse consequences outweighing benefits of the
43 remediation are recommended for IRMs.
44

1 Final decisions will be made between DOE, EPA, and Ecology on whether particular
2 IRMs are justified. These decisions will be based at least in part, on the recommendation
3 provided in this AAMSR, results of a supporting LFI, and availability of resources.
4

6 9.1.3 Final Remedy Selection Path

7
8 Sites recommended for initial consideration in the final remedy selection path are those
9 not recommended for IRMs, LFIs, or ERAs, and those considered to be low priority sites. It
10 is recognized that all units and unplanned releases within the operable unit or aggregate area
11 will eventually be addressed collectively under the final remedy path to support a final
12 Record of Decision.
13

14 The initial step in the final remedy selection process path is to assess whether the
15 combined data from the AAMS, and any completed ERAs, IRMs, and LFIs are adequate for
16 performing a risk assessment and selecting a final remedy. Whereas the scope of an ERA,
17 IRM, and LFI is limited to individual waste management units or groups of similar waste
18 management units, the final remedy selection path will likely address an entire operable unit
19 or aggregate area.
20

21 If the data are collectively sufficient, an operable unit or aggregate area risk assessment
22 will be performed. If sufficient data are not available, additional needs will be identified and
23 collected.
24

26 9.2 PATH RECOMMENDATIONS

27
28 Initial recommendations for ERA, IRM, and LFI are discussed in Sections 9.2.1 through
29 9.2.3, respectively. Waste management units and unplanned releases proposed for initial
30 consideration under the final remedy selection path are discussed in Section 9.2.4. Table 9-1
31 provides a summary of the data evaluation process path assessment. A summary of the
32 responses to the decision points on the flowchart that led to the recommendations is provided
33 in Table 9-2. Following approval by DOE, EPA, and Ecology, these recommendations will
34 be further developed and implemented in work plans.
35
36

37 9.2.1 Proposed Sites for Expedited Response Actions

38
39 Thirteen waste management units meet all the criteria for an ERA prior to determining
40 whether the proposed action was within the scope of an operational program. None of the
41 candidate units were recommended for an ERA. All 13 candidate ERA units (cribs with
42 collapse potential and surface contamination sites) were recommended for disposition under
43 the RARA program. A discussion of the recommendations for these waste management units
44 are included in this section. Since the anticipated response actions are not expected to fully
45 remediate the ERA sites, all units will be included for further data evaluation in the
46 assessment paths.

1 **9.2.1.1 Cribs With Collapse Potential.** Two of the older cribs are open wooden structures
2 that could collapse and potentially expose workers. A sudden collapse could bring
3 contaminated dust from the buried crib to the surface. Based on crib inventory data, dust
4 derived from the bottom of the cribs would be expected to contain radionuclides at several
5 orders of magnitude above reportable quantities and quality standards. Cribs 216-S-7 and
6 216-S-20 both have potential collapse problems.

7
8 Maintenance and contamination control measures for cribs with collapse potential are
9 implemented under the RARA program. Therefore, actions to mitigate environmental releases
10 from these facilities will be performed under the RARA program. An engineering study is
11 planned under the RARA program for 1993 to evaluate the potential for crib collapse.

12
13 Response actions such as the addition of clean fill material over the cribs or pressure
14 grouting void areas within the crib to prevent collapse may be considered for these waste
15 management units. Evaluation and recommendation of response actions for these facilities
16 will be performed under the RARA program.

17
18 **9.2.1.2 Sites With Significant Surface Contamination.** There are 11 unplanned releases
19 with levels of surface contamination that are high enough to be of immediate concern.
20 Surface contamination is immediately accessible to humans (i.e., workers) and biota. The
21 potential for transport by the wind or biota is also significant and so surface migration is also
22 a problem. It is expected that the releases of radionuclides and potential radiation exposure
23 levels at these sites would be greater than 100 times reportable quantities and quality
24 standards. The corrective action for surface contamination sites is addressed within the scope
25 of the RARA program.

26
27 The following unplanned release sites have had surface contamination in excess of
28 standards. Surface contamination control activities are recommended for evaluation and
29 implementation under the RARA program. Investigation as a part of the aggregate area RI is
30 recommended following RARA action to confirm waste management unit cleanup.

- 31
32 • UN-200-W-32 had 7,000 to 30,000 d/min beta present.
33
34 • UN-200-W-34 had a maximum dose rate of 1 R/hr at the ground surface.
35
36 • UN-200-W-69 had a maximum 100,000 c/min reading on the surface.
37
38 • UN-200-W-80 has had surface contamination of ⁹⁰Sr and ¹³⁷Cs with readings to
39 60,000 c/min (WHC 1991a).
40
41 • UN-200-W-81 has had surface contamination of unknown beta/gamma to over
42 100,000 c/min (WHC 1991a).
43
44 • UN-200-W-109 had surface contamination of 200 to 6,000 c/min during October
45 1990 (WHC 1991a).
46

- 1 • UN-200-W-114 had general surface contamination from 200 to 450 c/min with
2 specks of contamination up to 4 mR/h in October 1990 (WHC 1991a).
3
- 4 • UN-200-W-116 had surface contamination at 200 c/min with isolated specks to
5 2 mR/h in October 1990.
6
- 7 • UN-216-W-25 has surface contamination from 2,000 to 40,000 c/min beta.
8
- 9 • UN-216-W-30 has surface contamination of 3,500 c/min beta.
10
- 11 • UPR-200-W-96 had surface contamination of 200 to 3,000 c/min during October
12 1990 (WHC 1991a).
13

14 **9.2.1.3 Non-ERA Sites.** The primary reason most waste management units and unplanned
15 releases were not recommended for ERAs was because of the lack of driving force to an
16 exposure pathway. Inactive cribs, ponds, ditches, and trenches are no longer receiving waste
17 and, therefore, no longer have artificial recharge as a driving force to move subsurface
18 contaminants. Natural recharge from local precipitation was not considered a significant
19 short-term driving force. Specifics for each waste management unit or unplanned release are
20 provided in Table 9-2.
21

22 **9.2.2 Proposed Sites for Interim Remedial Measures**

23
24
25 Thirty-four of the 78 waste management units addressed in the S Plant Aggregate Area
26 data evaluation process were identified as high priority units (refer to Section 5.0) and were
27 assessed as candidates for IRMs. Ten of the 25 units were designated as high priority
28 because of high HRS and mHRS scores. The remaining units were designated as high
29 priority because of surface radiation measurements and/or because of qualitative "high" scores
30 based on their discharge history of large quantities of hazardous materials, that potentially
31 could have been transported to the groundwater. The Environmental Protection rankings did
32 not add to the high priority sites because they had been included on the list because of the
33 other criteria. Septic tanks and drain fields and unplanned releases were two primary classes
34 of units not considered in the IRM path.
35

36 All of the 34 candidate IRM units met the criteria for IRM designation, with the
37 exception of having adequate data. It was determined that an LFI could gather sufficient data
38 for 22 of the 34 units; therefore, 12 units remain IRM candidates. A discussion of the LFIs is
39 provided in Section 9.2.3.
40

41 **9.2.3 Proposed Sites for Limited Field Investigation Activities**

42
43
44 Twenty-two waste management units are recommended to undergo LFIs. The rationale
45 for IRM and LFI will be more completely developed in work plans; however, the following
46 addresses possible considerations during work plan development.

Possible LFI objectives would be to:

- Evaluate the potential for releases from the waste management unit to impact underlying groundwater quality.
- Determine if contamination exists in the soil beneath the waste management unit, and if so, assess the extent.
- Assess the nature and extent of contaminant migration from the waste management unit in support of focused feasibility studies.

Candidate IRM units have been categorized into two groups that contain similar release waste, release mechanisms, and design. The groups are cribs and drains, and ditches and ponds.

9.2.3.1 Cribs and Drains. Cribs with collapse potential have been recommended for actions under the RARA Program (see Section 9.2.1.2.1). The actions implemented under the RARA Program will precede the LFI activities. Cribs with collapse potential are:

- 216-S-7 Crib
- 216-S-20 Crib.

Cribs to be involved in LFI activities that do not require actions under the RARA program (cribs without collapse potential) include:

- 216-S-1 and -2 Cribs
- 216-S-5 Crib
- 216-S-6 Crib
- 216-S-9 Crib
- 216-S-13 Crib
- 216-S-22 Crib
- 216-S-23 Crib
- 216-S-25 (active)
- 216-S-26 (active).

The cribs and french drain were high priority units with the exception of the 216-S-13, -22, and -23 Cribs, which do not have high HRS numbers. However, the waste types and disposal

1 methods for these low priority sites are similar enough to other high priority sites to justify
2 their inclusion in this path. The two active cribs will be included in investigation activities if
3 they are deactivated prior to preparation of investigation plans.
4

5 French drains are essentially small diameter cribs and are therefore categorized with
6 cribs. The one unit of this type is:

- 7 • 216-S-3 French Drain.

8
9
10 The cribs with collapse potential were addressed in the IRM path after first being
11 assessed by the ERM path. The actions recommended for these units will not address the
12 subsurface contaminations in the facilities; therefore, they were included for assessment under
13 the remaining criteria.
14

15 The initial decision point in the IRM path is to assess whether data are adequate to
16 conduct an IRM. The data available for cribs are screening level data and estimated
17 inventories which do not provide information on the nature and extent of the contamination.
18 Therefore, an IRM could not be implemented without further investigation.
19

20 Similarities of units may make it possible to remediate them using the observational
21 approach after characterizing only a few of the units. Therefore, it was expected that a LFI
22 would provide sufficient information to proceed with an IRM for waste management unit
23 groups. Therefore, the basis for recommending a LFI is that sufficient information can be
24 gained from a more detailed investigation of one or two of the cribs and a french drain that
25 would allow a remedial decision to be made on the other cribs with little or no additional
26 characterization.
27

28 Possible representative cribs for the S Plant Aggregate Area would be the combined
29 216-S-1 and 216-S-2 Cribs, the 216-S-9 Crib, and the 216-S-3 French Drain. The 216-S-1
30 and 216-S-2 Cribs were selected to represent cribs receiving waste during initial operations.
31 The 216-S-9 Crib was selected to be representative of cribs receiving waste from more recent
32 operations, and because it has the highest inventory of contaminants. The 216-S-3 French
33 Drain was selected because it is the only french drain in the S Plant Aggregate Area. The
34 rationale for IRM and LFI will be more completely developed in work plans.
35

36 **9.2.3.2 Ditches and Ponds.** The waste management units in this system consist of the
37 following:

- 38 • 216-S-10D Ditch (RCRA)
- 39 • 216-S-10P Pond (RCRA)
- 40 • 216-S-11 Pond
- 41 • 216-S-15 Pond

- 1 • 216-S-16D Ditch
- 2
- 3 • 216-S-16P Pond
- 4
- 5 • 216-S-17 Pond
- 6
- 7 • 216-S-19 Pond
- 8
- 9 • 216-U-9 Ditch.

10
11 These waste management units are high priority units, with the exception of the 216-
12 S-15 and 216-S-19 Ponds, and have been designated as IRM candidates. The 216-S-15 and
13 216-S-19 Ponds are low priority units, but they are similar enough to the other units to justify
14 their inclusion in this path. All these units have insufficient data to conduct an IRM and,
15 therefore, have been recommended for additional characterization. The vast area of the ponds
16 and ditches does not require an exhaustive characterization effort because contaminant profiles
17 are expected to be similar along the ditches and throughout the pond area. Therefore, a LFI
18 was recommended to characterize a limited number of areas of the ponds and ditches. The
19 information gained from the LFI is expected to provide sufficient information to continue
20 with an IRM if it is determined to be justified.

21
22 **9.2.3.3 Control Structures.** The waste management units in this group are:

- 23 • 2904-S-160 Control Structure
- 24
- 25 • 2904-S-170 Control Structure
- 26
- 27
- 28 • 2904-S-171 Control Structure.

29
30 These units are high priority subsurface structures. They have insufficient data to
31 conduct an IRM and, therefore, have been recommended for additional characterization.
32 Because contaminant profiles are expected to be similar for these three units, an LFI was
33 recommended to characterize one of them. The information gained from the LFI is expected
34 to provide sufficient information to continue with an IRM if it is determined to be justified.

35 36 37 **9.2.4 Proposed Sites for Final Remedy Selection**

38
39 A number of unplanned releases, along with several diverse waste management units
40 which are unique because of design, contaminants received, or operational history, have been
41 proposed for the final remedy selection path. Section 9.2.4.2 discusses the sites proposed for
42 direct inclusion in the final remedy selection risk assessment. Direct inclusion in the final
43 remedy selection RI is recommended for the remainder of the waste management units and
44 unplanned releases due to the lack of information to perform risk assessments and select final
45 remedies. These waste management units and unplanned releases are discussed in Section
46 9.2.4.1.

1 **9.2.4.1 Proposed Sites for Remedial Investigation.** An RI has been recommended for the
2 S Plant Aggregate Area which includes several groups of waste management units and
3 unplanned releases. The first group consists of generally low priority disposal trenches which
4 were in use for a short period of time and received relatively small volumes of waste. The
5 second group contains septic tanks and the sanitary crib which require confirmatory sampling
6 to show that the sites do not contain hazardous or radioactive substances. The third group
7 contains a retention basin which was assessed in the IRM path had insufficient data to
8 conduct an IRM. The fourth group consists of burial grounds which were assessed in the
9 IRM path but had insufficient data to conduct an IRM. The fifth group consists of low
10 priority unplanned releases which have unique contamination histories.

11
12 **9.2.4.1.1 Trenches.** Four trenches have been grouped as a single class because of their
13 similarity. These trenches are basically excavations which were opened for a short duration
14 of time and then filled in. The trenches include:

- 15
16 • 216-S-8 Trench
17
18 • 216-S-12 Trench
19
20 • 216-S-14 Trench
21
22 • 216-S-18 Trench.

23
24 They are generally low priority units which were assessed in the final remedy selection
25 path only. The 216-S-8 Trench is a high priority unit, which was assessed in the IRM path;
26 however, there was not sufficient data to proceed with an IRM. The 216-S-8 Trench is the
27 only one of its kind and was included in this path. All the units are unique in the types of
28 waste received. Most of them were in use for a short period of time and received relatively
29 small volumes of waste.

30
31 The units were grouped and risk assessment possibilities were examined. No data exists
32 to determine the nature and extent of contamination at these sites. Therefore, a RI which
33 includes each unit was recommended to provide data adequate to perform a risk assessment
34 and select a final remedy for the units. The unique nature of the units will not allow for
35 investigation of a representative unit and applying the information to the other sites.

36
37 **9.2.4.1.2 Septic Tanks and Sanitary Cribs.** Confirmatory investigation levels should
38 be performed at the following waste management units: the 2607-W6 Septic Tank, the 2607-
39 WZ Septic Tanks, and the Sanitary Crib. These units have low HRS scores.

40
41 There are no sampling or inventory data for any of the sites and so a risk assessment
42 (RA) cannot be performed. The purpose of a limited sampling program is to confirm that no
43 contamination exists in the tanks and drain fields. If no contamination were to be found, than
44 no further action would likely be recommended.
45

1 **9.2.4.1.3 Basins.** The 207-S Retention Basin is a high priority unit which has been
2 assessed in the IRM path. Sufficient data does not exist to proceed with the IRM, and no
3 similar unit exists. This unit was recommended for inclusion in the aggregate area RI to
4 provide data adequate to perform a risk assessment and select a final remedy.
5

6 **9.2.4.1.4 Burial Sites.** The 218-W-7 and the 218-W-9 Burial Grounds are high priority
7 units that have been assessed in the IRM path. Sufficient data does not exist to proceed with
8 the IRMs, and no similar units exist. These units received unique wastes, and cannot be
9 grouped together for an LFI. The 218-W-7 Burial Ground is steel caisson, and received dry
10 laboratory wastes from the 222-S Laboratory from 1952 to 1960. The 218-W-9 Burial
11 Ground was an excavation which received scrap metal during September 1954. Therefore,
12 inclusion in the aggregate area RI was recommended for each waste management unit to
13 provide data adequate to perform a risk assessment and select a final remedy.
14

15 **9.2.4.1.5 Unplanned Releases.** Thirty-nine unplanned releases with known
16 contamination are candidates for inclusion in an aggregate area or operable unit RI. Eleven
17 of these sites are recommended to undergo surface radiation cleanup under the RARA
18 program before RI initiation. These sites are:
19

| | | |
|----|---------------------|---------------------|
| 20 | UN-200-W-10 | UN-200-W-116 (RARA) |
| 21 | UN-200-W-30 | UN-200-W-123 |
| 22 | UN-200-W-32 (RARA) | UN-200-W-127 |
| 23 | UN-200-W-34 (RARA) | UN-216-W-25 (RARA) |
| 24 | UN-200-W-35 | UN-216-W-30 (RARA) |
| 25 | UN-200-W-42 | UPR-200-W-13 |
| 26 | UN-200-W-43 | UPR-200-W-15 |
| 27 | UN-200-W-49 | UPR-200-W-20 |
| 28 | UN-200-W-50 | UPR-200-W-36 |
| 29 | UN-200-W-52 | UPR-200-W-47 |
| 30 | UN-200-W-56 | UPR-200-W-51 |
| 31 | UN-200-W-61 | UPR-200-W-57 (RARA) |
| 32 | UN-200-W-69 (RARA) | UPR-200-W-59 |
| 33 | UN-200-W-80 (RARA) | UPR-200-W-87 |
| 34 | UN-200-W-81 | UPR-200-W-95 |
| 35 | UN-200-W-82 | UPR-200-W-96 (RARA) |
| 36 | UN-200-W-83 | UPR-200-W-124 |
| 37 | UN-200-W-108 | UPR-200-W-139 |
| 38 | UN-200-W-109 (RARA) | UPR-200-W-140 |
| 39 | UN-200-W-114 (RARA) | |

40
41 Confirmatory sampling is recommended for these unplanned releases, including all those
42 which will first be addressed by the RARA program. The majority of unplanned releases
43 have low HRS scores; or are described as having been cleaned up or released as radiation
44 zones as contamination decayed to background levels, and are therefore assumed to have low
45 HRS scores. These sites do not have any data to support a risk assessment. Confirmatory
46 sampling is recommended for these unplanned releases to provide enough data to confirm that

1 contamination does not exist at these locations, and to perform a risk assessment. If no
2 contamination is found, no further action would likely be recommended.
3

4 **9.2.4.2 Proposed Sites for Risk Assessment.** One candidate has sufficient information for
5 inclusion in the final RA under the final remedy selection path. The candidate, Unplanned
6 Release UN-200-W-41, occurred during transit of a contaminated piece of equipment across
7 the aggregate area. There is no specific geographic area identified as contaminated and no
8 contamination has been attributed to this release.
9

10 It is recommended that this unplanned release be included in the final RA without
11 additional investigation. It is likely that no further action will be required for this release.
12

13 **9.3 SOURCE OPERABLE UNIT REDEFINITION AND PRIORITIZATION**

14
15 The investigation process can be made more efficient if units with similar histories and
16 waste constituents are studied together. The data needs and remedial actions required for
17 similar waste management units are generally the same. It is much easier to ensure a
18 consistent level of effort and investigation methodology if like units are grouped together.
19 Economies of scale also make the investigation process more cost effective if similar units are
20 studied together.
21
22

23 **9.3.1 Units Addressed by Other Aggregate Areas or Programs**

24
25 The investigation of at least one site should be transferred from the S Plant Aggregate
26 Area to the U Plant Aggregate Area. Although the 216-U-9 Ditch is physically within the
27 S Plant Aggregate Area, the ditch was used to transfer overflow from the 216-U-10 Pond
28 which received waste from the facilities within U Plant Aggregate Area. Transfer of this unit
29 to the U Plant Aggregate Area would allow it to be investigated with other units having
30 similar waste characteristics.
31
32

33 Recommendations were not developed for units that will be completely addressed by
34 other operational programs including the single- and double-shell tank programs (and the
35 auxiliary units supporting tank farm operations such as diversion boxes, catch tanks, and
36 transfer lines) and the Hanford Surplus Facilities Program. In addition, recommendations
37 were not developed for units that will be completely addressed by RCRA. Recommendations
38 were developed for RARA units that will be only partially remediated by the program (for
39 example, recommendations need to be developed for the remaining contaminant at a crib
40 stabilized under the RARA program). There are no previously identified ERAs within the
41 S Plant operable units.
42

43 The following waste management units within the 200-RO-4 Operable Unit are
44 addressed by the Single-Shelled Tank Closure program: the 241-S-151 Diversion Box; the
45 241-S-A, -B, -C, and -D, 241-SX-A and -B, and the 241-SY-A and -B Valve Pits; the 240-S-
46 302, 241-S-302B, and 241-SX-302 Catch Tanks; and the UPR-200-W-140, -141, -142, -143,

1 -144, -145, and -146 Unplanned Releases are being addressed by the Single-Shell Tank
2 Program because these units are logically associated with the 241-S or 241-SX Tank Farm
3 operations.
4

5 Deactivation of active liquid effluent units should remain within the existing Defense
6 Waste Management Program. The active facilities include the 216-S-25 Crib, 216-S-26 Crib
7 and 207-SL Retention Basin. Investigation of these facilities will be deferred until after
8 deactivation.
9

10 11 9.3.2 S Plant Operable Unit Redefinition

12
13 Redefinition of the 200-RO-1, -2, -3, and -4 Operable Units are suggested based on the
14 data evaluation in this report. In general, it is recommended that:

- 15 • Investigation of groundwater should be removed from the scope of S Plant
16 Operable Units and included under a 200 West Groundwater Operable Unit as
17 defined by the 200 West Groundwater AAMS.
18
- 19 • High-level waste transfer facilities and pipelines should be removed from the work
20 scope because they are within the Defense Waste Management and Surplus
21 Facilities Programs.
22

23
24 The 200-RO-1 Operable Unit boundary should be redefined to include the 216-S-4
25 French Drain and the 216-S-21 Crib. These units are currently part of the 200-UP-1 Operable
26 Unit of the U Plant Aggregate Area.
27

28 29 9.3.3 Investigation Prioritization

30
31 Very little if any data exist to rank the waste management units and unplanned releases
32 within the S Plant Aggregate Area on a risk-related basis. The HRS and surface
33 contamination data which were used to sort the waste management units and unplanned
34 releases into either high or low priority are indicators of potential risk but are not suitable to
35 develop a risk-related ranking. The most useful data for indicating potential risk are probably
36 the waste inventories and facility construction or operation information.
37

38 Based on inventories of contaminants, the cribs and french drain received the largest
39 quantities of contamination and should be investigated first. The S Pond system received the
40 next largest quantity of contamination and should be evaluated second. Based on this
41 ranking, the 200-RO-2 Operable Unit should be investigated prior to the 200-RO-1 Operable
42 Unit, which should be investigated prior to the 200-RO-3 Operable Unit. The 200-RO-4
43 Operable Unit will be dispositioned under the Single-Shell Tank Program. Unit-specific
44 priorities will be developed in subsequent work plans.
45
46

1 **9.3.4 RCRA Facility Interface**
2

3 Section 2.6 identifies 46 RCRA waste management units that exist within the S Plant
4 Aggregate Area. Of these, three units have entered interim status and will require final
5 permitting or closure, as specified in the *Tri-Party Agreement*.
6

7 The 276-S-141 and 276-S-142 Hexon Storage and Treatment Closure Plan will be
8 submitted to Ecology and EPA by November 1992. These units are not addressed under this
9 study because they are currently in the process of clean closure under the RCRA program.
10 The 276-S-141 and 276-S-142 Hexone Storage Tanks received radioactive mixed waste with
11 organic solvents. The units will be clean closed under interim status. As part of closure, the
12 waste was transferred from the storage tanks and stored in railcar storage tanks. The waste is
13 being shipped to an off-site incineration facility. The railcar tanks will be decontaminated
14 after removal of the wastes. Closure of the units will be verified by soil chemical analysis or
15 by a radiation survey.
16

17 The 216-S-10P Pond and the 216-S-10D Ditch are RCRA waste management units
18 which will require integration into future investigations. Both units have been
19 decommissioned, and may require characterization for closure under RCRA. The data for
20 characterization will be developed in an LFI, in conjunction with other ponds and ditches (see
21 Section 9.2.3.2). The closure plan for the 216-S-10P Pond and the 216-S-10D Ditch is
22 scheduled for submission to Ecology and EPA by May 1996.
23

24 In addition to the three units discussed above, Section 2.6 identifies other RCRA waste
25 management units that exist within the S Plant Aggregate Area but that are not addressed by
26 the *Tri-Party Agreement*. The 222-S Complex includes three of these units: the 219-S Waste
27 Handling Facility, the 222-S Dangerous and Mixed Waste Facility, and the 222-S Analytical
28 Laboratory. The 219-S Waste Handling Facility and the 222-S Dangerous and Mixed Waste
29 Facility will be permitted for the treatment and/or storage of dangerous and mixed waste
30 under the Washington state Department of Ecology "Dangerous Waste Regulations,"
31 Washington Administrative Code (WAC) 173-303-806. The planned activities for closing
32 these units are included in the 222-S Laboratory Complex Dangerous Waste Part B Permit
33 Application. The 222-S Complex units are to be clean closed when the laboratory is no
34 longer needed; therefore, a postclosure plan will not be prepared.
35

36 The 2727-S Nonradioactive Dangerous Waste Storage Facility has been designated as a
37 RCRA facility. This unit is located in the southeast portion of the 200 West Area and
38 provides container storage for nonradioactive dangerous wastes generated in the research and
39 development laboratories, process operations, and maintenance and transportation function
40 throughout the Hanford Site. A clean closure plan for this unit was submitted to Ecology and
41 EPA in January 1992.
42

43 The RCRA units associated with the 241-S and 241-SX Tank Farms including 27 tanks,
44 the 240-S-152, 241-S-152, 241-SX-151, and 241-SX-152 Diversion Boxes, and the 241-S-
45 302A Catch Tank were not assessed under this study because these units will be completely
46 addressed by the RCRA single-shell tank farm closure programs. These units belong to a

1 separate program with separate Tri-Party Agreement milestones. Recommendations were not
2 developed for the 241-S-151 Diversion Box; the 241-S-A, -B, -C, and -D, and the 241-SX-A
3 and -B Valve Pits; and the 241-S-302B and 241-SX-302 Catch Tanks because these units are
4 logically associated with the tank farm operations and should be included in the RCRA tank
5 farm closure programs.
6

7 The RCRA units associated with the 241-SY Tank Farm including three tanks, the
8 244-S Double Contained Receiver Tank, and the 241-SY-A and 241-SY-B Valve Pits were
9 not assessed under this study because these units are part of the permitted RCRA facility.
10

11 12 **9.4 FEASIBILITY STUDY**

13
14 Two types of the FS will be conducted to support remediation in the 200 Area including
15 focused and the final FS. Focused feasibility studies are studies in which a limited number of
16 units or remedial alternatives are considered. Final FS will be prepared to provide the data
17 necessary to support the preparation of final record of decision. Insufficient data exists to
18 prepare either a focused or final FS for any units or group of units within the S Plant
19 Aggregate Area. Sufficient data are considered available to prepare a focused feasibility
20 study on selected remedial alternatives.
21

22 23 **9.4.1 Focused Feasibility Study**

24
25 Both LFI's and IRMs are planned for the S Plant Aggregate Area for individual waste
26 management units or waste management unit groups. The IRMs will be implemented as they
27 are approved, and the focused feasibility study will be prepared to support their
28 implementation. The focused feasibility study applied in this manner is intended to examine
29 a limited number of alternatives for a specific site or groups of sites. The focused feasibility
30 study supporting IRMs will be based on the technology screening process applied in
31 Section 7.0, engineering judgment, and/or new characterization data such as that generated by
32 an LFI.
33

34 Recommendations for the focused feasibility study in support of IRMs are not provided
35 in this report because of limited data availability. In most cases, LFIs will be conducted at
36 sites initially identified for IRMs. The information gathered is considered necessary prior to
37 making a final determination whether an IRM is actually necessary or whether a remedy can
38 be selected.
39

40 Rather than being driven by an IRM, the focused feasibility study will also be prepared
41 to evaluate select remedial alternatives. In this case the focused feasibility study focuses on
42 technologies or alternatives that are considered to be viable based on their implementability,
43 cost, and effectiveness and have broad application to a variety of sites. The following
44 recommendations are made for FS that focus on a particular technology or alternative:
45

- 46 • Capping

- 1 • Ex situ treatment of contaminated soils
- 2
- 3 • In situ stabilization.
- 4

5 These recommendations reflect select technologies developed in Section 7.0 of this report.

6
7 The focused feasibility study is intended to provide a detailed analysis of select
8 remedial alternatives. The results of the detailed analysis provide the basis for identifying
9 preferred alternatives. The detailed analysis for alternatives consists of the following
10 components:

- 11
- 12 • Further definition of each alternative, if appropriate, with respect to the volumes
13 or areas of contaminated environmental media to be addressed, the technologies to
14 be used, and any performance requirements associated with those technologies.
15 Remedial investigations and treatability studies, if conducted, will also be used to
16 further define applicable alternatives.
- 17
- 18 • An assessment and summary of each alternative against evaluation criteria
19 specified in EPA's *Guidance for Conducting Remedial Investigations and*
20 *Feasibility Studies under CERCLA* (EPA 1988b).
- 21
- 22 • A comparative analysis of the alternatives that will facilitate the selection of a
23 remedial action.
- 24
- 25

26 9.4.2 Final Feasibility Study

27
28 To complete the remediation process for an aggregate area, a final or summary FS will
29 be prepared. This study will address those sites not previously evaluated and will summarize
30 the results of preceding evaluations. The overall study and evaluation process for an
31 aggregate area will consist of a number of focused feasibility studies, field investigations, and
32 interim Record of Decision (RODs). All of this study information will be summarized in one
33 final FS to provide the data necessary for the final ROD. The summary FS will likely be
34 conducted on an aggregate area basis; however, future considerations may indicate that a
35 larger scope is appropriate.

36 37 38 9.5 TREATABILITY STUDIES

39
40 A range of technologies which are likely to be considered for remediation of sites
41 within the S Plant Aggregate Area were discussed in Section 7.3. The range of technologies
42 included:

- 43
- 44 • Engineered multimedia cover
- 45
- 46 • In situ grouting

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- 1 • Excavation and soil treatment
- 2
- 3 • In situ vitrification
- 4
- 5 • Excavation, treatment, and disposal of transuranic (TRU) radionuclides
- 6
- 7 • In situ soil vapor extraction of volatile organic compounds(VOCs).
- 8

9 Treatability testing will be required to conduct a detailed analysis for most of the
10 technologies. Relevant EPA guidance will be relied upon to conduct these future treatability
11 studies. A summary of treatability testing needs outlined in Section 7.3 is as follows:

- 12
- 13 • Engineered multimedia cover -- performance testing (pilot-scale testing) of
14 conceptual designs is needed.
- 15
- 16 • In situ grouting -- testing required to optimize injection properties of grout and
17 verify effectiveness in stabilizing contaminants.
- 18
- 19 • Excavation and soil treatment -- testing of dust control measures, soil treatment
20 reagents, and contacting methods will be required. Some limited soil washing
21 bench scale studies have been initiated.
- 22
- 23 • In situ vitrification -- testing required to verify contaminant stabilization
24 effectiveness and to establish operating parameters. Some vitrification pilot
25 testing is ongoing.
- 26
- 27 • Excavation, treatment, and disposal of TRU radionuclides -- testing to evaluate
28 dust control measures and stabilization or vitrification effectiveness and to
29 establish operating parameters is required.
- 30
- 31 • In situ soil vapor extraction of VOCs -- extraction effectiveness needs to be
32 verified and operating parameters require development. A program is currently
33 under way for field testing of vapor extraction techniques.
- 34

35 As treatability testing of the various alternatives progresses, other parameters are likely
36 to be identified which require further development.

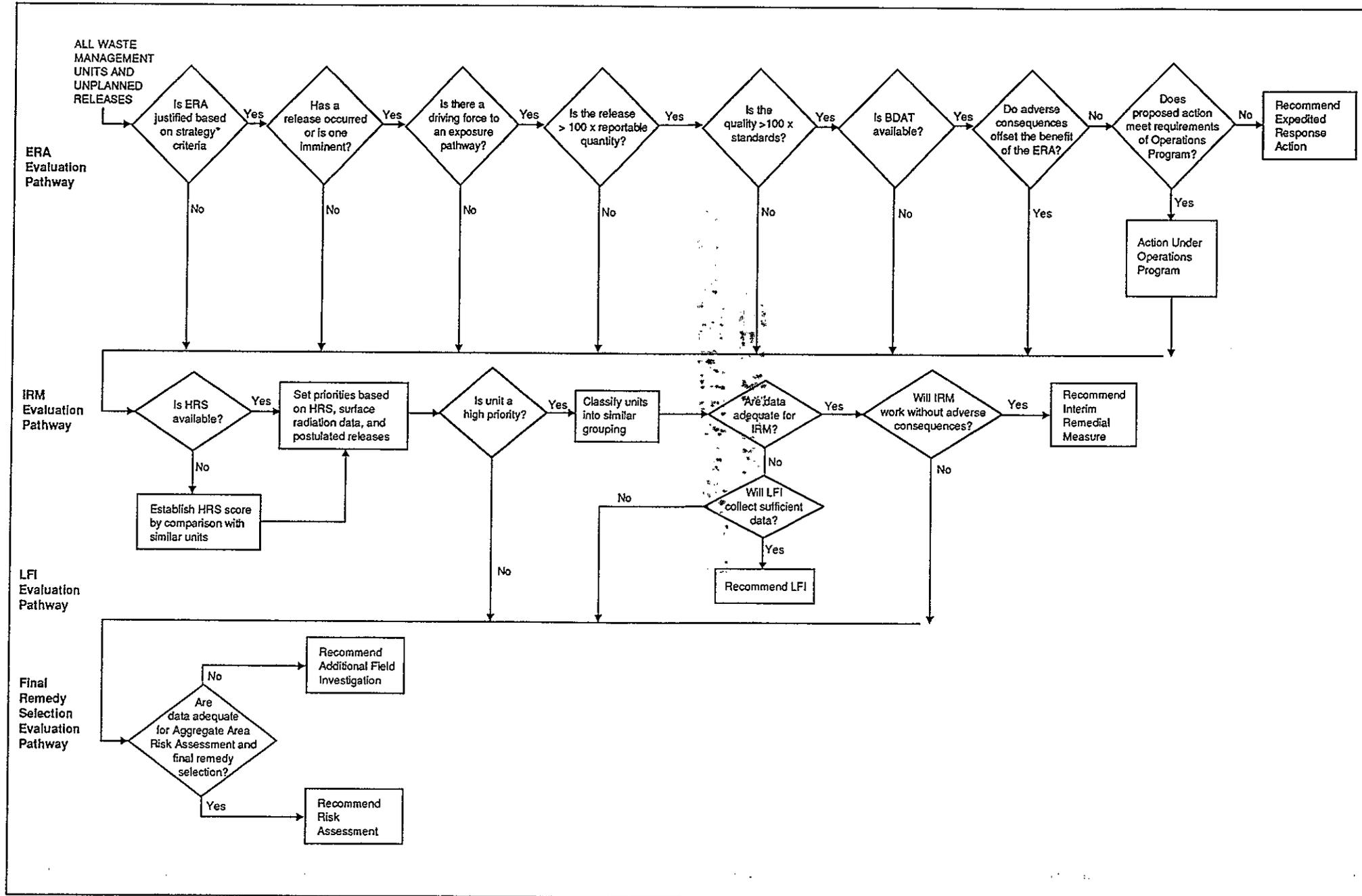


Figure 9-1. 200 Aggregate Area Management Study Data Evaluation Process.

9 3 1 2 0 5 1 3 0 2

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Table 9-1. Summary of the Results of Remediation Process Path Assessment.

| Waste Management Unit Name or Unplanned Release Site | Recommended Actions | | | | | | REMARKS |
|---|---------------------|-----|-----|----|----|-----|------------------------|
| | ERA | IRM | LFI | RA | RI | OPS | |
| Cribs and Drains | | | | | | | |
| 216-S-1 & -2 Crib/UPR | | X | X | | | | |
| 216-S-5 Crib | | X | X | | | | |
| 216-S-6 Crib | | X | X | | | | |
| 216-S-7 Crib | | X | X | | | X | RARA-Cave-in Potential |
| 216-S-9 Crib | | X | X | | | | |
| 216-S-13 Crib | | X | X | | | | |
| 216-S-20 Crib | | X | X | | | X | RARA-Cave-in Potential |
| 216-S-22 Crib | | X | X | | | | |
| 216-S-23 Crib | | X | X | | | | |
| 216-S-3 French Drain | | X | X | | | | |
| Ponds, Ditches, and Trenches | | | | | | | |
| 216-S-10P Pond | | X | X | | | X | RCRA |
| 216-S-11 Pond | | X | X | | | | |
| 216-S-15 Pond | | X | X | | | | |
| 216-S-16P Pond | | X | X | | | | |
| 216-S-17 Pond | | X | X | | | | |
| 216-S-19 Pond | | X | X | | | | |

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Table 9-1. Summary of the Results of Remediation Process Path Assessment.

| Waste Management Unit Name or Unplanned Release Site | Recommended Actions | | | | | | REMARKS |
|--|---------------------|-----|-----|----|----|-----|---------|
| | ERA | IRM | LFI | RA | RI | OPS | |
| 216-S-10D Ditch | | X | X | | | X | RCRA |
| 216-S-16D Ditch | | X | X | | | | |
| 216-U-9 Ditch | | X | X | | | | |
| 216-S-8 Trench | | | | | X | | |
| 216-S-12 Trench | | | | | X | | |
| 216-S-14 Trench | | | | | X | | |
| 216-S-18 Trench | | | | | X | | |
| Septic Tanks and Associated Drain Fields | | | | | | | |
| 2607-W6 Septic Tank | | | | | X | | |
| 2607-WZ Septic Tank | | | | | X | | |
| Sanitary Crib | | | | | X | | |
| Transfer Facilities, Diversion Boxes, and Pipelines | | | | | | | |
| 2904-S-160 Control Structure | X | X | | | | | |
| 2904-S-170 Control Structure | X | X | | | | | |
| 2904-S-172 Control Structure | X | X | | | | | |
| Basins | | | | | | | |
| 207-S Retention Basin | | | | | X | | |

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Table 9-1. Summary of the Results of Remediation Process Path Assessment.

| Waste Management Unit Name or Unplanned Release Site | Recommended Actions | | | | | | |
|---|---------------------|-----|-----|----|----|-----|----------------------------|
| | ERA | IRM | LFI | RA | RI | OPS | REMARKS |
| Burial Sites | | | | | | | |
| 218-W-7 Burial Ground | | | | | X | | |
| 218-W-9 Burial Ground | | | | | X | | |
| Unplanned Releases | | | | | | | |
| UN-200-W-10 Unplanned Release | | | | | X | | |
| UN-200-W-30 Unplanned Release | | | | | X | | |
| UN-200-W-32 Unplanned Release | | | | | X | | |
| UN-200-W-34 Unplanned Release | | | | | X | X | RARA Surface Contamination |
| UN-200-W-35 Unplanned Release | | | | | X | | |
| UN-200-W-41 Unplanned Release | | | | X | | | |
| UN-200-W-42 Unplanned Release | | | | | X | | |
| UN-200-W-43 Unplanned Release | | | | | X | | |
| UN-200-W-49 Unplanned Release | | | | | X | | |
| UN-200-W-50 Unplanned Release | | | | | X | | |
| UN-200-W-52 Unplanned Release | | | | | X | | |
| UN-200-W-56 Unplanned Release | | | | | X | | |
| UN-200-W-61 Unplanned Release | | | | | X | | |
| UN-200-W-69 Unplanned Release | | | | | X | X | RARA Surface Contamination |

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Table 9-1. Summary of the Results of Remediation Process Path Assessment.

| Waste Management Unit Name or Unplanned Release Site | Recommended Actions | | | | | | REMARKS |
|---|---------------------|-----|-----|----|----|-----|----------------------------|
| | ERA | IRM | LFI | RA | RI | OPS | |
| UN-200-W-80 Unplanned Release | | | | | X | X | RARA Surface Contamination |
| UN-200-W-81 Unplanned Release | | | | | X | X | RARA Surface Contamination |
| UN-200-W-82 Unplanned Release | | | | | X | | |
| UN-200-W-83 Unplanned Release | | | | | X | | |
| UN-200-W-108 Unplanned Release | | | | | X | | |
| UN-200-W-109 Unplanned Release | | | | | X | X | RARA Surface Contamination |
| UN-200-W-114 Unplanned Release | | | | | X | X | RARA Surface Contamination |
| UN-200-W-116 Unplanned Release | | | | | X | X | RARA Surface Contamination |
| UN-200-W-123 Unplanned Release | | | | | X | | |
| UN-200-W-127 Unplanned Release | | | | | X | | |
| UN-216-W-25 Unplanned Release | | | | | X | X | RARA Surface Contamination |
| UN-216-W-30 Unplanned Release | | | | | X | X | RARA Surface Contamination |
| UPR-200-W-13 Unplanned Release | | | | | X | | |
| UPR-200-W-15 Unplanned Release | | | | | X | | |
| UPR-200-W-20 Unplanned Release | | | | | X | | |
| UPR-200-W-36 Unplanned Release | | | | | X | | |
| UPR-200-W-47 Unplanned Release | | | | | X | | |
| UPR-200-W-51 Unplanned Release | | | | | X | | |

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Table 9-1. Summary of the Results of Remediation Process Path Assessment.

| Waste Management Unit Name or Unplanned Release Site | Recommended Actions | | | | | | REMARKS |
|---|---------------------|-----|-----|----|----|-----|----------------------------|
| | ERA | IRM | LFI | RA | RI | OPS | |
| UPR-200-W-57 Unplanned Release | | | | | X | | |
| UPR-200-W-59 Unplanned Release | | | | | X | | |
| UPR-200-W-87 Unplanned Release | | | | | X | | |
| UPR-200-W-95 Unplanned Release | | | | | X | | |
| UPR-200-W-96 Unplanned Release | | | | | X | X | RARA Surface Contamination |
| UPR-200-W-124 Unplanned Release | | | | | X | | |
| UPR-200-W-139 Unplanned Release | | | | | X | | |
| UPR-200-W-140 Unplanned Release | | | | | X | | |
| UPR-200-W-141 Unplanned Release | | | | | X | | |
| UPR-200-W-142 Unplanned Release | | | | | X | | |
| UPR-200-W-143 Unplanned Release | | | | | X | | |
| UPR-200-W-144 Unplanned Release | | | | | X | | |
| UPR-200-W-145 Unplanned Release | | | | | X | | |
| UPR-200-W-146 Unplanned Release | | | | | X | | |

Key:

- ERA = Expedited Response Action
- RI = Remedial Investigation/Feasibility Study
(RCRA Facility Investigation/Corrective Measures Study)
- LFI = Limited Field Investigation
- RA = Risk Assessment

- IRM = Interim Remedial Measure
- OPS = Operational Programs
- RARA = Radiation Area Reduction Action Program
- RCRA = Resource Conservation and Recovery Act Program

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Table 9-2. S Plant Aggregate Area Data Evaluation Decision Matrix.

| Waste Management Unit | ERA Evaluation Path | | | | | | | | IRM Evaluation Path | | | LPI Path | Final Remedy |
|-------------------------------------|----------------------|----------|----------|-----------|----------------|-----------------------|-----------------------|-----------------------|---------------------|----------------|-----------------------|--------------|---------------|
| | Is an ERA Justified? | Release? | Pathway? | Quantity? | Concentration? | Technology Available? | Adverse Consequences? | Operational Programs? | High Priority? | Data Adequate? | Adverse Consequences? | Collect Data | Data Adequate |
| Cribs and Drains | | | | | | | | | | | | | |
| 216-S-1 & -2, Crib | N | N | - | - | - | - | - | - | Y | N | - | Y | - |
| 216-S-5, Crib | N | N | - | - | - | - | - | - | Y | N | - | Y | - |
| 216-S-6, Crib | N | N | - | - | - | - | - | - | Y | N | - | Y | - |
| 216-S-72, Crib | N | Y | Y | Y | Y | Y | N | Y | Y | N | - | Y | - |
| 216-S-9, Crib | N | N | - | - | - | - | - | - | Y | N | - | Y | - |
| 216-S-13, Crib | N | N | - | - | - | - | - | - | N | - | - | Y | - |
| 216-S-20, Crib | Y | Y | Y | Y | Y | Y | N | Y | Y | N | - | Y | - |
| 216-S-22, Crib | N | N | - | - | - | - | - | - | N | - | - | Y | - |
| 216-S-23, Crib | N | N | - | - | - | - | - | - | N | - | - | Y | - |
| 216-S-25, Crib | N | N | - | - | - | - | - | Y | Y | - | - | Y | - |
| 216-S-26, Crib | N | N | - | - | - | - | - | Y | Y | - | - | Y | - |
| 216-S-3, French Drain | N | N | - | - | - | - | - | - | Y | N | - | Y | - |
| Ponds, Ditches, and Trenches | | | | | | | | | | | | | |
| 216-S-10P, Pond | N | N | - | - | - | - | - | - | Y | N | - | Y | - |
| 216-S-11, Pond | N | N | - | - | - | - | - | - | Y | N | - | Y | - |
| 216-S-15, Pond | N | N | - | - | - | - | - | - | N | - | - | Y | - |
| 216-S-16P, Pond | N | N | - | - | - | - | - | - | Y | N | - | Y | - |
| 216-S-17, Pond | N | N | - | - | - | - | - | - | Y | N | - | Y | - |
| 216-S-19, Pond | N | N | - | - | - | - | - | - | N | - | - | Y | - |
| 216-S-10D, Ditch | N | N | - | - | - | - | - | - | Y | N | - | Y | - |
| 216-S-16D, Ditch | N | N | - | - | - | - | - | - | Y | N | - | Y | - |

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Table 9-2. S Plant Aggregate Area Data Evaluation Decision Matrix. Page 2 of 5

| Waste Management Unit | ERA Evaluation Path | | | | | | IRM Evaluation Path | | | | LFI Path | Final Remedy | |
|--|----------------------|----------|------------|-----------|----------------|-----------------------|-----------------------|-----------------------|----------------|----------------|----------|--------------|-----------------------|
| | Is an ERA Justified? | Release? | Frequency? | Quantity? | Concentration? | Technology Available? | Adverse Consequences? | Operational Programs? | High Priority? | Data Adequate? | | | Adverse Consequences? |
| 216-U-9, Ditch | N | N | - | - | - | - | - | - | Y | N | - | Y | - |
| 216-S-8, Trench | N | N | - | - | - | - | - | - | Y | N | - | - | N |
| 216-S-12, Trench | N | N | - | - | - | - | - | - | N | - | - | - | N |
| 216-S-14, Trench | N | N | - | - | - | - | - | - | N | - | - | - | N |
| 216-S-18, Trench | N | N | - | - | - | - | - | - | N | - | - | - | N |
| Septic Tanks and Associated Drain Fields | | | | | | | | | | | | | |
| 2607-W6, Septic Tank | N | N | - | - | - | - | - | - | N | - | - | - | Y |
| 2607-WZ, Septic Tanks | N | N | - | - | - | - | - | - | N | - | - | - | Y |
| Sanitary Crb | N | N | - | - | - | - | - | - | N | - | - | - | Y |
| Transfer Facilities, Diversion Boxes, and Pipelines | | | | | | | | | | | | | |
| 216-S-172, Cont. Street | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 2904-S-160, Cont. Street | N | N | - | - | - | - | - | - | Y | N | - | Y | - |
| 2904-S-170, Cont. Street | N | N | - | - | - | - | - | - | Y | N | - | Y | - |
| 2904-S-171, Cont. Street | N | N | - | - | - | - | - | - | Y | N | - | Y | - |
| 240-S-151, Diversion Box | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 240-S-152, Diversion Box | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 241-S-151, Diversion Box | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 241-S-152, Diversion Box | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 241-SX-151, Diversion Box | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 241-SX-152, Diversion Box | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 241-S-A, Valve PR | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 241-S-B, Valve PR | - | - | - | - | - | - | - | - | - | - | - | - | - |

Table 9-2. S Plant Aggregate Area Data Evaluation Decision Matrix.

| Waste Management Unit | ERA Evaluation Path | | | | | | | | IRM Evaluation Path | | | LPI Path | Final Remedy |
|---------------------------|----------------------|----------|----------|-----------|----------------|-----------------------|-----------------------|-----------------------|---------------------|----------------|-----------------------|--------------|---------------|
| | Is an ERA Justified? | Release? | Pathway? | Quantity? | Concentration? | Technology Available? | Adverse Consequences? | Operational Programs? | High Priority? | Data Adequate? | Adverse Consequences? | Collect Data | Data Adequate |
| 241-S-C, Valve Pk | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 241-S-D, Valve Pk | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 241-SX-A, Valve Pk | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 241-SX-B, Valve Pk | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 241-SY-A, Valve Pk | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 241-SY-B, Valve Pk | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Basins | | | | | | | | | | | | | |
| 207-S, Retention Basin | N | N | - | - | - | - | - | - | Y | N | - | N | N |
| 207-SL, Retention Basin | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Burial Sites | | | | | | | | | | | | | |
| 218-W-7, Burial Ground | N | N | - | - | - | - | - | - | Y | N | - | N | N |
| 218-W-9, Burial Ground | N | N | - | - | - | - | - | - | Y | N | - | N | N |
| Unplanned Releases | | | | | | | | | | | | | |
| UN-200-W-10 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UN-200-W-30 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UN-200-W-32 | N | Y | Y | Y | Y | Y | N | Y | Y | N | - | N | N |
| UN-200-W-34 | N | Y | Y | Y | Y | Y | N | Y | Y | N | - | N | N |
| UN-200-W-35 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UN-200-W-41 | N | N | - | - | - | - | - | - | N | - | - | - | Y |
| UN-200-W-42 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UN-200-W-43 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UN-200-W-49 | N | N | - | - | - | - | - | - | N | - | - | - | N |

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Table 9-2. S Plant Aggregate Area Data Evaluation Decision Matrix.

| Waste Management Unit | ERA Evaluation Path | | | | | | | | IRM Evaluation Path | | | LFI Path | Final Remedy |
|------------------------|----------------------|----------|----------|-----------|----------------|-----------------------|-----------------------|-----------------------|---------------------|----------------|-----------------------|--------------|---------------|
| | Is an ERA Justified? | Release? | Pathway? | Quantity? | Concentration? | Technology Available? | Adverse Consequences? | Operational Programs? | High Priority? | Data Adequate? | Adverse Consequences? | Collect Data | Data Adequate |
| UN-200-W-50 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UN-200-W-52 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UN-200-W-56 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UN-200-W-61 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UN-200-W-69 | N | Y | Y | Y | Y | Y | N | Y | Y | N | - | N | N |
| UN-200-W-80 | N | Y | Y | Y | Y | Y | N | Y | Y | - | - | N | N |
| UN-200-W-81 | N | Y | Y | Y | Y | Y | N | Y | Y | N | - | N | N |
| UN-200-W-82 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UN-200-W-83 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UN-200-W-108 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UN-200-W-109 | N | Y | Y | Y | Y | Y | N | Y | Y | N | - | N | N |
| UN-200-W-114 | N | Y | Y | Y | Y | Y | N | Y | Y | N | - | N | N |
| UN-200-W-116 | N | Y | Y | Y | Y | Y | N | Y | Y | N | - | N | N |
| UN-200-W-123 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UN-200-W-127 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UN-216-W-25, Rad Emis. | N | Y | Y | Y | Y | Y | N | Y | Y | N | - | N | N |
| UN-216-W-30 | Y | Y | Y | Y | Y | Y | N | Y | Y | N | - | N | N |
| UPR-200-W-13 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UPR-200-W-15 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UPR-200-W-20 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UPR-200-W-36 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UPR-200-W-47 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UPR-200-W-51 | N | N | - | - | - | - | - | - | N | - | - | - | N |

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Table 9-2. S Plant Aggregate Area Data Evaluation Decision Matrix.

| Waste Management Unit | ERA Evaluation Path | | | | | | | | IRM Evaluation Path | | | LFI Path | Final Remedy |
|-----------------------|----------------------|----------|----------|-----------|----------------|-----------------------|-----------------------|-----------------------|---------------------|----------------|-----------------------|--------------|---------------|
| | Is an ERA Justified? | Release? | Pathway? | Quantity? | Concentration? | Technology Available? | Adverse Consequences? | Operational Programs? | High Priority? | Data Adequate? | Adverse Consequences? | Collect Data | Data Adequate |
| UPR-200-W-57 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UPR-200-W-59 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UPR-200-W-87 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UPR-200-W-95 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UPR-200-W-96, Spill | Y | Y | Y | Y | Y | Y | N | Y | Y | N | - | N | N |
| UPR-200-W-124 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UPR-200-W-139 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UPR-200-W-140 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UPR-200-W-141 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UPR-200-W-142 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UPR-200-W-143 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UPR-200-W-144 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UPR-200-W-145 | N | N | - | - | - | - | - | - | N | - | - | - | N |
| UPR-200-W-146 | N | N | - | - | - | - | - | - | N | - | - | - | N |

Y = Yes

N = No

- = Decision point not reached on pathway. Evaluation branched to lower path.

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10.0 REFERENCES

- 1
2
3
4 Anderson, J.D., 1990, *A History of the 200 Area Tank Farms*, Prepared for the U.S.
5 Department of Energy Office of Environmental Restoration and Waste Management,
6 WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.
7
8 ANSI/ASME, 1989, *Quality Assurance Program Requirements for Nuclear Facilities*,
9 ASME NQA-1-1989 Edition.
10
11 ASTM, 1985, *High-Resolution Gamma Ray Spectrometry of Water*, ASTM 0361-85, 1985
12 Merican Society for Testing and Material, Philadelphia, Pennsylvania.
13
14 Baker, S.M., J.L. Devary, R.P. Elmore, R.F. Lorang, A.J. Rossi, and M.D. Freshley, 1988,
15 *U1/U2 Uranium Plume Characterization, Remedial Action Review and Recommendation*
16 *for Future Action*, WHC-EP-0133, Westinghouse Hanford Company, Richland,
17 Washington.
18
19 Beard, S.J. and W. L. Godfrey, 1967, *Waste Disposal into the Ground at Hanford*. Presented
20 at the IAEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna,
21 Austria, May 19 - June 2, 1967.
22
23 Bjornstad, B.N., 1984, *Suprabasalt Stratigraphy Within and Adjacent to the Reference*
24 *Repository Location*, SD-BWI-DP-039, Rockwell Hanford Operations, Richland,
25 Washington.
26
27 Bjornstad, B.N., 1990, *Geohydrology of the 218-W-5 Burial Ground, 200-West Area, Hanford*
28 *Site*, PNL-7336, Pacific Northwest Laboratory, Richland, Washington, May 1990.
29
30 Bjornstad, B.N., K.R. Fecht, and A.M. Tallman, 1987, *Quaternary Stratigraphy of the Pasco*
31 *Basin Area, South-central Washington*, RHO-BW-SA-563A, Rockwell Hanford
32 Operations, Richland, Washington.
33
34 Borsheim, G. and N. Kirch, 1991, *Summary of Single-Shell Task Waste Stability*. Prepared
35 for the U.S. Department of Energy Office of Environmental Restoration and Waste
36 Management. WHC-EP-0347, Westinghouse Hanford Company, Richland, Washington.
37
38 Brownell, L.E., J.G. Backer, R.E. Isaacson, D.J. Brown, 1975, *Soil Moisture Transport in*
39 *Arid Site Vadose Zones*, Prepared for the U.S. Energy Research and Development
40 Administration under Contract E(45-1)-2130, Atlantic Richfield Hanford Company, July
41 1975.
42

- 1 Chamness, M.A., S.S. Teel, A.W. Pearson, K.R.O. Barton, R.W. Fruland, and R.E. Lewis,
2 1991, *S Plant Geologic and Geophysics Data Package for the 200 Aggregate Area*
3 *Management Study*, WHC-SD-EN-DP-019, Westinghouse Hanford Company, Richland,
4 Washington.
- 5
6 Deford, D., 1991, *200-UP Operable Unit Technical Baseline Report*, WHC-EP-0400, Prepared
7 for the U.S. Department of Energy, Office of Environmental Resotration and Waste
8 Management, Westinghouse Hanford Company, Richland, Washington.
- 9
10 Delaney, C.D., K.A. Lindsey, and S.P. Reidel, 1991, *Geology and Hydrology of the Hanford*
11 *Site: A Standardized Text for use in Westinghouse Hanford Company Documents and*
12 *Report*. WHC-SD-ER-TI-003, Rev. 0, Westinghouse Hanford Company, Richland,
13 Washington.
- 14
15 DOE (United States Department of Energy), 1987, *Final Environmental Impact Statement,*
16 *Disposal of Hanford Defense Transuranic and Tank Wastes*, DOE/EIS-0113.
- 17
18 DOE, 1988, *Consultation Draft Site Characterization Plan*, DOE/RW-0164, Vols. 1-9,
19 Office of Civilian Radioactive Waste Management, U.S. Department of Energy,
20 Washington, D.C.
- 21
22 DOE/EML, 1990, *Procedures Manual 27th Edition*, Volume 1, U.S. Deparatmt of Energy
23 Environmental Measurements Laboratory, HASL-300-Ed.27, New York, New York.
- 24
25 DOE/RL, 1983, *Quality Assurance*, DOE/RL Order 5700.1A, U.S. Department of Energy
26 Richland Operations Office, Richland, Washington.
- 27
28 DOE/RL, 1988, *Preliminary Assessment/Site Inspection Activities on Inactive Waste Sites at*
29 *Hanford*, Draft, Richland, Washington.
- 30
31 DOE/RL, 1991, *Hanford Site Baseline Risk Assessment Methodology*. DOE/RL-91-45, dated
32 September 1991.
- 33
34 DOE/RL, 1992, *Hanford Site Waste Management Units Report*, DOE/RL-88-30, Department
35 of Energy, Richland, Washington.
- 36
37 Ecology, EPA, and DOE, 1989, *Community Relations Plan for the Hanford Federal Facility*
38 *Agreement and Consent Order*, Benton County, Washington, August 1989.
- 39
40 Ecology, EPA, and DOE, 1990, *Hanford Federal Facility Agreement and Consent Order*
41 *(First Amendment)*, 89-10 Rev. 1, Olympia, Washington, October 1989.
- 42

- 1 Ecology, EPA, and DOE/RL, 1991, *Hanford Federal Facility Agreement and Consent Order*
2 *Change Packages*, Washington State Department of Ecology, Olympia, Washington, U.S.
3 Environmental Protection Agency, Region X, Seattle, Washington, and U.S. Department of
4 Energy, Richland Operations Office, Richland, Washington, May 16, 1991.
5
- 6 Elder, R.E., A.W. Conklin, D.D. Brekke, G.W. Egert, and W.L. Osborne, 1986, *Rockwell*
7 *Hanford Operations Environmental Surveillance Annual Report, Calendar Year 1985*,
8 Prepared for the U.S. Department of Energy under Contract DE-AC06-77RL01030,
9 RHO-HS-SR-85-13P, Rockwell Hanford Operations, Richland, Washington.
10
- 11 Elder, R.E., A.W. Conklin, D.D. Brekke, G.W. Egert, and W.L. Osborne, 1987, *Rockwell*
12 *Hanford Operations Environmental Surveillance Annual Report, Calendar Year 1986*,
13 Prepared for the U.S. Department of Energy under Contract DE-AC06-77RL01030,
14 RHO-HS-SR-86-13P, Rockwell Hanford Operations, Richland, Washington.
15
- 16 Elder, R.E., G.W. Egert, A.R. Johnson, and W.L. Osborne, 1988, *Westinghouse Hanford*
17 *Company Environmental Surveillance Report - Calendar Year 1987*, WHC-EP-0145,
18 Westinghouse Hanford Company, Richland, Washington, April 1988.
19
- 20 Elder, R.E., S.M. McKinney, and W.L. Osborne, 1989, *Westinghouse Hanford Company*
21 *Environmental Surveillance Annual Report - 200/600 Areas. Calendar Year 1988*,
22 Prepared for the U.S. Department of Energy under Contract DE-AC06-87RL10930,
23 WHC-EP-0145-1, Westinghouse Hanford Company, Richland, Washington.
24
- 25 EPA (Environmental Protection Agency), 1980a, *Prescribed Procedures for Measurement of*
26 *Radioactivity in Drinking Water*, In-House Report #EPA-600/4-80-032, Environmental
27 Monitoring and Support Lab, Cincinnati, Ohio, August 1980.
28
- 29 EPA, 1980b, *Radionuclide Method for the Determination of Uranium in Soil and Air*, U.S.
30 EPA Environmental Monitoring and Support Laboratory, Las Vegas, Nevada,
31 EPA-600/7-80-019.
32
- 33 EPA, 1983, *Methods for Chemical Analysis of Water and Wastes*, U.S. Environmental
34 Protection Agency, EMSL, EPA-600/14-79-020.
35
- 36 EPA, 1984, *Eastern Environmental Radiation Facility Radiochemistry Procedures Manual*,
37 EPA-520/5-84-006, Montgomery, Alabama.
38
- 39 EPA, 1986, *Test Methods for Evaluating Solid Wastes, SW-846*, Third edition U.S.
40 Environmental Protection Agency/Office of Solid Waste and Emergency Response,
41 Washington, D.C.
42
- 43 EPA, 1987, *Data Quality Objectives for Remedial Response Activities — Development*
44 *Process*, EPA/540/G-87/003, OSWER Directive 9335.3-01, U.S. Environmental Protection
45 Agency, Washington D.C.

- 1 EPA, 1988a, *USEPA Contract Laboratory Program Statement of Work for Organic Analysis*,
2 Sample Management Office, U.S. Environmental Protection Agency, Washington D.C.
3
- 4 EPA, 1988b, *USEPA Guidance for Conducting Remedial Investigation and Feasibility Studies*
5 *Under CERCLA*.
6
- 7 EPA, 1989a, *USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis*,
8 Sample Management Office, U.S. Environmental Protection Agency, Washington D.C.
9
- 10 EPA, 1989b, *Risk Assessment Guidance for Superfund, Vol. I: Human Health Evaluation*
11 *Manual*, EPA/540/1-89/002, Office of Emergency and Remedial Response, U.S.
12 Environmental Protection Agency, Washington, D.C.
13
- 14 EPA, 1991, *Integrated Risk Information System (IRIS)*, Toxnet online database.
15
- 16 Fecht, K.R., S.P. Reidel, and A.M. Tallman, 1987, "Paleodrainage of the Columbia River
17 System on the Columbia Plateau of Washington State -- a Summary," in *Selected Papers*
18 *on the Geology of Washington*, Division of Geology and Earth Resources, Bulletin 77,
19 p. 219-248, edited by J.E. Schuster.
20
- 21 Gee, G.W. and P.R. Heller, 1985, *Unsaturated Water Flow at the Hanford Site: A Review of*
22 *Literature and Annotated Bibliography*, PNL-5428, Pacific Northwest Laboratory,
23 Richland, Washington.
24
- 25 Gee, G.W., 1987, *Recharge at the Hanford Site: Status Report*, PNL-6403, Pacific Northwest
26 Laboratory, Richland, Washington.
27
- 28 Goodwin, S.M. and B.N. Bjornstad, 1990, *200-East and 200-West Areas Low-Level Burial*
29 *Grounds Borehole Summary Report*, (WHC-MR-0204).
30
- 31 Graham, M.J., M.D. Hall, S.R. Strait, and W.R. Brown, 1981, Hydrology of the Separations
32 Area, RHO-ST-42, Rockwell Hanford Operations, Richland Washington.
33
- 34 Graham, M.J., G.V. Last, and K.R. Fecht, 1984, *An Assessment of Aquifer*
35 *Intercommunication in the B Pond-Gable Mountain Pond Area of the Hanford Site*,
36 RHO-RE-ST-12 P, Rockwell Hanford Operations, Richland, Washington.
37
- 38 Hanlon, B.M, 1991, *Tank Farm Surveillance and Waste Status Report - November 1991*.
39 WHC-EP-0182-42, Westinghouse Hanford Company, Richland, Washington.
40
- 41 Hillel, D., 1971, *Soil and Water, Physical Principles and Process*, Academic Press, Inc.
42 New York, New York.
43

- 1 Hoover, J.D., and T. LeGore, 1991, *Characterization and Use of Soil and Groundwater*
2 *Background for the Hanford Site*. Prepared for the U.S. Department of Energy Office of
3 Environmental Restoration and Waste Management. Westinghouse Hanford Company,
4 Richland, Washington.
5
- 6 Huckfeldt, C.R., 1991, *Quarterly Environmental Radiological Survey Summary-Third Quarter*
7 *1991 100, 200, 300, and 600 Areas*. Prepared for the U.S. Department of Energy
8 Assistant Secretary for Environment, Safety and Health, WHC-SP-0665-2. Westinghouse
9 Hanford Company, Richland, Washington.
10
- 11 Hughes, M.C., R.K. Wahlen, and R.A. Winship, 1990, *Hanford Surplus Facilities Program*
12 *Plan*. Prepared for the U.S. Department of Energy Assistant Secretary for Defense
13 Programs. WHC-EP-0231-3.
14
- 15 Kasza, G.L., S.F. Harris, M.J. Hartman, 1990, *Ground Water Maps of the Hanford Site*,
16 Westinghouse Hanford Company, WHC-EP-0394-1, December 1990.
17
- 18 Klem, M.J., 1990, *Inventory of Chemicals Used at Hanford Site Production Plants and*
19 *Support Operations (1944-1980)*. Prepared for the U.S. Department of Energy Assistant
20 Secretary for Defense Programs. WHC-EP-0172, Westinghouse Hanford Company,
21 Richland, Washington.
22
- 23 Klepper, E.L., K.A. Gano, and L.L. Cadwell, 1985, *Rooting Depth and Distributions of*
24 *Deep-Rooted Plants in the 200 Area Control Zone of the Hanford Site*, Prepared for the
25 U.S. Department of Energy under Contract DE-AC06-76RL01830, PNL-5247, Pacific
26 Northwest Laboratory, Richland, Washington.
27
- 28 Landen, D.S., A.R. Johnson, and R.M. Mitchell, 1991, *Status of Birds at the Hanford Site in*
29 *Southeastern Washington*, Prepared for the U.S. Department of Energy Office of
30 Environmental Restoration and Waste Management, WHC-EP-0402, Westinghouse
31 Hanford Company, Richland, Washington.
32
- 33 Last, G.V. et al., 1988, *Interim Characterization Report for the 200 Area Low-Level Burial*
34 *Ground Detection - Level Monitoring Project*. Prepared for the U.S. Department of
35 Energy under Contract DE-AC06-76RL01830. Pacific Northwest Laboratory, Richland,
36 Washington.
37
- 38 Last, G.V., B.N. Bjornstad, M.P. Bergeron, D.W. Wallace, D.R. Newcomer, J.A.
39 Schramke, M.A. Chamness, C.S. Cline, S.P. Airhart, and J.S. Wilbur, 1989, *Hydrogeology*
40 *of the 200 Areas Low-Level Burial Grounds - An Interim Report*, Westinghouse Hanford
41 Company, PNL-6820, January 1989.
42
- 43 Lindsey, K.A., and D.R. Gaylord, 1989, *Sedimentology and Stratigraphy of the*
44 *Miocene-Pliocene Ringold Formation, Hanford Site, South-Central Washington*,
45 WHC-SA-0740-FP, Westinghouse Hanford Company, Richland, Washington.

DOE/RL-91-60
Draft A

- 1 Lindsey, K.A., B.N. Bjornstad, and M.P. Connelly, 1991, *Geologic Setting of the 200 West*
2 *Area: An Update*, WHC-SD-EB-TI-008, Rev. 0, Westinghouse Hanford Company,
3 Richland, Washington.
4
- 5 Maxfield, H.L., 1979, *Handbook -- 200 Area Waste Sites*, RHO-CD-673, Rockwell
6 Hanford Operations, Richland, Washington.
7
- 8 McCain, R.G., and W.L. Johnson, 1990, *A Proposal Data Quality Strategy for Hanford Site*
9 *Characterization*, WHC-SD-EN-AP-023, Westinghouse Hanford Company, Richland,
10 Washington.
11
- 12 Meinhardt, C.C., J.C. Frostenson, 1979, *Current Status of 200 Area Ponds*, RHO-CD-798.
13
- 14 Myers, C.W., S.M. Price, and J.A. Caggiano, M.P. Cochran, W.J. Czimer, N.J. Davidson,
15 R.C. Edwards, K.R. Fecht, G.E. Holmes, M.G. Jones, J.R. Kunk, R.D. Landon, R.K.
16 Ledgerwood, J.T. Lillie, P.E. Long, T.H. Mitchell, E.H. Price, S.P. Reidel, and A.M.
17 Tallman, 1979, *Geological Studies of The Columbia Plateau: A Status Report*,
18 RHO-BWI-ST-4, Rockwell Hanford Operations, Richland, Washington.
19
- 20 Newcomb, R.C., 1958, *Ringold Formation of the Pleistocene Age in the Type Locality, the*
21 *White Bluffs, Washington*, American Journal of Science, Vol. 33, No. 1, p. 328-340.
22
- 23 PSPL (Puget Sound Power and Light Company), 1982, *Skagit/Hanford Nuclear Project,*
24 *Preliminary Safety Analysis Report*, Vol. 4, App. 20, Amendment 23, Puget Sound Power
25 and Light Company, Bellevue, Washington.
26
- 27 Reidel, S.P., and K.R. Fecht, 1981, "Wanapum and Saddle Mountains Basalt in the Cold
28 Creek Syncline Area" in *Subsurface Geology of the Gold Creek Syncline*,
29 RHO-BWI-ST-14, Rockwell Hanford Operations, Richland, Washington.
30
- 31 Reidel, S.P., 1984, "The Saddle Mountains: the Evolution of an Anticline in The Yakima Fold
32 Belt," *American Journal of Science*, Vol. 284, p. 942-978.
33
- 34 Reidel, S.P., K.R. Fecht, M.C. Hagood, and T.L. Tolan, 1989a, "The Geologic Evolution
35 of the Central Columbia Plateau," in *Volcanism and Tectonism in the Columbia River*
36 *Flood-Basalt Province*, Special Paper 239, edited by S.P. Reidel and P.R. Hooper,
37 Geological Society of America, Boulder, Colorado, p. 247-264.
38
- 39 Reidel, S.P., T.L. Tolan, P.R. Hooper, M.H. Beeson, K.R. Fecht, R.D. Bentley, J.L. Anderson,
40 1989b, "The Grande Ronde Basalt, Columbia River Basalt Group: Stratigraphic
41 Descriptions and Correlations in Washington, Oregon, and Idaho," in *Volcanism and*
42 *Tectonism in the Columbia River Flood-Basalt Province*, Special Paper 239, edited by S.P.
43 Reidel and P.R. Hooper, Geological Society of America, Boulder, Colorado, p. 21-53.
44

- 1 Reynolds, D.A. et al., 1991, *A Survey of Available Information on Gas Generation in Tank*
2 *241-SY-101*, PNL-7520, Pacific Northwest Laboratory, Richland, Washington.
- 3
4 Rockhold, M.L., M.J. Fayer, and G.W. Gee, 1988, *Characterization of Unsaturated Hydraulic*
5 *Conductivity at the Hanford Site*, Prepared for the U.S. Department of Energy, Pacific
6 Northwest Laboratory, PNL-6488, Richland, Washington.
- 7
8 Rockhold, M.L., M.J. Fayer, G.W. Gee, and M.J. Kanyid, 1990, *Natural Groundwater*
9 *Recharge and Water Balance at the Hanford Site*, PNL-7215, Pacific Northwest
10 Laboratory, Richland, Washington.
- 11
12 Rogers, L.E. and W.H. Rickard, 1977, *Ecology of the 200 Area Plateau Waste Management*
13 *Environs: A Status Report*. PNL-2253, Pacific Northwest Laboratory, Richland,
14 Washington.
- 15
16 Routson, R.C., and V.G. Johnson, 1990, *Recharge Estimates for the Hanford Site 200 Areas*
17 *Plateau*, Northwest Science, Vol. 64, No. 3.
- 18
19 Schmidt J.W., C.R. Huckfeldt, A.R. Johnson, and S.M. McKinney, 1990, *Westinghouse*
20 *Hanford Company Environmental Surveillance Report--200-600 Areas, Calendar Year*
21 *1989*, WHC-EP-0145-2, Westinghouse Hanford Company, Richland, Washington, June
22 1990.
- 23
24 Schmidt, J.W., C.R. Huckfeldt, A.R. Johnson, and S.M. McKinney, 1991, *Westinghouse*
25 *Hanford Company Environmental Surveillance Annual Report - 200/600 Areas. Calendar*
26 *Year 1990*. Prepared for the U.S. Department of Energy Office of Environmental
27 Restoration and Waste Management under Contract DE-AC06-87RL10930, Westinghouse
28 Hanford Company, Richland, Washington.
- 29
30 Serne, R.J., and M.I. Wood, 1990, *Hanford Waste-Form Release and Sediment Interaction, A*
31 *Status Report with Rationale and Recommendations for Additional Studies*, Prepared for
32 the U.S. Department of Energy by Pacific Northwest Laboratory, PNL-7297/UC-512,
33 dated May 1990.
- 34
35 Smith, G.A., B.N. Bjornstad, and K.R. Fecht, 1989, *Neogene Terrestrial Sedimentation on*
36 *and Adjacent to the Columbia Plateau; Washington, Oregon, and Idaho*, in *Volcanism and*
37 *Tectonism in the Columbia River Flood-Basalt Province*, Special Paper 239, edited by S.P.
38 Reidel and P.R. Hooper, Geological Society of America, Boulder, CO, p. 187-198.
- 39
40 Smoot, J.L., J.E. Szecsody, B. Sagar, G.W. Gee, and C.T. Kincaid, 1989, *Simulations of*
41 *Infiltration of Meteoric Water and Contaminant Plume Movement in the Vadose Zone at*
42 *Single-Shell Tank 241-T-106 at the Hanford Site*, WHC-EP-0332, Westinghouse Hanford
43 Company, Richland, Washington.
- 44

- 1 Stone, W.A., J.M. Thorp, O.P. Gifford, and D.J. Hoitink, 1983, *Climatological*
2 *Summary for the Hanford Area*, PNL-4622, Pacific Northwest Laboratory, Richland,
3 Washington.
4
- 5 Streng, D.L., and S.R. Peterson, 1989, *Chemical Data Bases for the Multimedia*
6 *Environmental Pollutant Assessment System (MEPAS): Version I*, Prepared for the U.S.
7 Department of Energy, Pacific Northwest Laboratory, PNL-7145/UN-602, 630, December
8 1989.
9
- 10 Swanson, D.A., T.L. Wright, P.R. Hooper, and R.D. Bentley, 1979, *Revisions in*
11 *Stratigraphic Nomenclature of the Columbia River Basalt Group*, Bulletin 1457-G,
12 U.S. Geological Survey, Washington, D.C.
13
- 14 Tallman, A.M., J.T. Lillie, and K.R. Fecht, 1981, *Suprabasalt Sediments of the Cold*
15 *Creek Syncline Area*, in *Subsurface Geology of the Cold Creek Syncline*,
16 RHO-BWI-ST-14, edited by C.W. Myers and S.M. Price, Rockwell Hanford
17 Operations, Richland, Washington.
18
- 19 Thompson, K.M., 1991, *Hanford Past Practice Investigation Strategy*, DOE/RL-91-40,
20 Draft A, U.S. Department of Energy, Washington D.C., August 1991.
21
- 22 Tolan, T.L., and S.P. Reidel, 1989, *Structure Map of a Portion of the Columbia River*
23 *Flood-Basalt Province*, in *Volcanism and Tectonism in the Columbia River*
24 *Flood-Basalt Province*, Special Paper 239, edited by S.P. Reidel and P.R. Hooper,
25 Geological Society of America, Boulder, Colorado, plate 1.
26
- 27 Tolan, T.L., S.P. Reidel, M.H. Beeson, J.L. Anderson, K.R. Fecht, and D.A. Swanson, 1989,
28 *Revisions to the Extent and Volume of the Columbia River Basalt Group in Volcanism and*
29 *Tectonism in the Columbia River Flood-Basalt Province*, Special Paper 239, edited by S.P.
30 Reidel and P.R. Hooper, Geological Society of America, Boulder, CO, p. 1-20.
31
- 32 Van Genuchten, N.P., S.J. Lij, and S.R. Yates, 1991, *The RETC Code for Quantifying the*
33 *Hydraulic Functions of Unsaturated Soils*, Robt. S. Kerr Environmental Research
34 Laboratory, Office of Research and Development, United States Environmental Protection
35 Agency, Ada, Oklahoma.
36
- 37 Van Luik, A.E., R.M. Smith, 216-S-1 and S-2, *Mixed Fission Product Crib Characterization*
38 *Study*, March 1982, Rockwell International.
39
- 40 Washington Department of Resources, 1990, Natural Heritage Program, *Endangered,*
41 *Threatened, and Sensitive Vascular Plant Species of Washington*, Department of Natural
42 Resources, Olympia, Washington.
43
44

- 1 WHC (Westinghouse Hanford Company), 1951, *Redox Technical Manual*, HW-18700.
2 Chemical Development Section, Separations Technology Division, Hanford Works,
3 Richland, Washington.
4
- 5 WHC, 1988a, *Quality Assurance Manual*, WHC-CM-4-2, Westinghouse Hanford Company,
6 Richland, Washington.
7
- 8 WHC, 1988b, *Radiation Protection - Safety, Quality Assurance and Security*, WHC-CM-4-10
9 Westinghouse Hanford Company, Richland, Washington, March 1988.
10
- 11 WHC, 1988c, *Environmental Investigation and Site Characterization Manual*, Westinghouse
12 Hanford Company, Richland, Washington.
13
- 14 WHC, 1990a, *Environmental Engineering, Technology, and Permitting Function Quality*
15 *Assurance Program Plan*, WHC-EP-0383, Westinghouse Hanford Company, Richland,
16 Washington.
17
- 18 WHC, 1990b, *Liquid Effluent Study Final Project Report*, WHC-EP-0367-UC-702,
19 Westinghouse Hanford Company, Richland, Washington, August 1990.
20
- 21 WHC, 1991a, *Waste Information Data System (WIDS)* Westinghouse Hanford Company,
22 Richland, Washington.
23
- 24 WHC, 1991b, *Prioritizing Sites for Expedited Response Actions at the Hanford Site*,
25 WHC-MR-0244, Westinghouse Hanford Company, Richland, Washington.
26
- 27 Winship, R.A., and M.C. Hughes, 1991, *Hanford Site Surface Radioactive Contamination*
28 *Control Plan for Fiscal Year 1992*. Prepared for the U.S. Department of Energy Office of
29 Environmental Restoration and Waste Management. WHC-EP-0489.
30

APPENDIX A
SUPPLEMENTAL DATA

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

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9 3 1 2 8 5 1 9 2 4

1 **1.0 SUBSURFACE GEOPHYSICAL LOGS**
2

3 Geophysical well logging has been conducted at the S Plant Aggregate Area, since at least
4 as early as 1958, as a surveillance technique to evaluate radionuclide migration in the
5 unsaturated zone underlying or adjacent to waste disposal or storage areas. Vadose zone
6 monitoring wells (dry wells) and groundwater monitoring wells have been constructed at
7 many of the S Plant Aggregate Area waste management units. Geophysical well logs have
8 been acquired from monitoring wells at the following 15 waste management units:
9

- 10 • 216-S-1 and -2 Cribs
- 11 • 216-S-5 Crib
- 12 • 216-S-6 Crib
- 13 • 216-S-7 Crib
- 14 • 216-S-9 Crib
- 15 • 216-S-13 Crib
- 16 • 216-S-20 Crib
- 17 • 216-S-22 Crib
- 18 • 216-S-23 Crib
- 19 • 216-S-25 Crib
- 20 • 216-S-26 Crib
- 21 • 216-S-8 Trench
- 22 • 216-S-10D Ditch
- 23 • 216-S-10P Pond
- 24 • 216-S-11 Pond

25
26 As part of this Aggregate Area Management Study, select geophysical well logs from
27 these 15 waste management units were examined to provide a preliminary appraisal of
28 migration of radionuclides in the unsaturated zone. The objectives of the geophysical well
29 log study were to qualitatively, if possible, evaluate the extent and rate of vertical and lateral
30 migration of radionuclides. Several previously conducted studies provide important
31 background information. Brodeur (1988) provides a very brief evaluation of more recent logs
32 from four S Plant waste management units (216-S-1 and -2 cribs, 216-S-7 crib, 216-S-9 crib,
33 and 216-S-20 crib). Other documents such as Hanlon (1991) summarize information on tank
34 farm surveillance studies. Pertinent results of previously conducted studies or observations
35 are discussed along with results of this study in sections describing individual waste
36 management units (Section 4.1).
37

38 The following vadose zone fluid migration pathways have been recognized in the
39 200 West Area: (1) vertical downward migration; (2) lateral migration at the interface of an
40 underlying coarser-grained zone or low permeability zone; (3) a combination of vertical and
41 lateral migration that may be manifested in adjacent wells as digitate clean and contaminated
42 zones; and (4) vertical downward migration along the well casings in poorly constructed
43 wells. Additional complications in interpreting the migration of contaminants include the
44 natural decay of radionuclides and the different migration rates of various radionuclides.
45

1.1 Available Geophysical Well Logs

The array of geophysical logs acquired from the S Plant Aggregate Area includes gross gamma-ray logs, gamma-gamma logs, neutron-epithermal-neutron logs, density logs, sonic logs, and temperature logs. The gross gamma-ray log was by far the most common log acquired and, with the exception of the spectral gamma-ray log, is the most useful for evaluating migration of anthropogenic radionuclides in the unsaturated zone. Ancillary logs, such as the neutron and density logs, may also provide useful information. The interpretation of those logs, however, is complicated by several factors, including the presence of multiple casing strings, the complications of logging in unsaturated zones, uncertainties in well construction and modifications, and questionable tool geometry and response characteristics. Consequently, the ancillary logs were not evaluated as part of this study.

Nearly all of the available gamma-ray logs have been acquired from S Plant monitoring wells by the Westinghouse Hanford Tank Farm Surveillance Group or the Pacific Northwest Laboratory (PNL).

The Tank Farm Surveillance Group, organized in the early 1970s, began acquiring gross gamma-ray logs from dry wells at 241-S and 241-SX tank farms in 1973. The logging equipment used was designed in-house by F. Stong specifically for surveillance. The original design was modified from about 1976 to 1977, and implemented some time thereafter, possibly beginning about 1977. The nature of the logs do not change during that period; however, and the effect of design modifications are not apparent. The Tank Farm Surveillance Group utilized four types of gross gamma-ray probes, depending on the severity of contamination. In order of increasing radioactivity, the corresponding probe type used would be probe No. 4, utilizing a scintillation detector (also called the "S" probe); probe No. 14, utilizing a shielded scintillation detector (also called the "SS" probe; seldom used); probe No. 1, utilizing a Geiger-Mueller detector (also called the "green" or "GM-1" probe); and probe No. 2, utilizing a shielded Geiger-Mueller detector (also called the "red" or "GM-2" probe). Several vans are outfitted for logging and so there are several copies of each probe. The probe type utilized is recorded on each log, but not the probe serial number. The electronics circuits utilized with the Surveillance Group probes do not incorporate an electronic smoothing system (i.e., a "time constant") as in typical petroleum industry logging tools or the PNL logging tools. Instead, the detector response is summed over a 1-ft interval and then plotted in units of counts per second (cts/sec). This method does not produce an appreciable depth log (but it does reduce bad resolution and makes it difficult to correlate log features). The logging speed is 0.75 ft/sec. The probes are free floating (not centered or uncentered), but response variability resulting from unconstrained lateral movement in the borehole is estimated to be negligible. Instrument calibration is discussed below.

The PNL began recording gross gamma-ray logs from S Plant monitoring wells in 1958. On the basis of log presentation, three generations of logging equipment have been used in the S Plant Aggregate Area since 1958. However, based on conversations with long-term Westinghouse Hanford and PNL employees, several more subtle equipment modifications were made within generations of logging equipment. Beginning in 1982, procedures were

1 implemented to improve log quality and consistency. Further improvements in logging
2 procedures were implemented in 1989. Since 1976, two probes with similar response
3 characteristics have been used by PNL. Beginning in 1982, the serial number of the probe
4 used has been recorded on the log header.

5 6 1.2 Log Quality 7

8 An assessment of gross gamma-ray log quality is difficult, particularly for the very early
9 logs, because of a lack of accessible documentation of procedures and results. Evaluation of
10 log quality ultimately encompasses a large number of factors including documentation of
11 design specifications, modifications, and repairs; detailed performance tests of probes and
12 instrumentation; evaluation of the precision and accuracy of the depth measurement system;
13 and probe response; and periodic calibration. Of equal importance to equipment
14 considerations is documentation of monitoring well construction and modifications ("as-built"
15 diagrams) and reference elevations. The PNL has vastly improved their quality control
16 procedures over the last decade. Beginning in 1979, a designated test well (399-5-2) was
17 logged on a quarterly basis, and probe serial numbers were recorded along with basic logging
18 information. "Calibration" logs acquired between 1979 and 1988, when more sophisticated
19 procedures were implemented, are fairly uniform with respect to log intensity and bed
20 resolution. No known quality control information exists for logs acquired by PNL prior to
21 1979. Since 1988, a significant campaign has been mounted to improve PNL log quality (for
22 details, see Brodeur and Koizumi, 1989; Arthur, 1990).
23

24 Without documentation, the only means to evaluate log quality is to compare logs
25 collected from the same well. There is substantial variability in probe sensitivity both
26 between and within the three generations of equipment, although reproducibility increases
27 significantly after 1980. There also appears to be variability in the linearity of probe
28 response, because peak to background ratios are not consistent. Resolution of marker beds
29 seems to be consistent between generations, but depths typically vary by ± 2 ft. Both intensity
30 and depth measurements are very difficult to assess on major peaks from the 1958-1959 logs
31 (Esterline-Angus recorder).
32

33 The level and evolution of quality control measures practiced by the Tank Farm
34 Surveillance Group is similar to that of PNL. The Tank Farm Surveillance Group has
35 conducted extensive tests to determine response characteristics of their scintillation probe
36 (No. 4) and their unshielded and shielded Geiger-Mueller probes (Nos. 1 and 2, respectively).
37 Radiological calibration curves were constructed using probe responses to several radium and
38 cesium sources contained in a test pit (Stong, 1980). The resulting curves document the
39 linear range of the probes, and relate counting rate (cts/sec) to decay rates (Roentgen/hr). The
40 upper limit of the linear response ranges for the scintillation and Geiger-Mueller type probes
41 are approximately 7,000 and 3,000 cts/sec, respectively (Stong, 1980).
42

43 For the few monitoring wells that have been logged by both PNL and the Tank Farm
44 Surveillance Group, there seems to be a fairly substantial depth discrepancy (up to 5 ft) for
45 marker beds recognizable in both logs. It is not clear which logs are more reliable.

1
2 **1.3 Technical Approach**
3

4 To facilitate differentiation of peaks resulting from natural and anthropogenic
5 radionuclides, logs from waste management areas were compared to logs from S Plant wells
6 showing background or natural gamma-ray responses. Figure A-1 shows the difference
7 between natural gamma-ray responses shown in Well 299-W22-19 versus anthropogenic
8 radionuclide responses shown in Well 299-W22-14. Correlations shown on Well Log 299-
9 W22-19 (Figure A-1) are based on geologic descriptions by Last et al. (1989) and typical
10 gamma-ray log characteristics (Schlumberger 1972, 1979). Below is a description of the
11 background gamma-ray response of S Plant area wells.
12

13 In the S Plant Aggregate Area, the upper 50 to 160 ft consist of sand, silty sand, sandy
14 silt, and occasional gravels identified as the basal slack-water sequence of the Hanford
15 formation. The fine-grained nature of this unit produces a slightly higher gamma response
16 than the upper coarse unit, but the response is not as uniform. Gamma response frequently
17 observed in the upper 20 ft is probably due to attenuation by conductor casing.
18

19 One of the most striking features of many logs is the relatively high gamma-ray response
20 resulting from the fine-grained eolian sand and silt (loess) comprising the Early Palouse soil.
21 That unit is typically 20 to 30 ft thick and has one or two peaks yielding the greatest gamma-
22 ray response of the natural radionuclides. The underlying Pliocene-Pleistocene basaltic
23 gravels and caliche-rich paleosal (calcrete) units are not easily recognizable on the logs,
24 although they often display a relatively low gamma-ray response (as low as the Hanford
25 coarse unit). Zones of especially low response are probably gravel and rich, whereas zones of
26 especially high response may result from the calcrete layers. The Plio-Pleistocene unit is thin
27 and discontinuous, which also may account for low gamma-ray response. Underlying the
28 Plio-Pleistocene horizons is the middle Ringold Formation, consisting of sand and gravels and
29 occasional lenses of sand and clay. In the southern portion of 200 West, the upper Ringold
30 Formation is present. The discontinuous fine sands and muds of the Upper Ringold produce a
31 fairly high gamma-ray response comparable to the Early Palouse soils.
32

33 For each WMU (excluding the 241-S and 241-SX tank farms), logs from nearby wells
34 were compared to the baseline response to identify anomalies that might represent
35 anthropogenic radionuclides. For many of the more recently drilled wells (1985 and later),
36 gross gamma-ray logs were acquired during construction of the well, often through multiple
37 strings of temporary carbon steel casing. Well construction diagrams showing temporary
38 casing strings were used to aid in the evaluation of these logs.
39
40

1 **1.4 Site Specific Results**
2

3 Results of the log interpretations for each of the WMUs are presented in Section 4.1,
4 Nature and Extent of Contamination.
5
6
7

8 **2.0 CONCLUSIONS**
9

10 In some of the intervals discussed by waste management in Section 4.1, man-made
11 radionuclides are only tentatively identified. In these cases, the intensity of the gamma
12 signals were close to intensities observed in naturally occurring high gamma zones. Low
13 intensity manmade radionuclide zones and high intensity naturally occurring zones may be
14 difficult to distinguish. As discussed in Section A.1.2, the interpretation of these results is
15 also complicated by changes in logging equipment, procedures, and documentation through
16 time. The data could not be interpreted in a quantitative fashion because of these
17 complications.
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ACRONYMS AND ABBREVIATIONS

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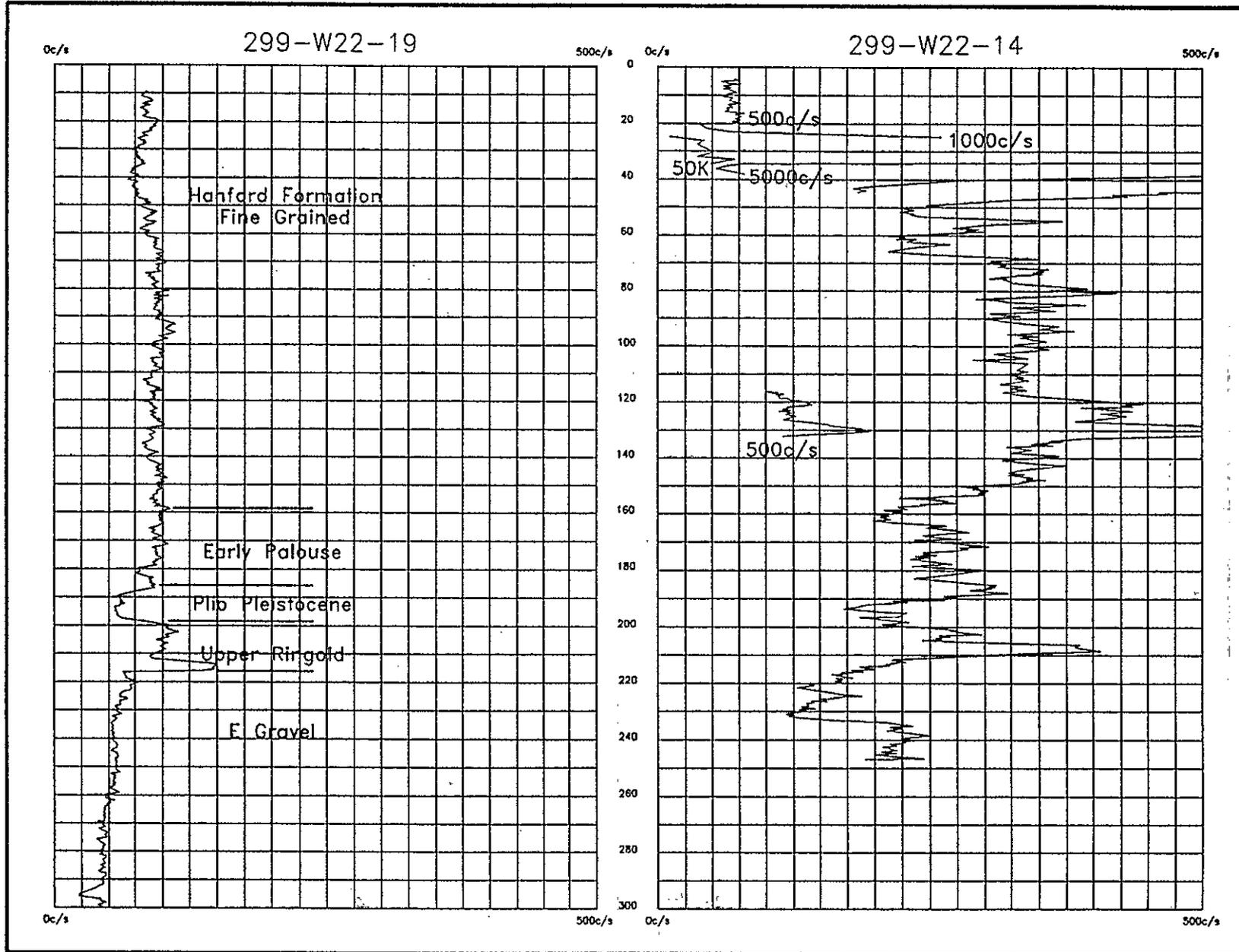
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| AAMS | aggregate area management study |
| PNL | Pacific Northwest Laboratory |
| Westinghouse Hanford | the Westinghouse Hanford Company |

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REFERENCES

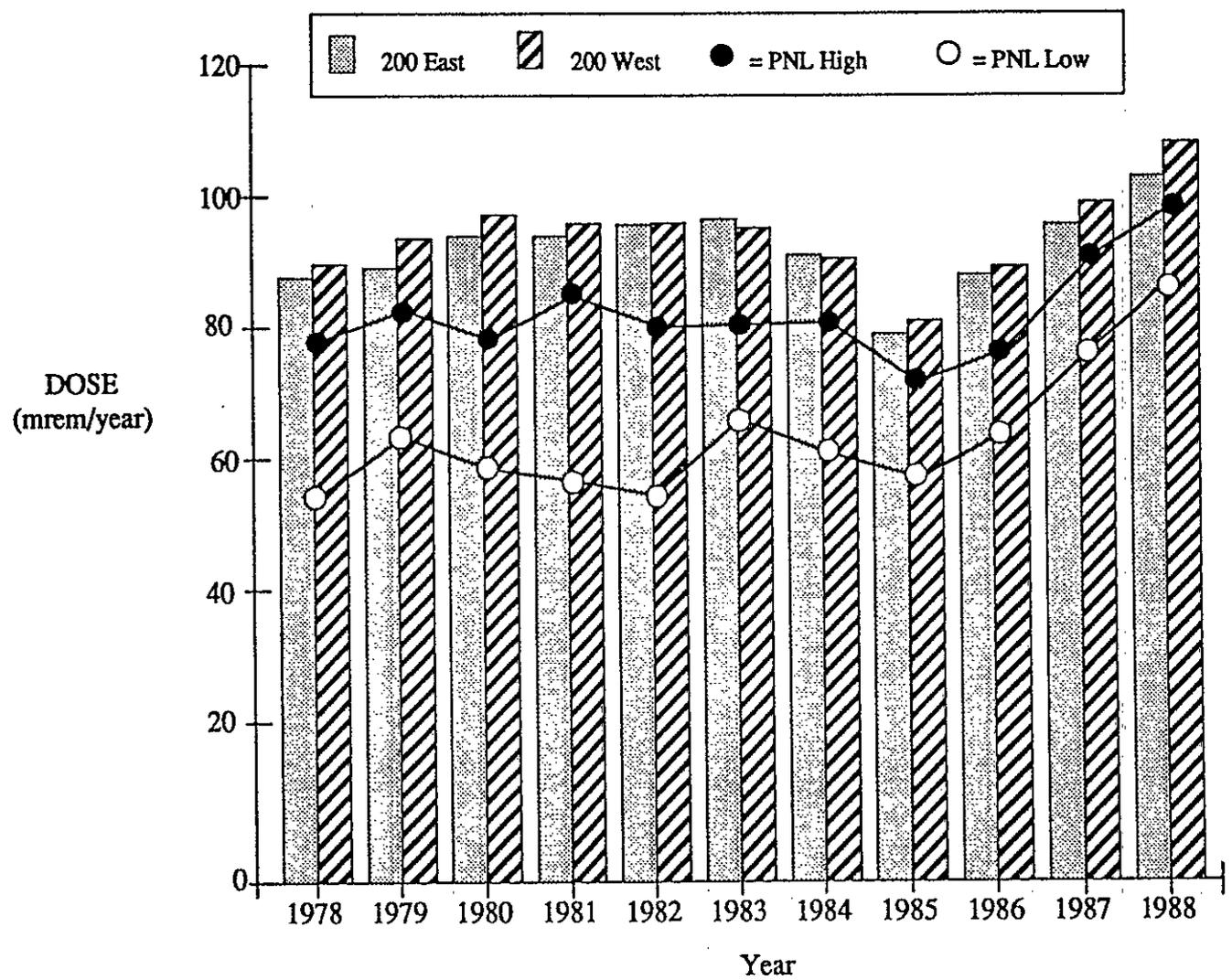
- 1
2
3
4 Arthur, R.J., 1990, *1990 Yearly Calibration of Pacific Northwest Laboratory's Gross-Gamma*
5 *Borehole Geophysical Logging System*, PNL-7460, UC-606, Battelle Pacific Northwest
6 Laboratory, Richland, Washington.
7
8 Brodeur, J.R., and C.J. Koizumi, 1989, *Base Calibration of Pacific Northwest Laboratory's*
9 *Gross-Gamma Borehole Geophysical Logging System*, WHC-EP-0246, Westinghouse
10 Hanford Company, Richland, Washington.
11
12 Hanlon, B.M., 1991, *Tank Farm Surveillance and Waste Status Report for July 1991*,
13 WHC-EP-1082-40, UC-721, Westinghouse Hanford Company, Richland, Washington.
14
15 Jensen, H.F., 1976, *Occurrence Report: Dry Well 60-10-07 Radiation Increase Approaching*
16 *Criteria*, ARH-76-74, Atlantic Richfield Hanford Company, Richland, Washington.
17
18 Last, G.V., B.N. Bjornstad, M.P. Bergeron, D.W. Wallace, D.R. Newcomer, J.A. Schramke,
19 M.A. Chamness, C.S. Cline, S.P. Airhart, and J.S. Wilbur, 1989, *Hydrogeology of the*
20 *200 Areas Low-Level Burial Grounds—An Interim Report*, PNL-6820, Westinghouse
21 Hanford Company, Richland, Washington.
22
23 Price, W.H., and K.R. Fecht, 1976, *Geology of the 241-U Tank Farm*, ARH-LD-138, Atlantic
24 Richfield Hanford Company, Richland, Washington.
25
26 Schlumberger, 1972, *Log Interpretation: Volume I - Principles*, New York, N.Y.,
27 Schlumberger Ltd., 113 p.
28
29 Schlumberger, 1979, *Log Interpretation Charts*, New York, N.Y., Schlumberger Ltd., 97 p.
30
31

AF-1



DOE/RL-91-60
Draft A

Figure A-1. Natural Gamma Ray Responses versus Anthropogenic Radionuclide Responses.



AF-2

Elder et al. 1989.

DOE/RL-91-60
Draft A

Figure A-2. Yearly Averages for Thermoluminescent Dosimeter versus Pacific Northwest Laboratories Perimeter Stations.

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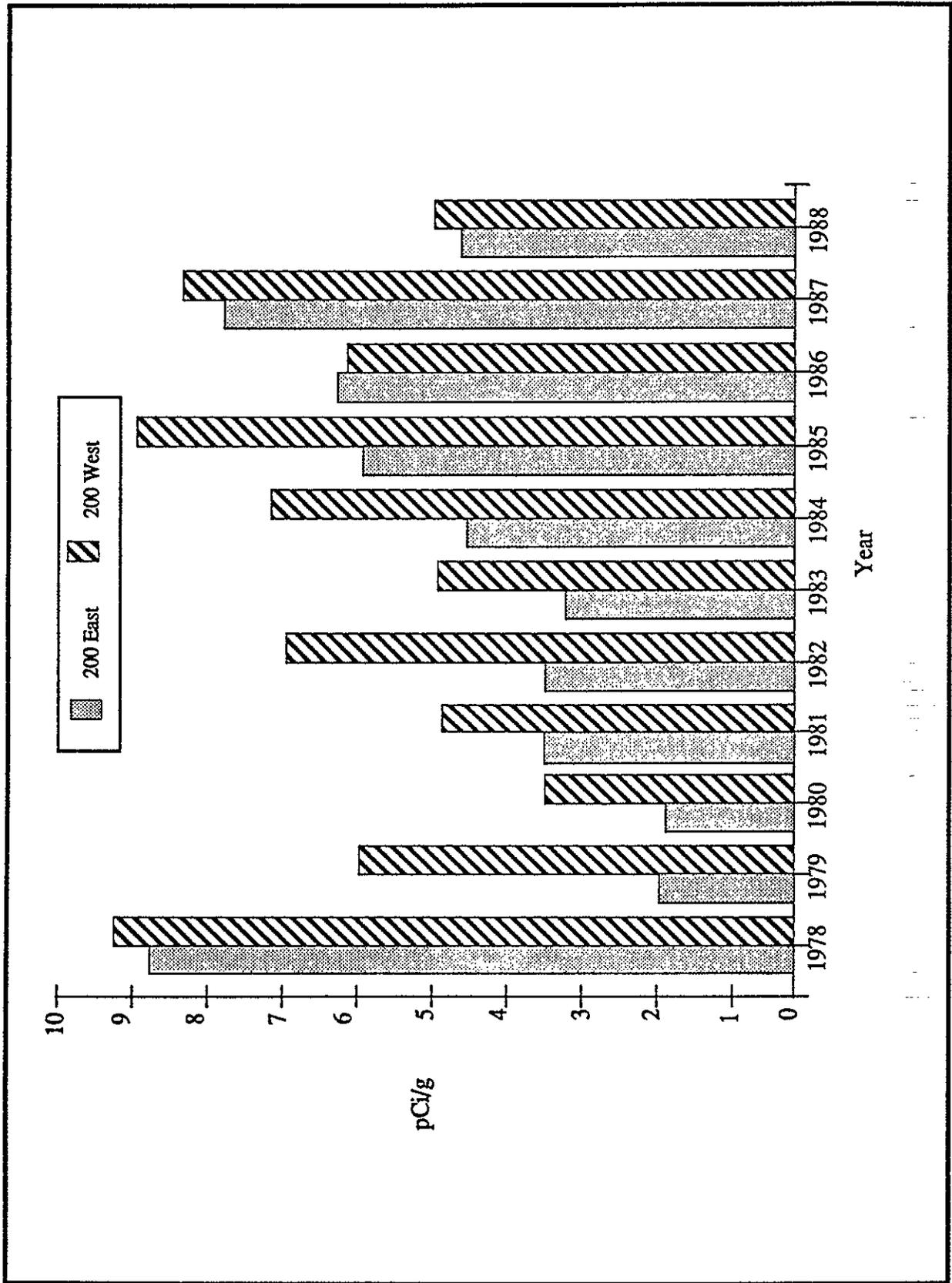
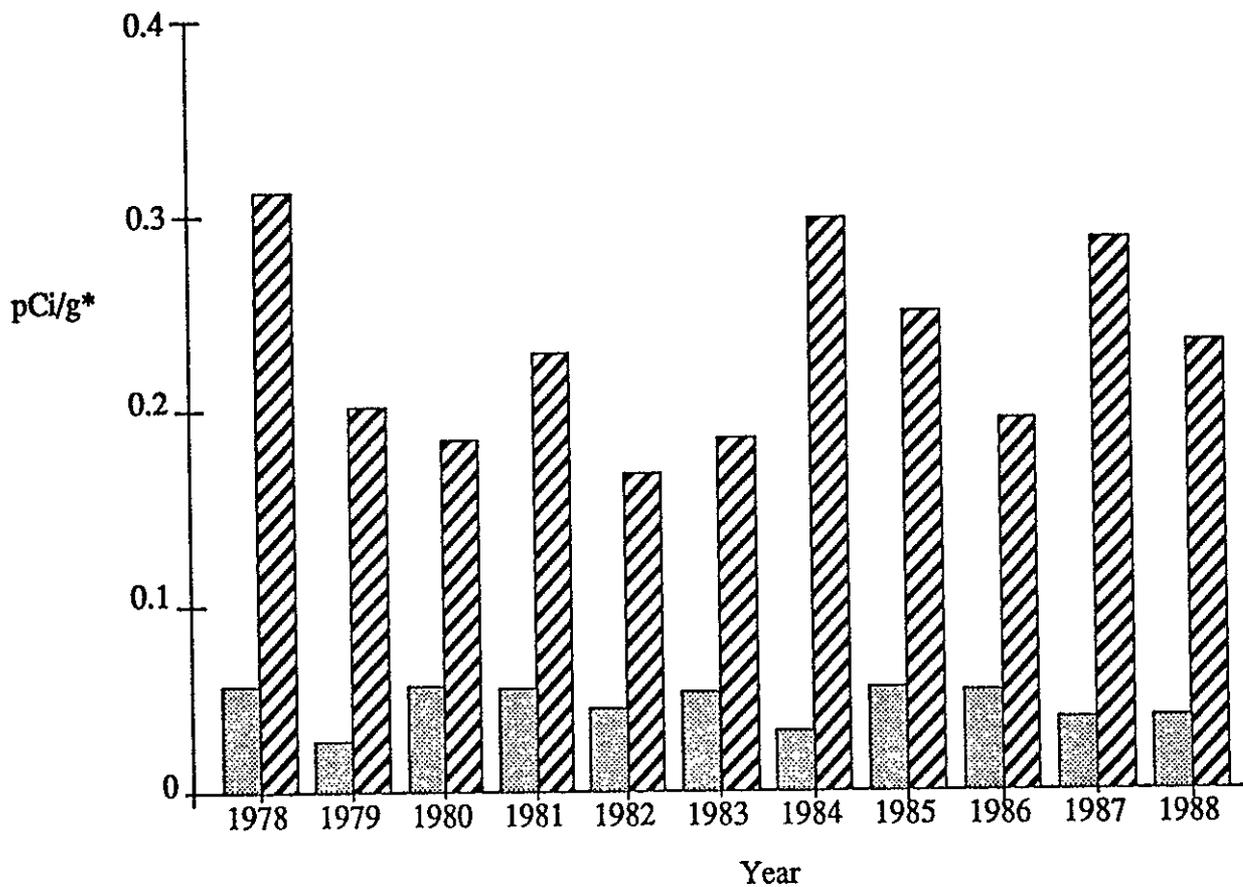


Figure A-3. Yearly Averages for Cesium-137 in Soil.

200 East 200 West



*pCi/g = picocuries per gram.

AF-4

Schmidt et al. 1990.

DOE/RL-91-60
Draft A

Figure A-4. Yearly Averages for Plutonium-239 in Soil.

AF-5

Schmidt et al. 1990.

DOE/RL-91-60
Draft A

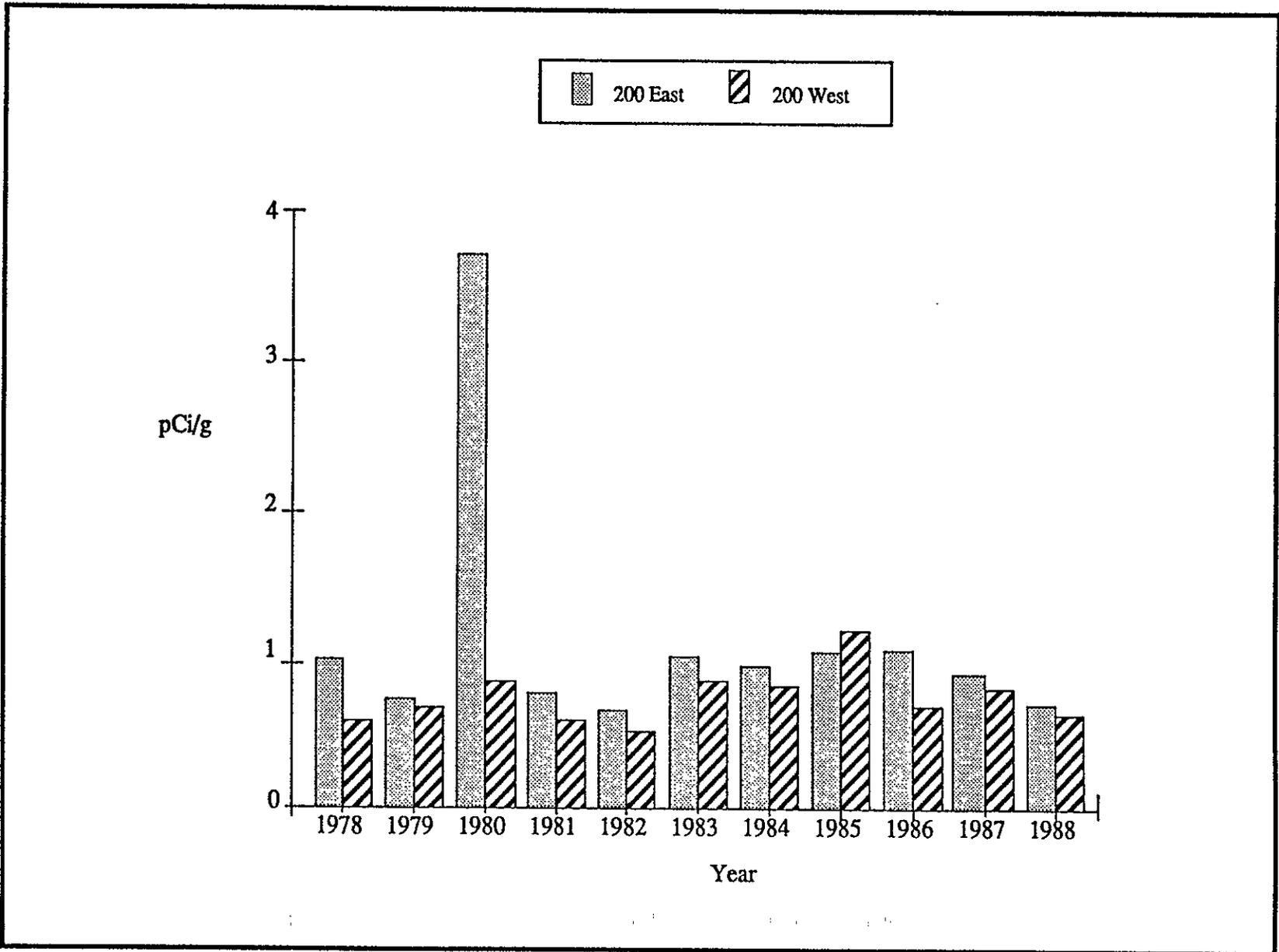


Figure A-5. Yearly Averages for Strontium in Soil.

AF-6

DOE/RL-91-60
Draft A

Elder et al. 1989.

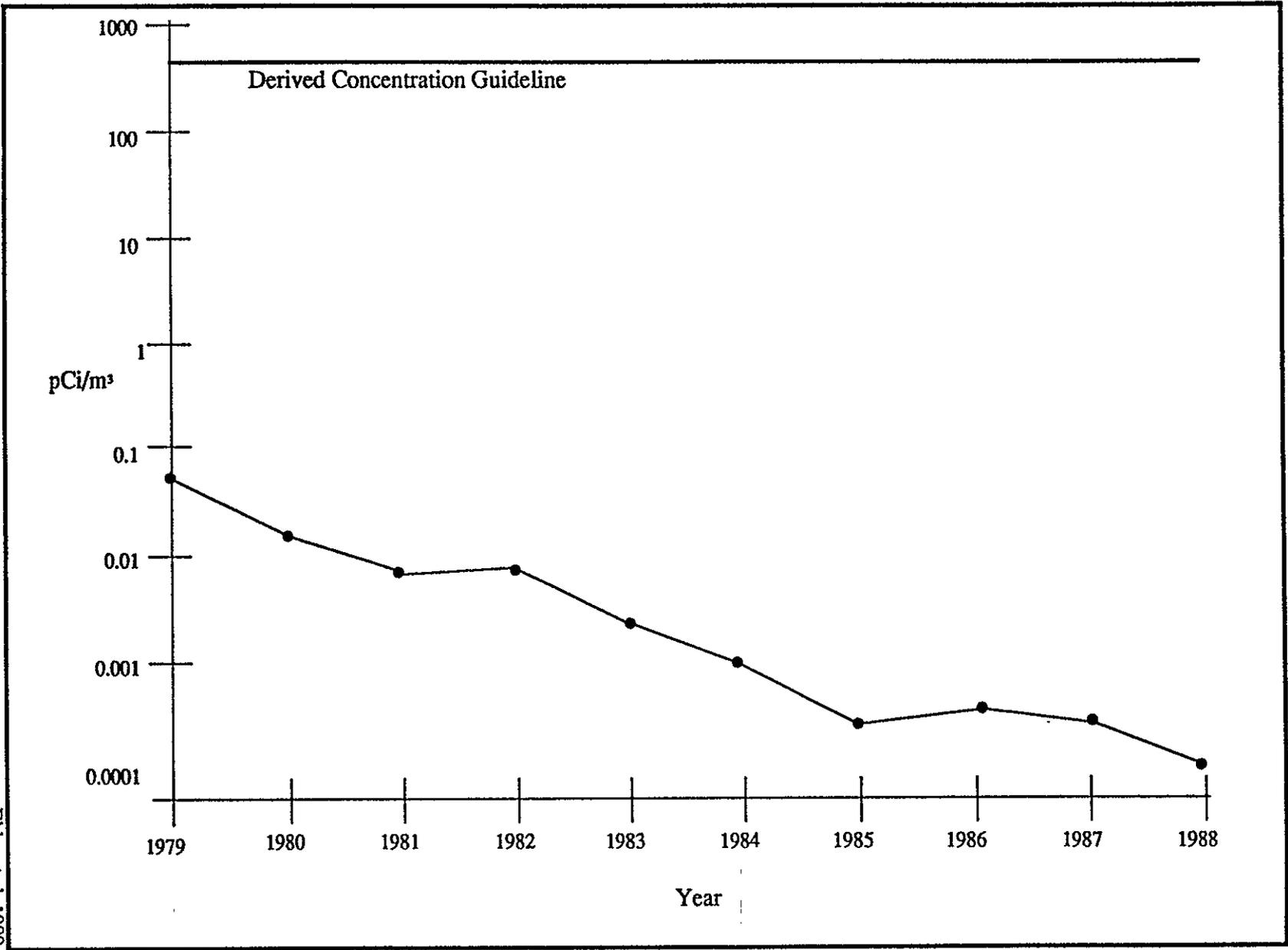
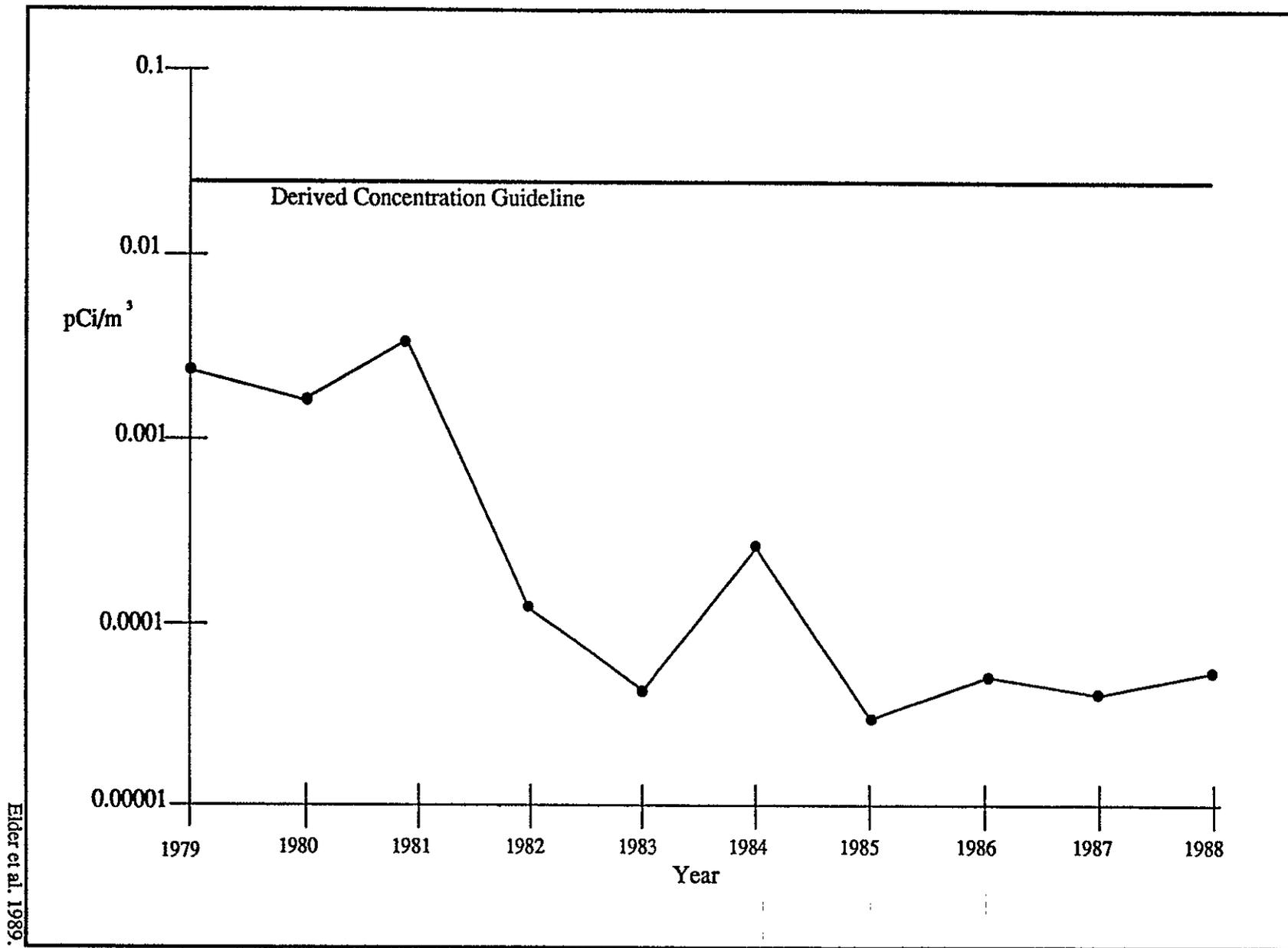


Figure A-6 Cesium-137 in Air, S Plant Aggregate Area Sampling Location.

AF-7

DOE/RL-91-60
Draft A

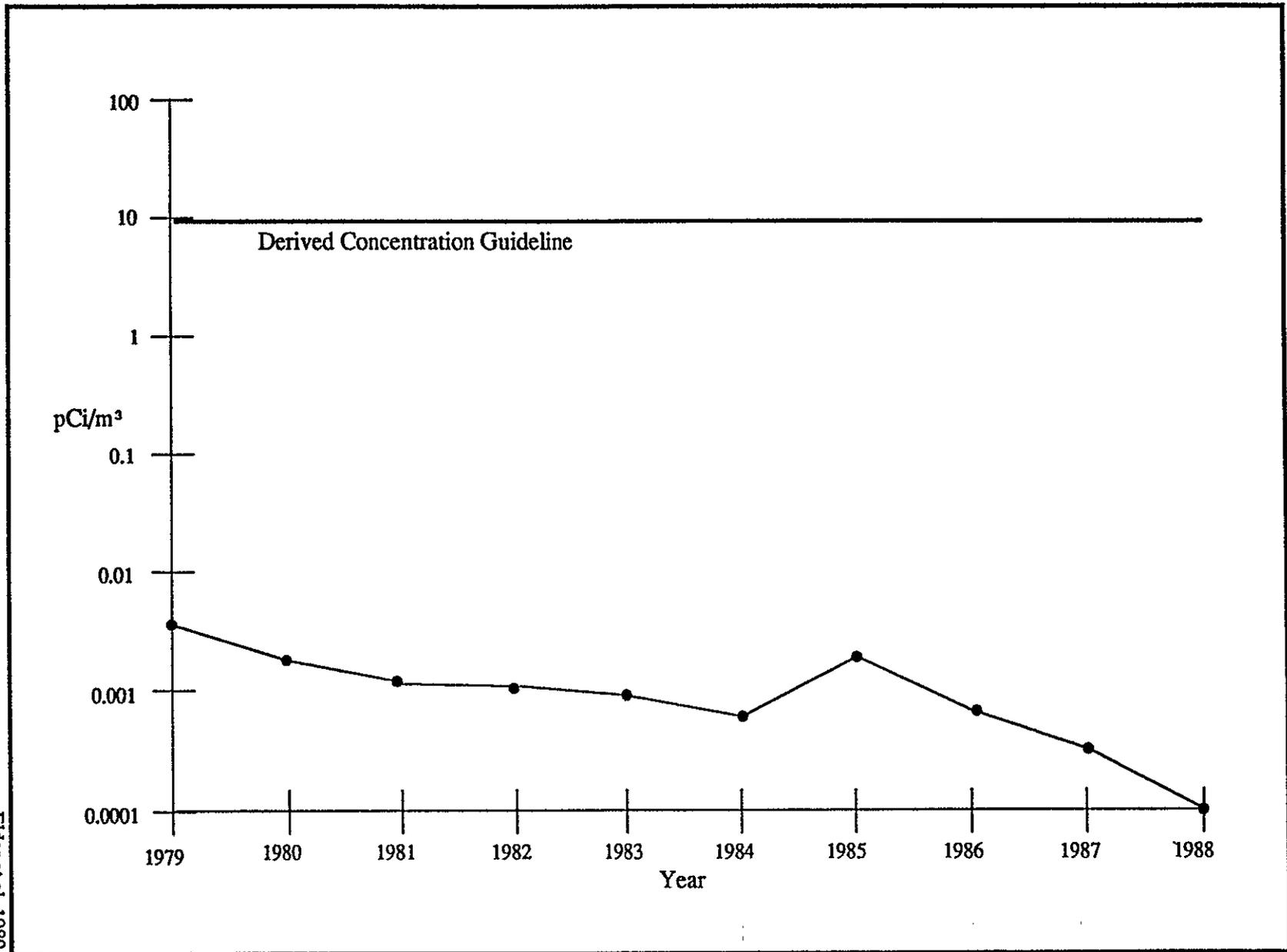


Elder et al. 1989.

Figure A-7. Plutonium-239 in Air, S Plant Aggregate Area Sampling Location.

AF-8

Elder et al. 1989.



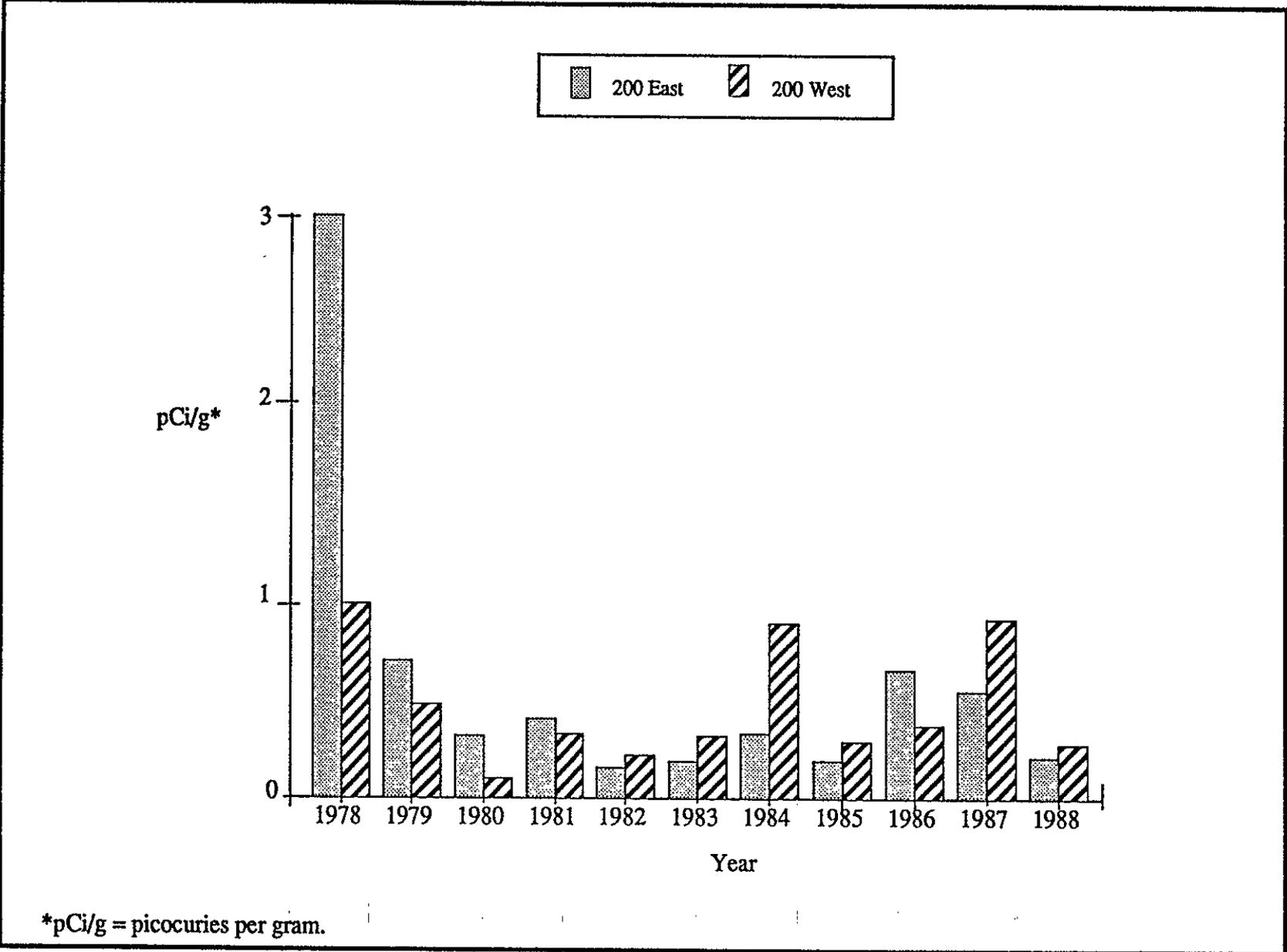
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Figure A-8. Strontium 90 in Air, S Plant Aggregate Area Sampling Location.

AF-9

Elder et al. 1989.

DOE/RL-91-60
Draft A



*pCi/g = picocuries per gram.

Figure A-9. Yearly Averages for Cesium-137 in Vegetation.

Table A-1. Gamma-ray Logs Examined.

| Waste Management Unit | Well Number | Log Date | Log Type |
|-----------------------|-------------|----------|----------|
| 216 S-1 and S-2 Crib | 299-W22-1 | 1/30/58 | 2 |
| | | 5/8/63 | 3a |
| | | 3/9/66 | 3b |
| | 299-W22-2 | 2/23/76 | 4a |
| | | 1/30/58* | 2 |
| | | 2/16/68* | 3b |
| | | 4/8/70* | 3b |
| | | 5/14/76 | 4a |
| | 299-W22-5 | 7/9/79 | 4 |
| | | 5/9/63* | 3a |
| | | 2/22/68* | 3b |
| | | 5/14/76* | 4a |
| | | 7/9/79 | 4 |
| | | 6/3/80 | 4b |
| | | 2/25/86 | 4b |
| | 299-W22-6 | 8/20/87 | 4b |
| | | 2/27/58* | 2 |
| | | 2/22/68* | 3b |
| | | 5/14/76* | 4a |
| | | 2/25/86 | 4b |
| | 299-W22-10 | 8/20/87 | 4b |
| | | 5/9/63* | 3a |
| | | 2/22/68* | 3b |
| | | 5/14/76* | 4a |
| | | 7/9/79 | 4 |
| | | 2/25/86 | 4b |
| | 299-W22-15 | 3/23/87 | 4b |
| | | 4/12/66* | 3b |
| | | 5/8/63* | 3a |
| | | 5/14/76* | 4a |
| | | 7/9/79 | 4 |
| | 299-W22-16 | 2/25/86 | 4b |
| 8/20/87 | | 4b | |
| 5/9/63* | | 3a | |
| 4/8/70* | | 3b | |
| 5/14/76* | | 4a | |
| 299-W22-17 | 2/25/86 | 4b | |
| | 8/20/87 | 4b | |
| | 2/13/58 | 2 | |
| | 2/22/68 | 3b | |
| | 5/14/76 | 4a | |
| | 7/9/79 | 4 | |
| | 2/25/86 | 4b | |
| | 8/20/87 | 4b | |

9 3 1 2 0 1 5 1 0 4 1

Table A-1. Gamma-ray Logs Examined.

| Waste Management Unit | Well Number | Log Date | Log Type |
|-----------------------|--------------|------------|----------|
| | 299-W22-18 | 2/16/68* | 3b |
| | | 5/14/76* | 4a |
| | | 7/9/79 | 4 |
| | | 6/3/80 | 4 |
| | | 2/25/86 | 4b |
| | 299-W22-29 | 8/20/87 | 4b |
| | | 2/16/68* | 3b |
| | 299-W22-30 | 5/14/76* | 4a |
| | | 2/4/86 | 4b |
| | | 2/16/68* | 3b |
| | 299-W22-31 | 5/14/76* | 4a |
| | | 7/9/79 | 4 |
| | | 3/19/80 | 4 |
| | | 6/30/80 | 4 |
| | 299-W22-36 | 2/16/68* | 3b |
| 5/14/76* | | 4a | |
| 299-W22-67 | 2/4/86 | 4b | |
| | 2/22/68 | 3b | |
| | 5/14/76 | 4a | |
| | 7/9/79 | 4 | |
| | 2/25/86 | 4b | |
| 216-S-5 Crib | 8/20/87 | 4b | |
| | 299-W26-1 | 5/18/76* | 4a |
| | 299-W26-3 | 5/18/76* | 4a |
| | 299-W26-4 | 5/18/76* | 4a |
| | 299-W26-5 | 5/18/76* | 4a |
| 216-S-6 Crib | 299-W26-2 | 5/18/76* | 4a |
| | 216-S-7 Crib | 299-W22-12 | 2/13/58* |
| 299-W22-13 | | 2/16/68* | 3b |
| | 2/23/76* | 4a | |
| | 5/9/63 | 3a | |
| | 2/16/68* | 3b | |
| 299-W22-14 | 5/14/76* | 4a | |
| | 2/27/58* | 2 | |
| | 5/9/63* | 3a | |
| | 5/14/76* | 4a | |
| 299-W22-32 | 2/12/87 | 4b | |
| | 2/16/68* | 3b | |
| | 5/13/76* | 4a | |
| 299-W22-33 | 2/28/79 | 4 | |
| | 2/16/68* | 3b | |
| | 5/13/76* | 4a | |
| | 2/28/79 | 4 | |
| | 5/3/79 | 4 | |
| | | 8/20/87 | 4b |

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Table A-1. Gamma-ray Logs Examined.

| Waste Management Unit | Well Number | Log Date | Log Type |
|-----------------------|-------------|---------------|----------|
| 216-S-9 Crib | 299-W22-25 | 3/3/70* | 3b |
| | | 2/23/76* | 4a |
| | | 9/23/86 | 4b |
| | | 8/19/87 | 4b |
| | 299-W22-26 | 3/7/66* | 3b |
| | | 3/7/70* | 3b |
| | 299-W22-34 | 5/14/76* | 4a |
| | | 9/22/86 | 4b |
| | | 8/19/87 | 4b |
| | 299-W22-35 | 5/14/76* | 4a |
| | | 9/22/86 | 4b |
| | | 8/19/87 | 4b |
| 216-S-13 Crib | 299-W22-21 | 5/9/63* | 3a |
| | | 2/16/68* | 3b |
| | | 2/23/76* | 4a |
| 216-S-20 Crib | 299-W22-20 | 5/6/63* | 3a |
| | | 2/16/68* | 3b |
| | | 5/13/76* | 4a |
| 216-S-22 Crib | 299-W22-19 | 7/5/63* | 3a |
| | | 2/16/68 | 4b |
| | | 2/23/76* | 4a |
| | | 3/14/84 | |
| 216-S-23 Crib | 299-W19-5 | 5/13/76* | 4a |
| | 299-W19-6 | 5/13/76* | 4a |
| | 299-W22-37 | 5/13/76* | 4a |
| | 299-W22-38 | 5/13/76* | 4a |
| 216-S-25 Crib | 299-W23-9 | 2/23/76* | 4a |
| | 299-W23-10 | 5/18/76* | 4a |
| | 299-W23-11 | 5/18/76* | 4a |
| 216-S-10D Ditch | 299-W26-7 | | |
| | 299-W26-8 | 4/15/90 | 4c |
| | 299-W26-11 | 4/5 & 4/13/90 | 4c |
| | 299-W26-12 | | |
| 216-S-10P Pond | 699-32-77 | 8/15/80 | |
| 216-S-11 Pond | 299-W26-9 | 4/2 & 4/12/90 | 4c |

9 0 1 2 0 5 1 0 4 3

Table A-1. Gamma-ray Logs Examined.

NOTES

* Used by Fecht et al. (1977)

Types of Natural Gamma-Ray Logs (designated in "Log Type" column)

1. Battelle PNL, circa 1954-1955 (none for S Plant)
2. Battelle PNL, circa 1958-1959; Esterline-Angus Co., Inc., chart recorder
3. Battelle PNL, circa 1963-1971; video chart recorder
 - a. circa 1963-1965
 - b. circa 1966-1971, improvements in electronics (pers. comm. J.R. Raymond)
4. Battelle PNL, circa 1976-present
 - a. circa 1976; probe serial no. NG 001 (pers. comm. J.R. Raymond)
 - b. circa 1982-1987; probe serial no. NG 001
 - c. circa 1985-present; probe serial no. CG 27A97

Location of Natural Gamma-Ray Logs (corresponding to "Log-Type")

1. Battelle PNL, 3000 area, bldg. Sigma 5
2. Battelle PNL, 3000 area, bldg. Sigma 5, room 2521; medium-sized notebook
3. Battelle PNL, 3000 area, bldg. Sigma 5, room 2521; small-sized notebook
4. WHC Environmental and Waste Management Geophysics Group, 1100 area, bldg. 1816TD; large-sized notebook

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Table A-2. Calcium Carbonate and Moisture Data

Well 299-W10-17.

Page 1 of 12

| Depth Feet | CaCO ₃ Wt. % | Moisture Wt. % |
|------------|-------------------------|----------------|
| 5 | 2.3 | 18.78 |
| 10 | 0.5 | 3.44 |
| 15 | 0.6 | 2.63 |
| 20 | 0.8 | 1.78 |
| 25 | 1 | 2.55 |
| 30 | 0.6 | 2.5 |
| 35 | 0.5 | 3.66 |
| 40 | 0.3 | 2.86 |
| 45 | 0.8 | 6.97 |
| 50 | 0.6 | 4.95 |
| 55 | 0.6 | 3.7 |
| 60 | 0.5 | 3.12 |
| 65 | 0.9 | 5.85 |
| 70 | 0.5 | 3.37 |
| 75 | 0.6 | 4.57 |
| 80 | 0.6 | 3.52 |
| 90 | 1.8 | 9.82 |
| 95 | 2.5 | 11.77 |
| 100 | 3.6 | 5.36 |
| 105 | 11 | 9.9 |
| 110 | 5.9 | 6.87 |
| 115 | 0.8 | 22.98 |
| 120 | 0 | 3.78 |
| 125 | 1.3 | 26.96 |
| 128 | 0.8 | 3.01 |
| 135 | 0 | 5.23 |
| 140 | 0.1 | |
| 145 | 0.1 | |
| 150 | 0.3 | |
| 155 | 0.3 | |
| 160 | 0.3 | |
| 165 | 0.1 | |
| 170 | 0.1 | |
| 175 | 0.1 | |
| 181 | 0.3 | |
| 185 | 0.1 | |
| 190 | 0.1 | |
| 195 | 0.1 | |
| 200 | 0.1 | |
| 205 | 0.1 | |
| 210 | 0.1 | |
| 215 | 0.1 | |

9 3 1 3 3 5 1 0 4 5

Table A-2. Calcium Carbonate and Moisture Data

Well 299-W10-18.

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| Depth Feet | CaCO3 Wt. % | Moisture Wt. % |
|------------|-------------|----------------|
| 5 | 0.8 | 4.97 |
| 10 | 0.4 | 3.42 |
| 15 | 0.3 | 4.01 |
| 20 | 0.4 | 3.58 |
| 25 | 0.9 | 2.98 |
| 30 | 0.8 | 3.7 |
| 35 | 0.8 | 4.04 |
| 40 | 0.6 | 5.22 |
| 45 | 0.3 | 4.25 |
| 50 | 0.1 | 4.17 |
| 55 | 0.8 | 5.44 |
| 60 | 0.6 | 7.98 |
| 65 | 0.3 | 4.23 |
| 70 | 0.3 | 3.96 |
| 75 | 1 | 4.76 |
| 80 | 0.9 | 6.24 |
| 85 | 1 | 4.7 |
| 90 | 0.9 | 3.39 |
| 95 | 0.9 | 15.2 |
| 100 | 8.5 | 12.41 |
| 105 | 9.4 | 8.04 |
| 110 | 8.5 | 11.1 |
| 115 | 8.8 | |
| 118 | | |
| 120 | 1.8 | |
| 125 | 1.5 | |
| 130 | | |
| 135 | 0.6 | |
| 140 | 0.1 | |
| 145 | 0.3 | |
| 150 | 0.8 | 1.45 |
| 155 | 0.3 | 1.99 |
| 160 | 0.1 | 3.7 |
| 165 | 0.3 | |
| 170 | 0.3 | |
| 175 | 0.5 | |
| 180 | 0.5 | |
| 185 | 0.3 | |
| 190 | 0.1 | |
| 195 | 0.3 | |
| 200 | 0.3 | |
| 205 | 0.1 | |
| 208 | | |
| 215 | 0.3 | |
| 220 | 5.3 | |

9 3 1 2 3 5 1 3 4 6

Table A-2. Calcium Carbonate and Moisture Data

Well 299-W15-22.

Page 3 of 12

| Depth Feet | CaCO ₃ Wt. % | Moisture Wt. % |
|------------|-------------------------|----------------|
| 5 | 0.8 | 3.12 |
| 10 | 0.9 | 4.06 |
| 15 | 0.3 | 2.72 |
| 20 | 0.5 | 2.24 |
| 25 | 0.5 | 2.78 |
| 30 | 0.6 | 3.29 |
| 35 | 0.5 | 4.34 |
| 40 | 0.3 | 3.8 |
| 45 | 0.9 | 6.27 |
| 50 | 0.5 | 4.23 |
| 55 | 0.5 | 6.54 |
| 60 | 0.3 | 2.39 |
| 65 | 1 | 3.07 |
| 70 | 0.5 | 5.55 |
| 75 | 0.3 | 2.87 |
| 80 | 0.8 | 3.26 |
| 85 | 0.9 | 5.39 |
| 90 | 0.8 | 3.99 |
| 95 | 0.9 | 6.32 |
| 100 | 1.6 | 4.39 |
| 105 | 1.6 | 15.76 |
| 110 | 9.5 | 13.86 |
| 115 | 21 | 7.9 |
| 120 | 9.4 | 9.63 |
| 125 | 0.5 | 8.84 |
| 130 | 0.5 | 2.29 |
| 135 | 0.1 | 2.68 |
| 140 | 0.3 | |
| 145 | 0.3 | |
| 150 | 0.3 | |
| 157 | 0.1 | |
| 160 | 0.1 | |
| 165 | 0.1 | |
| 170 | 0.1 | |
| 175 | 0.1 | |
| 180 | 0.1 | |
| 185 | 0.3 | |
| 190 | 0.3 | |
| 195 | 0.3 | |
| 200 | 0.3 | |
| 205 | 0.3 | |
| 210 | 0.5 | |

9 3 1 2 0 5 1 2 4 7

Table A-2. Calcium Carbonate and Moisture Data

Well 299-W18-25.

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| Depth Feet | CaCO3 Wt. % | Moisture Wt. % |
|------------|-------------|----------------|
| 45 | 1.4 | 8.74 |
| 50 | 0.9 | 3.85 |
| 55 | 1.1 | 4.47 |
| 60 | 1 | 6.16 |
| 65 | 0.9 | 14.67 |
| 70 | 1.3 | 6.13 |
| 75 | 1.5 | 7.59 |
| 80 | 1.3 | 7.75 |
| 85 | 0.9 | 6.41 |
| 90 | 1 | 7.78 |
| 95 | 0.8 | 5.7 |
| 100 | 0.8 | 4.23 |
| 105 | 0.6 | 5.06 |
| 110 | 0.8 | 11.23 |
| 115 | 1 | 8.79 |
| 120 | 1.5 | 12.27 |
| 125 | 1.5 | 11.17 |
| 130 | 1 | 9.91 |
| 135 | 2 | 17.41 |
| 140 | 6.1 | |
| 145 | 3.8 | |
| 150 | 0.8 | |
| 155 | 0.4 | |
| 160 | 0.3 | |
| 165 | 0.3 | |
| 170 | 0.3 | |
| 175 | 0.3 | |
| 180 | 0.3 | |
| 190 | 0.3 | |
| 195 | 0.3 | |
| 200 | 0.3 | |
| 205-207 | 0.5 | 11 |
| 213-215 | 0.3 | 8.08 |

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Table A-2. Calcium Carbonate and Moisture Data

Well 299-W19-31.

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| Depth Feet | CaCO ₃ Wt. % | Moisture Wt. % |
|------------|-------------------------|----------------|
| 30 | 1.3 | 3.9 |
| 35 | 0.8 | 4.24 |
| 40 | 0 | 4.57 |
| 45 | 0 | 3.76 |
| 50 | 0 | 52.56 |
| 55 | 0 | 2.7 |
| 60 | 0 | 3.97 |
| 65 | 0 | 2.55 |
| 70 | 0.4 | 5.93 |
| 75 | 0.3 | 2.98 |
| 80 | 0.9 | 6.2 |
| 85 | 0.6 | 3 |
| 90 | 0.6 | 3.52 |
| 95 | 1 | 12.94 |
| 100 | 0.9 | 7.8 |
| 105 | 0.9 | 10.99 |
| 110 | 0.6 | 4.88 |
| 115 | 0.8 | 4.56 |
| 120 | 0.9 | 11.23 |
| 125 | 1 | 7.13 |
| 130 | | 14.12 |
| 135 | 2.5 | 23.12 |
| 135.5 | 17 | 14.24 |
| 137.5 | 805 | 27.06 |
| 140 | 9.4 | 18.64 |
| 145 | 0.3 | |
| 150 | 0.8 | |
| 155 | 0.9 | |
| 160 | 0.3 | |
| 165 | 0.4 | |
| 170 | 0.5 | |
| 175 | 0.3 | |
| 180 | 0.5 | |
| 185 | 0.3 | |
| 195 | 0.1 | 3.99 |
| 195.5 | 0.1 | 3.61 |
| 200 | 0.1 | |
| 205 | 0.3 | |
| 210 | 0.1 | |
| 215 | 0.3 | |
| 220 | 0.1 | |
| 225 | 0.5 | |

9 3 1 2 8 5 1 2 2 9

Table A-2. Calcium Carbonate and Moisture Data

Well 299-W19-32.

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| Depth Feet | CaCO ₃ Wt. % | Moisture Wt. % |
|------------|-------------------------|----------------|
| 20 | 0.5 | 5.76 |
| 22.5 | 1.6 | 4.96 |
| 23 | 0.9 | 3.85 |
| 25 | 0.8 | 5.54 |
| 30 | 0.8 | 5.13 |
| 35 | 0.5 | 5 |
| 40 | 0.8 | 3.41 |
| 41 | 0.6 | 40.5 |
| 45 | 0.8 | 3.75 |
| 50 | 0.5 | 4.49 |
| 55 | 0.5 | 3.79 |
| 60 | 0.4 | 4.02 |
| 65 | 0.4 | 4.04 |
| 70 | 0.4 | 4.03 |
| 75 | 0.8 | 16.89 |
| 80 | 0.4 | 3.11 |
| 85 | 1 | 8.92 |
| 90 | 0.6 | 13.17 |
| 95 | 0.5 | 5.08 |
| 100 | 0.5 | 4.22 |
| 105 | 0.8 | 9.18 |
| 110 | 0.9 | 8.6 |
| 115 | 1.4 | 6.42 |
| 120 | 0.9 | 14.03 |
| 125 | 0.9 | 5.46 |
| 130 | 0.9 | 11.01 |
| 135 | 1.6 | 16.17 |
| 140 | 1.5 | 7.14 |
| 145 | 0.8 | 18.02 |
| 150 | 6.1 | 3.98 |
| 170 | 0.3 | |
| 175 | 0.3 | |
| 180 | 0.3 | |
| 190 | 0.3 | |
| 195 | 0.3 | |
| 200 | 0.4 | |
| 215 | 0.6 | |
| 220 | 0.3 | |

9 3 1 2 3 5 1 3 5 0

Table A-2. Calcium Carbonate and Moisture Data

Well 299-W22-39.

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| Depth Feet | CaCO ₃ Wt. % | Moisture Wt. % |
|------------|-------------------------|----------------|
| 5 | 0.3 | 5.43 |
| 10 | 0.1 | 3 |
| 15 | 0.8 | 12.37 |
| 20 | 0.6 | 5.43 |
| 24 | 0.1 | 32.57 |
| 25 | 0.8 | 6.87 |
| 30 | 0.9 | 6.97 |
| 35 | 0.8 | 6.41 |
| 40 | 1 | 6.69 |
| 45 | 0.8 | 7.06 |
| 50 | 0.6 | 11.64 |
| 55 | 0.6 | 3.56 |
| 60 | 0.6 | 5.3 |
| 65 | 0.5 | 6.23 |
| 70 | 0.5 | 3.25 |
| 75 | 0.8 | 6.5 |
| 80 | 0.9 | 5.46 |
| 85 | 0.6 | 3.88 |
| 90 | 1 | 12.31 |
| 95 | 0.8 | 6.38 |
| 100 | 0.6 | 4.68 |
| 105 | 0.8 | 4.13 |
| 110 | 0.8 | 4.24 |
| 115 | 1 | 3.46 |
| 120 | 1 | 2.91 |
| 125 | 1 | 3.3 |
| 130 | 1 | 7.63 |
| 135 | 1.7 | 6.07 |
| 140 | 0.8 | 4.23 |
| 145 | 1.8 | 16.61 |
| 147 | 6 | 10.85 |
| 150 | 1.7 | 7.73 |
| 155 | 2.5 | |
| 160 | 1.8 | |
| 165 | 0.8 | |
| 170 | 0.9 | |
| 175 | 0 | |
| 180 | 0.1 | |
| 185 | 0.1 | |
| 190 | 0 | |
| 195 | 0.1 | |
| 200 | 0.1 | |
| 205 | 0.1 | |
| 205-207 | 0.1 | |
| 210 | 0 | |
| 215 | 0.1 | |
| 220 | 0.1 | |
| 221-223 | 0.5 | |

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

Table A-2. Calcium Carbonate and Moisture Data

Well 299-W23-13.

Page 8 of 12

| Depth Feet | CaCO3 Wt. % | Moisture Wt. % |
|------------|-------------|----------------|
| 5 | 2 | 12.52 |
| 10 | 0 | 3.1 |
| 15 | 0.8 | 20 |
| 20 | 0.5 | 3.43 |
| 25 | 0.5 | 2.97 |
| 30 | 0.3 | 3.87 |
| 35 | 0.3 | 4.74 |
| 40 | 0.3 | 4.51 |
| 45 | 0.5 | 6.97 |
| 50 | 0.5 | 6.57 |
| 55 | 0.6 | 7.33 |
| 60 | 0.5 | 8.36 |
| 65 | 0.6 | 4.92 |
| 70 | 0.8 | 5.48 |
| 72 | 1.5 | 25.95 |
| 15 | 0.3 | 3.87 |
| 80 | 1 | 14.57 |
| 85 | 0.8 | 2.45 |
| 90 | 0.6 | 2.33 |
| 95 | 0.5 | 8.87 |
| 100 | 0.5 | 4.73 |
| 105 | 0.6 | 5.72 |
| 110 | 0.8 | 6.77 |
| 115 | 0.8 | 9.71 |
| 120 | 0.8 | 5.74 |
| 125 | 1.8 | 9.87 |
| 130 | 0.8 | 14.46 |
| 135 | 1.8 | 8.99 |
| 140 | 1.8 | 14.94 |
| 145 | 1.6 | 9.42 |
| 150 | 3.3 | 17.74 |
| 155 | 0.9 | |
| 164 | 2.5 | |
| 170 | 0.5 | |
| 175 | 0.3 | |
| 180 | 0.3 | |
| 185 | 0.3 | |
| 190 | 0.3 | |
| 195 | 0.5 | |
| 200 | 0.5 | |
| 200.3 | 0.3 | |
| 205 | 0.3 | |
| 210 | 0.3 | |
| 215 | 0.3 | |

9 3 1 2 3 5 1 8 5 2

Table A-2. Calcium Carbonate and Moisture Data

Well 299-W23-14.

Page 9 of 11

| Depth Feet | CaCO ₃ Wt. % | Moisture Wt. % |
|------------|-------------------------|----------------|
| 10 | 0.1 | 9.77 |
| 15 | 0.8 | 8.95 |
| 20 | 0.3 | 4.49 |
| 25 | 0.5 | 3.98 |
| 30 | 0.5 | 2.82 |
| 35 | 0.3 | 3.34 |
| 40 | 0.9 | 6.12 |
| 46 | 0.9 | 6.31 |
| 50 | 0.8 | 6.36 |
| 55 | 0.6 | 6.6 |
| 60 | 0.8 | 5.08 |
| 65 | 0.8 | 5.84 |
| 70 | 0.9 | 6.16 |
| 75 | 0.5 | 4.44 |
| 81 | 0.1 | 15.17 |
| 85 | 0.5 | 12.68 |
| 90 | 0.3 | 2.67 |
| 95 | 0.5 | 4.9 |
| 100 | 0.9 | 6.61 |
| 105 | 1.7 | 22.29 |
| 111 | 2 | 12.12 |
| 115 | 0.9 | 7.42 |
| 120 | 0.9 | 11.21 |
| 125 | 2 | 24.4 |
| 130 | 2.5 | 26.2 |
| 135 | 1 | 8.7 |
| 140 | 1.7 | 18.12 |
| 145 | 0.9 | 11.3 |
| 150 | 1 | 11.3 |
| 155 | 1.5 | 10.69 |
| 160 | 5.1 | 6.53 |
| 165 | 0.1 | 5.51 |
| 170 | 0.1 | 3.6 |
| 175 | 0.1 | |
| 181 | 0.1 | |
| 185 | 0.1 | |
| 190 | 0.1 | |
| 195 | 0.3 | |
| 200 | 0.5 | |
| 205 | 0.3 | |
| 210 | 0.1 | |
| 215 | 0.5 | |
| 220 | 0.5 | |

9 3 1 2 8 5 1 9 5 3

Table A-2. Calcium Carbonate and Moisture Data

Well 299-W24-20.

Page 10 of 12

| Depth Feet | CaCO3 Wt. % | Moisture Wt. % |
|------------|-------------|----------------|
| 5 | 0.5 | 4.87 |
| 10 | 0.1 | 3.41 |
| 15 | 0.3 | 3.83 |
| 20 | 0.1 | 4.75 |
| 22 | 0.8 | 3.31 |
| 25 | 0.1 | 4.51 |
| 30 | 0.8 | 14.1 |
| 35 | 0.6 | 4.24 |
| 40 | 0.6 | 4.17 |
| 45 | 0.6 | 3.05 |
| 50 | 0.8 | 3.47 |
| 55 | 0.8 | 3.5 |
| 60 | 0.8 | 3.23 |
| 65 | 0.6 | 3.2 |
| 70 | 0.8 | 3.91 |
| 75 | 0.5 | 3.46 |
| 80 | 0.5 | 3.42 |
| 85 | 0.5 | 4.41 |
| 90 | 0.6 | 5.91 |
| 95 | 0.8 | 2.62 |
| 100 | 0.9 | 4.64 |
| 105 | 0.5 | 2.7 |
| 110 | 0.9 | 3.1 |
| 115 | 0.8 | 3.41 |
| 120 | 0.8 | 3.93 |
| 125 | 0.8 | 3.2 |
| 130 | 0.8 | 3.11 |
| 135 | 0.9 | 3.27 |
| 140 | 0.8 | 3.38 |
| 145 | 0.8 | 3.58 |
| 150 | 0.9 | 3.56 |
| 155 | 1.4 | 5.36 |
| 160 | 0.9 | 3.06 |
| 165 | 0.9 | 2.22 |
| 170 | 0.9 | 2.49 |
| 175 | 1 | 2.54 |
| 180 | 1 | 2.4 |
| 185 | 0.8 | 2.3 |
| 190 | 0.9 | 2.39 |
| 195 | 0.8 | |
| 200 | 1.4 | 3.18 |
| 205 | 0.9 | 2.75 |
| 210 | 0.8 | 3.42 |
| 215 | 0.8 | 3.07 |
| 220 | 0.8 | 2.74 |
| 225 | 0.8 | 2.73 |
| 230 | 0.6 | 2.93 |

9 6 1 2 8 5 1 3 5 4

Table A-2. Calcium Carbonate and Moisture Data

Well 299-W24-20.

Page 10 of 12

| Depth Feet | CaCO ₃ Wt. % | Moisture Wt. % |
|------------|-------------------------|----------------|
| 235 | 0.6 | 2.69 |
| 240 | 0.6 | 2.77 |
| 245 | 0.6 | 2.77 |
| 250 | 0.8 | 2.91 |
| 255 | 0.6 | 2.84 |
| 260 | 0.6 | 2.68 |
| 265 | 1 | 3.56 |
| 270 | 0.9 | 3.59 |
| 275 | 1.4 | 17.62 |
| 280 | 0.8 | 6.57 |
| 285 | 0.8 | 14.18 |
| 290 | 0.6 | 6.45 |
| 295 | 0.5 | |
| 300 | 0.5 | |

9 3 1 2 0 5 1 0 5 5

Table A-2. Calcium Carbonate and Moisture Data

Well 299-W33-41.

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| Depth Feet | CaCO ₃ Wt. % | Moisture Wt. % |
|------------|-------------------------|----------------|
| 0 | 0.5 | 5.61 |
| 5 | 0.3 | 3.4 |
| 10 | 0.5 | 6.28 |
| 15 | 0.3 | 3.52 |
| 20 | 0.3 | 2.78 |
| 25 | 0.3 | 4.35 |
| 30 | 0.1 | 3.21 |
| 35 | 0.1 | 3.01 |
| 40 | 0.3 | 3.53 |
| 45 | 0.3 | 4.15 |
| 50 | 0.5 | 4.18 |
| 55 | 0.3 | 5.61 |
| 60 | 0.5 | 4.11 |
| 65 | 0.5 | 3.89 |
| 70 | 0.3 | 2.75 |
| 75 | 0.5 | 2.23 |
| 80 | 0.6 | 2.39 |
| 85 | 0.3 | 2.62 |
| 90 | 0.3 | 2.21 |
| 95 | 0.3 | 3.46 |
| 100 | 0.5 | 8.74 |
| 105 | 0.6 | 3.06 |
| 110 | 0.5 | 3.3 |
| 115 | 0.3 | 6.74 |
| 120 | 0.5 | 25.52 |
| 123 | 2.3 | 5.01 |
| 125 | 0.3 | 4.64 |
| 130 | 0.3 | 4.33 |
| 135 | 0.5 | 5.72 |
| 140 | 0.5 | 4.53 |
| 145 | 0.3 | 4.26 |
| 150 | 0.5 | 4.61 |
| 155 | 0.6 | 26.27 |
| 164 | 2.4 | 5.68 |
| 165 | 0.5 | 4 |
| 170 | 0.3 | 3.35 |
| 175 | 0.3 | 3.69 |
| 180 | 0.1 | 3.99 |
| 185 | 0.3 | 3.47 |
| 190 | 0.3 | 3.19 |
| 195 | 0.3 | 3.63 |
| 200 | 0.5 | 3.46 |
| 205 | 0.5 | 3.71 |
| 210 | 0.3 | 3.53 |
| 215 | 0.5 | |
| 244 | 0.5 | |
| 254 | 0.3 | |

9 5 1 3 5 6
9 5 1 3 5 6
9 5 1 3 5 6

APPENDIX B
HEALTH AND SAFETY PLAN

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ACRONYMS AND ABBREVIATIONS

| | |
|-------------------------|---|
| AAMS | aggregate area management study |
| CERCLA | Comprehensive Environmental Response, Compensation and Liability Act |
| CFR | Code of Federal Regulations |
| DOE | U.S. Department of Energy |
| EII | Environmental Investigations Instructions |
| HEHF | Hanford Environmental Health Foundation |
| HSP | health and safety plan |
| HWOP | Hazardous Waste Operations Permit |
| JSA | Job Safety Analysis |
| NIOSH | National Institute for Occupational Safety and Health |
| OSHA | Occupational Safety and Health Administration |
| RCRA | Resource Conservation Recovery Act |
| RWP | Radiation Work Permit |
| SCBA | self-contained breathing apparatus |
| Westinghouse Hanford | Westinghouse Hanford Company |
| WISHA | Washington Industrial Safety and Health Act |

9 3 1 2 0 5 1 8 5 9

1
2
3
4 **1.0 GENERAL CONSIDERATIONS AND REQUIREMENTS**

5
6
7 **1.1 INTRODUCTION**

8 The purpose of this Health and Safety Plan (HSP) is to outline standard health and
9 safety procedures for Westinghouse Hanford Company (Westinghouse Hanford) employees
10 and contractors engaged in investigation activities in the S Plant Aggregate Area Management
11 Study (AAMS). These activities will include surface investigation, drilling and sampling
12 boreholes, and environmental sampling in areas of known chemical and radiological
13 contamination. Appropriate site-specific safety documents (e.g., Hazardous Waste Operations
14 Permit [HWOP] or Job Safety Analysis [JSA]) will be written for each task or group of tasks.
15 A more complete discussion of Westinghouse Hanford environmental safety procedures is
16 presented in the Westinghouse Hanford manual *Health and Safety for Hazardous Waste Field
Operations*, WHC-CM-4-3 vol. 4 (DOE/RL 1992).

17 All employees of Westinghouse Hanford or any other contractors who are participating
18 in onsite activities in the S Plant AAMS shall read the site-specific safety document and
19 attend a pre-job safety or tailgate meeting to review and discuss the task.
20
21

22 **1.2 DESIGNATED SAFETY PERSONNEL**

23
24 The field team leader and site safety officer are responsible for site safety and health.
25 Specific individuals will be assigned on a task-by-task basis by project management, and their
26 names will be properly recorded before the task is initiated.
27

28 All activities onsite must be cleared through the field team leader. The field team
29 leader has responsibility for the following:
30

- 31
- 32 • Allocating and administering resources to successfully comply with all
33 technical and health and safety requirements
 - 34 • Verifying that all permits, supporting documentation, and clearances are in
35 place (e.g., electrical outage requests, welding permits, excavation permits,
36 HWOP or JSA, sampling plan, radiation work permits [RWP], and
37 onsite/offsite radiation shipping records)
 - 38
 - 39 • Providing technical advice during routine operations and emergencies
 - 40
 - 41 • Informing the appropriate site management and safety personnel of the
42 activities to be performed each day
 - 43
 - 44 • Coordinating resolution of any conflicts that may arise between RWPs and
45 the implementation of the HWOP or JSA with health physics

- Handling emergency response situations as may be required
- Conducting pre-job and daily tailgate safety meetings
- Interacting with adjacent building occupants and/or inquisitive public.

The site safety officer is responsible for implementing the HWOP at the site. The site safety officer shall do the following.

- Monitor chemical, physical, and (in conjunction with the health physics technician) radiation hazards to assess the degree of hazard present; monitoring shall specifically include organic vapor detection, radiation screening, and confined space evaluation where appropriate.
- Determine protection levels, clothing, and equipment needed to ensure the safety of personnel in conjunction with the health physics department.
- Monitor the performance of all personnel to ensure that the required safety procedures are followed.
- Halt operations immediately, if necessary, due to safety or health concerns.
- Conduct safety briefings as necessary.
- Assist the field team leader in conducting safety briefings as necessary.

The health physics technician is responsible for ensuring that all radiological monitoring and protection procedures are being followed as specified in the Radiation Protection Manual and in the appropriate RWP. Westinghouse Hanford Industrial Safety and Fire Protection personnel will provide safety overview during drilling operations consistent with Westinghouse Hanford policy and, as requested, will provide technical advice. Also, downwind sampling for hazardous materials and radiological contaminants and other analyses may be requested from appropriate contractor personnel as required.

The ultimate responsibility and authority for employee's health and safety lies with the employee and the employee's colleagues. Each employee is responsible for exercising the utmost care and good judgment in protecting his or her personal health and safety and that of fellow employees. Should any employee observe a potentially unsafe condition or situation, it is the responsibility of that employee to immediately bring the observed condition to the attention of the appropriate health and safety personnel, as designated previously. In the event of an immediately dangerous or life-threatening situation, the employee automatically has temporary "stop work" authority and the responsibility to immediately notify the field team leader or site safety officer. When work is temporarily halted because of a safety or health concern, personnel will exit the exclusion zone and meet at a predetermined place in the support zone. The field team leader, site safety officer, and health physics technician will determine the next course of action.

1
2 **1.3 MEDICAL SURVEILLANCE**
3

4 All field team members engaged in operable unit activities at sites governed by an
5 HWOP must have baseline physical examinations and be participants in Westinghouse
6 Hanford (or an equivalent) hazardous waste worker medical surveillance program.
7

8 Medical examinations will be designed to identify any pre-existing conditions that may
9 place an employee at high risk, and will verify that each worker is physically able to perform
10 the work required by this plan without undue risk to personal health. The physician shall
11 determine the existence of conditions that may reduce the effectiveness or prevent the
12 employee's use of respiratory protection. The physician shall also determine the presence of
13 conditions that may pose undue risk to the employee while performing the physical tasks of
14 this work plan using level B personal protection equipment. This would include any
15 condition that increases the employee's susceptibility to heat stress.

16
17 The examining physician's report will not include any nonoccupational diagnoses unless
18 directly applicable to the employee's fitness for the work required.
19
20

21 **1.4 TRAINING**
22

23 Before engaging in any onsite activities, each team member is required to have received
24 40 hours of health and safety training related to hazardous waste site operations and at least 8
25 hours of refresher training each year thereafter as specified in 29 Code of Federal Regulations
26 (CFR) 1910.120. In addition, each inexperienced employee (never having performed site
27 characterization) will be directly supervised by a trained/experienced person for a minimum of
28 24 hours of field experience.
29

30 The field team leader and the site safety officer shall receive an additional 8 hours of
31 training (in addition to the refresher training previously discussed).
32

33
34 **1.5 TRAINING FOR VISITORS**
35

36 For the purposes of this plan, a visitor is defined as any person visiting the Hanford
37 Site, who is not a Westinghouse Hanford employee or a Westinghouse Hanford contractor
38 directly involved in the Resource Conservation and Recovery Act (RCRA)/Comprehensive
39 Environmental Response, Compensation and Liability Act of 1980 (CERCLA) facility
40 investigation activities, including but not limited to those engaged in surveillance, inspection,
41 or observation activities.
42

43 Visitors who must, for whatever reason, enter a controlled (either contamination
44 reduction or exclusion) zone, shall be subject to all of the applicable training, respirator fit
45 testing, and medical surveillance requirements discussed in Westinghouse Hanford
46 Environmental Investigations Instructions (EII) 1.1 and Appendix B to EII 1.1 (WHC 1991).

1 All visitors shall be informed of potential hazards and emergency procedures by their
2 escorts and shall conform to EII 1.1 (WHC 1991).
3
4

5 1.6 RADIATION DOSIMETRY 6

7 All personnel engaged in onsite activities shall be assigned dosimeters according to the
8 requirements of the RWP applicable to that activity. All visitors shall be assigned basic
9 dosimeters, as a minimum, that will be exchanged annually.
10

11 1.7 REQUIREMENTS FOR THE USE OF RESPIRATORY 12 PROTECTION 13 14

15 All employees of Westinghouse Hanford and subcontractors who may be required to use
16 air-purifying or air-supplied respirators must be included in the medical surveillance program
17 and be approved for the use of respiratory protection by the Hanford Environmental Health
18 Foundation (HEHF) or other licensed physician. Each team member must be trained in the
19 selection, limitations, and proper use and maintenance of respiratory protection (existing
20 respiratory protection training may be applicable towards the 40-hour training requirement).
21

22 Before using a negative pressure respirator, each employee must have been fit-tested
23 (within the previous year) for the specific make, model, and size according to Westinghouse
24 Hanford fit-testing procedures. Beards (including a few days' growth), large sideburns, or
25 moustaches that may interfere with a proper respirator seal are not permitted.
26

27 Subcontractors must provide evidence to Westinghouse Hanford that personnel are
28 participants in a medical surveillance and respiratory protection program that complies with
29 29 CFR 1910.120 and 29 CFR 1910.134, respectively.
30

31 2.0 GENERAL PROCEDURES 32 33 34 35

36 The following personal hygiene and work practice guidelines are intended to prevent
37 injuries and adverse health effects. A hazardous waste site poses a multitude of health and
38 safety concerns because of the variety and number of hazardous substances present. These
39 guidelines represent the minimum standard procedures for reducing potential risks associated
40 with this project and are to be followed by all job-site employees at all times.
41
42

1 **2.1 GENERAL WORK SAFETY PRACTICES**

2
3
4 **2.1.1 Work Practices**

5
6 The following work practices must be observed.

- 7
- 8 • Eating, drinking, smoking, taking certain medications, chewing gum, and
9 similar actions are prohibited within the exclusion zone. All sanitation
10 facilities shall be located outside the exclusion zone; decontamination is
11 required before using such facilities.
 - 12
 - 13 • Personnel shall avoid direct contact with contaminated materials unless
14 necessary for sample collecting or required observation. Remote handling of
15 such things as casings and auger flights will be practiced whenever practical.
 - 16
 - 17 • While operating in the controlled zone, personnel shall use the "buddy
18 system" where appropriate, or be in visual contact with someone outside of
19 the controlled zone.
 - 20
 - 21 • The buddy system will be used where appropriate for manual lifting.
 - 22
 - 23 • Requirements of Westinghouse Hanford radiation protection and RWP
24 manuals shall be followed for all work involving radioactive materials or
25 conducted within a radiologically controlled area.
 - 26
 - 27 • Onsite work operations shall only be carried out during daylight hours,
28 unless the entire control zone is adequately illuminated with artificial
29 lighting. A new tour (shift) will operate the drilling rig after completion of
30 each shift.
 - 31
 - 32 • Do not handle soil, waste samples, or any other potentially contaminated
33 items unless wearing the protective equipment specified in the HWOP or
34 JSA.
 - 35
 - 36 • Whenever possible, stand upwind of excavations, boreholes, well casings,
37 drilling spoils, and the like, as indicated by an onsite windsock.
 - 38
 - 39 • Stand clear of trenches during excavation. Always approach an excavation
40 from upwind.
 - 41
 - 42 • Be alert to potentially changing exposure conditions as evidenced by such
43 indications as perceptible odors, unusual appearance of excavated soils, or
44 oily sheen on water.
 - 45

- Do not enter any test pit or trench deeper than 1.2 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.
- At the end of each work day or each job, disposable clothing shall be removed and placed in (chemical contamination) drums, plastic-lined boxes or other containers as appropriate. Clothing that can be cleaned may be sent to the Hanford Site laundry.
- Individuals are expected to thoroughly shower before leaving the work site or Hanford Site if directed to do so by the health physics technician, site safety officer, or field team leader.

1 **2.1.4 Emergency Preparation**

- 2
- 3 • A multipurpose dry chemical fire extinguisher, a fire shovel, a complete
- 4 field first-aid kit, and a portable pressurized spray wash unit shall be
- 5 available at every site where there is potential for personnel contamination.
- 6
- 7 • Prearranged hand signals or other means of emergency communication will
- 8 be established when respiratory protection equipment is to be worn, because
- 9 this equipment seriously impairs speech.
- 10
- 11 • The Hanford Fire Department shall be initially notified before the start of
- 12 the site investigation project. This notification shall include the location and
- 13 nature of the various types of field work activities as described in the work
- 14 plan. A site location map shall be included in this notification.
- 15

16 **2.2 CONFINED SPACE/TEST PIT ENTRY PROCEDURES**

17

18

19 The following procedures apply to the entry of any confined space, which for the

20 purpose of this document shall be defined as any space having limited egress (access to an

21 exit) and the potential for the presence or accumulation of a toxic or explosive atmosphere.

22 This includes manholes, certain trenches (particularly those through waste disposal areas), and

23 all test pits greater than 1 m (4 ft) deep. If confined spaces are to be entered as part of the

24 work operations, a hazardous work permit (filled out for confined space entry) must be

25 obtained from Industrial Safety and Fire Protection.

26

27

28 The identified remedial investigation activities on the S Plant AAMS should not require

29 confined space entry. Nevertheless, the hazards associated with confined spaces are of such

30 severity that all employees should be familiar with the safe work discussed in the following

31 paragraphs.

32

33 No employee shall enter any test pit or trench deeper than 1 m (4 ft) unless the sides

34 are shored or laid back to a stable slope as specified in OSHA 29 CFR 1926.652 or

35 equivalent state occupational health and safety regulations.

36

37 When an employee is required to enter a pit or trench 1 m (4 ft) deep or more, an

38 adequate means of access and egress, such as a slope of at least 2:1 to the bottom of the pit

39 or a secure ladder or steps shall be provided.

40

41 Before entering any confined space, including any test pit, the atmosphere will be tested

42 for flammable gases, oxygen deficiency, and organic vapors. If other specific contamination,

43 such as radioactive materials or other gases and vapors may be present, additional testing for

44 those substances shall be conducted. Depending on the situation, the space may require

45 ventilation and retesting before entry.

1 An employee entering a confined or partially confined space must be equipped with an
2 appropriate level of respiratory protection in keeping with the monitoring procedures
3 discussed previously and the action levels for airborne contaminants (see "Warnings and
4 Action Levels" in HWOP).
5

6 No employee shall enter any test pit requiring the use of level B protection, unless a
7 backup person also equipped with a pressure-demand self-contained breathing apparatus
8 (SCBA) is present. No backup person shall attempt any emergency rescue unless a second
9 backup person equipped with an SCBA is present, or the appropriate emergency response
10 authorities have been notified and additional help is on the way.
11
12
13

14 3.0 SITE BACKGROUND

15
16
17 Specific details on the S Plant AAMS background and known and suspected
18 contamination are described in Chapters 2.0 through 10.0 of the plan. The S Plant Aggregate
19 Area is situated within the 200 West Area of the U.S. Department of Energy's (DOE)
20 Hanford Site, in the south-central portion of the state of Washington. The 200 West Area is
21 located in Benton County in the central portion of the Hanford Site. It is adjacent to the 200
22 East Area, located roughly 5 km to the west.
23

24 The S Plant Area at the Hanford Site was used by the U.S. Government as a chemical
25 separations area in the process to produce plutonium for nuclear weapons. These operations
26 resulted in the release of chemical and radioactive wastes into the soil, air, and water of the
27 area. Each waste site in the aggregate area is described separately in this document. Close
28 relationships between waste units, such as overflow from one to another, are also discussed.
29
30
31

32 4.0 SCOPE OF WORK AND POTENTIAL HAZARDS

33
34
35 While the information presented in Chapters 2.0 through 10.0 of the plan are believed to
36 be representative of the constituents and quantities of wastes at the time of discharge, the
37 present chemical nature, location, extent, and ultimate fate of these wastes in and around the
38 liquid disposal facilities are largely unknown. The emphasis of the investigation in the
39 S Plant AAMS will be to characterize the nature and extent of contamination in the vadose
40 (unsaturated subsurface soil) zone.
41
42

1 **4.1 WORK TASKS**

2
3 Work tasks are described in Chapter 5.0 of the plan.
4
5

6 **4.2 POTENTIAL HAZARDS**

7
8 Onsite tasks will involve noninvasive surface sampling procedures and invasive soil
9 sampling either directly in or immediately adjacent to areas known or suspected to contain
10 potentially hazardous chemical substances, toxic metals, and radioactive materials.
11

12 Surface radiological contamination and fugitive dust will be the potential hazards of
13 primary concern during noninvasive mapping and sampling activities.
14

15 Existing data indicate that hazardous substances may be encountered during invasive
16 sampling; these include radionuclides, heavy metals, and corrosives. In addition, volatile
17 organics may also be associated with certain facilities such as the solvent storage buildings or
18 underground storage tanks.
19

20 Potential hazards include the following:

- 21
- 22 • External radiation (gamma and to a lesser extent, beta) from radioactive
23 materials in the soil
 - 24
 - 25 • Internal radiation resulting from radionuclides present in contaminated soil
26 entering the body by ingestion or through open cuts and scratches
 - 27
 - 28 • Internal radiation resulting from inhalation of particulate (dust) contaminated
29 with radioactive materials
 - 30
 - 31 • Inhalation of toxic vapors or gases such as volatile organics or ammonia
 - 32
 - 33 • Inhalation or ingestion of particulate (dust) contaminated with inorganic or
34 organic chemicals, and toxic metals
 - 35
 - 36 • Dermal exposure to soil or groundwater contaminated with radionuclides
 - 37
 - 38 • Dermal exposure to soil or groundwater contaminated with inorganic or
39 organic chemicals, and toxic metals
 - 40
 - 41 • Physical hazards such as noise, heat stress, and cold stress
 - 42
 - 43 • Slips, trips, falls, bumps, cuts, pinch points, falling objects, other overhead
44 hazards, crushing injuries, and other hazards typical of a construction-related
45 job site
 - 46

- Unknown or unexpected underground utilities
- Biological hazards; snakes, spiders, etc.

4.3 ASSESSMENT AND MITIGATION OF POTENTIAL HAZARDS

The likelihood of significant exposure (100 mR/h or greater) to external radiation is remote and can be readily monitored and controlled by limiting exposure time, increasing distance, and employing shielding as required.

Internal radiation by inhalation or inadvertent ingestion of contaminated dust is a realistic concern and must be continuously evaluated by the health physics technician. Appropriate respiratory protection, protective clothing, and decontamination procedures will be implemented as necessary to reduce potential inhalation, ingestion, and dermal exposure to acceptable levels.

Dermal exposure to toxic chemical substances is not expected to pose a significant problem for the identified tasks given the use of the designated protective clothing. The appropriate level of personal protective clothing and respiratory protection will vary from work site to work site.

5.0 ENVIRONMENTAL AND PERSONAL MONITORING

The site safety officer or authorized delegate shall be present at all times during work activities which require an HWOP, and shall be in charge of all environmental/personal monitoring equipment. Industrial Hygiene and Safety shall review all activities involving or potentially involving radiological exposure or contamination control and shall prescribe the appropriate level of technical support and/or monitoring requirements. Other equipment deemed necessary by the site safety officer or Industrial Hygiene and Safety shall be obtained at their direction; work will be initiated or continued until such equipment is in place. These instruments are to be used only by persons who are trained in their usage and who understand their limitations. No work shall be done unless instrumentation is available and in proper working order.

Air sampling may be required downwind of the referenced waste sites to monitor particulates and vapors before job startup. Siting of such sampling devices will be determined by Health Physics, the site safety officer, and HEHF, if appropriate. Any time personnel exposure monitoring, other than radiological, is required to determine exposure levels, it must be done by HEHF. Discrete sampling of ambient air within the work zone and breathing zones will be conducted using a direct-reading instrument, as specified in the site-

1 specific safety document, and other methods as deemed appropriate (e.g., pumps with tubes,
2 O₂ meters). The following standards will be used in determining critical levels:

- 3
- 4 • "Radionuclide Concentrations in Air," in Chapter XI, DOE Order 5480.1B
- 5 (DOE 1986)
- 6
- 7 • "Air Contaminants - Permissible Exposure Limits," in 29 CFR 1910.1000
- 8
- 9 • *Threshold Limit Values and Biological Exposure Indices for 1990-1991*
- 10 (ACGIH 1991)
- 11
- 12 • *Occupational Safety and Health Standards*, 29 CFR 1910.1000
- 13
- 14 • *Pocket Guide to Chemical Hazards* (NIOSH 1991), which provides National
- 15 Institute for Occupational Safety and Health (NIOSH)-recommended
- 16 exposure limits for substances that do not have either a threshold limit value
- 17 or a permissible exposure limit.
- 18
- 19

20 5.1 AIRBORNE RADIOACTIVE AND RADIATION

21 MONITORING

22

23 An onsite health physics technician will monitor airborne radioactive contamination
24 levels and external radiation levels. Action levels will be consistent with derived air
25 concentrations and applicable guidelines as specified in the radiation protection manual WHC-
26 CM-4-10 (WHC 1988).

27

28 Appropriate respiratory protection shall be required when conditions are such that the
29 airborne contamination levels may exceed an 8-hour derived air concentration (e.g., the
30 presence of high levels of uncontained, loose contamination on exposed surfaces or operations
31 that may raise excessive levels of dust contaminated with airborne radioactive materials, such
32 as excavation or drilling under extremely dry conditions).

33

34 Specific conditions requiring the use of respiratory protection because of radioactive
35 materials in air will be incorporated into the RWP. If, in the judgement of the health physics
36 technician, any of these conditions arise, work shall cease until appropriate respiratory
37 protection is provided.

40 6.0 PERSONAL PROTECTIVE EQUIPMENT

41

42

43

44 The level of personal protective equipment required initially at a site will be specified in
45 the site-specific safety document for each task or group of tasks. Personal protective clothing

APPENDIX C
PROJECT MANAGEMENT PLAN

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1 and respiratory protection shall be selected to limit exposure to anticipated chemical and
2 radiological hazards. Work practices and engineering controls may be used to control
3 exposure.
4
5
6

7 7.0 SITE CONTROL

8
9
10 The field team leader, site safety officer, and health physics technician are designated to
11 coordinate access control and security on the site. Special site control measures will be
12 necessary to restrict public access. The zones will be clearly marked with rope and/or
13 appropriate signs. The size and shape of the control zone will be dictated by the types of
14 hazards expected, the climatic conditions, and specific operations required.
15

16 Control zone boundaries may be increased or decreased based on results of field moni-
17 toring, environmental changes, or work technique changes. The site RWP and the
18 contractor's standard operating procedures for radiation protection may also dictate the
19 boundary size and shape. All team members must be surveyed for radioactive contamination
20 when leaving the controlled zone if in a radiation zone.
21

22 The onsite command post and staging area will be established near the upwind side of
23 the control zone as determined by an onsite windsock. Exact location for the command post
24 is to be determined just before start of work. Vehicle access, availability of utilities (power
25 and telephone), wind direction, and proximity to sample locations should be considered in
26 establishing a command post location.
27
28
29

30 8.0 DECONTAMINATION PROCEDURES

31
32
33 Remedial investigation activities will require entry into areas of known chemical and
34 radiological contamination. Consequently, it is possible that personnel and equipment could
35 be contaminated with hazardous chemical and radiological substances.
36

37 During site activities, potential sources of contamination may include airborne vapors,
38 gases, dust, mists, and aerosols; splashes and spills; walking through contaminated areas; and
39 handling contaminated equipment. Personnel who enter the exclusion zone will be required to
40 go through the appropriate decontamination procedures on leaving the zone. Decontamination
41 procedures shall be consistent with EII 5.4, "Field Decontamination of Drilling, Well
42 Development, and Sampling Equipment," and EII 5.5, "Decontamination of Equipment for
43 RCRA/CERCLA Sampling" (WHC 1991), or other approved decontamination procedures.
44
45
46

1 **9.0 CONTINGENCY AND EMERGENCY RESPONSE PLANS**
2
3

4 As a general rule, in the event of an unanticipated, potentially hazardous situation
5 indicated by instrument readings, visible contamination, unusual or excessive odors, or other
6 indications, team members shall temporarily cease operations and move upwind to a
7 predesignated safe area as specified in the site-specific safety documentation.
8
9

10 **10.0 REFERENCES**
11
12
13

14 ACGIH, 1991, *Threshold Limit Values and Biological Exposure Indices for 1990-1991*,
15 American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.

16 DOE, 1986, *Environment, Safety & Health Program for DOE Operations*, DOE Order
17 5480.1B, U.S. Department of Energy, Washington, D.C.

18 NIOSH, 1991, *Pocket Guide to Chemical Hazards, National Institute for Occupational Safety*
19 *and Health*, U.S. Department of Health and Human Services, Public Health Service,
20 Centers for Disease Control, Washington, D.C.

21 WHC, 1988, *Radiation Protection*, WHC-CM-4-10, Westinghouse Hanford Company,
22 Richland, Washington.

23 WHC, 1991, *Environmental Investigations and Site Characterization Manual*, WHC-CM-7-7,
24 Westinghouse Hanford Company, Richland, Washington.

25 WHC, 1992, *Health and Safety for Hazardous Waste Field Operations*, WHC-CM-4-3 Vol. 4,
26 Westinghouse Hanford Company, Richland, Washington.
27
28
29
30
31
32

ACRONYMS AND ABBREVIATIONS

| | |
|-------------------------|---|
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| DOE | U.S. Department of Energy |
| Ecology | Washington State Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| FS | feasibility study |
| MCS | Management Control System |
| PMP | Project Management Plan |
| QAPP | quality assurance project plan |
| RCRA | Resource Conservation Recovery Act |
| RI | remedial investigation |
| Tri-Party Agreement | Hanford Federal Facility Agreement and Consent Order |
| Westinghouse Hanford | Westinghouse Hanford Company |

9 3 1 2 8 1 3 7 7

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1.0 INTRODUCTION

This Project Management Plan (PMP) defines the administrative and institutional tasks necessary to support the S Plant Aggregate Area investigations at the Hanford Site. Also, this PMP defines the responsibilities of the various participants, the organizational structure, and the project tracking and reporting procedures. This PMP is in accordance with the provisions of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) Action Plan dated August 1990. Any revisions to the Tri-Party Agreement Action Plan that would result in changes to the project management requirements would supersede the provisions of this chapter.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 INTERFACE OF REGULATORY AUTHORITIES AND THE U.S. DEPARTMENT OF ENERGY

The S Plant Aggregate Area consists of active and inactive waste management units to be remedied under either Resource Conservation Recovery Act (RCRA) or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The U.S. Department of Ecology (Ecology) has been designated as the lead regulatory agency, as defined in the Tri-Party Agreement. Accordingly, Ecology is responsible for overseeing remedial action activity at this aggregate area and ensuring that the applicable authorities of both the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) are applied. The specific responsibilities of EPA, Ecology, and DOE are detailed in the Tri-Party Agreement Action Plan.

2.2 PROJECT ORGANIZATION AND RESPONSIBILITIES

The project organization for implementing remedial activities at the S Plant Aggregate Area is shown in Figure C-1. The following sections describe the responsibilities of the individuals shown in Figure C-1.

2.2.1 Project Managers

The EPA, DOE, and Ecology have each designated one individual as project manager for remedial activities at the Hanford Site. These project managers will serve as the primary point of contact for all activities to be carried out under the Tri-Party Agreement Action Plan. The responsibilities of the project managers are given in Section 4.1 of the Tri-Party Agreement Action Plan.

1 **2.2.2 Unit Managers**
2

3 As shown in Figure C-1, EPA, DOE, and Ecology will each designate an individual as a
4 unit manager for the S Plant Aggregate Area.
5

6 The unit manager from Ecology will serve as the lead unit manager. The Ecology unit
7 manager will be responsible for regulatory oversight of all activities required for the S Plant
8 Aggregate Area.
9

10 The unit manager from EPA will be responsible for making decisions related to issues
11 for which the supporting regulatory agency maintains authority. All such decisions will be
12 made in consideration of recommendations made by the Ecology unit manager.
13

14 The unit manager from DOE will be responsible for maintaining and controlling the
15 schedule and budget and keeping the EPA and Ecology unit managers informed as to the
16 status of the activities at the S Plant Aggregate Area, particularly the status of agreements and
17 commitments.
18

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 auditing
24 program controls that may be appropriately applied to the remedial activities. The quality
25 assurance officer is specifically vested with the organizational independence and authority to
26 identify conditions adverse to quality, and to systematically seek effective corrective action.
27

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
38 **2.2.5 Health and Safety Officer (Environmental Division/Environmental Field Services)**
39

40 The health and safety officer is responsible for monitoring all potential health and safety
41 hazards, including those associated with radioactive, volatile, and/or toxic compounds during
42 sample handling and sampling decontamination activities. The health and safety officer has
43 the responsibility and authority to halt field activities resulting from unacceptable health and
44 safety hazards.
45
46

1 **2.2.6 Technical Lead**
2

3 The technical lead will be a designated person within the Westinghouse Hanford
4 Company (Westinghouse Hanford) Environmental Engineering Group. The responsibilities of
5 the technical lead will be to plan, authorize, and control work so that it can be completed on
6 schedule and within budget, and to ensure that all planning and work performance activities
7 are technically sound.
8
9

10 **2.2.7 Remedial Investigation/Feasibility Study Coordinators**
11

12 The remedial investigation (RI) and feasibility study (FS) coordinators will be
13 responsible for coordinating all activities related to the RI and FS, respectively, including data
14 collection, analysis, and reporting. The RI and FS coordinators will be responsible for
15 keeping the technical lead informed as to the RI and FS work status and any problems that
16 may arise.
17

18
19 **2.2.8 Resource Conservation Recovery Act Facility Investigation/Corrective Measures**
20 **Study Contractor**
21

22 Figure C-1 shows the organizational relationship of an offsite contractor. Assuming a
23 contractor is used to perform the RI/FS for the S Plant Aggregate Area, the contractor would
24 assume responsibilities of the RI and FS coordinators, as described above. In this instance,
25 the contractor will be directly responsible for planning data collection activities and for
26 analyzing and reporting the results of the data-gathering in the RI and FS reports. However,
27 the Westinghouse Hanford coordinator would retain the responsibility for securing and
28 managing the field sampling efforts of the Hanford Site technical resource teams, described
29 below. Figure C-2 shows a sample organizational structure for an RI/FS contractor team.
30
31

32 **2.2.9 Hanford Site Technical Resources**
33

34 The various technical resources available on the Hanford Site for performing the field
35 studies are shown in Table C-1. These resources will be responsible for performing data
36 collection activities and analyses, and for reporting the results of specific technical activities.
37 Figures C-3 through C-6 show the detailed organizational structure of specific technical
38 teams. Internal and external work orders and subcontractor task orders will be written by the
39 Westinghouse Hanford technical lead to use these technical resources, which are under the
40 control of the technical lead. Statements of work will be provided to the technical teams and
41 will include a discussion of authority and responsibility, a schedule with clearly defined
42 milestones, and a task description including specific requirements. Each technical team will
43 keep the coordinator informed of the work status performed by that group and any problems
44 that may arise.
45
46

3.0 DOCUMENTATION AND RECORDS

1
2
3
4 All plans and reports will be categorized as either primary or secondary documents as
5 described by Section 9.1 of the Tri-Party Agreement Action Plan. The process for document
6 review and comment will be as described in Section 9.2 of the Tri-Party Agreement Action
7 Plan. Revisions, should they become necessary after finalization of any document, will be in
8 accordance with Section 9.3 of the Tri-Party Agreement Action Plan. Changes in the work
9 schedule, as well as minor field changes, can be made without having to process a formal
10 revision. The process for making these changes will be as stated in Section 12.0 of the Tri-
11 Party Agreement Action Plan. Administrative records, which must be maintained to support
12 the Hanford Site activities, will be in accordance with Section 9.4 of the Tri-Party Agreement
13 Action Plan.
14

4.0 FINANCIAL AND PROJECT TRACKING REQUIREMENTS

4.1 MANAGEMENT CONTROL

15
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21
22 Westinghouse Hanford will have the overall responsibility for planning and controlling
23 the investigation activities, and providing effective technical, cost, and schedule baseline
24 management. If a contractor is used, the contractor will assume the direct day-to-day
25 responsibilities for these management functions. The management control system used for
26 this project must meet the requirements of DOE Order 4700.1, Project Management System
27 and DOE Order 2250.1C, Cost and Schedule Control Systems Criteria. The Westinghouse
28 Hanford Management Control System (MCS) meets these requirements. The primary goals of
29 the Westinghouse Hanford MCS are to provide methods for planning, authorizing, and
30 controlling work so that it can be completed on schedule and within budget, and to ensure
31 that all planning and work performance activities are technically sound and in conformance
32 with management and quality requirements.
33

34 The schedule developed for the S Plant Aggregate Area will be updated at least
35 annually, to expand the new current fiscal year and the follow-on year. In addition, any
36 approved schedule changes (see Section 12.0 of the Tri-Party Agreement Action Plan for the
37 formal change control system) would be incorporated at this time, if not previously
38 incorporated. This update will be performed in the fourth quarter of the previous fiscal year
39 (e.g., July to September) for the upcoming current fiscal year. The work schedule can be
40 revised at any time during the year if the need arises, but the changes would be restricted to
41 major changes that would not be suitable for the change control process.
42
43

1 **4.2 MEETINGS AND PROGRESS REPORTS**
2

3 Both project and unit managers must meet periodically to discuss progress, review
4 plans, and address any issues that have arisen. The project managers' meeting will take place
5 at least quarterly, and is discussed in Section 8.1 of the Tri-Party Agreement Action Plan.
6

7 Unit managers shall meet monthly to discuss progress, address issues, and review near-
8 term plans pertaining to their respective operable unit and/or treatment, storage, and disposal
9 groups/units. The meetings shall be technical in nature, with emphasis on technical issues
10 and work progress. The assigned DOE unit manager for the S Plant Aggregate Area will be
11 responsible for preparing revisions to the aggregate area schedule prior to the meeting. The
12 schedule shall address all ongoing activities associated with the S Plant Aggregate Area,
13 including actions on specific source units (e.g., sampling). This schedule will be provided to
14 all parties and reviewed at the meeting. Any agreements and commitments (within the unit
15 manager's level of authority) resulting from the meeting will be prepared and signed by all
16 parties as soon as possible after the meeting. Meeting minutes will be issued by the DOE
17 unit manager and will summarize the discussion at the meeting, with information copies given
18 to the project managers. The minutes will be issued within five working days following the
19 meeting. The minutes will include, at a minimum, the following information:
20

- 21 • Status of previous agreements and commitments
22
23 • Any new agreements and commitments
24
25 • Schedules (with current status noted)
26
27 • Any approved changes signed off at the meeting in accordance with Section 12.1
28 of the Tri-Party Agreement Action Plan.
29

30 Project coordinators for each operable unit also will meet on a monthly basis to share
31 information and to discuss progress and problems.
32

33 The DOE shall issue a quarterly progress report for the Hanford Site within 45 days
34 following the end of each quarter. Quarters end on March 31, June 30, September 30, and
35 December 31. The quarterly progress reports will be placed in the public information
36 repositories as discussed in Section 10.2 of the Tri-Party Agreement Action Plan. The report
37 shall include the following:
38

- 39 • Highlights of significant progress and problems
40
41 • Technical progress with supporting information, as appropriate
42
43 • Problem areas with recommended solutions. This will include any anticipated
44 delays in meeting schedules, the reason(s) for the potential delay, and actions to
45 prevent or minimize the delay
46

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- Significant activities planned for the next quarter
- Work schedules (with current status noted).

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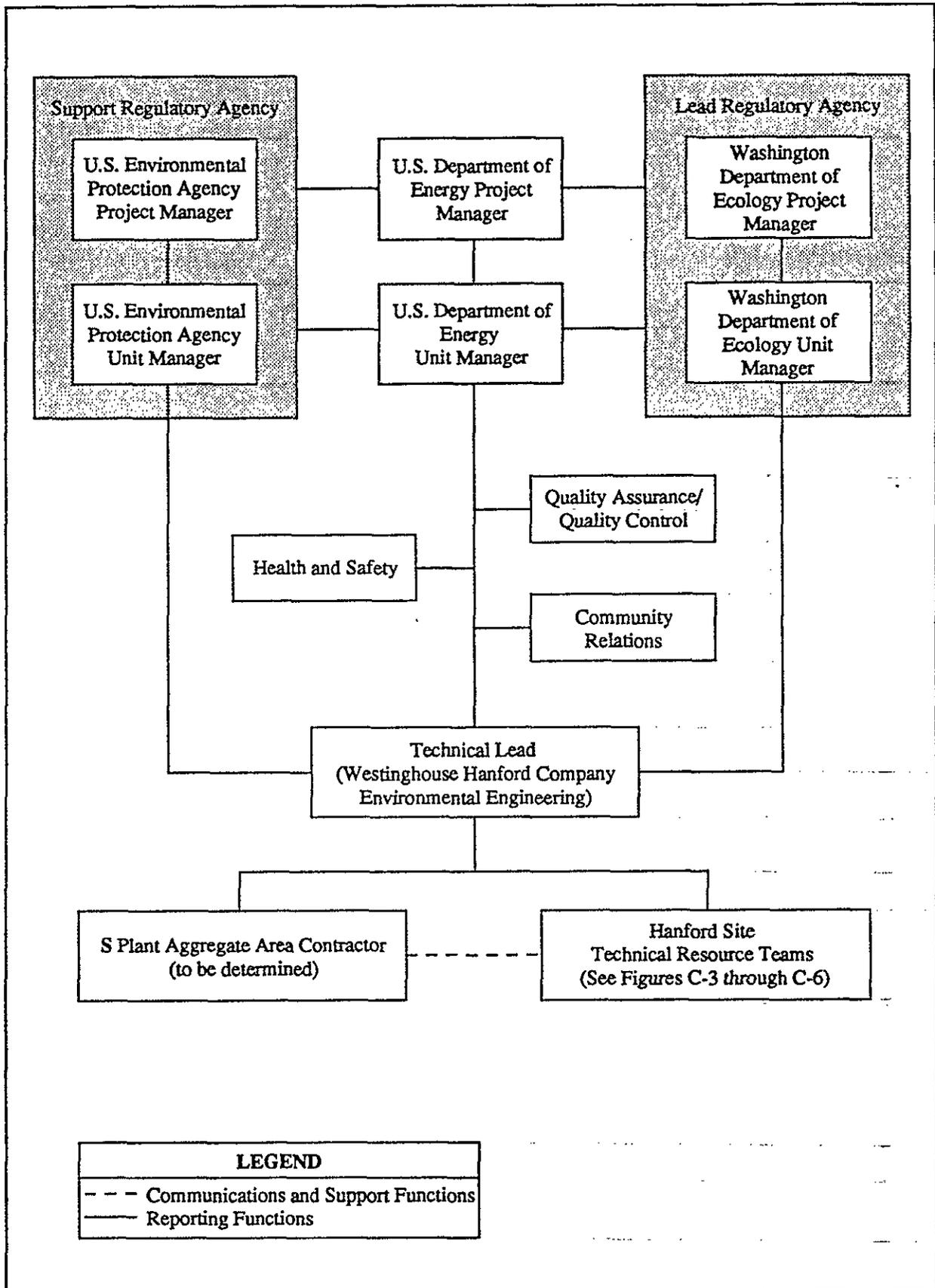


Figure C-1. Project Organization for the S Plant Aggregate Area Project.

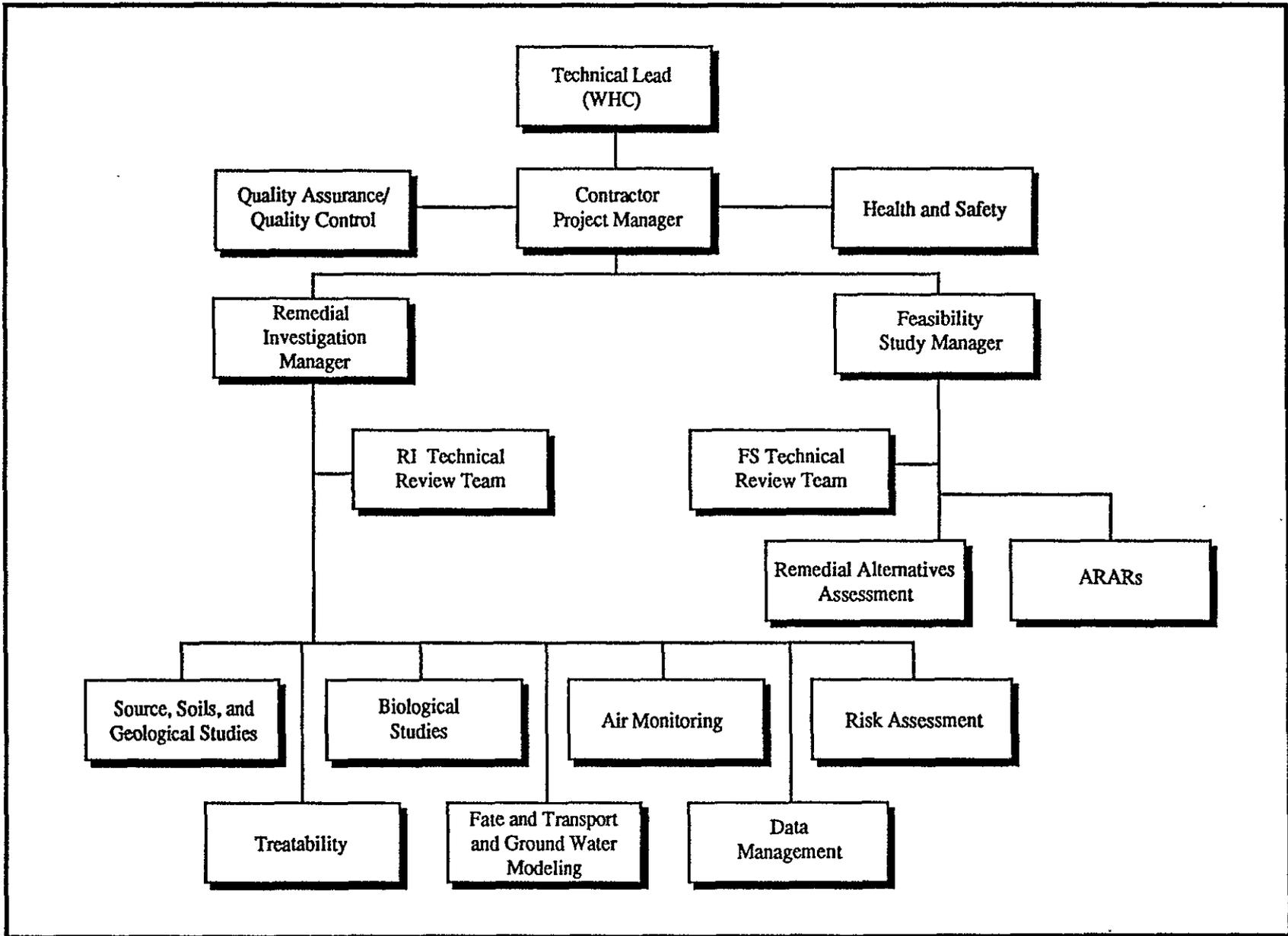


Figure C-2. Example Project Organization for the S Plant Aggregate Area.

CF-2

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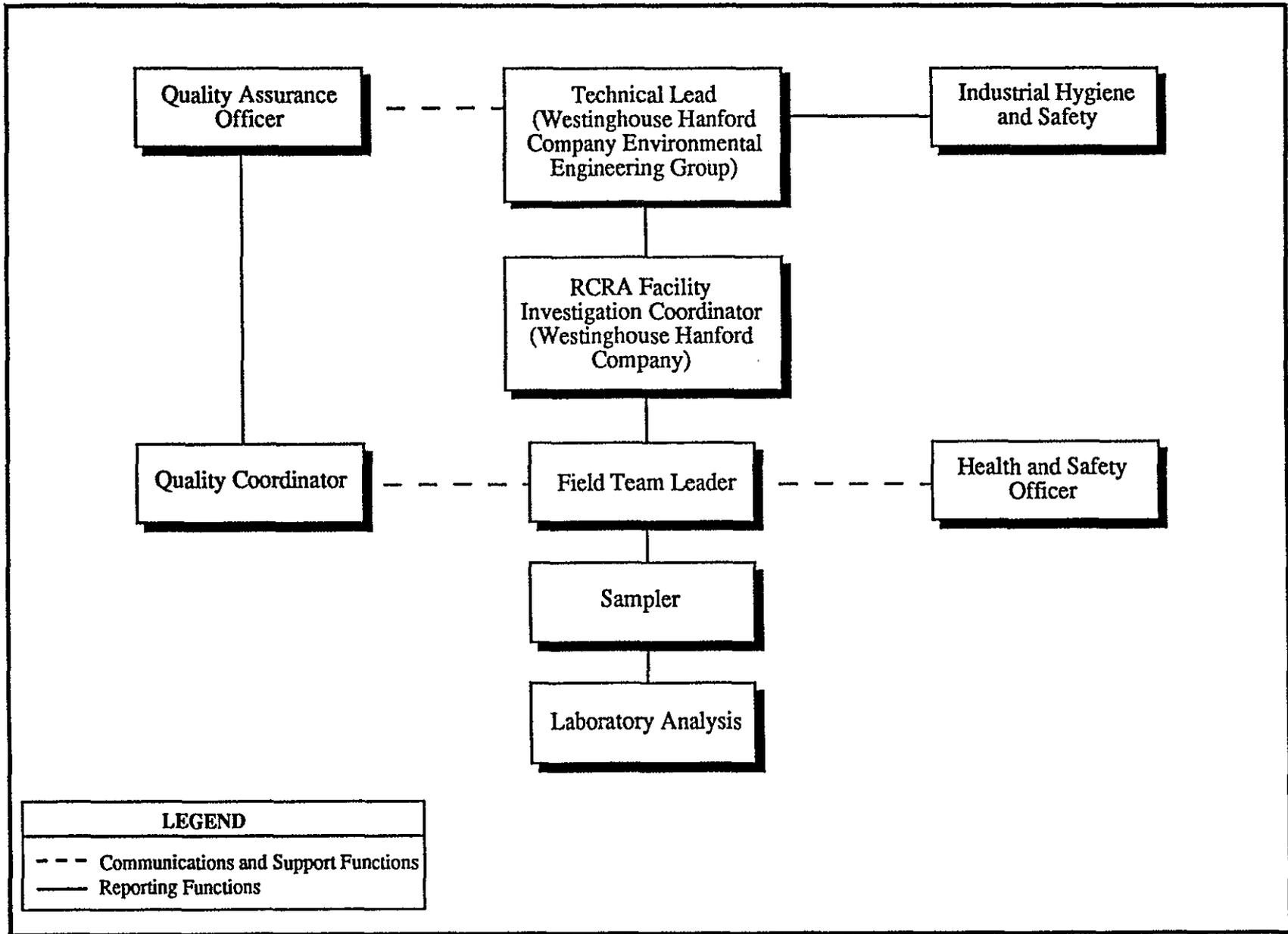
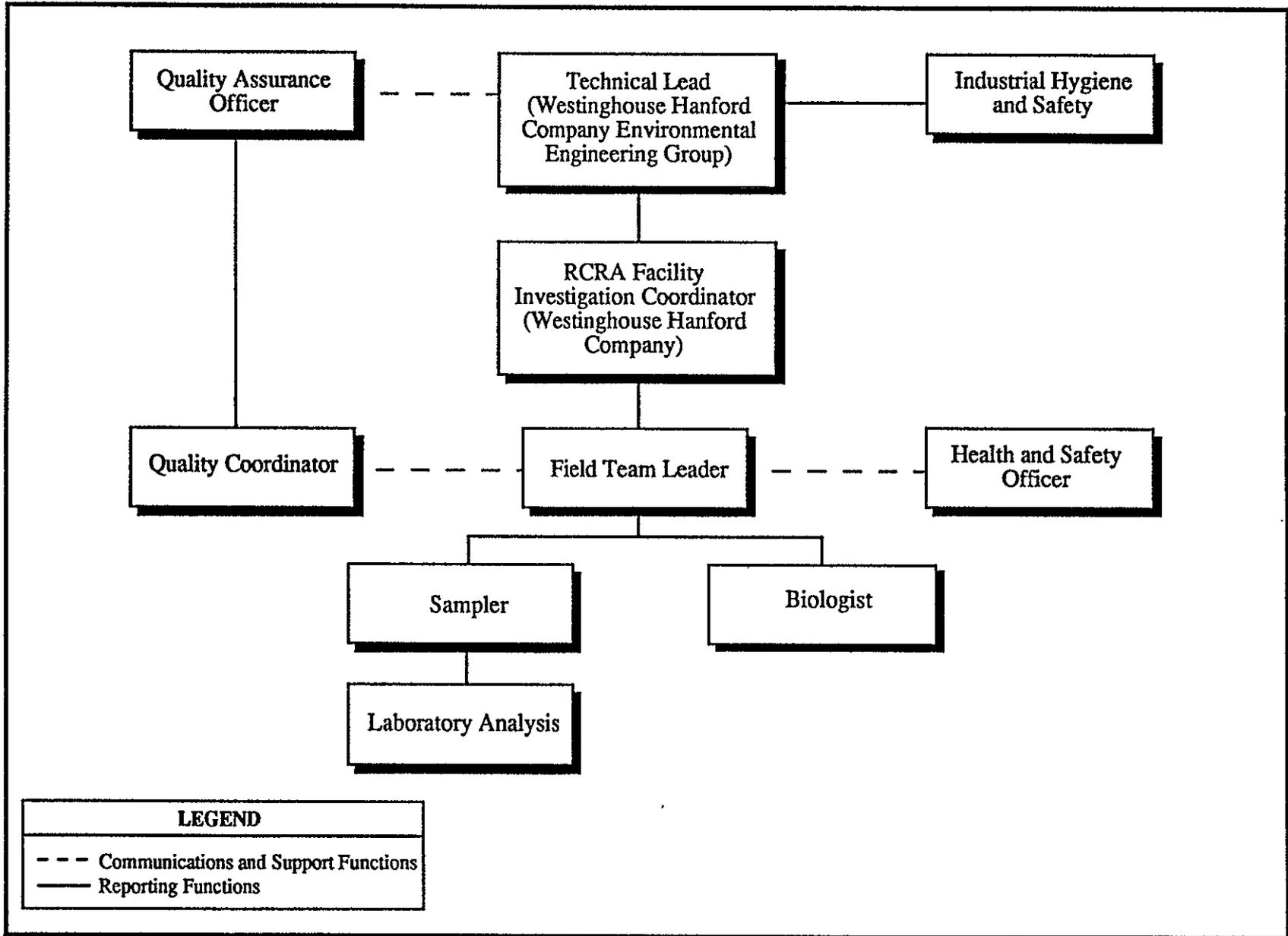


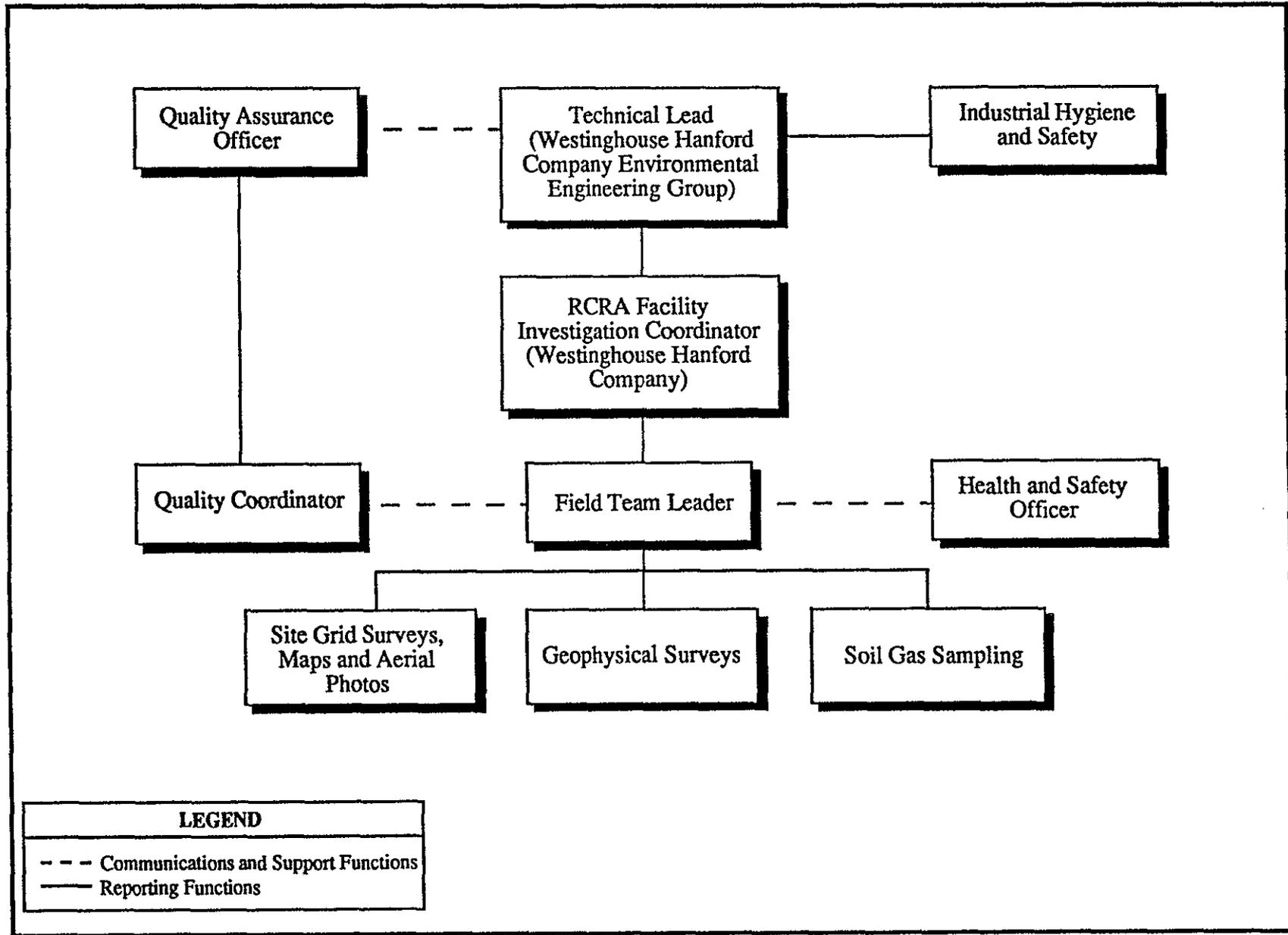
Figure C-3. The Hanford Site Soil Sampling Team.



CF-4

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Draft A

Figure C-4. The Hanford Site Biological Sampling Team.

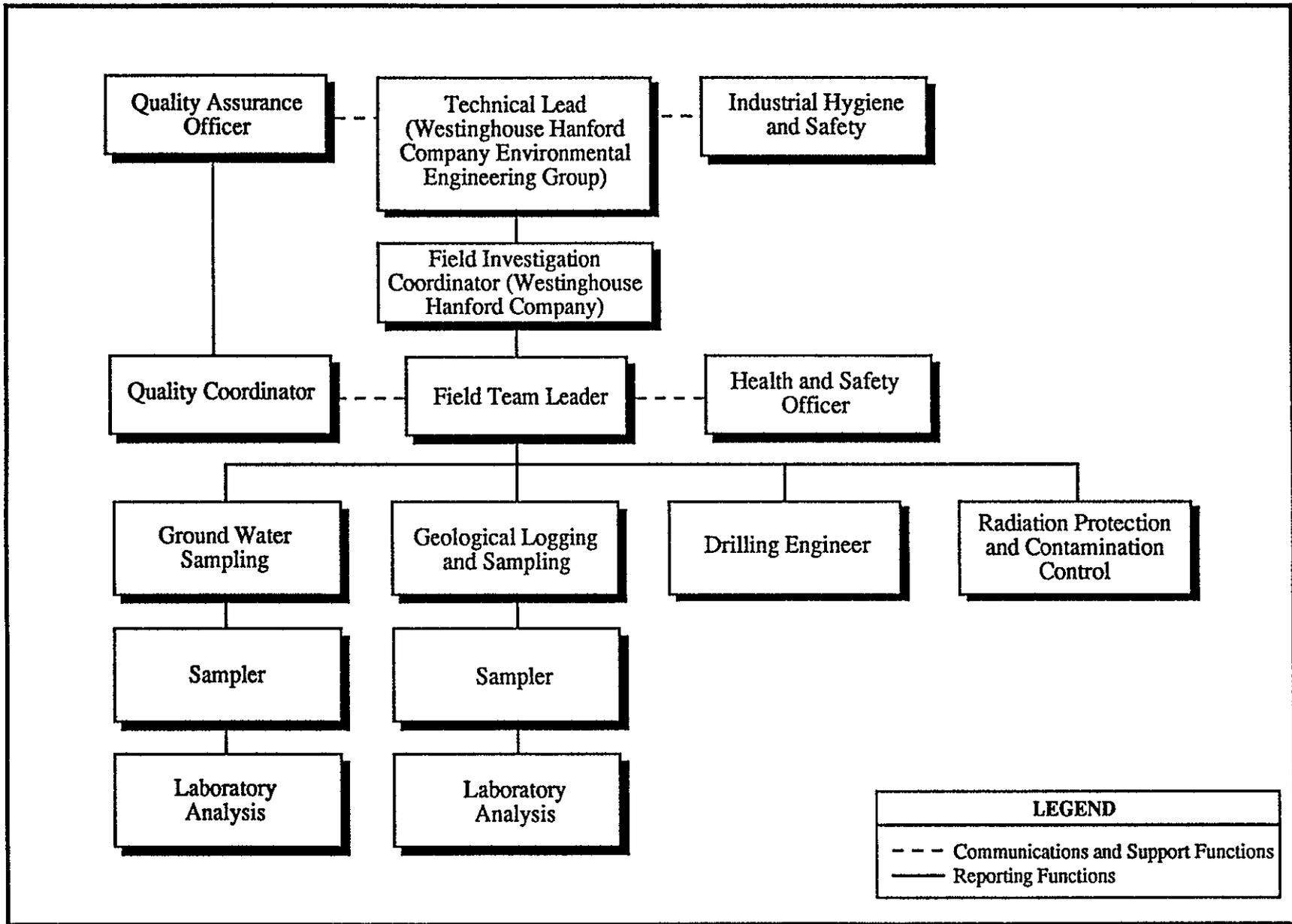


CF-5

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Figure C-5. The Hanford Site Physical and Geophysical Survey Team.

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CF-6

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Draft A

Figure C-6. Drilling, Sampling, and Well-Development Team.

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 |
| Groundwater 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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APPENDIX D

DATA MANAGEMENT PLAN

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|--|------|

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ACRONYMS AND ABBREVIATIONS

| | |
|-------------------------|--|
| 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 |
| DOE/RL | U.S. Department of Energy, Richland Operations Office |
| Ecology | Washington Department of Ecology |
| EDMC | Environmental Data Management Center |
| EHPSS | Environmental Health and Pesticide Services Section |
| 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 |
| ROD | record of decision |
| TR | training records |
| Tri-Party Agreement | Hanford Federal Facility Agreement and Consent Order |
| TSD | treatment, storage, and disposal |
| Westinghouse Hanford | Westinghouse Hanford Company |

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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 groundwater 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.

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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).

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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 S 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 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 (Westinghouse Hanford) *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 manager and process facility. All data entering the EDMC will be indexed, recorded, and placed into safe and secure storage. Data designated for placement into the AR will be copied, placed into the Hanford Site AR file, and distributed by the EDMC to the user community. The hard copy files are the primary sources of information; the various electronic data bases are secondary sources.

Normal access to data is through EDMC which is responsible for the AR. The Administrative Record Public Access Room is located in the 345 Hills Street Facility in Richland, Washington. This facility includes AR file documents (including identified guidance documents and technical literature).

Project participants may access data that are not in the AR by requesting it at the monthly unit managers' meeting for the operable unit of concern. As the project moves to completion, it is expected that all of the relevant data will be contained in the AR and the need to access data will be minimal.

The following types of data will be accessed from and reside in locations other than the EDMC:

| <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. |

1 **2.4 DATA QUANTITY**
2

3 Data quantities for the investigative activities will be estimated based on the sampling
4 and analysis plans developed for investigation of sites within the aggregate area.
5
6
7

8 **3.0 DATA MANAGEMENT PLAN**
9

10
11 **3.1 OBJECTIVE**
12

13 A considerable amount of data will be generated through the implementation of the aggregate
14 area sampling and analysis plans. The QAPP will provide the specific procedural direction
15 and control for obtaining and analyzing samples in conformance with requirements to ensure
16 quality data results. The sampling and analysis plans will provide the basis for selecting the
17 location, depth, frequency of collection, etc., of media to be sampled and methods to be
18 employed to obtain samples of selected media for cataloging, shipment, and analysis. Figure
19 D-1 displays the general DMP outline for data generated through work plan activities.
20
21

22 **3.2 ORGANIZATIONS CONTROLLING DATA**
23

24 This section addresses the organizations that will receive data generated from
25 aggregate area activities.
26
27

28 **3.2.1 Environmental Engineering Group**
29

30 The Westinghouse Hanford Environmental Engineering Group provides the operable
31 unit technical coordinator. The technical coordinator is responsible for maintaining and
32 transmitting data to the designated storage facility.
33
34

35 **3.2.2 Office of Sample Management**
36

37 The Westinghouse Hanford OSM will validate all analytical data packages received
38 from the laboratory. Validated summary data (sample results and copies of chain-of-custody
39 forms) will be forwarded to the technical coordinator. Nonvalidated data will be forwarded to
40 the technical coordinator on request. Preliminary data will be clearly labeled as such. The
41 OSM will maintain raw sample data, QA/QC laboratory data, and the archived sample index.
42
43

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.

1 **3.2.7 Technical Training Records and Scheduling Section**
2

3 The Westinghouse Hanford Technical Training Records and Scheduling Section
4 provides training and maintains training records (Section 3.3.4).
5
6

7 **3.2.8 Pacific Northwest Laboratory**
8

9 The PNL operates the HMS and collects and maintains meteorological data (Section
10 3.3.1). Data management is discussed in Andrews (1988).
11

12 The PNL collects and maintains radiation exposure data (Section 3.3.3).
13
14

15 **3.3 DATABASES**
16

17 This section addresses databases that will receive data generated from the aggregate area
18 activities. These and other databases are described in the EIMP (Michael et al. 1990). All of
19 these databases exist independently of this aggregate area and serve other site functions. Data
20 pertinent to the operable unit, housed in these databases, will be submitted to the AR.
21

22 **3.3.1 Meteorological Data**
23

24 The HMS collects and maintains meteorological data. Their database contains
25 meteorological data from 1943 to the present, and Andrews (1988) is the document containing
26 meteorological data management information.
27
28

29 **3.3.2 Nonradiological Exposure and Medical Records**
30

31 The HEHF collects and maintains data for all nonradiological exposure records and
32 medical records.
33
34

35 **3.3.3 Radiological Exposure Records**
36

37 The PNL collects and maintains data on occupational radiation exposure. This database
38 contains respiratory personal protective equipment fitting records, work restrictions, and
39 radiation exposure information.
40
41
42

9 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42

1 **3.3.4 Training Records**
2

3 Training records for Westinghouse Hanford and subcontractor personnel are managed by
4 the Westinghouse Hanford Technical Training Support Section. Other Hanford Site
5 contractors (PNL and KEH) maintain their own personnel training records. Training records
6 for non-Westinghouse personnel are entered into the Westinghouse (soft reporting) database to
7 document compliance.
8
9

10 Training records include:

- 11 • Initial 40-h hazardous waste worker training
- 12 • Annual 8-h hazardous waste worker training update
- 13 • Hazardous waste generator training
- 14 • Hazardous waste site specific training
- 15 • Radiation safety training
- 16 • Cardiopulmonary resuscitation
- 17 • Scott air pack
- 18 • Fire extinguisher
- 19 • Noise control
- 20 • Mask fit.
- 21
- 22

23
24 **3.3.5 Environmental Information/Administrative Record**
25

26 Environmental information and the AR are managed by Westinghouse Hanford EDMC
27 personnel. They provide an index and key information on all data transmitted to the EDMC.
28 This database is used to assist in data retrieval and to produce index lists as required.
29
30

31 **3.3.6 Sample Status Tracking**
32

33 The OSM maintains the sample status tracking database. This database contains
34 information about each sample. Information maintained includes sample number, ship date,
35 receipt date, and laboratory identification.
36
37
38

39 **4.0 ENVIRONMENTAL INFORMATION AND RECORDS MANAGEMENT PLAN**
40

41
42 This section briefly discusses the EIMP (Michael et al. 1990) that was developed to
43 provide an overview of an integrated approach to managing Hanford Site environmental data,
44 and the *Environmental Restoration Remedial Action Program Records Management Plan*
45 (WHC 1991b).

1
2 **4.1 ENVIRONMENTAL INFORMATION MANAGEMENT PLAN**
3

4 The EIMP provides an overview of how information is managed throughout the lifetime
5 of Hanford Site environmental programs.
6

7 The Environmental Division of Westinghouse Hanford is responsible for the protection
8 and improvement of the Hanford Site environment. To fulfill responsibility, the
9 Environmental Division has assumed a management role with respect to Hanford Site
10 environmental information. This management role includes (1) establishing standards for how
11 data are validated and controlled, (2) developing and maintaining a supporting computer-based
12 environment, and (3) sustaining a centralized file management system.
13

14 Hanford Site environmental information is defined as data related to the protection or
15 improvement of the Hanford Site environment, including data required to satisfy
16 environmental statutes, applicable DOE orders, or the *Hanford Federal Facility Agreement*
17 *and Consent Order* (Ecology et al. 1990), (Tri-Party Agreement).
18

19 Environmental information falls into several overlapping categories, such as
20 administrative versus technical and electronic versus manual or hard copy. A considerable
21 amount of data are recorded in documents, which are governed by company-wide document
22 and records control practices. Other data are collected or generated by computer and,
23 therefore, exist in electronic form. The name ENCORE has been given to the combination of
24 administrative, hardware, and software systems that serve to integrate the management of this
25 electronic data.
26

27 Administrative information (e.g., budgets and schedules) is subject to accounting and
28 other standard business practices. Scientific and technical data are subject to a different set of
29 legal, classification, release, and engineering requirements.
30

31 Superimposed over these categories is the files management system for environmental
32 information. This management system, has been developed to meet a number of
33 Environmental Division needs, including requirements for compilation of AR files. The AR
34 files are compilations of all material related to environmental restoration and remedial action
35 records of decision (ROD) for each operable unit and treatment, storage, and disposal (TSD)
36 group described in the Tri-Party Agreement.
37

38 Data in electronic form flows from information systems in the ENCORE realm to both
39 scientific/technical and administrative documents. Environmental documents distributed within
40 the Hanford Site and from regulatory agencies are received by the EDMC for storage and
41 future processing.
42

43 Part I of the EIMP describes the overall Westinghouse Hanford systems that are
44 generally applied to documents and records. Part I also describes, in greater detail, the files
45 management system developed to manage the AR file information. The EDMC compiles the

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1 AR files and provides controlled distribution of specified information to the AR files held by
2 DOE, Ecology, and the EPA. The EDMC also provides controlled distribution of specified
3 community relations information to regional information repositories.
4

5 Part II addresses computer-based information, with an emphasis on scientific and
6 technical data. The long-term nature of environmental programs and the complex
7 interrelationships of environmental data require that the data be preserved, retrievable,
8 traceable, and sufficient for future use. To ensure data availability for response to regulatory
9 and agency requirements, the plan is directed toward optimizing the use of automated
10 techniques for managing data. The current processing environment and the proposed
11 ENCORE realm are described, and the plans for implementation of ENCORE are addressed.
12

13 14 **4.2 ENVIRONMENTAL RESTORATION REMEDIAL ACTION PROGRAM** 15 **RECORDS MANAGEMENT PLAN**

16
17 The ERRA Program records management plan was developed to fulfill the requirements
18 of the U.S. Department of Energy, Richland Operations Office (DOE-RL) *Environmental*
19 *Restoration Field Office Management Plan* (FOMP) (DOE-RL 1989). The FOMP describes
20 the plans, organization, and control systems to be used for management of the Hanford Site
21 ERRA Program. The Westinghouse Hanford ERRA Program Office has developed this ERRA
22 Program records management plan to fulfill the requirements of the FOMP. This records
23 management plan will enable the program office to identify, control, and maintain the quality
24 assurance, decisional, or regulatory prescribed records generated and used in support of the
25 ERRA Program.
26

27 The ERRA Program records management plan describes how the applicable records
28 management requirements will be implemented for the ERRA Program. The plan also
29 develops the criteria for identifying the appropriate requirements for each individual piece of
30 information related to ERRA work activities.
31

32 This records management plan applies to all ERRA Program records and documents
33 generated, used, or maintained in support of ERRA-funded work activities on the Hanford
34 Site. The terms, information, documents, nonrecord material, records, record material, and QA
35 records used throughout the ERRA records management plan are interpreted as ERRA
36 information, ERRA documents, ERRA nonrecord material, ERRA records, ERRA record
37 material, and ERRA QA records.
38
39
40

41 **5.0 HANFORD ENVIRONMENTAL INFORMATION SYSTEM**

42 43 44 **5.1 OBJECTIVE** 45

1 The Hanford Environmental Information System (HEIS) has been developed by PNL for
2 Westinghouse Hanford as a primary resource for computerized storage, retrieval, and analysis
3 of quality-assured technical data associated with Comprehensive Environmental Response,
4 Compensation and Liability Act of 1980 (CERCLA) remedial investigation/feasibility study
5 (RI/FS) activities and RCRA Facility Investigation/Corrective Measures Study (RFI/CMS)
6 activities being undertaken at the Hanford Site. The HEIS will provide a means of interactive
7 access to data sets extracted from other databases relevant to implementation of the Tri-Party
8 Agreement (Ecology et al. 1990). The HEIS will support graphics analysis, including a
9 geographic information system. Implementation of HEIS will serve to ensure that data
10 consistency, quality, traceability, and security are achieved through incorporation of all
11 environmental data within a single controlled database.

12
13 The following is a list of data subjects proposed to be entered into HEIS:

- 14
- 15 • Geologic
- 16 • Geophysics
- 17 • Atmospheric
- 18 • Biotic
- 19 • Site characterization
- 20 • Soil gas
- 21 • Waste site information
- 22 • Surface monitoring
- 23 • Groundwater.
- 24

25
26 **5.2 STATUS OF THE HANFORD ENVIRONMENTAL**
27 **INFORMATION SYSTEM**
28

29 The HEIS, a computerized database containing technical data and information used to
30 support the Hanford environmental restoration (ER) activities, is operational. The data for the
31 Hanford groundwater wells and groundwater samples is currently accessible via the Hanford
32 Local Area Network (HLAN) to local users and to offsite users via a modern link to the HEIS
33 database computer. Additional data, including geologic, biota, and other pertinent
34 environmental sample results, are being entered into the HEIS database.

35
36 The *Hanford Environmental Information System (HEIS) User's Manual* (WHC 1990)
37 was issued in October 1990. An operator manual is being prepared and is expected to be
38 issued in 1992.

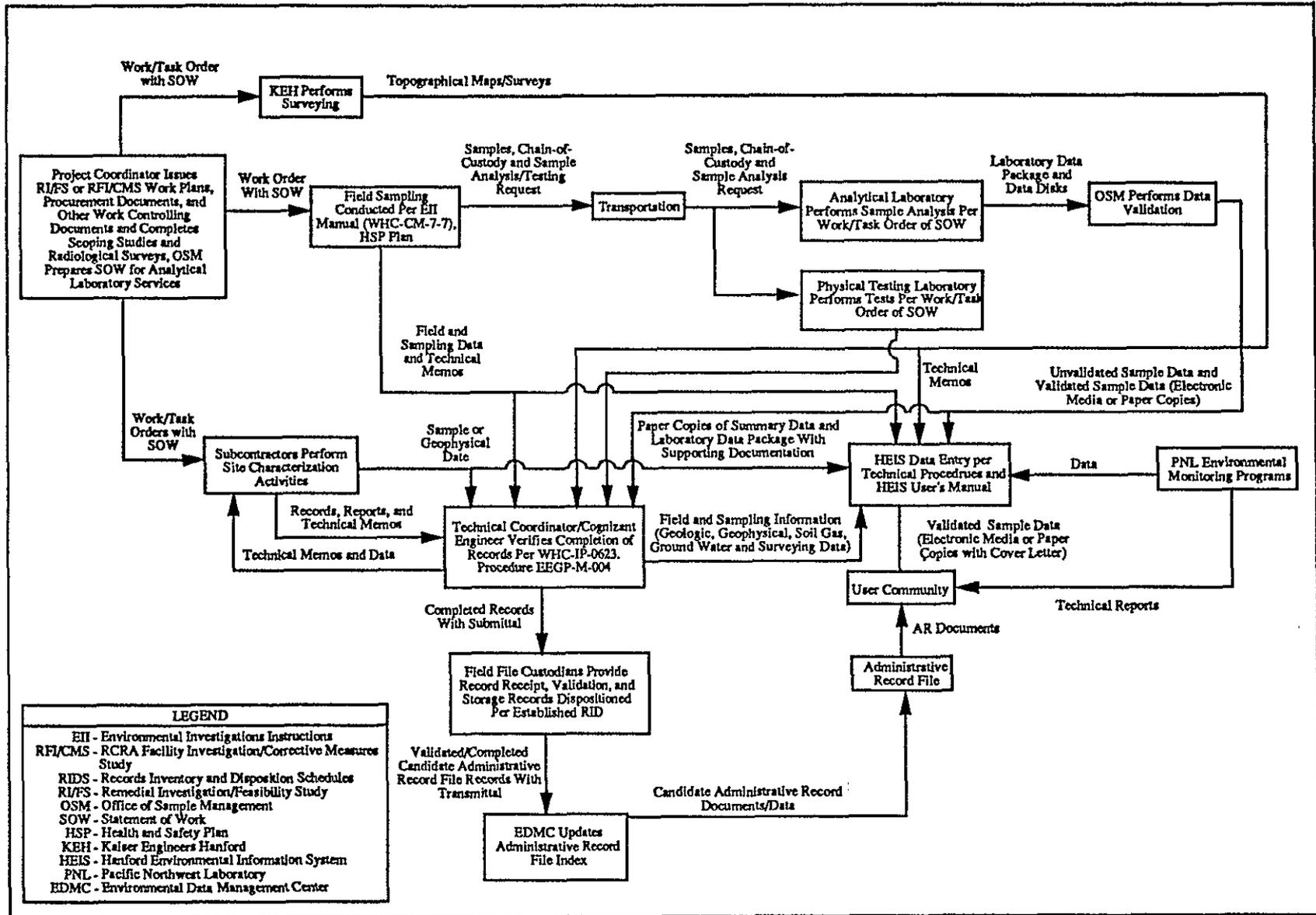
39
40 The HEIS geographic information system (GIS) will display detailed maps for the
41 Hanford restoration sites including data from the HEIS database. Such spatially related data
42 will be used to support analysis of waste site technical issues and restoration options. The
43 combination of the HEIS for data and the GIS spatial displays offers some powerful tools for
44 many users to analyze and collectively evaluate the environmental data from the ER and
45 site-wide monitoring programs.

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6.0 REFERENCES

- 1
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4
5
6 Andrews, G. L., 1988, *The Hanford Meteorological Data Collection System and Data Base*,
7 PNL-6509, Pacific Northwest Laboratory, Richland, Washington.
8
9 DOE-RL, 1989, *Environmental Restoration Field Office Management Plan*, DOE/RL-89-29,
10 U.S. Department of Energy, Richland Operations Office, Richland, Washington.
11
12 DOE-RL, 1990, *Hanford Federal Facility Agreement and Consent Order (Tri-Party*
13 *Agreement) Handbook*, RL-TPA-90-0001, U.S. Department of Energy, Richland
14 Operations Office, Richland, Washington.
15
16 Ecology, EPA, and DOE-RL, 1990, *Hanford Federal Facility Agreement and Consent Order*,
17 *First amendment, Two Volumes, 89-10 Revision 1*, Washington Department of Ecology,
18 Olympia, Washington, U.S. Environmental Protection Agency, Region X, Seattle,
19 Washington, and U.S. Department of Energy, Richland Operations Office, Richland,
20 Washington.
21
22 Michael, L. E., G. C. Main, and E. J. See, 1990, *Environmental Information Management*
23 *Plan*, WHC-EP-0219, Revision 1, Westinghouse Hanford Company, Richland,
24 Washington.
25
26 Steward, J. C., G. C. Main, and E. J. See, 1989, *Environmental Information Management*
27 *Plan*, WHC-EP-0219, Westinghouse Hanford Company, Richland, Washington.
28
29 WHC, 1988, *Quality Assurance Manual*, WHC-CM-4-2, Westinghouse Hanford Company,
30 Richland, Washington.
31
32 WHC, 1991a, *Environmental Investigations and Site Characterization Manual*, WHC-CM-7-7,
33 Westinghouse Hanford Company, Richland, Washington.
34
35 WHC, 1991b, *Environmental Restoration Remedial Action Program Records Arrangement*
36 *Plan*, WHC-EP-0430, Westinghouse Hanford Company, Richland, Washington.
37

DF-1



DOE/RL-91-60
Draft A

Figure D-1. Environmental Engineering, Technology and Permitting Data Management Model.

Table D-1. Types of Related Administrative Data.

| Type of Data | Controlling document/procedure | Record Custodians | | | | |
|--|--------------------------------|-------------------|------|-----|------|-------|
| | | TR | HEHF | PNL | EDMC | EHPSS |
| <u>Personnel</u> | | | | | | |
| Personnel training and qualifications | EII 1.7 ^{a/} | X | | | | |
| Occupational exposure records (nonradiological) | EII 2.2 ^{a/} | | X | | | X |
| Radiological exposure records | | | | X | | |
| Respiratory protection fitting | | | | | | X |
| Personnel health and safety records | EII 2.1 ^{a/} | | X | | | X |
| <u>Compliance/regulatory</u> | | | | | | |
| Action-specific requirements/screening levels | EII 1.6 ^{a/} | | | | X | |
| Guidance document tracking | EII 1.6 ^{a/} | | | | X | |
| Compliance issues | EII 1.6 ^{a/} | | | | X | |
| Problem resolution | EII 1.6 ^{a/} | | | | X | |
| Administrative record | TPA-MP-11 ^{b/} | | | | X | |
| ^{a/} WHC 1991a, <i>Environmental Investigations and Site Characterization Manual</i> . ^{b/} DOE-RL 1990, <i>Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Handbook</i> . EDMC = Environmental Data Management Center (Westinghouse Hanford Company). EHPSS = Environmental Health and Pesticide Services Section (Westinghouse Hanford Company). EII = Environmental Investigations Instructions. HEHF = Hanford Environmental Health Foundation. TR = training records (Westinghouse Hanford Company, Pacific Northwest Laboratory [PNL], Kaiser Engineers Hanford [KEH]). | | | | | | |

9 6 1 2 0 5 1 9 1 1

APPENDIX E
TELEPHONE CONVERSION EXHIBITS

9 3 1 2 3 4 5 1 2 1 2

EBASCO ENVIRONMENTAL
HANFORD ENVIRONMENTAL RESTORATION PROGRAMS
RECORD OF TELEPHONE CONVERSATION

DATE: 2-6-92

DATE OF CONTACT: 1-17-92

TO: Distribution

FROM: _____

TASK: _____

SUBJECT: Tank cascade layout

DISCUSSION WITH: Vic Boyles

Discussed tank farm layout. Mr. Boyles said that the tanks were arranged in groups of three (S Farm; 4 groups of three; SX Farm, five groups of three) Cascade system was used 30-40 years ago.

9 5 1 2 0 5 1 9 1 3

Distribution

By: Bruce Holzer
Name

geologist
Title

Dept.

EBASCO ENVIRONMENTAL
HANFORD ENVIRONMENTAL RESTORATION PROGRAMS
RECORD OF TELEPHONE CONVERSATION

DATE: 2-7-92

DATE OF CONTACT: 1-28-92

TO: Distribution

FROM: Bev Holzer

TASK: S-Plant Aggregate Area

SUBJECT: Tank Farm.

DISCUSSION WITH: Alan Alstad

Spoke with Alan Alstad concerning pumping of tank waste. Gave me information concerning the pumping of the S Tank farm (7 tanks). Also that the last pumping of S farm was in 1978.

9319851914

Distribution

By: Bev Holzer
Name

geologist
Title

944
Dept.

EBASCO ENVIRONMENTAL
 HANFORD ENVIRONMENTAL RESTORATION PROGRAMS
 RECORD OF TELEPHONE CONVERSATION

DATE: 2/4/92

DATE OF CONTACT: 1/16/92

TO: Distribution
 FROM: Bryan Walz FAX (509) 373-2280
 TASK: S Plant AAMS Report (509) 373-2774
 SUBJECT: 216-S-10 Ditch & French Drains

DISCUSSION WITH: Bob Egge X

- 216-S-10 Ditch stopped receiving waste October 1, 1991. It received 2907-S H₂O Tower overflow & the 202-S compressor cooling H₂O.
- Reference: (may be useful)
 - Redox Plant Deactivation completion report. C.B. Foster, CE
 - McMahill. June 1, 1966.
- Bob indicated that there is a possibility of a Tritium plume beneath the 202-S Bldg.
- Bob indicated heavy contamination on the floor of the 202-S bldg. and contamination may have migrated through cracks in the floor.
- Bob also mentioned a couple releases due to the 202-S bldg. via holding cell leaks, broken coils & transfers to Basins.
- Bob indicated that there was an unreleased reference on the 202-S leaks and he was going to try and locate it.
- The 291-S French Drain (number unknown) is actively receiving steam condensate.

Distribution

By: Bryan Walz Associate Engineer 944
 Name Title Dept.

- Bob indicated that some French Drains received anticorrosives.
- Bob is sending references on the 202-S leaks and French Drains.
- Bob also informed me that the 202-S cells have had cover blocks on them since 1967.

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Westinghouse Hanford Company
Aggregate Area Management Studies

S PLANT AGGREGATE AREA
PLATE 1 - Facilities, Sites, & Unplanned Releases

LEGEND



Aggregate Area Boundary



Specific System Boundary

Westinghouse Hanford Company
Aggregate Area Management Studies

S PLANT AGGREGATE AREA
PLATE 2 - Topography

LEGEND



Aggregate Area Boundary

Westinghouse Hanford Company
Aggregate Area Management Studies

PLANT AGGREGATE AREA
PLATE 3 - Monitor Wells & Sample Locations

LEGEND

----- Aggregate Area Boundary

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Draft A

Westinghouse Hanford Company
Aggregate Area Management Studies

PLATE 4 CONCEPTUAL MODEL
S PLANT AGGREGATE AREA

Mar. 19, 1992