DOE/RL-96-81
Rev. 0

Waste Site Grouping for 200 Areas Soil Investigations

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Date Published
January 1997

United States
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CONTENTS

1.0 INTRODUCTION 1-1

2.0 SITE CONDITIONS 2-1
2.1 GEOLOGY 2-1
2.2 VADOSE ZONE HYDROGEOLOGY 2-10
2.3 RECHARGE 2-11

3.0 WASTE SITE GROUPS 3-1
3.1 PROCESS OVERVIEW 3-1
3.2 200 AREA WASTE GROUPS 3-3

4.0 CONCEPTUAL MODELS 4-1
4.1 GENERAL CONCEPTUAL MODEL 4-1
4.1.1 Radionuclides and Inorganic Contaminants 4-5
4.1.2 Organic Contaminants 4-7
4.1.3 Contaminant Distribution and Transport to Groundwater 4-8
4.1.4 Characteristics and Hazards Associated with Contaminants of Concern . 4-10
4.2 URANIUM-RICH PROCESS CONDENSATE/PROCESS WASTE GROUP . . 4-12
4.2.1 Group Description 4-12
4.2.2 Known and Suspected Contamination 4-13
4.2.3 Conceptual Model Summary 4-14
4.3 PLUTONIUM PROCESS CONDENSATE/PROCESS WASTE GROUP 4-17
4.3.1 Group Description 4-17
4.3.2 Known and Suspected Contamination 4-17
4.3.3 Conceptual Model Summary 4-22
4.4 PLUTONIUM/ORGANIC-RICH PROCESS CONDENSATE/PROCESS WASTE GROUP 4-22
4.4.1 Group Description 4-22
4.4.2 Known and Suspected Contamination 4-24
4.4.3 Conceptual Model Summary 4-25
4.5 ORGANIC-RICH PROCESS CONDENSATE/PROCESS WASTE GROUP . . . 4-27
4.5.1 Group Description 4-27
4.5.2 Known and Suspected Contamination 4-28
4.5.3 Conceptual Model Summary 4-28
4.6 FISSION PRODUCT-RICH PROCESS CONDENSATE/PROCESS WASTE GROUP 4-30
4.6.1 Group Description 4-30
4.6.2 Known and Suspected Contamination 4-31
4.6.3 Conceptual Model Summary 4-31
4.7 GENERAL PROCESS CONDENSATE/PROCESS WASTE GROUP 4-32
4.7.1 Group Description 4-32
4.7.2 Known and Suspected Contamination 4-34
4.7.3 Conceptual Model Summary 4-34

CONTENTS (Continued)

4.8 TANK WASTE GROUP 4-36
4.8.1 Group Description 4-36
4.8.2 Known and Suspected Contamination 4-37
4.8.3 Conceptual Model Summary 4-38
4.9 SCAVENGED WASTE GROUP 4-38
4.9.1 Group Description 4-38
4.9.2 Known and Suspected Contamination 4-42
4.9.3 Conceptual Model Summary 4-43
4.10 STEAM CONDENSATE GROUP 4-43
4.10.1 Group Description 4-43
4.10.2 Known and Suspected Contamination 4-45
4.10.3 Conceptual Model Summary 4-46
4.11 CHEMICAL SEWER GROUP 4-48
4.11.1 Group Description 4-48
4.11.2 Known and Suspected Contamination 4-49
4.11.3 Conceptual Model Summary 4-49
4.12 U-POND/Z-DITCHES COOLING WATER GROUP 4-51
4.12.1 Group Description 4-51
4.12.2 Known and Suspected Contamination 4-52
4.12.3 Conceptual Model Summary 4-52
4.13 GABLE MOUNTAIN/B-POND AND DITCH COOLING WATER GROUP . . 4-54
4.13.1 Group Description 4-54
4.13.2 Known and Suspected Contamination 4-56
4.13.3 Conceptual Model Summary 4-57
4.14 200 NORTH POND COOLING WATER GROUP 4-57
4.14.1 Group Description 4-57
4.14.2 Known and Suspected Contamination 4-59
4.14.3 Conceptual Model Summary 4-59
4.15 S-PONDS/DITCHES COOLING WATER GROUP 4-61
4.15.1 Group Description 4-61
4.15.2 Known and Suspected Contamination 4-62
4.15.3 Conceptual Model Summary 4-62
4.16 T-PONDS/DITCHES COOLING WATER GROUP 4-64
4.16.1 Group Description 4-64
4.16.2 Known and Suspected Contamination 4-64
4.16.3 Conceptual Model Summary 4-65
4.17 200 AREAS CHEMICAL LABORATORY WASTE GROUP 4-65
4.17.1 Group Description 4-67
4.17.2 Known and Suspected Contamination 4-67
4.17.3 Conceptual Model Summary 4-68
4.18 300 AREA CHEMICAL LABORATORY WASTE GROUP 4-68
4.18.1 Group Description 4-68
4.18.2 Known and Suspected Contamination 4-70

CONTENTS (Continued)

4.18.3 Conceptual Model Summary 4-70
4.19 RADIOACTIVE LANDFILLS AND DUMPS GROUP 4-72
4.19.1 Group Description 4-72
4.19.2 Known and Suspected Contamination 4-73
4.19.3 Conceptual Model Summary 4-73
4.20 NONRADIOACTIVE LANDFILLS AND DUMPS GROUP 4-75
4.20.1 Group Description 4-75
4.20.2 Known and Suspected Contamination 4-75
4.20.3 Conceptual Model Summary 4-76
4.21 MISCELLANEOUS WASTE GROUP 4-76
4.21.1 Group Description 4-76
4.21.2 Known and Suspected Contamination 4-79
4.21.3 Conceptual Model Summary 4-80
4.22 SEPTIC TANKS AND DRAIN FIELDS GROUP 4-80
4.22.1 Group Description 4-80
4.23 TANKS/BOXES/PITS/LINES GROUP 4-82
4.23.1 Group Description 4-82
4.24 UNPLANNED RELEASES GROUP 4-83
4.24.1 Group Description 4-83

5.0 GROUP PRIORITIZATION AND REPRESENTATIVE WASTE SITES 5-1
5.1 GROUNDWATER IMPACTS 5-1
5.2 CHARACTERIZATION INFORMATION AND CHEMISTRY KNOWLEDGE 5-6
5.3 IMPLEMENTABILITY AND PROGRESS 5-7
5.4 OTHER CONSIDERATIONS 5-7

6.0 REFERENCES 6-1

APPENDICES:

A WASTE SITE/CATEGORY GROUPINGS A-1
B TANK FARM OPERABLE UNIT WASTE SITES B-1
C UNPLANNED RELEASES AND RCRA TREATMENT, STORAGE, AND DISPOSAL UNITS C-1
D GROUNDWATER PLUME MAPS D-1

FIGURES:

1-1. 200 Areas Soil Remediation Strategy Implementation Flowchart 1-3
2-1. Hanford Site Map 2-2
2-2. Stratigraphic Key 2-6

CONTENTS (Continued)

FIGURES (cont.):

2-3. East-West Cross Section Through the 200 Areas (View A-A') 2-7
2-4. North-South Cross Section Through the 200 West Area (View B-B') 2-8
2-5. North-South Cross Section Through the 200 East Area (View C-C') 2-9
4-2. Uranium-Rich Process Condensate/Process Waste Group Crib Conceptual Model . . . 4-15
4-3. Uranium-Rich Process Condensate/Process Waste Group Trench Conceptual Model . 4-16
4-4. Plutonium Process Condensate/Process Waste Group Conceptual Model 4-23
4-5. Plutonium/Organic-Rich Process Condensate/Process Waste Group Conceptual Model 4-26
4-6. Organic-Rich Process Condensate/Process Waste Group Conceptual Model 4-29
4-7. Fission Product-Rich Process Condensate/Process Waste Group Conceptual Model . 4-33
4-8. General Process Condensate/Process Waste Group Conceptual Model 4-35
4-9. Tank Waste Group Crib and Specific Retention Trench Conceptual Model 4-39
4-10. Tank Waste Group Reverse Well Conceptual Model 4-40
4-11. Scavenged Waste Group Conceptual Model 4-44
4-12. Steam Condensate Group Conceptual Model 4-47
4-13. Chemical Sewer Group Conceptual Model 4-50
4-14. U-Pond/Z-Ditches Cooling Water Group Conceptual Model 4-53
4-15. Gable Mountain/B-Pond and Ditch Cooling Water Group Conceptual Model 4-58
4-16. 200 North Pond Cooling Water Group Conceptual Model 4-60
4-17. S-Ponds/Ditches Cooling Water Group Conceptual Model 4-63
4-19. 200 Area Chemical Laboratory Waste Group Conceptual Model 4-69
4-20. 300 Area Chemical Laboratory Waste Group Conceptual Model 4-71
4-21. Radioactive Landfills and Dumps Group Conceptual Model 4-74
4-22. Nonradioactive Landfills and Dumps Group Conceptual Model, Landfills 4-77
4-23. Nonradioactive Landfills and Dumps Group Conceptual Model, Dump Sites 4-78
4-24. Miscellaneous Waste Group Conceptual Model 4-81

TABLES:

2-1. Summary of Site Conditions That May Affect Contaminant Fate and Transport 2-3
3-1. Waste Site Categories and Associated Waste Site Groups 3-2
4-1. Contaminant Mobility in Hanford Soils 4-3
4-2. Radionuclides - Physical/Chemical Data 4-6
4-3. Selected Representative Waste Sites for Each Waste Group 4-18
5-1. Waste Site Group Prioritization Ratings 5-2
5-2. Waste Group Prioritization 5-5

ACRONYMS

AAMS	aggregate area management study
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COC	contaminant of concern
DBBP	dibutyl butyl phosphonate
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ITS	in-tank solidification
NPH	normal paraffin hydrocarbon
NPL	National Priorities List
NRDWL	Nonradioactive Dangerous Waste Landfill
PCE	tetrachloroethylene
PFP	Plutonium Finishing Plant
PRF	Plutonium Reclamation Facility
PUREX	Plutonium/Uranium Extraction (Plant)
RARA	Radiation Area Remedial Action
RCRA	*Resource Conservation and Recovery Act of 1976*
REDOX	Reduction/Oxidation (Plant)
RFI/CMS	RCRA Field Investigation/Corrective Measures Study
SWL	Solid Waste Landfill
TBP	tributyl phosphate
TCE	trichloroethylene
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRU	transuranic
TSD	treatment, storage, and disposal
URP	Uranium Recovery Program
WIDS	Waste Information Data System

1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA), in November 1989, included the 200 Areas of the Hanford Site on the National Priorities List (NPL) under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA). Under the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement), signed by the Washington State Department of Ecology (Ecology), the U.S. Department of Energy (DOE), and the EPA (Ecology et al. 1994), the 200 NPL Site encompasses the 200 Areas and selected portions of the 600 Area. The 200 NPL Site includes a total of 42 operable units, including 19 in the 200 East Area, 17 in the 200 West Area, 1 in the 200 North Area, and 5 isolated operable units.

The purpose of the Tri-Party Agreement is to ensure that the environmental impacts of past and present activities are investigated and appropriately remediated to protect human health and the environment. The Tri-Party Agreement strategy was supplemented by the *Hanford Past-Practice Strategy* (DOE-RL 1991) to streamline the remedial investigation/feasibility study and *Resource Conservation and Recovery Act of 1976* (RCRA) facility investigation/corrective measures study (RFI/CMS) processes. Based on concepts outlined in the *Hanford Past-Practice Strategy* (DOE-RL 1991) and existing scoping studies (aggregate area management study [AAMS] reports), the *200 Areas Soil Remediation Strategy - Environmental Restoration Program* was developed for 200 Area soil waste sites (DOE-RL 1996a).

A concept advanced in the *Hanford Past-Practice Strategy* (DOE-RL 1991) is the use of analogous data to reduce the amount of investigation needed at individual waste sites by performing characterization activities by groups of similar waste sites. This analogous site approach concept was a key element in the development of the *200 Areas Soil Remediation Strategy - Environmental Restoration Program* (DOE-RL 1996a) because many of the 200 Area waste sites share similarities in geological conditions, function, and types of waste received. As a result, the need to establish waste site groups for 200 Area waste sites was identified as an initial step in the implementation of the 200 Areas Soil Remediation Strategy (DOE-RL 1996a).

The purpose of this document is to identify logical waste site groups for characterization based on criteria established in the 200 Areas Soil Remediation Strategy (DOE-RL 1996a). Specific objectives of the document include the following:

- Finalize waste site groups based on the approach and preliminary groupings identified in the 200 Areas Soil Remediation Strategy

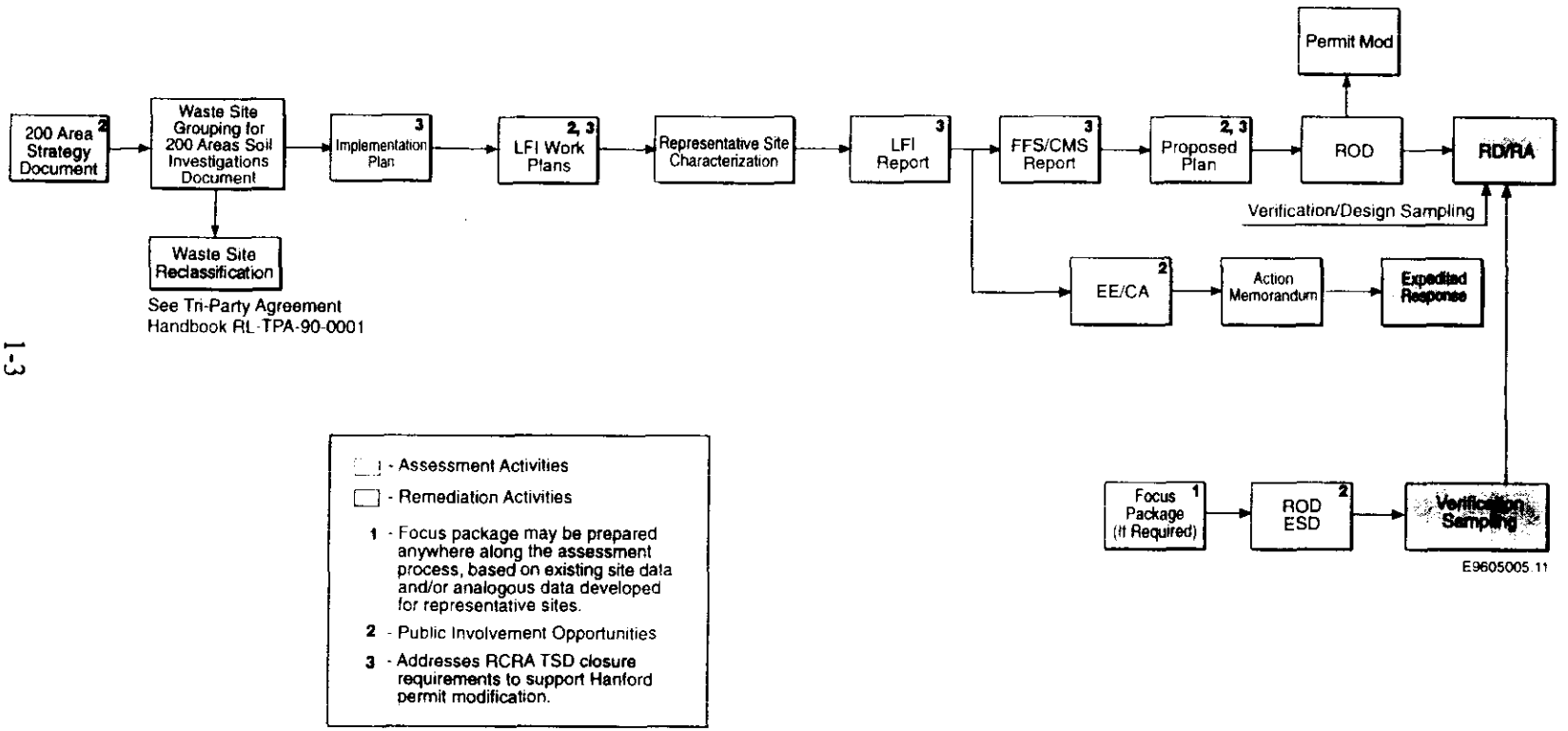
- Prioritize the waste site groups based on criteria developed in the 200 Areas Soil Remediation Strategy

- Select representative site(s) that best represents typical and worst-case conditions for each waste group
- Develop conceptual models for each waste group.

Waste site group prioritization and representative site selection will support a more efficient and cost-effective approach to characterizing 200 Area waste sites. Characterization efforts will be limited to representative sites, the data from which will be used to reach remedial action decisions for all waste sites within a group (consistent with the analogous site approach). Waste site group priorities will be used to establish a sequence in which the representative sites are expected to be addressed. The conceptual models developed in this document provide an initial prediction of the nature and extent of primary contaminants of concern and support the selection of representative sites and prioritization of groups.

This document will serve as a technical baseline for implementing the 200 Areas Soil Remediation Strategy (DOE-RL 1996a). The intent of the document is to provide a framework, based on waste site groups, for organizing soil characterization efforts in the 200 Areas and to present initial conceptual models. This document does not attempt to ascertain if characterization or remediation is needed for any particular waste site or group. Data needs, data quality objectives, the characterization approach, and associated investigation tasks will be defined in subsequent documents including the 200 Areas Soil Remediation Strategy implementation plan and waste group-based limited field investigation work plans (see Figure 1-1 taken from DOE-RL 1996a). This document satisfies the requirements for the Waste Site Grouping for the 200 Areas Soil Investigations document identified in Figure 1-1. Documents addressing RCRA treatment, storage, and disposal (TSD) unit closures must meet RCRA document requirements as well as CERCLA document requirements.

Figure 1-1. 200 Areas Soil Remediation Strategy Implementation Flowchart (taken from DOE-RL 1996a).



2.0 SITE CONDITIONS

This section provides a brief summary of general site conditions present in the 200 Areas and focuses on geohydrology of the vadose zone. The discussion provided is based mainly on Connelly et al. (1992a, 1992b), Lindsey (1991, 1995), Singleton and Lindsey (1994), Weekes et al. (1995), AAMS reports, and recent operable unit investigations. Figure 2-1 shows the Hanford Site and the 200 Areas. Table 2-1 summarizes conceptually how 200 Area site conditions can impact the mobility of wastewater and associated contaminants. Buffering capacity, mineralogy, and stratigraphic layering are considered to be predominant factors affecting contaminant mobility. This information, combined with waste site- and stream-specific data, is used to support the development of preliminary conceptual models in Section 4.0.

2.1 GEOLOGY

The 200 Areas are located in the Pasco Basin on the Columbia Plateau. This area is underlain by basalt of the Columbia River Basalt Group, interbedded sediments of the Ellensburg formation, and a sedimentary sequence above the basalts called suprabasalt sediments. From oldest to youngest, major geologic units of interest include the Pomona and Elephant Mountain Members of the Columbia River Basalt Group and the intermediate Rattlesnake Ridge interbed, suprabasalt sediments (i.e., Ringold Formation unit A, the lower mud sequence, unit E, and upper Ringold unit), the undifferentiated Plio-Pleistocene unit/early Palouse soil, the Hanford formation, and Holocene surficial deposits. The generalized stratigraphy of the 200 Areas is shown in Figures 2-2 through 2-5.

- Rattlesnake Ridge Interbed and Elephant Mountain Member. The Rattlesnake Ridge interbed is the uppermost sedimentary unit of the Ellensburg formation in the 200 Areas. This unit typically lies between the Pomona and Elephant Mountain basalt members except where the upper basalt unit has been eroded away as represented in a small area north of the 200 East Area. The Rattlesnake Ridge interbed is laterally continuous beneath the 200 Areas and consists of clay, tuffaceous sand, and siltstones. Beneath the 200 Areas, the Rattlesnake Ridge interbed is 6 to 24 m thick and thins towards the north.

  The Elephant Mountain Member is the uppermost basalt (i.e., bedrock) in the 200 Areas. Except for a small area north of the 200 East Area boundary, the Elephant Mountain Member is laterally continuous throughout the 200 Areas. The Elephant Mountain Member is 21 to 30 m thick and thins to the north.

- Ringold Formation. The Ringold Formation is an interstratified sequence of unconsolidated clay, silt, sand, and granule-to-cobble gravel deposited by the ancestral Columbia River. In the 200 Areas, these clastic sediments, from oldest to youngest, consist of four major facies: fluvial gravel and sand of unit A, buried soil horizons and lake deposits of the lower mud sequence, fluvial sand and gravel of unit E, and floodplain deposits and fluvial sands of the upper Ringold unit.

Figure 2-1. Hanford Site Map.

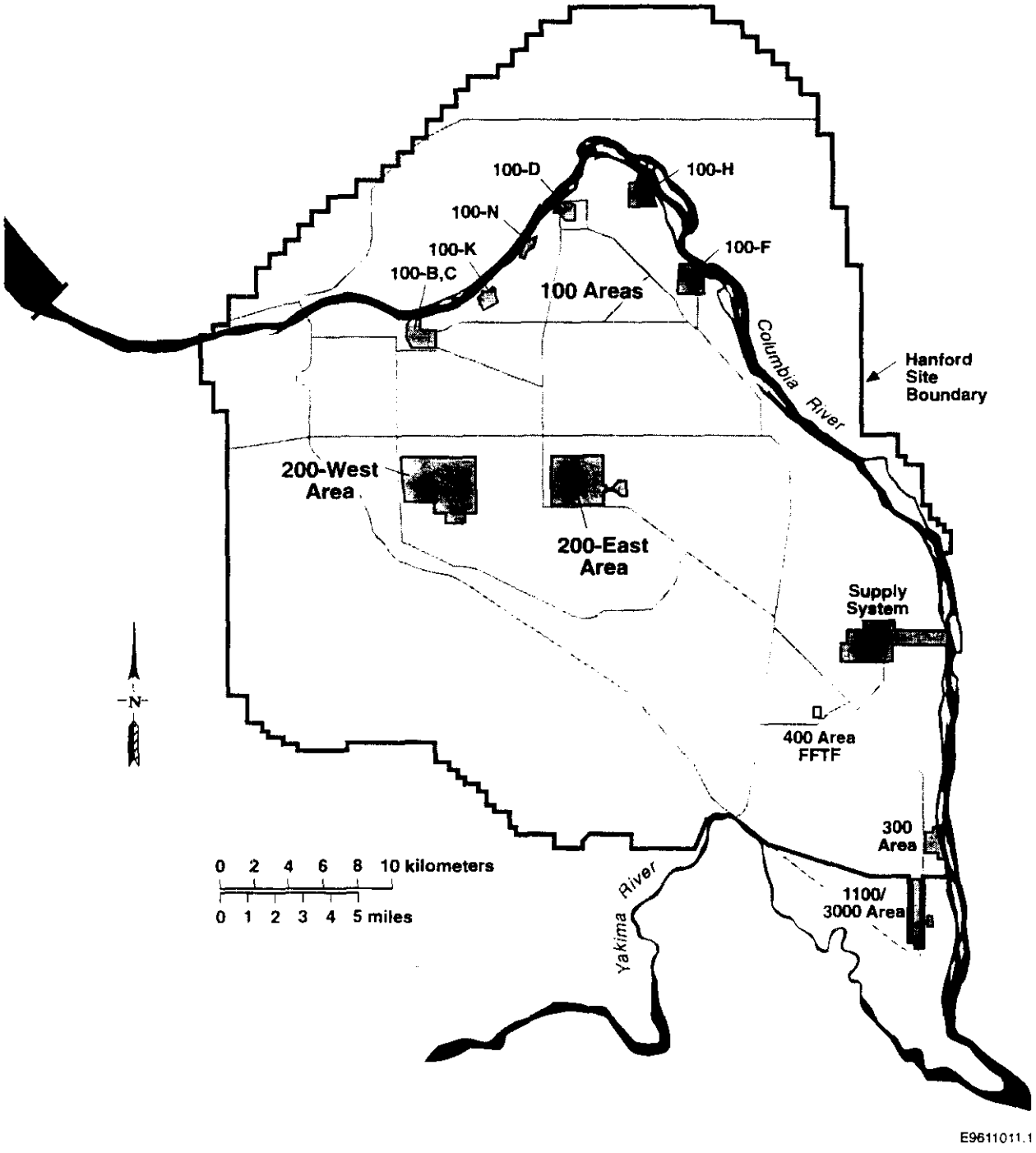


Table 2-1. Summary of Site Conditions That May Affect Contaminant Fate and Transport. (sheet 1 of 3)

Parameter/ Property	Representative values/conditions for 200 Area sediments	General Considerations
Natural recharge	0 to 10 cm/yr via precipitation	Low annual precipitation and low precipitation intensity provides little to no recharge. Recharge may be impacted by episodic events including high-intensity rainfall events and rapid snowmelt. Evapotranspiration potential is moderate to high depending on time of year. Recharge via precipitation is affected by surface soil type, vegetation, topography, and year-to-year variations in precipitation. Gravelly surface soils with no or minor shallow-rooted vegetation facilitate recharge. Well-vegetated, fine-grained surface soils minimize recharge. Waste sites that are capped with fine-grained soils (Radiation Area Remedial Action interim-stabilized sites) or impermeable covers should have little to no net precipitation recharge or leachate generation. Granular nature of surface soils maximizes infiltration. In instances where precipitation or snow melt is sufficient to generate runoff, low-lying areas and gravelly surface soils/fill occupying may serve as collection basins for runoff and locally increase infiltration.
Vegetation	Sparse to moderate densities	Vegetation of the 200 Areas Plateau is characterized by native shrub steppe interspersed with large areas of disturbed ground with a dominant annual grass component. Associated transpiration potential is low to moderate. The vegetation in and around active ponds and ditches (riparian zone) on the 200 Areas Plateau is significantly different and higher in density than that of the surrounding dryland areas. Vegetation may remove chemicals upward in or from the soil, bring them to the surface, and subsequently introduce them to the food web. Vegetation supported by active ponds and ditches provides locally higher evapotranspiration potential and radionuclide uptake.
Soil moisture	2% to 10% by volume	At low ambient moisture contents, moisture flux is minimal and the capacity of the soil to store infiltrating liquids is high. Low soil moisture results in higher capillary forces that inhibit downward migration of water. As a result, moisture from infiltrating precipitation is retained close to the surface where it is removed by evapotranspiration. Ambient moisture contents are typically higher in finer grained sediments than in coarse-grained sediments. Contaminated pore water can be transported to groundwater by drainage under unsaturated conditions but requires an extended time frame relative to saturated conditions because hydraulic conductivities are much lower under low moisture conditions.

Table 2-1. Summary of Site Conditions That May Affect Contaminant Fate and Transport. (sheet 2 of 3)

Parameter/ Property	Representative values/conditions for 200 Area sediments	General Considerations
Soil moisture (cont.)	2% to 10% by volume	Waste sites that received sufficient discharges to maintain localized saturated conditions in the vadose zone maximize downward pore water velocities and associated contaminant movement.
Vadose zone thickness	55 to 104 m (central plateau)	The thicker the vadose zone, the greater the potential for contaminants to interact with sediments. Vadose zone thins out from the 200 West and 200 East Areas north to Gable Gap.
Soil chemistry	Alkaline pH Low oxidizing Redox state Ion-exchange capacity dependent on contaminant and % fine-grained soil particles Very low organic carbon content, <1%	The mobility of radionuclides and other inorganic elements depends on the chemical form and charge of the element or molecule, which in turn depends on waste- and site-related factors such as the pH, Redox state, and ionic composition. Buffering or neutralizing capacity of the soil is correlated with the calcium carbonate content of the soil. 200 Area sediments generally have carbonate contents in the range of 0.1% to 5%. Higher carbonate contents (10%) are observed within the Plio-Pleistocene caliche layer. Additional buffering capacity is provided by hydroxides of iron, aluminum, manganese, and silicon. Acidic solutions are buffered to more neutral basic pH values when contacting Hanford sediments. Many constituents/contaminants precipitate or adsorb to the soil under neutral to basic pH conditions. The vadose zone is generally an oxidizing environment. Redox-sensitive elements from highly oxidized waste streams may become less mobile (are reduced) when contacting the vadose zone, which has a relatively lower oxidizing potential. Conversely, reduced waste streams could be oxidized when introduced into the vadose zone and thereby increase the mobility of Redox-sensitive elements. Many contaminants of concern in 200 Area waste streams are present as cations. Sediments have sufficient cation-exchange capacity to adsorb many of these cations. Considering the substantial thickness of vadose zone (50 to 140 m), the total cation-exchange capacity of a column of soil is substantial. 200 Area sediments have a poor affinity for anions because of their negative charge. Sorption to organic components is considered to be minimal considering the low organic content. Sorption to the inorganic fraction of soils may dominate over sorption to soil organic matter.

Table 2-1. Summary of Site Conditions That May Affect Contaminant Fate and Transport. (sheet 3 of 3)

Parameter/ Property	Representative values/conditions for 200 Area sediments	General Considerations
Soil chemistry (cont.)	Alkaline pH Low oxidizing Redox state Ion-exchange capacity dependent on contaminant and % fine-grained soil particles Very low organic carbon content, <1%	Mineralogy affects the abundance of sorption sites as well as the availability of ions for precipitation. Soil components that contribute to adsorption of inorganic compounds such as clays and organic matter are generally minor components in 200 Area sediments. Diffusion of contaminants into micropores of minerals can occur. Microorganisms in the soil may degrade organic chemicals and inorganic chemicals.
Soil texture	High sand and gravel content (~70 to 80 wt %), moderate in silt content (10 to 20 wt %) and low clay content (<1 to 10 wt%) and stratified	Coarse-grained nature of sediments generally provides for a quick-draining media. However, variations of the soil stratigraphy with depth, such as the presence of low-permeability layers, impedes the downward movement of liquids. Sediments are generally more permeable in the horizontal direction than in the vertical direction because of the stratified nature of the sediments. This facilitates the lateral spreading of liquids in the vadose zone and reduces the downward movement. Under unsaturated conditions, coarse-grained layers overlain with finer grained materials retard the movement of pore water because of the capillary barrier effect. Under saturated conditions, layers of finer grained soil such as silt layers and the Plio-Pleistocene unit function as localized aquitards. Where substantial quantities of liquid waste were disposed, perched water may form above these layers. These phenomena increase the potential for lateral movement of liquids. If perched water is laterally expansive, it can mobilize wastes beneath adjacent waste sites. Sorption to sediments increases as particle size decreases. Suspended solids/particulates in waste streams are likely to be physically filtered by the sediments at the boundary of the waste site.

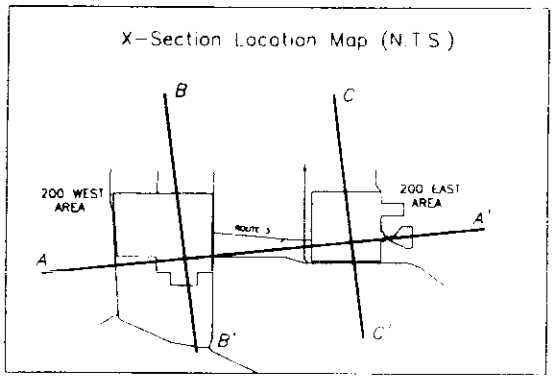
Figure 2-2. Stratigraphic Key.

2W:071796F

EO	Surfical Eolian Sand/Silt Deposits
H_1	Hanford Formation Undifferentiated
H_1	Hanford Formation Upper Coarse Unit
H_2	Hanford Formation Lower Fine Unit
H_3	Hanford Lower Coarse Unit
EP/PPU	Early Palouse Soil / Plio-Pleistocene Unit
RU	Ringold Formation Upper Unit
RE	Ringold Formation Unit E
RLM	Ringold Formation Lower Mud
RA	Ringold Formation Unit A
SBM/EM	Columbia River Basalt Group / Saddle Mountain Basalt / Elephant Mountain Member
SMB/PO	Columbia River Basalt Group / Saddle Mountain Basalt / Pomona Member

Stratigraphy

Sandy GRAVEL
Silty sandy GRAVEL
Silty GRAVEL
Gravelly SAND
SAND
Sandy SILT
SILT/CLAY
BASALT



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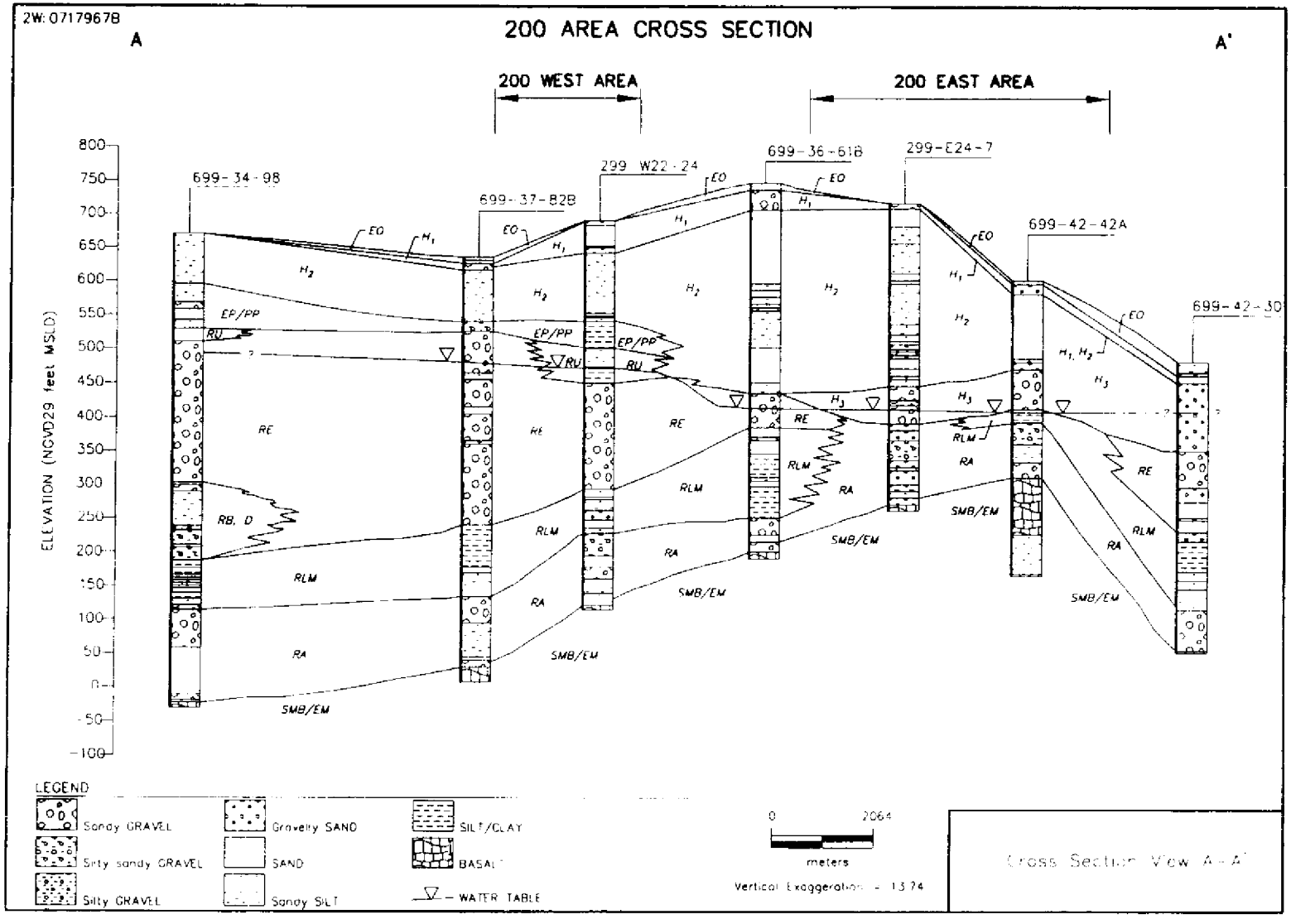


Figure 2-3. East-West Cross Section Through the 200 Areas (View A-A').

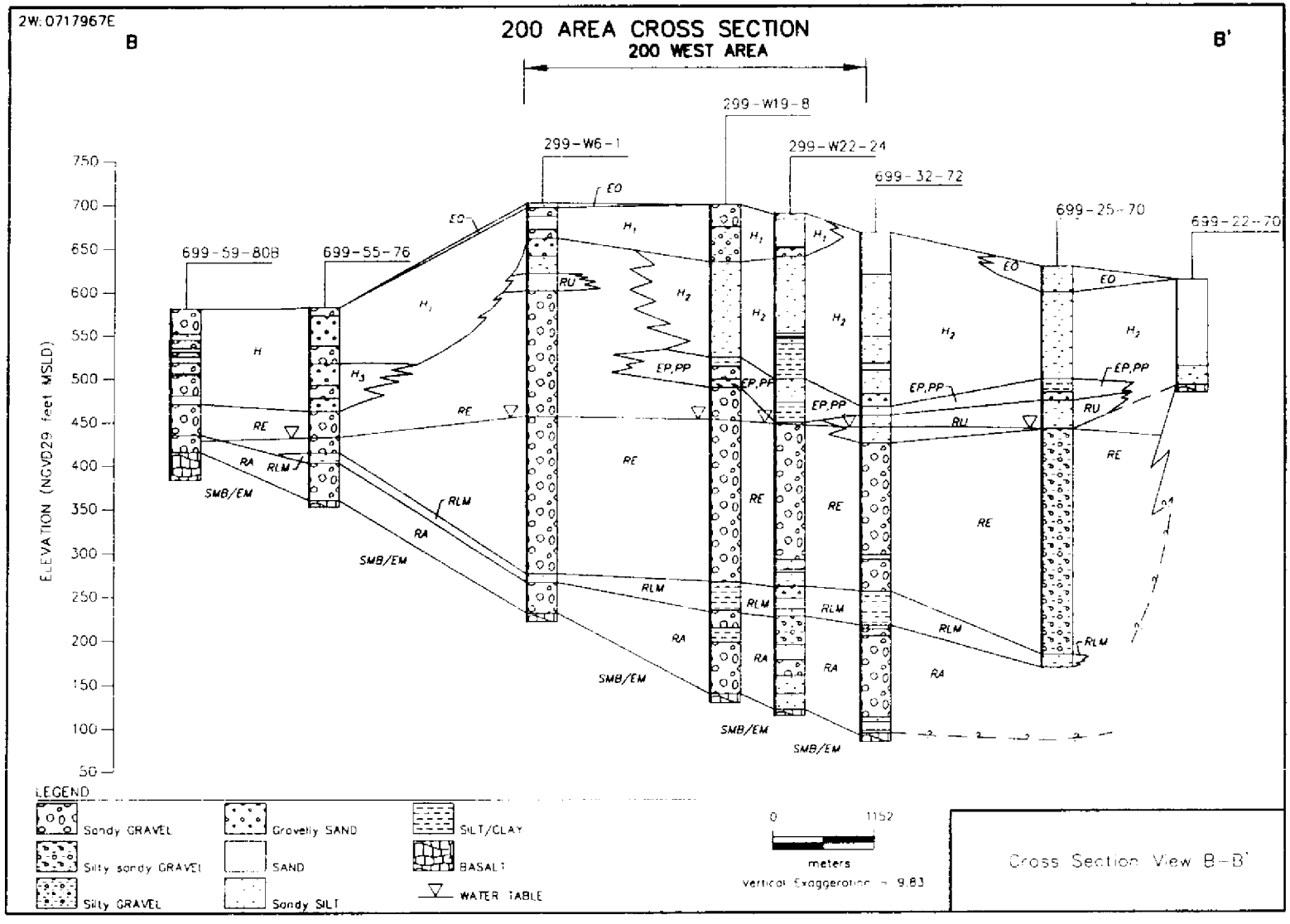


Figure 2-4. North-South Cross Section Through the 200 West Area (View B-B').

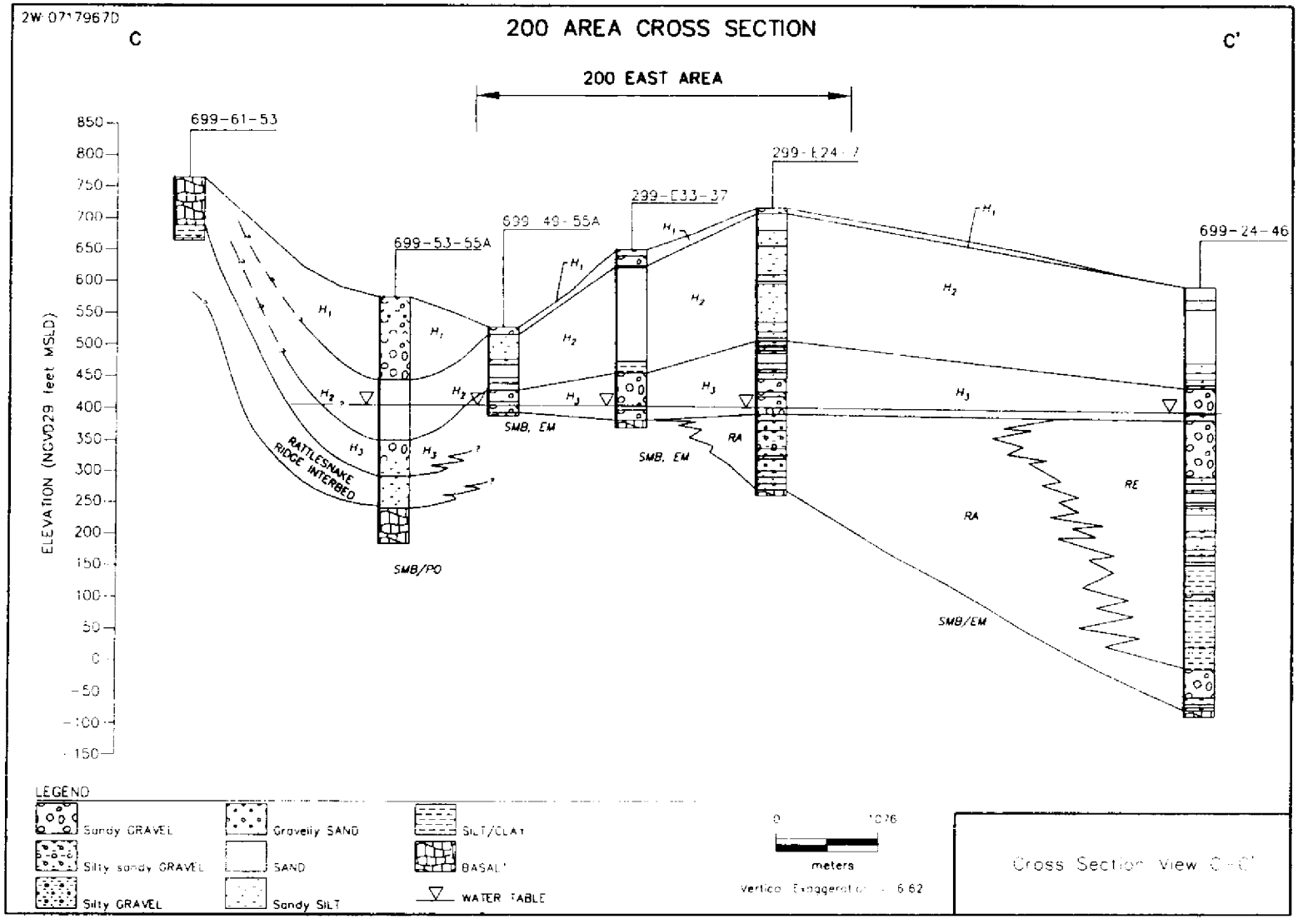


Figure 2-5. North-South Cross Section Through the 200 East Area (View C-C').

- Plio-Pleistocene Unit/Early Palouse Soil. Calcium carbonate-rich strata is the defining characteristic of the Plio-Pleistocene unit. This unit consists of massive calcium carbonate-cemented silt, sand, and gravel (caliche) to interbedded caliche-rich to caliche-poor silts and sands. This unit pinches out exteriorly to the northern, eastern, and southern boundaries of the 200 West Area. The thickness of this unit ranges from 1.5 to 14 m. In the 200 West Area this unit is often difficult to distinguish from the early Palouse soil, which is typically described as thinly laminated, silt-rich deposits.

- Hanford Formation. The Hanford formation consists of uncemented gravel, sands, and silts deposited by cataclysmic flood waters. These deposits are divided into three facies: (1) gravel-dominated, (2) sand-dominated, and (3) silt-dominated facies. The gravel-dominated facies consists of cross-stratified coarse-grained sands and granule to boulder gravel that contain minor intercalated silts. The gravels are uncemented and matrix-poor. The sand-dominated facies consists of well-stratified fine- to coarse-grained sand and granule gravel. Silt in this facies is variable and may be interbedded with the sand. Where the silt content is low, an open-framework texture is common. The silt-dominated facies consists of interbedded silts and fine- to coarse-grained sand forming well-stratified graded rhythmites. An upper gravel and lower sand facies predominate in the vicinity of the 200 West Area. In the vicinity of the 200 East Area, these units generally consist of an upper and lower gravel facies and a middle sand facies. The Hanford formation is up to 65 m thick in the 200 Areas.

- Surficial Deposits. Holocene-aged deposits in the 200 Areas are dominated by eolian sheets of sand that form a thin veneer across the 200 Areas except in localized areas where they have been removed by human activity. Surficial deposits consist of very fine- to medium-grained sand to occasionally silty sand and are generally less than 3 m thick. Silty deposits (<1 m thick) have also been documented at waste management facilities (e.g., ponds and ditches) where fine-grained windblown material has settled out through standing water over many years.

2.2 VADOSE ZONE HYDROGEOLOGY

The vadose zone beneath the 200 Areas ranges from approximately 55 m beneath the former U Pond to approximately 104 m in the southern portion of the 200 East Area. The vadose zone thins from the 200 Areas north to 0.3 m near West Lake. Sediments in the vadose zone consist of the (1) fluvial gravel of Ringold unit E, (2) upper unit of the Ringold Formation, (3) Plio-Pleistocene unit/early Palouse soil, (4) Hanford formation, and (5) surficial deposits. Variable surface topography and the variable elevation of the water table in the underlying uppermost aquifer causes this observed variation in vadose zone thickness. The unconfined aquifer water table typically lies within the Ringold Formation or the Hanford formation.

The vadose zone in the 200 West Area is dominated by the Ringold unit E and Hanford formation (Figures 2-3 and 2-5). Of the geologic units discussed in Section 2.1, only the Hanford formation is continuous throughout the vadose zone in the 200 Areas. The upper unit of the Ringold Formation and the Plio-Pleistocene unit/early Palouse soil only occur in the

200 West Area. In the vicinity of the 200 East Area, the vadose zone units primarily include the Hanford formation and the Ringold gravel unit A through the central and southern portions of the area and the Ringold lower mud unit to the east near the 216-B-3 Pond (Figures 2-3 and 2-4). Because of the discontinuous nature of the Ringold Formation north of the central part of the 200 East Area, the vadose zone is dominantly composed of Hanford formation sediments between the 200 East Area and Gable Mountain/Gable Gap. Areas of basalt project above the water table north of the 200 East Area. Calcium carbonate content is typically less than 1% in the Ringold Formation unit E, less than 1% in the upper Ringold unit, as much as 10% in the early Palouse soil/Plio-Pleistocene unit, and less than 2% in the Hanford formation.

Perched water zones form when moisture moving downward through the vadose zone accumulates on top of low-permeability soil lenses, highly cemented horizons, or above the contact between a fine-grained horizon and an underlying coarse-grained horizon as a result of the "capillary barrier" effect. The Plio-Pleistocene unit and early Palouse soil is the most significant aquitard in the 200 West Area above the water table and a major component controlling the accumulation of perched water where effluent was discharged. The Ringold lower mud sequence also represents a potential perching layer. Up to 2.1 m (7 ft) of perched water has been found above the lower mud sequence in the vicinity of the 216-B-3C Pond lobe.

The flow of water through unsaturated soils in the vadose zone depends in complex ways on several factors, including most significantly the moisture content of the soil and its hydraulic properties. Unsaturated hydraulic conductivities may vary by several orders of magnitude depending on moisture content. Moisture content measurements in the 200 Area vadose zone have historically ranged widely from 1% to saturation (perched water) from liquid disposal activities, but typically range from 2% to 10% under ambient conditions. Connelly et al. (1992a, 1992b) summarized hydraulic conductivity measurements made for 200 Area soils under various moisture contents. For Hanford formation samples taken in the 200 East Area, vadose zone hydraulic conductivity values at saturation ranged from about 10^{-6} to 10 cm/s, with many of the values falling in the 10^{-5} to 10^{-3} cm/s range. However, under unsaturated conditions at a 10% moisture content, hydraulic conductivity ranged from about 10^{-16} to 10^{-5} cm/s, with many of the values falling in the 10^{-10} to 10^{-5} m/s range. Unsaturated conductivities for Ringold unit A gravel samples ranged from less than 10^{-18} to 10^{-10} cm/s at moisture contents near 10% and from 10^{-7} to 10^{-5} cm/s at saturation moisture contents of 38% and 57%, respectively. Ringold lower mud samples had unsaturated hydraulic conductivities ranging from less than 10^{-18} at a 10% moisture content to approximately 10^{-9} at saturation (57%).

2.3 RECHARGE

Recharge to the unconfined aquifer within the 200 East Area is from artificial and possibly natural sources. If natural recharge occurs, it originates from precipitation because no natural surface waters exist within the 200 Areas. Artificial recharge in the 200 Areas occurred from large volumes of liquid waste disposed to the ground from plant operations that began in 1944 and plateaued in the 1950's through 1980's. Zimmerman et al. (1986) reports that between 1943 and 1980, 6.33×10^{11} L of liquid wastes was discharged to the soil column in the 200 Areas. Currently, most sources of artificial recharge have ceased in the 200 Areas and are largely

limited to liquid discharges to sanitary sewers, the two State-Approved Land Disposal Structures, and the 216-B-3C Pond.

The Hanford Site receives an annual average of 16 cm of precipitation, half of which occurs between November and February. During December through February, snowfall accounts for about 38% of all precipitation. On the average there are only two occurrences per year of 24-hour precipitation events that exceed 1 cm, indicating the low-intensity nature of precipitation on the Hanford Site. Evapotranspiration of precipitation is considered to significantly reduce the amount of precipitation that reaches the groundwater. Estimates for the percentage of evapotranspiration range from 38% to 99%. The primary factors affecting precipitation recharge are surface soil type, vegetation type, topography, and spatial and temporal variations in seasonal precipitation. In general, infiltration to soils is higher in the winter when precipitation is more frequent and evapotranspiration is low.

A number of field studies have been conducted on the Hanford Site to assess precipitation, infiltration, water storage changes, and evaporation to evaluate the natural water balance during the recharge process. Precipitation recharge values ranging from 0 to 10 cm/yr have been estimated from these studies and depend largely on soil texture and the type and density of vegetation. Historically, the volume of natural recharge is expected to be significantly lower than the volumes of recharge historically contributed by artificial sources throughout the 200 Areas. Graham et al. (1981) estimates that historical artificial recharge from liquid waste disposal in the 200 Areas exceeded all natural recharge on the Hanford Site by a factor of 10.

With the cessation of artificial recharge from plant closures in the 200 Areas, the downward flux of moisture in the vadose zone to groundwater has decreased and is expected to continue to decrease with time. The maximum flux of moisture occurred when plant operations were active, creating many localized areas of saturation/near saturation in the soil column beneath liquid disposal waste sites. When waste sites cease operating, the moisture flux continues to be significant for a period of time because of gravity drainage of the saturated/near-saturated soil column. When unsaturated conditions are reached, moisture flux becomes increasingly less significant with time as moisture contents decrease because unsaturated hydraulic conductivity decreases with decreased moisture content. The decrease in artificial recharge in the 200 Areas is reflected in the water table, which continues to decline throughout the 200 Areas. In the absence of artificial recharge, the potential for recharge from precipitation becomes more important as a driving force for remaining vadose zone contamination.

3.0 WASTE SITE GROUPS

The process of grouping waste streams and waste sites is outlined in Section 3.0 of the *200 Areas Soil Remediation Strategy - Environmental Restoration Program* (DOE-RL 1996a). The strategy established general categories of waste sites that were further divided into groups (Table 3-1). This document takes the process one step further by assigning individual waste sites to the proper groups. The grouping decisions were based on waste site inventory information from the AAMS reports and process knowledge data (i.e., Maxfield 1979, Waste Information Data System [WIDS] database). For many cases, waste site grouping decisions were straightforward based on process knowledge and inventory. For some sites that received multiple waste streams, the choice of group was less certain and will require additional confirmatory investigations. Appendix A presents the 23 groups and the individual waste sites placed in those groups.

3.1 PROCESS OVERVIEW

The 200 Areas have been the center for separations and concentration processes of plutonium at Hanford since the mid-1940's. There are five general groupings of these processes: (1) fuel processing, (2) plutonium isolation, (3) uranium recovery, (4) cesium/strontium recovery, and (5) waste storage/treatment.

Fuel processing started in the mid-1940's using the batch operation, bismuth phosphate ($BiPO_4$) extraction process at the 221/224-B and 221/224-T Plants. Starting in the late 1940's, technological improvements led to the development of the continuously operating hexone-based solvent extraction (Reduction/Oxidation [REDOX] Plant) process and, in the mid-1950's, to the tributyl phosphate solvent extraction (Plutonium/Uranium Extraction [PUREX] Plant) processes at the 202-S and 202-A facilities, respectively. A tributyl phosphate-based solvent extraction chemistry process was employed at the 221-U Plant to recover uranium from $BiPO_4$ process tank wastes. Solvent extraction processes were also used to recover cesium and strontium from tank wastes at the 221-B Plant from the mid-1960's to mid-1970's. A number of other shorter term processes were established at various facilities to recover valuable radionuclides such as promethium, cerium, technetium, and curium.

Plutonium was isolated and prepared for shipment at the 231-Z Plant in the mid-to-late-1940's using a peroxide/nitrate-based batch process. New processes were developed to improve plutonium refining, and the 234-5Z Building was constructed to convert plutonium into an oxide or metal. The 234-5Z Plant was modified to recover scrap plutonium via the Recuplex and, later, the Plutonium Recovery Facility (PRF). Americium was also recovered from plant wastes. Tributyl phosphate/carbon tetrachloride solvent extraction was the basis for the purification processes.

Table 3-1. Waste Site Categories and Associated Waste Site Groups (taken from DOE-RL 1996a).

Process Condensate/Process Waste Category
- Uranium-Rich Process Condensate/Process Waste Group
- Plutonium Process Condensate/Process Waste Group
- Plutonium/Organic-Rich Process Condensate/Process Waste Group
- Organic-Rich Process Condensate/Process Waste Group
- Fission Product-Rich Process Condensate/Process Waste Group
- General Process Condensate/Process Waste Group

Steam Condensate/Cooling Water/Chemical Sewer Category
- Steam Condensate Group
- Chemical Sewer Group
- U Pond/Z-Ditches Cooling Water Group
- Gable Mountain/B-Pond and Ditches Cooling Water Group
- 200 North Pond and Trenches Cooling Water Group
- S Pond and Ditches Cooling Water Group
- T Pond and Ditches Cooling Water Group

Chemical Waste Category
- 200 Areas Chemical Laboratory Waste Group
- 300 Areas Chemical Laboratory Waste Group

Miscellaneous Waste Category
- Miscellaneous Waste Group

Tank/Scavenged Waste Category
- Tank Waste Group
- Scavenged Waste Group

Tanks/Lines/Pits/Diversion Boxes Category
- Tanks/Lines/Pits/Boxes Group

Unplanned Releases - Nonfacility Specific
- Unplanned Releases Group

Septic Tank and Drain Fields Category
- Septic Tank and Drain Fields Group

Landfills and Dumps Category
- Radioactive Landfills and Dumps Group
- Nonradioactive Landfills and Dumps Group

Waste storage and treatment has been a major activity in the 200 Areas. It addressed the storage and volume reduction of high-level radioactive wastes derived from the separations of plutonium and, to a lesser degree, uranium from dissolved fuel rods. All high-level wastes contained large quantities of fission products, and the non-PUREX high-level wastes usually had very high uranium content. This waste was discharged to the single- and double-shell tanks. High separation process rates rapidly consumed tank storage capacity, and alternate measures were developed to reduce and concentrate the high-level waste volume. Four evaporators were built to reduce the tank farm waste volumes. In addition, the tank wastes were treated by plants to recover specific isotopes.

3.2 200 AREA WASTE GROUPS

Nine process waste type categories discussed in Section 3.0 are described below: ***Process Condensate/Process Waste*** sites; ***Tank and Scavenged Waste*** sites; ***Cooling Water, Steam Condensate, and Chemical Sewer Waste*** sites; ***Chemical Laboratory Waste*** sites; ***Landfills and Dumps*** waste sites; ***Miscellaneous Waste*** sites; ***Septic Tank and Drain Field*** waste sites; ***Tank/Line/Box/Pit*** sites, and ***Unplanned Release*** waste sites.

Process Waste results from the treatment of process liquids to regenerate specific chemicals for reuse in the process. Process waste streams were derived from solvent recovery, ion-exchange regeneration, and ammonia scrubber distillation. The processing was done off-line of a plant's major processing system. The waste stream generated from recovery/regeneration is referred to as process waste. **Process Waste** also covers a somewhat different waste stream associated with startup of most separations plants. Charges of unirradiated fuel rods, dissolved and run through the plant to test the process chemistry, produced cold startup wastes. The liquid solutions were then discharged to the ground as a waste. Waste sites used for disposal of cold startup liquids exist at the PUREX Plant, S Plant, Semiworks, and the Uranium Recovery Program (URP). Cold startup wastes were usually contaminated with uranium, whereas process wastes derived from fuel reprocessing tended to have a much more varied and equally concentrated inventory of contaminants.

Process Condensates were condensed liquids that became contaminated from direct contact with the process chemistry. The condensates formed from heating of the process chemistry and were removed in the vapor space of a dissolver or concentrator vessel, condensed off-line in a cooling vessel, treated as necessary, and disposed to the ground. The vaporized material was mostly water, but volatile chemicals and trace quantities of radionuclides were removed as well. Common contaminants included tritium, iodine-129, cesium-137, strontium-90, ruthenium-106, technetium-99, uranium-238, uranium-239/240, organics, nitrates, and a number of other inorganic components.

Based on the inventory reported for the individual waste sites, a number of criteria were considered for the process condensate/process waste category. The importance of the specific contaminants was recognized based on the relative, qualitative threat of the contaminants to human health and the environment. Evaluation of inventories led to the conclusion that certain process condensate/process waste streams had important quantities of uranium, combined

plutonium/organics, plutonium, fission products, and organics, and that the following distinct groups could be established.

- **Uranium-Rich Process Condensate/Process Waste Group**. This group was established to address those waste sites that received large quantities of total uranium (uranium-238), primarily from waste streams generated from dissolving fuel rods. Up to 38,500 kg of uranium-238 inventory is reported at these sites, but a minimum 150 kg inventory was used as a base value.

- **Plutonium Process Condensate/Process Waste Group**. This group is defined by its proximity to the 234-5Z Plant and addresses sites where process wastes have been discharged from Z Plant. Up to 340 g of plutonium-239/240 and 1,373 g of americium-241 were discharged to the soil column at these sites. There is no minimum cutoff of inventory for plutonium in this group.

- **Plutonium/Organic-Rich Process Condensate/Process Waste Group**. This is one of two process condensate/process waste groups that has both a contaminant and geographic relationship. These sites are located around the 234-5 Z Plant and are known or suspected to have received quantities of carbon tetrachloride and plutonium. Carbon tetrachloride is considered to have indirectly assisted plutonium movement, although it did not bind with the plutonium.

- **Organic-Rich Process Condensate/Process Waste Group**. This group encompasses all sites that are known to have received hexone, normal paraffin hydrocarbons (NPH) (refined kerosene), and tributyl phosphate from the PUREX, REDOX, or Semiworks Plants. The importance of these contaminants is their use in solvent extraction processes and the potential for increased mobilization of radionuclides. Most organics are expected to have vaporized or biodegraded after entering the environment, but others may continue to exist. The minimum organic cutoff value for inclusion in this group is 2,900 kg.

- **Fission Product-Rich Process Condensate/Process Waste Group**. Large curie inventories of strontium-90 and cesium-137 were recognized for process condensate/process waste sites across the 200 Areas. A minimum inventory of 20 Ci of either cesium or strontium qualified a site for inclusion in this group, based on potential for direct exposure.

- **General Process Condensate/Process Waste Group**. This group includes the remaining sites that received less significant quantities of chemical and radiological constituents.

The **Steam Condensate Group, Cooling Water Group, and Chemical Sewer Group** have been combined because of their relatively low potential for becoming contaminated. These waste streams were intended to be noncontact in character in that they either came from uncontaminated parts of the plants or were separated from contaminated process solutions by pipe or vessel walls. Chemical sewer contamination resulted from some form of process upset such as liquid draining back into an aqueous makeup area. A pipe or vessel failure was

such as liquid draining back into an aqueous makeup area. A pipe or vessel failure was necessary to contaminate the steam condensate or cooling water streams and sites. Steam condensate waste streams from the solvent extraction process plants were recognized as having a greater potential for becoming contaminated and were discharged to cribs instead of ditches and ponds.

The **Cooling Water Wastes** have been subdivided into a number of groups based primarily on geography. Most streams have very similar characteristics but are separated due to the recognition of potential differences in waste chemistry resulting from releases and leaks. The geography grouping follows from the expressed desire to accelerate remediation by selecting sites outside the fenceline for initial attention. Pond areas are generally expected to have lower inventories of contaminants that have been spread across broader areas. The waste is generally considered to be near the surface and may be more easily characterized by test pits. Cooling water waste sites may have significant inventories of contaminants that have accumulated from large volumes of slightly contaminated wastes. These systems have received more types of individual waste streams from a larger number of process facilities. Cooling water waste groups are as follows:

- **U-Ponds/Z-Ditches Cooling Water Group**. Waste sites in this group are commonly inside the 200 West Area fenceline and received cooling water waste from the major process facilities in the central part of the 200 West Area.

- **Gable Mountain Pond/B-Ponds and Ditches Cooling Water Group**. Waste sites in this group received mostly cooling water wastes from all major facilities in the 200 East Area. Most sites are outside the 200 East Area fenceline.

- **200 North Ponds Cooling Water Group**. Waste sites in this group include a series of cooling water ponds and cleanout trenches for the 212 Fuel Storage Basin Facilities used to age green irradiated fuel rods. These wastes sites are an isolated set of units located in the 200 North Area.

- **S-Ponds/Ditches Cooling Water Group**. Several ponds and ditches were used to percolate REDOX cooling water. The ponds and ditches are located south and southwest of the 200 West Area fenceline.

- **T-Ponds/Ditches Cooling Water Group**. Several ponds and ditches are associated with the multiple activities conducted at the T Plant facilities. The facilities are located inside the northern part of the 200 West Area fenceline.

- **Chemical Sewer Group**. This group has been established for the major ditches and ponds at the PUREX, REDOX, and B Plants that received waste from solvent extraction separation processes. Chemical sewers are generally low in all radiological contaminants. No reports of chemical contaminants in the chemical sewer have been found in the AAMS reports, but the ditches and ponds receiving this group's waste have been designated as RCRA TSD units.

- **Steam Condensate Group**. This group was established for the cribs that have received steam condensate wastes from solvent extraction separation processes at REDOX, PUREX, and B Plant facilities. Contamination entered the waste streams through pinhole leaks or vessel failure in the plants. These sites tend to be more seriously contaminated with uranium, plutonium, and fission products than others within this category as a result of equipment failures and unplanned releases.

Tank and Scavenged Wastes are generally defined as liquids discharged directly from the high-level, single-shell tank farms or as treated high-level tank wastes. These waste types are generally characterized by relatively small volumes of liquid with more highly concentrated contaminants than other groupings. Because of the generally high inventory, these wastes were discharged to specific retention sites intended to receive amounts of liquid normally less than the pore volume of the soil column beneath the site. In addition, an intermediate-level waste stream from the $BiPO_4$ separations process, discharged to waste sites around the tank farms, is included in this group. These wastes were generally lower volume streams with high concentrations of radionuclides and inorganic chemicals. Separate groupings were developed to address these waste types.

The **Tank Waste Group** consists of two types of waste streams:

- The cascaded waste streams originated from tank wastes in the high-level waste tank farms. Four types of high-level wastes were generated in the $BiPO_4$ operations at B and T Plants: fuel rod decladding waste, metal waste (uranium/fuel rod dissolution), first-cycle decontamination waste, and second-cycle decontamination waste. Each type of high-level liquid waste was sent to its own three-tank cascade, and each type had high quantities of fission products and uranium. The first- and second-cycle decontamination tank cascades were allowed to reside in the tank cascade allowing particulate and precipitated solids to settle into the tanks. The residual, less contaminated liquid, or supernatant, was then allowed to overflow to cribs. There were still significant concentrations of fission products and lesser concentrations of uranium in these wastes.

- The intermediate-level waste streams consisted of process liquids from the 224 Concentrator Buildings (high plutonium) and miscellaneous cell drainage from the 221 Canyon Buildings (high fission products). The sites receiving the waste did not operate as specific retention facilities, and many sites may have impacted the groundwater. Significant to this group are two reverse wells (216-B-5 and 216-T-3) that injected waste deep into the sediments and near the groundwater. These wastes also have large quantities of inorganic process chemicals.

Scavenged Wastes were largely a product of the URP conducted at the 221-U Plant, which was initiated to reclaim the large reserves of uranium from the tank farms and to recover used tank space rather than constructing new tank farms. Unfortunately, the URP created more waste going back to the tanks than the process had removed. A ferrocyanide precipitation (scavenging) process was established at the end of the URP process to precipitate cesium and strontium into tanks and was later used at the 244-CR vaults to treat URP waste already returned to the tank farms. Upon removal of the fission products, the waste was routed to the ground at several cribs

in the 200 East Area BY Cribs and the BC Cribs located south of the 200 East Area. In addition, two sites in the 200 West Area are associated with a test scavenging of first-cycle decontamination wastes at 221-T.

Sites that received scavenged wastes are known to have received significant quantities of uranium, fission products, including cobalt-60, and minor quantities of plutonium. Ferrocyanide is a characteristic chemical in this group's inventory. A number of other inorganic compounds are also reported in this group's inventory.

The **Chemical Laboratory Waste Category** has been divided into the following two groups based on the point of origin of the liquid wastes:

- **200 Area Chemical Laboratory Wastes Group**. This group includes chemical laboratory wastes commonly associated with the 222 Laboratory buildings at the B, T, U, and S Plants where a number of cribs, reverse wells, french drains, and ponds received various liquid streams from laboratory operations. Chemical laboratory waste sites are also known at PUREX and Z Plant, but these sites are grouped with other streams because they were combined with other streams at the disposal sites and inventory cannot be differentiated. Waste streams are generally low in all radionuclides, although some have significant inventories of plutonium, uranium, and fission products. Sodium dichromate is also reported at several of the waste sites. Liquid volumes for these streams are typically lower.

- **300 Area Chemical Laboratory Waste Group**. This group covers a series of specific retention trenches in the 200 Areas where relatively limited volumes of more concentrated wastes were received from the 300 Area. Liquid wastes from hot-cell experiments conducted in the 300 Area laboratories (324, 325, 327, 328, and 331 Laboratories) were collected at the 340 Facilities if analysis indicated the wastes were too contaminated to be discharged to the ground, and then transported to the 200 Areas by truck or railcar for disposal in specific retention trenches. More recently, this waste was transported by railcar to the T Plant Unloading Facility for release at two T Plant cribs. Later, the 204-AR Vault was built to receive this waste, which was then discharged to the PUREX tank farms. The waste inventory is generally low for all radionuclides, but instances of significant values of uranium, plutonium, and fission products are known. Also grouped in the 300 Area Chemical Laboratory Wastes is one BC trench that received contaminated cooling water from the 309 Reactor building that became contaminated when a fuel rod ruptured during testing. Several sites currently grouped in the 200 Area Chemical Laboratory Waste subgroup (216-S-20 and 216-Z-7) are reported or suspected to have received 300 Area laboratory waste, but radiological/ chemical/volume characteristics do not allow a differentiation between the two groups.

The **Miscellaneous Wastes Category and Group** covers a combination of moderate-volume equipment decontamination and ventilation system wastes, plus small-volume waste streams commonly disposed to french drains. Most streams are low in radionuclides and chemicals, except for higher inventories of uranium, plutonium, fission products, and occasional reports of sodium dichromate attributed to the PUREX ventilation system. Equipment decontamination

wastes are associated with the decontamination mission of T Plant. There is one equipment decontamination site each at the 202-S Building and 241-U Tank Farms. Decontamination wastes are lightly contaminated, high-volume streams, but are expected to be accompanied by detergents or cleaning agents that may have mobilized the contaminants. Miscellaneous wastes receiving the process waste classification of Miscellaneous Drainage cover sites receiving liquids including a host of potentially contaminated, small-volume waste streams, such as vacuum pump seal water wastes, fan bearing cooling water wastes, stack drainage, floor drainage from stack control rooms, and stack condensate drainage. Four french drains located inside the A-Tank Farms received liquids from the 241-A-431 Fan House Building, but will not be considered for characterization because of their location.

The **Landfills and Dumps Category** consists of the following two groups based on radiological inventory.

- **Radiological Landfills and Dumps Group**. Sites included in this group encompass those constructed/excavated sites (218 Burial Grounds) that have received either low-level or transuranic (TRU) wastes. Ten major burial grounds consisting of a number individual trenches received dry contaminated equipment, solid laboratory waste, clothing, or tightly packed/sealed liquid wastes in radiological vessels. Before 1970, TRU and low-level wastes were disposed to the same burial grounds' trenches, while post-1970 wastes were segregated according to the low-level waste/TRU designation. For post-1970 sites, wastes with significant inventories of TRU were placed into underground concrete caissons.

- **Nonradiological Landfill and Dump Group**. This group covers those sites that consist of power plant ash, construction debris, and burned materials. It also includes the inactive Central Landfill complex, which is composed of the Nonradiological Dangerous Waste Landfill (NRDWL) and the Solid Waste Landfill (SWL). The Central Landfill is located southeast of the 200 East Area. A large number of the sites in this group are recent discovery sites, and their status within WIDS is not resolved in all cases.

The **Septic Tank and Drain Fields Category and Group** covers the approximately 50 sites that received liquid wastes from office facilities. Waste types going to the ground include shower water, janitorial sink effluent, drinking water, as well as kitchen and bathroom effluent. Quantities discharged are not known. A remote possibility of radiological contamination does exist for shower and janitorial sink effluents, particularly at radiological facilities. Cumulative quantities washed off by workers or picked up off floors must have been in exceptionally small quantities. Chemical constituents are unknown, but small quantities of soaps and detergents were likely used and sent to the ground.

The **Tanks/Lines/Pits/Boxes Category and Group** includes a large number of facilities used in the transfer of high-level liquid wastes from separations plants to tank farm to reprocessing facilities and evaporators. As a result of the various programs for tank volume reduction and uranium and fission product recovery, a web of concrete-encased pipelines connects facilities inside each area as well as both 200 Areas. Although most of these structures are closely associated with tank farm operable units (200-BP-7, 200-PO-3, 200-RO-4, 200-TP-5, 200-TP-6,

and 200-UP-3), a number of the facilities lie outside the operable unit boundaries and are included in this group. In addition, a number of diversion boxes are associated with cribs. These structures are usually not considered separately from the cribs themselves. Waste sites (216-A-16, A-17, A-23A, A-23B, and S-15) within the boundaries of the tank farm operable units are grouped in the Tank Farm Operable Units Waste Sites listed in Appendix B of this document and are not considered in this document.

The **Unplanned Releases Category and Group** include documented contamination releases. Information related to these sites is often incomplete. An attempt has been made to group the unplanned releases with the waste site they went to or came from and thus have been placed in that site's group. Unplanned releases that are related to the tank farm operations or process facilities are listed in Appendix C. The remaining unplanned releases are placed in this group.

Several waste sites were built but have not received liquid wastes. These sites have been placed in the Miscellaneous Waste Group for completeness. The 216-A-38-1, 216-B-56, and 216-B-61 Cribs were constructed but never used.

4.0 CONCEPTUAL MODELS

This chapter discusses conceptual models for the contaminants within the soil column beneath liquid waste management units. Generalizations regarding the properties and behavior of inorganic, organic, and radiological contaminants are given in Section 4.1 to aid in understanding basic principles that affect contaminant distribution for liquid waste sites. Sections 4.2 through 4.24 provide individual conceptual models and figures for each of the 23 groupings to aid in assessing the need for and planning of future characterization activities. A key to the figures is provided in Figure 4-1.

Available data on radiological and selected chemical inventories for each waste site are provided in Appendix A. These data are derived from the AAMS reports, from Maxfield (1979), and from the WIDS database and reflect radioactive decay through 1989.

4.1 GENERAL CONCEPTUAL MODEL

The vertical and horizontal distribution of contaminants in the soil column beneath waste sites is generally dependent on the contaminant's chemical properties, which determine its ability to adhere to or react with soil particles. The major processes affecting transport of chemicals discharged to the vadose zone include precipitation/dissolution, adsorption/desorption, filtration of colloids and suspended particles, and diffusion into micropores within mineral grains (Serne and Wood 1990). Of these processes, precipitation/dissolution and adsorption/desorption are considered the most important.

Other characteristics that can affect the contaminant/soil interaction include the operational characteristics of the disposal unit and the site-specific geological and geochemical properties of the soil column. Because the 200 Area waste streams were generally low salt and neutral to basic pH and because Hanford sediments are generally basic in nature, the behavior of specific contaminants in the soils is generally the same from site to site and primarily dependent on the contaminant's own chemical properties. However, some waste streams contained other constituents such as organics or acids that can alter the contaminant's soil affinity, resulting in either greater or lesser mobility relative to the "typical" situation. A more detailed discussion of these aspects is given in the following subsections.

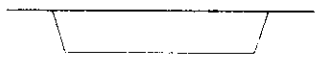
The generalized conceptual model discussion in this section focuses primarily on the deposition and distribution of contaminants that occurred during the active water discharge phase of the waste site operations. Active discharges provided the primary driving forces for contaminant transport through the vadose zone and in some cases to groundwater. Since cessation of waste discharges, only natural recharge and, in some cases, influences from currently minor artificial sources of recharge are available for continued contaminant transport. However, these driving forces are considered to be much less significant now and in the future relative to the past active discharges.

Contaminant mobility in Hanford soils is summarized in Table 4-1.

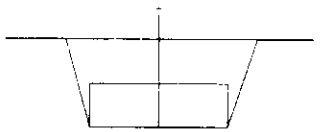
Figure 4-1. Explanation of Conceptual Model Features.

2W 110496A

FACILITY TYPES



TRENCHES, DITCHES, PONDS, LANDFILLS AND DUMPS



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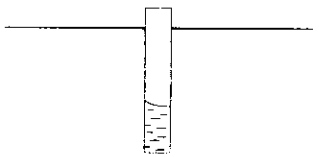


REVERSE WELLS AND FRENCH DRAINS

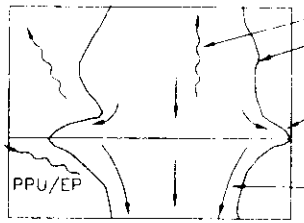
RELATIVE AMOUNT OF CONTAMINATION

- HIGH
- MEDIUM
- LOW
- NEAR BACKGROUND

HYDROGEOLOGIC NOTATIONS

[illegible]	HANFORD GRAVEL
[illegible]	HANFORD SAND
PPU/EP	PLIO-PLEISTOCENE/EARLY PALOUSE SOIL
RE	RINGOLD UNIT E
	DISCONTINUOUS SILT STRINGERS
	WATER TABLE DEPTH BELOW GROUNDSURFACE

MOISTURE FRONT/CONTAMINANT PATHWAY



ORGANIC VAPORS

VERTICAL AND LATERAL EXTENT OF MOISTURE FRONT AND CONTAMINATION

LATERAL SPREADING IS PREDOMINATELY ASSOCIATED WITH FINER GRAINED UNIT

ARROWS INDICATE CONTAMINANT PATHWAY IS TYPICALLY DOWNWARD BENEATH FACILITY TYPE

NARRATIVE

1. LOW SALT, NEUTRAL/BASIC, LOW ORGANIC WASTE STREAM WITH LOW CONCENTRATIONS OF U-238, Cs-137, AND Sr-90 DISCHARGED TO CRIB, ALONG WITH SMALLER AMOUNTS OF Pu-239/240 AND NITRATE. SOLIDS AND PRECIPITATES SETTLE OUT IN CRIB GRAVEL, WHILE LESS MOBILE CONSTITUENTS SORB ONTO SOIL PARTICLES DIRECTLY BENEATH CRIB. CONTAMINANTS ARE MORE CONCENTRATED AND PENETRATE DEEPER AT CRIBS HEAD END.

2. HIGH VOLUMES OF WASTEWATER SPREAD LESS MOBILE CONTAMINANTS DEEPER INTO SOIL COLUMN. MORE MOBILE CONSTITUENTS (Sr-90) PENETRATE DEEPER INTO SOIL COLUMN. MOST CONTAMINANTS ARE EXPECTED TO BE WITHIN 25M OF CRIB BOTTOM.

3. MOBILE CONSTITUENTS SUCH AS TRITIUM AND NITRATES PASS THROUGH SATURATED SEDIMENTS TO THE GROUNDWATER TABLE WHERE PLUMES FORM IF CONTAMINANTS ARE PRESENT IN SUFFICIENT CONCENTRATION.

U.S DEPARTMENT OF ENERGY DOE FIELD OFFICE, RICHLAND HANFORD ENVIRONMENTAL RESTORATION PROGRAM	EXPLANATION OF CONCEPTUAL MODEL FEATURES

Table 4-1. Contaminant Mobility in Hanford Soils. (sheet 1 of 2)

Contaminant	Normal Mobility	Factors Affecting Mobility
Cobalt-60	Low	Highly sorbed by cation ion exchange at pH<9; readily reacts with organics and inorganic ions to form more mobile complexes (e.g., with ferrocyanide or phosphates).
Strontium-90	Moderate	Sorbs by cation ion exchange, but competes for sites with calcium. May immobilize as a coprecipitate in the mineral apatite formed by phosphate wastes. Highly mobile in acidic conditions. Mobility is increased by organics (e.g., tributyl phosphate).
Technetium-99	High	Generally present as pertechnetate anion, which is relatively nonadsorbing.
Ruthenium-106	High	Highly influenced by presence of nitrite or nitrate; short (1-year) half-life offsets high mobility,
Cesium-137	Low	Highly sorbed by cation ion exchange. Competes for sites with potassium and sodium. Mobile. Does not tend to form soluble inorganic or organic complexes. More mobile at low pH.
Uranium-238	High	Highly mobile at low pH and at pH>8 where soluble anionic carbonate complexes can form. However, uranium forms insoluble precipitates with phosphate that are highly immobile.
Plutonium-239/240	Low	Maximum sorption occurs in pH range of 4 to 8.5 as a result of formation of insoluble precipitates. Sorption is less at low pH (<4) and high pH (>8.5). Plutonium can form more mobile complexes with codisposal of organics (e.g., tributyl phosphate, hexone, dibutyl butyl phosphate).
Americium-241	Low	Behaves similar to plutonium.
Cadmium	Moderate to high	Mobile as a dissolved metal for most waste streams in Hanford soil column conditions.
Carbon tetrachloride	High	Used as diluent for Plutonium Finishing Plant separations processes. Not highly sorbed by Hanford soils, which are low in organic carbon content.
Chloroform	High	Degradation product of carbon tetrachloride; may be formed during chlorine treatment of potable water supplies.
Chromium	High	Generally present as an anion (chromate), which is mobile in the +6 valence state.

Table 4-1. Contaminant Mobility in Hanford Soils. (sheet 2 of 2)

Contaminant	Normal Mobility	Factors Affecting Mobility
Cyanide	High	Anionic species that is essentially nonadsorbing; forms complexes with cationic species, increasing their mobility.
Dibutyl butyl phosphonate	a	Used as a solvent with carbon tetrachloride diluent in Plutonium Finishing Plant separations process for americium-241 removal. Potential for increased mobilization of americium-241 and plutonium-239/240 due to complexation.
Hexone (methyl isobutyl ketone)	a	Used as solvent for plutonium and uranium in REDOX separations process. May increase radionuclide mobility due to formation of organic complexes.
Hydrazine	a	Strong reductant, soluble in water. Breaks down into mobile amines or ammonium ions in water.
Nitrate	High	Anionic species, nonadsorbing, considered to travel with water.
Tributyl phosphate	a	Used as solvent in extraction of plutonium and uranium in PUREX and Uranium Recovery Program and for plutonium in Plutonium Finishing Plant separations processes. May increase radionuclide mobility in soil column due to formation of organic complexes.
Trichloroethylene	High	Not highly sorbed by Hanford soils, which are low in organic carbon content.

Mobility factor: High = K_d 0 to 5; Moderate = K_d 5 to 100; Low = K_d >100.

[a]Organic compounds: Generally considered to be mobile due to low organic carbon content of Hanford soils.

4.1.1 Radionuclides and Inorganic Contaminants

A general measure of a contaminant's distribution between soil and water is the soil-water distribution coefficient K_d. This coefficient is experimentally derived and is usually expressed in units of milliliters per gram.

The K_d for a contaminant is greatly affected by the following:

- The pH of the wastewater and the ionic strength
- The mineral composition of the soil
- The ionic composition of the soil pore water
- Other site-specific factors (e.g., formation of chemical complexes).

Contaminant mobilities for radionuclides and inorganic contaminants commonly disposed in 200 Area waste sites are tabulated in Tables 4-1 and 4-2.

4.1.1.1 Effects of pH. The pH of the wastewater can greatly affect the K_d and can increase the mobility of radionuclides such as plutonium and cesium. However, the alkaline nature of the Hanford sediments (due to carbonate content) tends to buffer acidic waste discharges such that the acidity is neutralized quickly near the point of discharge. For example, it was shown that for the 216-Z-20 Crib (Johnson 1993), a 1-m thickness of soil beneath the crib was capable of neutralizing 4×10^9 L of pH 5 water. Contaminants in acidic wastewaters are driven deeper into the soil column as the buffering capacity of the soil is exceeded by higher discharge volumes.

Although many contaminants may become more mobile in an acidic environment, increased alkalinity can also increase mobility of some contaminants. For example, although plutonium is one of the most immobile of the Hanford contaminants, plutonium mobility is known to increase moderately at pH values above 8.

4.1.1.2 Effects of Organics and Chemical Complexes. Organic compounds may also affect mobility by complexing the contaminants. Organics such as hexone, tributyl phosphate (TBP), and carbon tetrachloride were used in the chemical processing plants to separate product components (e.g., plutonium, uranium, americium) from irradiated fuel and its processed derivatives. These organic solvents were effective extractants because of their ability to form stable complexes. Disposal of wastes containing residual concentrations of these organic complexes may have increased the mobility of the contaminants relative to streams not containing the organics.

4.1.1.3 Other Effects. Effects of other factors on contaminant mobility are briefly discussed as follows.

- Ionic state--Because Hanford soils are generally neutral to alkaline, there is a net negative charge on the soil particles that facilitates sorption of positively charged cations. Conversely, anionic species that have negative charges are either only weakly sorbed or not sorbed at all.

Table 4-2. Radionuclides - Physical/Chemical Data.

Radionuclide	Half-Life[a] (yr)	Mode of Decay	Mobility Factors (K_d) (mL/g)	
			Neutral/Basic, Low Salt, Low Organic, Oxic Solution[b]	Neutral/Basic, High Salt, Low Organic, Oxic Solution[c]
Cobalt-60	5.27	Gamma	1,200 - 12,500	222 - 4,760
Strontium-90	29.1	Beta	5 -173	0.3 - 42
Technetium-99	2.13×10^5	Beta	0 - 1.3	0 - 0.01
Ruthenium-106	1.02	Beta	27 - 274	0 - 10
Cesium-137	30.2	Gamma	540 - 3,180	64 - 1,360
Uranium-238	4.47×10^9	Alpha	0.08 - 79.3	0 - 4
Plutonium-239/240	2.41×10^4	Alpha	80 - >1,980	10 - >98
Americium-241	432.7	Alpha	67 - >1,200	280 - >1,200

[a]Walker et al. (1989).
[b]Kaplan et al. (1995), Table 6.1.
[c]Kaplan et al. (1995), Table 6.3.

- Ionic strength--For some inorganics, ion exchange is the dominant mechanism leading to desorption. High ionic strength (high salt content) tends to drive the equilibrium toward desorption rather than sorption.

- Valance state--Generally, multivalent ions are more strongly sorbed than univalent ions with similar ionic radii.

- Contaminant particle size--Deposition of the contamination increases with increasing particle size through precipitation and filtration in the soil media.

- Soil grain size--Sorption increases as soil (sorbent) particle size decreases. Filtration and ion exchange also increase with decreased soil grain size. Filtration effects are more pronounced for contaminants that form insoluble precipitates.

- Soil mineralogy--Mineralogy affects the abundance of sorption sites as well as the availability of ions for precipitation. For example, clays are more sorptive than sands.

- Volume of discharge--Hydrostatic forces are the primary driving force for contaminant migration, so that discharges that maintain saturated conditions in the vadose zone result in more rapid downward migration.

- Lithology--Variations of the soil stratigraphy with depth, such as the presence of low-permeability layers, may increase the flowpath length of contaminant migration and slow its rate of descent.

- Wells--Poorly sealed wells may provide a conduit by which contaminants may flow through the vadose zone to the groundwater.

4.1.2 Organic Contaminants

The distribution of organic contaminants in the subsurface is affected by the solubility of the contaminant in water and the organic carbon content of the soil. The soil/organic matter partition coefficient K_{oc} is an empirical measure of distribution between organic carbon content of the soil and the water phase. K_d is related to K_{oc} according to the relationship $K_d = K_{oc}f_{oc}$, where f_{oc} is the fraction of organic carbon present in the soil. Hanford soils are low in organic carbon content, less than 0.1 wt%, and therefore, estimated K_d s for the principal organics of concern are generally less than 1, indicating high mobility.

In general, the more soluble compounds in water (acetone, hexone, alcohols, acetone, organic acids, methyl ethyl ketone, chloroform, aldehydes, and ketones) are less likely to adhere to soils, while the less soluble compounds (carbon tetrachloride, trichloroethylene [TCE], TBP) will adsorb more strongly to soils. Clays and organic matter will favor adsorption of organic solutions.

Biodegradation affects the persistence of organics in the subsurface. Biodegradation of water-soluble organics is more rapid under the oxidizing conditions found in Hanford soils, whereas the rate of biodegradation of the less soluble organics tends to be very slow.

Increased volatility generally decreases the persistence of organic contaminants. Organics such as carbon tetrachloride, TCE, and chloroform are highly volatile, whereas TBP and NPH are less volatile.

Because of their lower soil adhesion and greater biodegradability, solvents such as hexone and NPH do not generally persist in Hanford soils, whereas solvents such as carbon tetrachloride, because of higher soil interaction and low biodegradability, are generally highly persistent.

4.1.3 Contaminant Distribution and Transport to Groundwater

While Sections 4.1.1 and 4.1.2 discussed generalizations regarding contaminant mobility, this section provides a more in-depth discussion of contaminant distribution and groundwater transport in the 200 Area waste sites as follows.

- Highly mobile contaminants (tritium, iodine-129, and technetium-99) are believed to have already migrated to the groundwater from the waste sites for as long as active liquid waste discharge kept the intervening soil column saturated. Significant migration of these contaminants beyond the cessation of discharges (and some period of residual drainage following the cessation) is not expected unless a new and significant driving force is added at the sites.

- Uranium mobility is affected by the specific form of the uranium compound present as a result of the chemical process that created the waste. Uranium associated with phosphates can form insoluble precipitates that are not mobile. However, in nitrate form or in combination with carbonates, uranium tends to be highly mobile. The transport of uranium to groundwater in the 216-U-1/U-2 Crib system is believed to have resulted from mobilization of uranium present in the crib as a phosphate precipitate by acidic wastes that were discharged to an adjacent crib.

- Lateral spreading of contaminants at depth is not expected to exceed 15 to 30 m beyond the facility centerline unless there is a significant impermeable zone beneath the waste site that creates a perched water condition. High-volume streams where continuous discharges or large-volume batch releases occurred favor greater lateral spread when compared to those sites that received lower volumes of waste. The contaminant concentrations generally decrease as distance increases from the point of discharge. Although data are limited, lateral spreading is known at the 216-B-7A/7B, 216-B-57, 216-B-43/47, and 216-S-1/2 Cribs (Fecht et al. 1972).

- Maximum radionuclide contaminant concentrations are generally expected beneath the point at which the waste stream enters the soil column or waste site and decreases with depth. Typically, the highest concentrations of contaminants such as plutonium, cesium, and strontium are expected within 2 to 3 m below the point of discharge and are at near-background levels 20 m below the bottom of the waste site.

- Radionuclide contaminants generally concentrate in and just above fine-grained horizons rather than the coarser units. In general, whether in coarse or fine-grained units, the radionuclides are found to be associated with the silts and clays in the formations, which are present as 1% to 10% of the units by weight. The 200 East Area geologic units are composed of more coarse-grained units than those in the 200 West Area. The 200 West Area is further distinguished by the presence of the Plio-Pleistocene (caliche) unit, which has a much lower hydraulic conductivity than adjacent units because of the presence of calcium carbonate cemented silts, sands, and gravels. Lateral spreading is most common when facilities overlie these units.

- Downward contaminant movement has been accelerated at several cribs by poorly sealed wells or continuous clastic dikes.

- Sites receiving liquid wastes with surfactants (soaps and detergents) may have contamination at greater depths.

- Moderate half-life contaminants (cesium-137, strontium-90) are expected to have decayed or will decay to negligible quantities for most sites within 100 to 200 years. Shorter half-life contaminants such as cobalt-60, ruthenium-106, or tritium will decay to negligible levels in even shorter time frames.

- Vegetation or other organic matter (e.g., algae) present in sites such as ponds and ditches provided some uptake of radionuclides.

- Contaminant distribution below waste disposal units is generally affected by the type of disposal unit, the source of wastewater, and the volume discharged. Some generalizations with regard to these aspects are listed as follows.

  - Pond sites (and associated ditches) may have accumulated significant inventories of contaminants due to the large quantities of water discharged to the sites.

  - Cribs generally received waste streams with somewhat higher concentrations of radionuclides for long periods of time.

  - Reverse wells received smaller quantities of wastes generally considered to be more contaminated than crib waste and placed that waste deeper into the soil column.

- Specific retention trenches and cribs were used with the intent of not saturating the soil column so as to allow discharge of small volumes of some of the most contaminated waste streams to the ground. Trenches and cribs tended to receive waste with higher levels of chemical constituents.

- French drains received small volumes of waste from miscellaneous nonprocess sources that had generally low concentrations of contamination.

- Commonalities exist among the processing plants as a result of the types of chemical operations performed. From 1944 to 1956, bismuth phosphate processing occurred in the B and T Plants. Some processing similarities between U Plant and PUREX existed in later operations because both plants used TBP-based solvent extraction operations.

4.1.4 Characteristics and Hazards Associated with Contaminants of Concern

The characteristics and relative hazards of the radionuclides and chemical constituents are presented here to support prioritizing the waste groups and selecting the worst-case and typical waste sites. These data include discussions of persistence, toxicity/health hazards, and mobility of the constituents.

Persistence data for radionuclides are based on their half-lives. Half-lives of some of the principal radionuclides are listed in Table 4-2.

Inorganics such as cadmium, chromium (VI), and nitrate persist in the environment indefinitely. Both persistence and mobility determine the potential for exposure by receptors. For organics, persistence data are not well known, but, as described in Section 4.1.2, chlorinated organics are more persistent than are nonchlorinated organics primarily driven by the relative degree of biodegradation that occurs in the soil. To a lesser extent, higher volatility decreases persistence. Mobility, as measured by K_d, also influences the tendency of a contaminant for deep migration or transport to groundwater. Values of K_d values for radionuclides shown in Table 4-2 are taken from Kaplan et al. (1995). The K_d data are stated for Hanford sediments receiving either neutral to high pH, low salt, low organic, oxic solutions or neutral to high pH, high salt, low organic, oxic solutions. High organic solution data were not presented in Kaplan et al. (1995).

4.1.4.1 Radionuclides. Uranium isotopes are regarded as important contaminants of concern (COC) due to their long half-lives, high mobility (once transported into groundwater), presence at certain waste sites in larger quantities, and high toxicity. Uranium is currently present in groundwater as a result of discharge of acidic wastes, which is believed to have mobilized uranium at an adjacent crib.

Plutonium and americium are hazardous due to their long half-life, highly toxic nature, and radiologic impacts when inhaled. However, plutonium and americium pose less of a threat to receptors at most waste sites because of their immobile nature in the soil column and generally small inventories within the waste site. Americium is a decay product of plutonium and is reported at only a few sites around Z Plant. Any site with significant quantities of plutonium will also have detectable quantities of americium.

Fission products are common to most sites. Relatively short-lived radionuclides such as cobalt-60 and ruthenium-106 have decayed at most sites to very small fractions of the original inventory and are not expected to represent a significant future threat. Tritium, which has a 12-year half-life, is highly mobile but should decay to low levels within 50 to 100 years. Moderate half-life fission products such as strontium-90 and cesium-137 are also expected to decay to insignificant levels within a 100- to 200-year time frame. In most waste streams, strontium is moderately mobile and cesium has low mobility. Mobile fission products with long half-lives such as technetium-99 and iodine-129 pose a greater long-term health risk. The fission products tritium, technetium-99, iodine-129, and ruthenium-106 are mobile and are currently present in groundwater. Cobalt-60 is generally highly immobile but has been found in groundwater plumes as a result of its association with ferrocyanide.

4.1.4.2 Inorganics. The primary inorganic chemicals/compounds in the waste sites are ferrocyanide, nitrate, hydrazine, cadmium, and chromium. Although cyanide is a deadly poison by most routes into the body, cyanide salts are much less toxic as long as the material is not ingested. Cyanide is noted for its affinity to bond with metals, making it an ideal scavenging agent. It is highly mobile and forms a groundwater plume north of the 200 East Area. It has been found in Hanford soils around the 216-BY Cribs as a component of scavenged waste and is likely present at other sites in that group.

Nitrate is a very widespread and mobile contaminant in the soil column and groundwater. It is associated with waste streams where nitric acid was used to dissolve and separate radionuclides. Its poses little hazard in small doses when taken orally, but is known to cause health problems in young children.

Hydrazine was used at PUREX to adjust the valence of plutonium. It is carcinogenic, poisonous by most routes into the body, mutagenic, teratogenic, and moderately toxic by inhalation. Hydrazine is very soluble in water and breaks down into amines. Retention in the soil is not expected. The quantities of hydrazine used at PUREX are unknown.

Cadmium and chromium (VI) are heavy metals and are known and suspected carcinogens, respectively, to the respiratory system. Both are toxic, cadmium by inhalation and chromium when ingested. Cadmium's mobility is generally limited as it tends to attach to soil, whereas chromium tends to be highly mobile in the forms found on site. Both are considered to be long-lived because toxicity is not reduced in various chemical forms. Mobility is more important in determining exposure to humans and the environment.

4.1.4.3 Organics. A number of organic compounds have been used at the Hanford Site, including hexone (aka methyl isobutyl ketone), TBP, NPH, and dibutyl butyl phosphonate (DBBP). Carbon tetrachloride is also present, in large quantities, along with the degradation product chloroform. TCE is also found in the same area as carbon tetrachloride but is not a degradation product.

Hexone, which was used at the REDOX Plant, is a poison by skin contact and toxic by ingestion and inhalation, but there is no known cancer risk. Hexone is a moderately volatile, light-phase organic and has a 2% solubility in water. It is highly biodegradable.

TBP and its NPH carrier have a relatively low vapor pressure. TBP is poisonous through adsorption and ingestion and toxic by all routes. These two compounds are highly biodegradable and generally do not persist in the environment.

Carbon tetrachloride is present in large quantities in the vadose zone and groundwater around Z Plant. It is a carcinogen, attacking the liver and a poison through ingestion. The degradation product chloroform is also a carcinogen and attacks the liver. Similarly, chloroform is a poison when ingested or inhaled. TCE is also a carcinogen and toxic by inhalation and ingestion. These constituents are mobile and form large groundwater plumes. DBBP is a known poison. The chlorinated hydrocarbons are not readily biodegradable in the subsurface conditions present at the Hanford Site.

4.2 URANIUM-RICH PROCESS CONDENSATE/PROCESS WASTE GROUP

4.2.1 Group Description

Uranium-rich (uranium-238) process condensate/process wastes were generated mainly at U Plant's Uranium Recovery Project (URP) and the 224-U/UO_3 Program for PUREX, as well as at the PUREX and REDOX process facilities in the 200 East and 200 West Areas. The three processes are similar in that organic compounds (hexone or TBP and NPH) were used to separate plutonium and/or uranium from the process solutions in solvent extraction columns. Twenty-three process condensate and process waste sites received 150 kg or more of uranium. Most of the process waste sites received uranium-rich solutions from the cold startup phase prior to the operation of the three plants. The process condensates were vapors collected from thermally hot process steps that were condensed and subsequently discharged to the ground. The COCs were carried along as minor constituents in the vapor phase and condensed with the water vapor before release.

A significant fraction of the waste sites in this group received potentially acidic liquid wastes. Several sites are regarded to be the origin of the 200 West Area uranium groundwater plume. Discharges to the 216-S-1/2, 216-U-1/2, 216-U-8, and 216-U-12 Cribs are known or thought to have acidic components in what were generally considered to be neutral/basic liquid wastes. As such, uranium mobilization has occurred, and groundwater contamination at several of these sites is known. These sites are regarded as the exceptions to this group's conceptual model.

The 216-A-10, 216-A-36B, and 216-U-12 Cribs are RCRA TSD units. The 216-A-10 Crib received process condensate liquids from the PUREX Canyon Building. The crib was active through 1987 and was designated a RCRA facility because of the caustic and acidic components in the waste stream. The 216-A-36B Crib is part of the original 216-A-36 Crib, a larger structure that received distillate waste from the PUREX ammonia scrubber system. The crib was subdivided after 6 months of operation following the rapid buildup of more than 147,000 Ci of short-lived beta-emitting fission products within the first 30 m (100 ft) of the crib. This section, renamed the 216-A-36A Crib, was isolated by a vertical grout barrier between the highly contaminated and less contaminated crib segment and by sealing and bypassing the crib distribution pipe. The remaining section, the 216-A-36B Crib, continued to receive ammonia

scrubber waste through October 1987 and was determined to be a RCRA TSD unit based on the presence of ammonia in the waste stream. For the purpose of this document, the 216-A-36A and 216-A-36B Cribs are considered to be one waste management unit. The 216-U-12 Crib received U Plant and 224-U Building process condensate, primarily from the UO_3 process, between 1960 and February 1988. The site was determined to be a RCRA TSD unit based on the acidic (pH <2.5) nature of the liquid waste.

Considerable characterization of the 216-U-1/2 Cribs, the associated 241-U-361 Settling Tank, and the 216-U-8 Crib has been performed as part of the focused feasibility study for the 200-UP-2 Operable Unit (DOE-RL 1996c). The cribs received the URP's process condensate (221-U) from 1951 to 1958 and then received acidic process waste from the UO_3 process condensate (224-U and 276-U) during 1966 and 1967. The cribs were then taken out of service. Additional information is available in the *Limited Field Investigation for the 200-UP-2 Operable Unit* (DOE-RL 1995b), the RFI/CMS Work Plan for the 200-UP-2 Operable Unit (DOE-RL 1993i), the U Plant AAMS report (DOE-RL 1992c), and the 200 West Groundwater AAMS report (DOE-RL 1993c).

The 216-B-60 Trench is placed in this group but is not considered for characterization. The trench was constructed to receive 221-B Building decontamination wastes prior to Waste Encapsulation and Storage Facility reconstruction and has an inventory of approximately 670 kg of uranium. The site was buried by the addition of the Waste Encapsulation and Storage Facility at B Plant.

4.2.2 Known and Suspected Contamination

The contaminants found at the cribs in this group are presented in Table A-1, Appendix A. The greatest quantities of uranium were from the PUREX cold startup to specific retention trenches 216-A-18, 216-A-19, and 216-A-20. More than 40,000 kg of depleted uranium in a process waste solution was discharged. The 216-B-12 and 216-U-8 Cribs are expected to have received 21,000 kg and 24,200 kg, respectively, in large quantities of URP process condensate. The REDOX process condensate discharged more than 4,800 kg of uranium to the 216-S-1/2 and 216-S-7 Cribs. The 216-U-1/2 Cribs received 4,000 kg of uranium.

Other contaminants associated with the uranium-rich process condensates are present in limited quantities. Plutonium is common, reaching up to 1,200 g in process waste cribs. Larger quantities of fission products (up to 2,000 Ci of cesium and 2,300 Ci of strontium) are found in process condensate waste sites but in limited quantity in process wastes sites. Technetium-99 is a fission product associated with uranium. It has been found in conjunction with uranium only at the 216-U-1/2 Cribs. Nitrate was reported for many of the streams but, except for several process condensate cribs, in smaller quantities. Nitric acid was reported for several of the more highly contaminated process condensate streams. Sodium-rich compounds, ammonium carbonate, and ammonium nitrates are also reported.

Many process condensates received enough wastewater to have washed the moderately mobile COCs to the groundwater table. However, at several cribs, contaminant migration may be partially attributable to flow along a crib monitoring well, either around the well casing annulus

or by penetration of the casing. Groundwater contamination beneath a crib was frequently used as a criterion for ceasing discharges to that site. Casing failure provided waste stream access to the inside of the well and resulted in groundwater contamination.

Groundwater contamination occurred at the 216-U-1/2 Cribs with significant uranium penetration to the groundwater and also at the 216-S-1/2 Cribs with fission product migration. An acidic waste stream was routed to the 216-U-1/2 Cribs in 1966 and 1967 and is the prime suspect in remobilizing some of the uranium, taking it to a depth of 49 m, just above a low-permeability caliche layer. Some of the material also leaked along the outside of a well casing through the caliche layer and to the groundwater. Large volumes of wastewater added to the adjacent 216-U-16 Crib in 1984 washed more of the uranium through to the groundwater. Sharp increases in uranium concentrations in the groundwater were noted, and a pump-and-treat action was initiated in 1986. The 200-UP-2 limited field investigation characterization (DOE-RL 1995b) found that most of the uranium and cesium-137 remained no more than 20 m below the crib. Groundwater contamination is also observed beneath the 216-A-10 and 216-A-36A/B Cribs.

4.2.3 Conceptual Model Summary

Uranium-rich process condensates from a number of facilities were disposed to either gravel-filled or wood-constructed cribs or excavated trenches. For crib structures, the condensate streams were characteristically high volume over their operating lifetime and thus were capable of driving the more mobile contaminants deep into the soil column and the groundwater. Less mobile contaminants such as plutonium and cesium-137 that are normally retained near the base of the crib structure or at shallow depths below the crib will also be carried deeper in the soil column. Competition for sorption sites is likely at those facilities receiving high quantities of sodium compounds and may have resulted in fission product migration to depth. The presence of other chemical constituents such as nitrates is known, and these constituents have produced broad groundwater plumes at several sites. These components are generally thought to have no influence on the movement of the primary COCs. The effects of dilute acidic waste streams are unknown but are expected to be limited due to high buffering capacity of the soil. Discharge of highly acidic waste streams is credited with mobilization of uranium at the 216-U-1/2 Cribs.

Process waste disposed to excavated trenches was of limited volume. The amount of liquid disposed was generally less than the soil column pore volume beneath the facility's footprint. Uranium at these sites is expected to be held fairly high within the soil column, close to the bottom of the disposal structure through sorption. The presence of nitrates in the process wastes is noted at several locations, but the nitrates appear to be in small quantities. Nitrate contamination in the vicinity of the 216-U-1/2 Cribs is an exception as the concentrations in groundwater are about 100 times the drinking water standard. Other contaminants are present in small amounts but are not deemed to pose a significant threat to human health and the environment and are not addressed in the conceptual model. The conceptual models for the Uranium-Rich Process Condensate/Process Waste Group crib and trench are shown in Figures 4-2 and 4-3, respectively.

Figure 4-2. Uranium-Rich Process Condensate/Process Waste Group Crib Conceptual Model.

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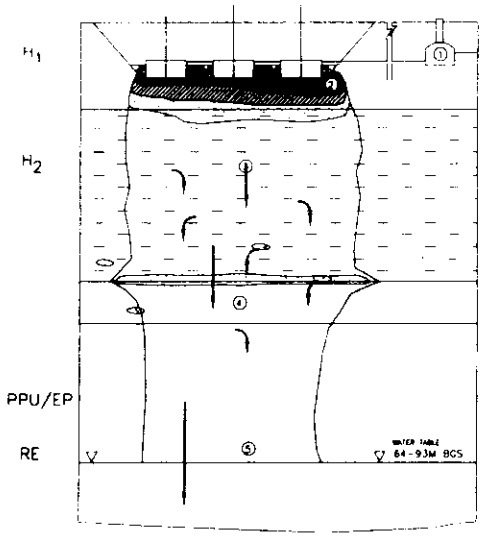


CONTAMINATION

- HIGH
- MEDIUM
- LOW

HYDROGEOLOGIC NOTATIONS

- H_1 HANFORD GRAVEL
- H_2 HANFORD SAND
- PPU/EP PLIO-PLEISTOCENE/EARLY PALOUSE SOIL
- RE RINGOLD UNIT E
- DISCONTINUOUS SILT STRINGERS
- WATER TABLE DEPTH BELOW GROUNDSURFACE
- MOISTURE FRONT/ CONTAMINANT PATHWAY

① LOW SALT, NEUTRAL/BASIC, LOW ORGANIC LIQUID WASTE PASSED THROUGH CARBONATE NEUTRALIZATION TANK ENROUTE TO CRIB. WASTE STREAM CONTAINS HIGH CONCENTRATIONS OF U-238, Pu-239/240, AND BETA EMITTERS. QUANTITIES OF NITRIC ACID-RICH LIQUIDS OCCASIONALLY DISCHARGED.

② PARTICULATES AND PRECIPITATES SETTLE OUT IN CRIB GRAVELS AND JUST BENEATH CRIB EXCAVATION. LESS MOBILE RAD. CONTAMINANTS SORB TO SOIL COLUMN. MORE MOBILE CONTAMINANTS SUCH AS U-238 FORM CARBONATE COMPOUNDS AND MIGRATE DOWNWARD.

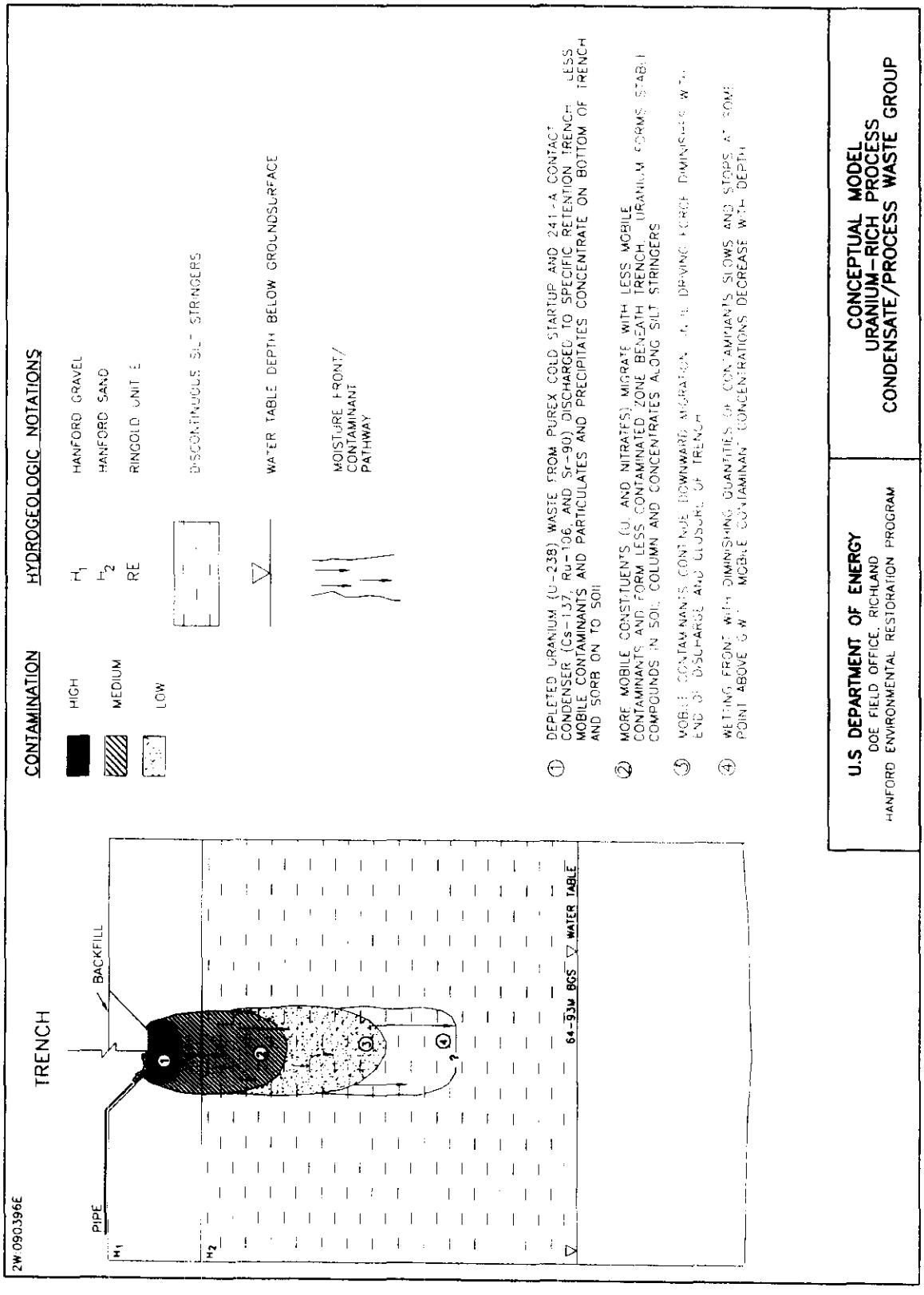
③ Cs-137 NOT REPORTED IN INVENTORY IS ALSO FOUND IN THIS VOLUME. LOW CONCENTRATION OF U-238 IS FOUND AT TOP OF PPU/EP AND ASSOCIATED SILT STRINGERS IN HANFORD SANDS.

④ CALICHE LAYER CAUSES PERCHING OF URANIUM-RICH LIQUIDS AND SOME CONTAMINANTS ARE RETAINED IN SOIL COLUMN. FINE-GRAINED PPU/EP RETARDS AND SPREADS WASTE WATER LATERALLY.

⑤ HIGH VOLUME WASTE STREAM DRIVES MOBILE CONTAMINANTS TO GW.

U.S DEPARTMENT OF ENERGY DOE FIELD OFFICE, RICHLAND HANFORD ENVIRONMENTAL RESTORATION PROGRAM	CONCEPTUAL MODEL URANIUM RICH PROCESS CONDENSATE/PROCESS WASTE GROUP

Figure 4-3. Uranium-Rich Process Condensate/Process Waste Group Trench Conceptual Model.



Based on the data presented in Appendix A, four waste sites were chosen as representative cases for this group. The 216-U-12 Crib was selected for its typical uranium inventory and its current level of characterization, which has provided better insight into contaminant distribution. The 216-B-12 Crib was selected for its contaminant inventory and the fact that it received a second process condensate that added high inventories of fission products. The 216-U-8 Crib was chosen as a "worst case" site because of its high inventory and its current level of characterization. The 216-A-19 Specific Retention Trench was chosen because it has the highest inventory of uranium and was discharged as a process waste stream. This information is summarized in Table 4-3.

4.3 PLUTONIUM PROCESS CONDENSATE/PROCESS WASTE GROUP

4.3.1 Group Description

Plutonium liquid process wastes without associated organic contaminants were discharged to the soil column through three cribs, one reverse well, and one french drain. All five sites are located within 300 m of the 234-5Z Plant (Plutonium Finishing Plant [PFP]) in the 200 West Area.

The cribs and reverse well received neutral/basic process wastes from the Plutonium Isolation Facility, which operated from approximately 1945 to 1949 to condense the plutonium nitrate solution from the separation process facilities into plutonium paste prior to additional offsite processing (DOE-RL 1992d). The french drain received neutral/basic overflow from a solids settling tank for backflush of the feed filters for the Recuplex process, which recovered plutonium from Z Plant liquid and solid scraps from 1955 to 1962 (see Section 4.4.1).

4.3.2 Known and Suspected Contamination

The primary COCs are plutonium-239/240 and americium-241. Co-contaminants of secondary concern include uranium, cesium-137, and strontium-90.

Radionuclides have been detected in the surface soils (0- to 1-m depth) at 216-Z-5; plutonium-239 has been detected as deep as 7.6 m at 216-Z-8. Plutonium and americium were discharged at a depth of 46 m at 216-Z-10. In the absence of organic complexants, plutonium and americium sorb to 200 West Area vadose zone sediments within a few meters of the release point (Johnson 1993). Eight wells drilled around the first wooden crib of the 216-Z-5 pair accounted for only 0.5 g of plutonium (0.1% of the inventory). Therefore, it is believed that most plutonium activity is in or directly below the crib (Owens 1981). Soil samples from wells drilled adjacent to the 216-Z-10 Reverse Well were collected every 1.5 m to depths of 53 m (7.5 m below the bottom of the reverse well). These samples showed no contamination (Owens 1981). At one well drilled adjacent to 216-Z-8, plutonium and americium activity was detected in a zone extending 5 m from the bottom of the drain (Marratt et al. 1985).

Table 4-3. Selected Representative Waste Sites for Each Waste Group. (sheet 1 of 4)

Group	Typical Case		Worst Case		Waste Site Selection Rationale
	1st Choice	2nd Choice	1st Choice	2nd Choice	
Uranium-Rich Process Condensate/ Process Waste (Section 4.2)	216-U-12 Cribs[a]	216-B-12 Crib[a]	216-U-8 Crib[a]	216-A-19 Trench[a]	216-U-12 Cribs selected for PCOC content and level of characterization. 216-U-8 Crib selected for high PCOC content and level of characterization. 216-A-19 Trench selected for the highest PCOC inventory to the soil column by a process waste stream. 216-B-12 Crib has a high PCOC content, has received a second process condensate waste stream with high fission product inventory, and is located in the 200 East Area.
Plutonium Process Condensate/Process Waste (Section 4.3)	216-Z-5 Crib[a]		216-Z-10 Reverse[a] Well		216-Z-5 Crib selected for high PCOC inventory and high volume of most liquid waste. 216-Z-10 Reverse Well released contamination deep below ground surface.
Plutonium/Organic-Rich Process Condensate/Process Waste (Section 4.4)	216-Z-1A[a] Crib		216-Z-9 Crib[a]		216-Z-1A Crib selected for high PCOC inventory and level of characterization. 216-Z-9 Crib selected for highest PCOC inventory and level of characterization.
Organic-Rich Process Condensate/ Process Waste (Section 4.5)	216-S-13 Crib[a]	216-A-2 Crib[a]	216-A-8 Crib[a]		216-S-13 Crib received typical quantities of hexone (methyl isobutyl ketone) and highest quantities of sodium dichromate along with large quantities of liquid waste. 216-A-2 Crib received high PCOC organic content along with high quantities of radionuclides. 216-A-8 Crib received highest quantities of radionuclides in group and had high PCOC content.
Fission Product Process Condensate/ Process Waste (Section 4.6)	216-B-57 Crib		216-S-9 Crib[a]		216-B-57 Crib selected for high PCOC inventory, level of characterization as part of 200-BP-1 Operable Unit, and receiving large quantities of liquid waste. 216-A-36A/B Crib has highest inventory of PCOCs in the group.
General Process Condensate/Process Waste (Section 4.7)	216-C-3 Crib[a]				216-C-3 Crib received highest inventory of PCOCs (uranium) and large quantities of SCOCs (strontium-90) in large quantities of liquid waste.

Table 4-3. Selected Representative Waste Sites for Each Waste Group. (sheet 2 of 4)

Group	Typical Case		Worst Case		Waste Site Selection Rationale
	1st Choice	2nd Choice	1st Choice	2nd Choice	
Tank Waste (Section 4.8)	216-B-38[a] Specific Retention Trench		216-B-7A/B[a] Crib	216-B-5 Reverse Well	216-B-38 Trench received high inventory of fission products in cascaded tank supernatant waste type. 216-B-7A/B Crib received highest inventory of PCOCs and SCOCs in the intermediate-level process waste stream type. The 216-B-5 Reverse Well received high inventories of PCOCs and SCOCs, which were discharged just above groundwater table.
Scavenged Waste (Section 4.9)	216-B-46 Crib[a]	216-T-26 Crib[a]			216-B-46 Crib selected due to PCOC/SCOC inventory and level of characterization under 200-BP-1 Operable Unit. 216-T-26 Crib selected due to high PCOC/SCOC inventory.
Steam Condensate (Section 4.10)	216-S-5 Crib[a]	216-A-6 Crib[a]			216-S-5 and 216-A-6 Cribs selected for high inventories and quantities of liquid waste received from REDOX and PUREX. Both sites have unplanned releases associated with operations.
Chemical Sewer (Section 4.11)	216-S-10 Ditch		216-A-29 Ditch[a]		216-A-29 Ditch selected due to high volume of liquid wastes discharged and reported quantities/types of chemicals. 216-A-29 Ditch to be characterized per DOE-RL (1993d). 216-S-10 Ditch selected due to volumes of liquid wastes received and reported quantities of PCOCs.
U-Pond/Z-Ditches Cooling Water (Section 4.12)	216-U-14 Ditch[a]	216-Z-11 Ditch[a]	216-U-10 Pond[a]		216-U-10 Pond selected due to high PCOC inventory, amounts of liquid waste discharged to site, and level of characterization under 200-UP-2 limited field investigation. 216-U-14 Ditch selected due to suspected high PCOC inventory, presence of laundry waste discharges, and long history of operations. 216-Z-11 Ditch selected to document known contamination distributions and suspected high PCOC inventory.

Table 4-3. Selected Representative Waste Sites for Each Waste Group. (sheet 3 of 4)

Group	Typical Case		Worst Case		Waste Site Selection Rationale
	1st Choice	2nd Choice	1st Choice	2nd Choice	
Gable Mountain/ B-Pond and Ditch Cooling Water (Section 4.13)	216-B-2-2[a] Ditch		216-A-25[a] Gable Mountain Pond		216-B-3 Pond system to be characterized by 200-BP-11 Operable Unit activities. 216-B-2-2 Ditch selected based on the expected inventory produced by unplanned release (UPR-200-E-138), which released 1,000 Ci of strontium-90. 216-A-25 Gable Mountain Pond selected due to high radionuclide inventory and large quantities of waste discharged.
200 North Pond Cooling Water (Section 4.14)	216-N-4 Pond[a]				216-N-4 Pond selected due to high volume of waste discharged to pond. Minimal inventory.
S-Ponds/Ditches Cooling Water (Section 4.15)	216-S-17 Pond and Ditch[a]				216-S-17 Pond and Ditch selected due to high volumes of liquid wastes, high radionuclide inventory, and significant number of unplanned releases.
T-Ponds/Ditches Cooling Water (Section 4.16)	216-T-4A Pond[a]				216-T-4A Pond selected on basis of inventory and high volumes of liquid waste received.
200 Area Chemical Laboratory Waste (Section 4.17)	216-S-20 Crib[a]		216-Z-7 Crib[a]		216-S-20 Crib selected on basis of length of service, inventory, and amount of waste received. 216-Z-7 Crib selected based on high radionuclide inventory. Both sites are known to have received liquid waste from 300 Area Laboratories, but quantities and inventory are not known.
300 Area Chemical Laboratory Waste (Section 4.18)	216-B-58 Trench[a]		216-T-28 Crib[a]		216-B-58 Specific Retention Trench selected based on inventory. 216-T-28 Crib selected based on high radionuclide inventory and volume of liquid waste received.
Radioactive Landfills and Dumps (Section 4.19)	218-W-2A Inactive TRU Burial Ground[a]	218-W-1 Inactive Low-Level Burial Ground[a]	218-W-4A Inactive TRU Burial Ground[a]		218-W-1A Low-Level Burial Grounds and 218-W-2A and 218-W-4A TRU Burial Grounds selected for large inventory of PCOC.

Table 4-3. Selected Representative Waste Sites for Each Waste Group. (sheet 4 of 4)

Group	Typical Case		Worst Case		Waste Site Selection Rationale
	1st Choice	2nd Choice	1st Choice	2nd Choice	
Nonradioactive Landfills and Dumps (Section 4.20)	Nonradioactive Dangerous Waste Landfill	600-40, West Lake Dumping Area[a]			Nonradioactive Dangerous Waste Landfill selected due to its representativeness of inventory and as an "engineered" landfill. West Lake Dumping Area selected as a site typical of miscellaneous solid waste disposal.
Miscellaneous Waste (Section 4.21)	216-T-33 Equipment Decontamination Crib[a]	216-U-3 French Drain[a]	216-A-4 Crib[a]		216-T-33 Crib received highest volume of liquid wastes of the equipment decontamination sites. 216-U-3 French Drain received reported quantities of radionuclides into a small facility and would be easily characterizable by test pit. 216-A-4 Crib received an undifferentiated blend of ventilation waste and PUREX laboratory waste.
Septic Tanks and Drain Fields (Section 4.22)					No representative sites selected.
Tanks/Boxes/Pits/ Lines (Section 4.23)					No representative sites selected.
Unplanned Releases (Section 4.24)					No representative sites selected.

[a]Sites counted in Good Representative Sites criterion, Table 5-1.

PCOC = potential contaminant of concern
SCOC = secondary contaminant of concern
TRU = transuranic

4.3.3 Conceptual Model Summary

The greatest concentration of plutonium and americium is immediately beneath the disposal sites (Figure 4-4). Radionuclides present in the waste streams as particles were filtered out by the sediments at the top of the soil column. "Non-particulate" radionuclides in solution may have precipitated or sorbed as a result of chemical interactions with the sediment particles (Price et al. 1979).

Representative sites selected for this group are based on data given above and in Appendix A. The 216-Z-5 Crib was selected for its high inventory and high volume of liquid waste received. The 216-Z-10 Reverse Well was chosen because this waste site released significant levels of contamination deep in the soil column and relatively close to the groundwater table. Representative sites are presented in Table 4-3.

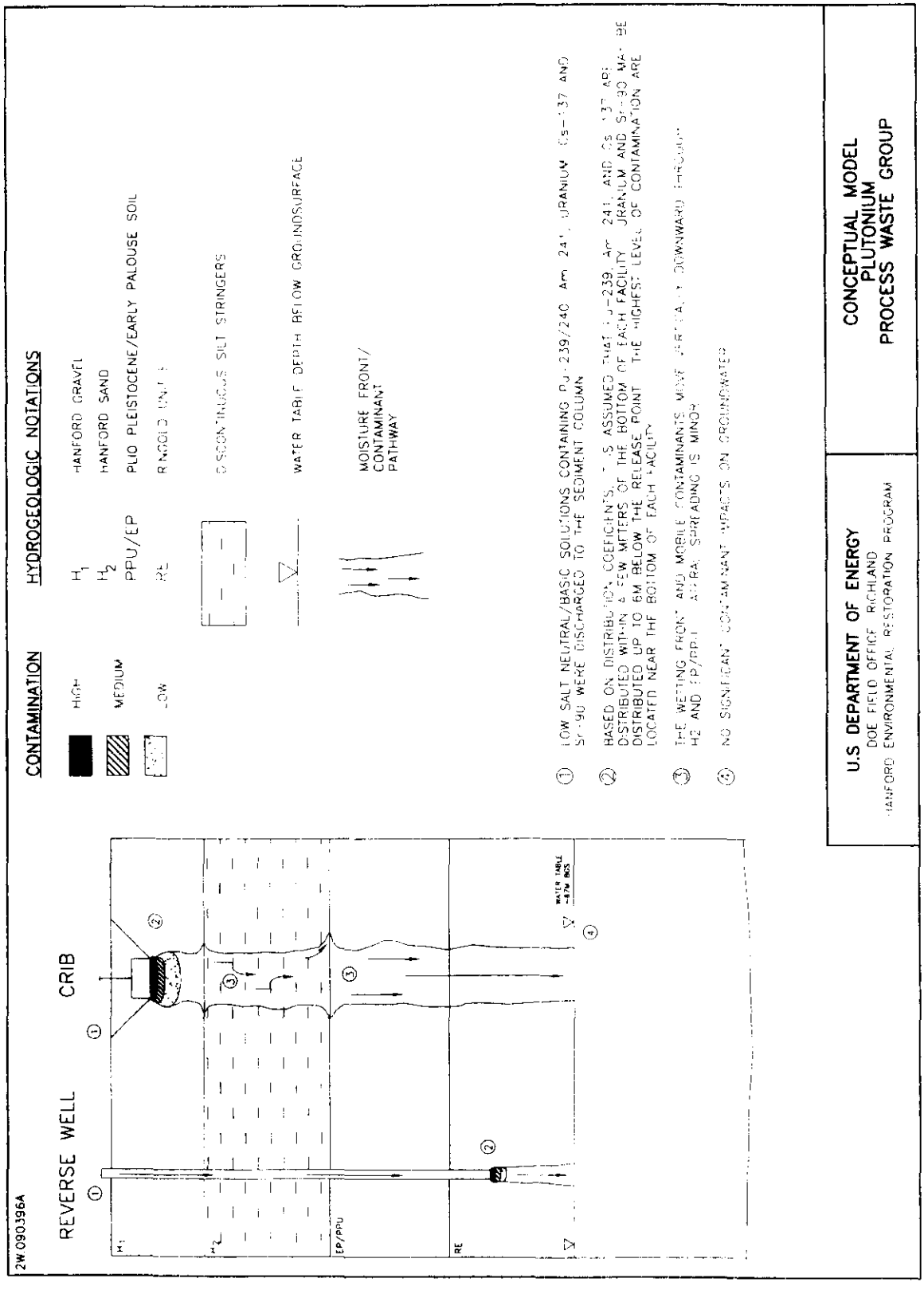
4.4 PLUTONIUM/ORGANIC-RICH PROCESS CONDENSATE/ PROCESS WASTE GROUP

4.4.1 Group Description

Plutonium/organic liquid wastes were discharged to the soil column through eight cribs and drains and one ditch (Table A-1, Appendix A). Two primary waste streams were discharged to these facilities: an organic stream and an aqueous stream. All nine sites are located within 550 m of the 234-5Z Plant (PFP) in the 200 West Area. Z Plant began operations in late 1949 to process plutonium nitrate solutions into plutonium oxide and plutonium metal. Each process line generated side streams that contained recoverable quantities of plutonium. Recuplex began operation in 1955 to reclaim plutonium from these streams. Recuplex operation was discontinued after a criticality incident in 1962 and was replaced in 1964 by the Plutonium Reclamation Facility (PRF). An americium recovery process was added on to PRF and also began operation in 1964. Recuplex and PRF were the primary contributors of carbon tetrachloride to the soil column.

In the plutonium recovery process, an organic solution was used to extract the plutonium from aqueous nitrate streams in solvent extraction columns. The plutonium-rich organic then entered another extraction column where it was stripped of its plutonium by another aqueous stream (DOE-RL 1991). The organic solutions consisted of 50% to 85% by volume carbon tetrachloride mixed with either TBP, DBBP, or lard oil (DOE-RL 1991). The TBP and DBBP formed several complexes with the plutonium or americium. The carbon tetrachloride was added as a diluent to increase the density and reduce the viscosity of the organic stream (DOE-RL 1991). The carbon tetrachloride solutions were periodically discharged to the soil column disposal sites in batches (DOE-RL 1991).

Figure 4-4. Plutonium Process Condensate/Process Waste Group Conceptual Model.



The aqueous waste stream was an acidic, high salt, sodium nitrate solution composed primarily of nitric acid, fluoride, nitrate, and phosphate (DOE-RL 1993c). Although the aqueous waste stream was saturated with carbon tetrachloride solutions, the organic content of the aqueous stream was less than 1%. The aqueous wastes were discharged to the same sites as the organic wastes.

The primary radionuclide components of the organic and aqueous waste liquids were plutonium-239/240 and americium-241.

All of the waste sites included in this group received plutonium- and carbon tetrachloride-laden waste (Table A-1, Appendix A). The three primary disposal sites, 216-Z-1A and associated 216-Z-1 and 216-Z-2, 216-Z-9, and 216-Z-18, were used for direct disposal of Recuplex or PRF aqueous and organic wastes from 1955 to 1973. The 216-Z-12 site, activated in 1959, received organic and aqueous carbon tetrachloride waste generated during laboratory development support of Z Plant operations (Kasper 1981); carbon tetrachloride vapor was detected during site characterization activities at this site (Rohay et al. 1994). The 216-Z-3 site, which is included within the 216-Z-1A fenced area, was used from 1952 to 1955 to dispose of laboratory development waste as the predecessor to 216-Z-12 (DOE-RL 1992d, Kasper 1981). Heavy organic emissions were noted in the outfall to the 216-Z-19 Ditch, and soil gas surveys have detected carbon tetrachloride at this location (Johnson 1993, Rohay et al. 1994). Ground disposal of organic wastes ceased in 1973; however, the carbon tetrachloride-laden aqueous waste was routed to an evaporator and discharged to the 216-T-19 site from 1973 to 1976 (Rohay et al. 1993).

Soil vapor extraction was implemented in 1992 under the 200 West Area Carbon Tetrachloride Expedited Response Action to remove carbon tetrachloride from the vadose zone and is still ongoing. Three extraction systems, with a total capacity of 85 m^3/min, are operating continuously at the 216-Z-9, Z-1A, Z-18, and Z-12 sites. In support of this cleanup action, characterization studies focusing on the distribution of carbon tetrachloride in the soil have been conducted in the disposal site area since 1991. Soil vapor extraction operations will be temporarily suspended in fiscal year 1997 to assess the rebound of carbon tetrachloride concentrations in soil.

4.4.2 Known and Suspected Contamination

The primary COCs are carbon tetrachloride, plutonium-239/240, and americium-241. Co-contaminants and/or degradation products of secondary concern include chloroform, methylene chloride, tetrachloroethylene (PCE), and TCE; plutonium and americium decay products (e.g., protactinium-233); and minor quantities of fission products (e.g., ruthenium-106).

Carbon tetrachloride has been detected in all potentially affected media (Table A-1, Appendix A). Radionuclides have been detected in all potentially affected media with the exception of air. Plutonium-239/240 and americium-241 were detected in groundwater samples from a single well that may have been a preferential pathway for movement of liquid wastes to groundwater (Rohay et al. 1994).

4.4.3 Conceptual Model Summary

Carbon tetrachloride was discharged to the subsurface both in an aqueous solution and as separate batches of nonaqueous-phase liquid (Figure 4-5). As a result of vadose zone transport and phase partitioning, carbon tetrachloride is present in the vadose zone as a vapor phase; as an aqueous phase dissolved in soil moisture; as a solid phase adsorbed to the exterior and interior of sediment particles; and/or as a nonaqueous liquid phase. Plutonium and americium were co-contaminants in both liquid discharges.

Chloroform, methylene chloride, PCE, and TCE have been detected in groundwater underlying the carbon tetrachloride disposal area (Rohay et al. 1994). The source of the chloroform and methylene chloride may be as degradation products of carbon tetrachloride. The past and current presence of sanitary drainage fields in the 216-Z-9 area suggest that anaerobic bacterial processes may be responsible (Dresel et al. 1995). Another potential source of chloroform is chlorinated water that was discharged to the 200 West Powerplant pond (DOE-RL 1993c). The TCE may be present as a degradation product of PCE, which was discharged to the 216-Z-9 site (Rohay et al. 1994). Low levels of PCE and TCE are observed in soil and groundwater at all three primary carbon tetrachloride disposal sites, suggesting PCE was also discharged to 216-Z-1A and 216-Z-18. Other sources of TCE in the groundwater are likely but unknown (Chiaramonte 1996).

In the vapor phase, some carbon tetrachloride has naturally vented to the atmosphere through wells and through the soil surface. In the vapor, aqueous, and/or liquid phases, carbon tetrachloride has migrated downward and contaminated the unconfined aquifer. Carbon tetrachloride dissolved in the groundwater has migrated laterally and has volatilized elsewhere within the vadose zone. The observed distribution of carbon tetrachloride in the subsurface suggests that all these mechanisms may be operating.

Laterally, the highest observed concentrations of carbon tetrachloride were consistently located in the vicinity of the 216-Z-9 Trench. Vertically, the highest concentrations have been associated with the fine-grained, lower permeability layers (Rohay et al. 1994).

The zone of highest carbon tetrachloride groundwater concentration still includes the 216-Z-9 Trench, suggesting that the carbon tetrachloride discharged there has been providing a continuous source of contamination to the groundwater (Rohay et al. 1994). Soil gas samples from the 216-Z-9 site indicate that residual and/or free liquid carbon tetrachloride was retained in the soil column above the water table (Rohay et al. 1994, Rohay 1996). Computer simulations of carbon tetrachloride migration beneath the 216-Z-9 Trench suggest that a major fraction of the total carbon tetrachloride discharged to 216-Z-9 is retained in the soil column above the water table and that continuous drainage has persisted from the soil column into the groundwater since 1963 (Chiaramonte 1996).

At the 216-Z-1A, 216-Z-12, and 216-Z-9 sites, the greatest concentration of plutonium and americium occurred immediately beneath the crib. These radionuclides were present in the waste streams as particles that were filtered out by the sediments at the top of the soil column. "Non-particulate" radionuclides in the aqueous solution may have precipitated or sorbed as a result of

Figure 4-5. Plutonium/Organic-Rich Process Condensate/Process Waste Group Conceptual Model.

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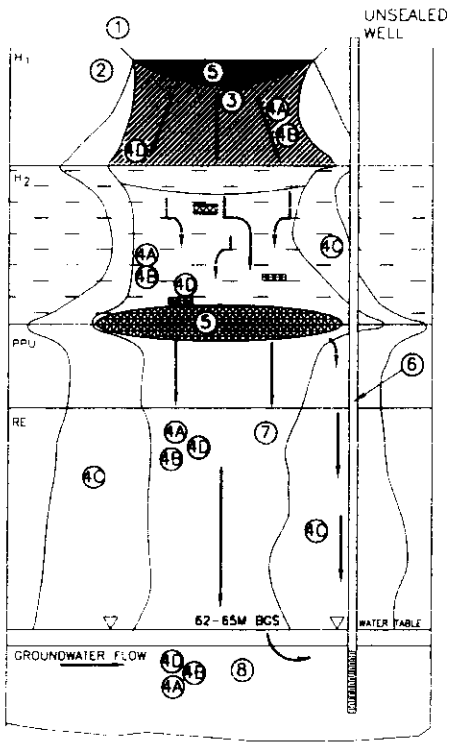
TRENCH



① HIGH SALT, HIGH ORGANIC SOLUTIONS CONTAIN Pu-239/240, Am-241, AND CARBON TETRACHLORIDE ARE DISCHARGED TO THE SEDIMENT COLUMN VIA TRENCHES.

② Pu-239/240 AND Am-241 SETTLE OUT OF SOLUTION MAINLY AS FINE PARTICULATES NEAR THE BOTTOM OF THE CRIB. CARBON TETRACHLORIDE ALSO PRESENT.

③ Pu-239/240 IN THE DISSOLVED PHASE MIGRATE VERTICALLY DOWNWARD WITH THE WETTING FRONT AND CARBON TETRACHLORIDE. SAMPLING ADJACENT TO THE CRIB SUGGEST THAT PU/AM HAS NOT SPREAD LATERALLY IN THE HANFORD FORMATION. Pu/Am CONTAMINATION EXTENDS TO A DEPTH OF 30M BENEATH THE TRENCH, THE HIGHEST CONCENTRATIONS ARE AT THE BOTTOM OF THE CRIB. THE ORGANIC PHASE LIKELY INCREASES THE MOBILITY OF Pu/Am WHICH HAS Kds OF >98 ml/g AND 1200 ml/g RESPECTIVELY IN HIGH SALT, LOW ORGANIC SOLUTIONS

④ CARBON TETRACHLORIDE IS PARTITIONED INTO FOUR PHASES IN THE VADOSE ZONE. 4A ADSORBED TO SEDIMENT PARTICLES
- 4B AQUEOUS PHASE/MISCIBLE PHASE
- 4C VAPOR PHASE
- 4D NON-AQUEOUS LIQUID PHASE/IMMISCIBLE PHASE

⑤ CARBON TETRACHLORIDE IS DETECTED THROUGHOUT THE SEDIMENT COLUMN. HIGHER CONCENTRATIONS ARE ASSOCIATED WITH FINE GRAINED, LOW PERMEABLE LAYERS SUCH AS THE EP/PPU AND DISCONTINUOUS FINER STRINGERS WITH IN HANFORD SAND

⑥ TRANSPORT OF CARBON TETRACHLORIDE TO GROUNDWATER IS HASTENED IN THE PRESENCE OF PREFERENTIAL PATHWAYS (i.e. INADEQUATELY SEALED WELLS).

⑦ THE WETTING FRONT AND CARBON TETRACHLORIDE MOVE VERTICALLY DOWNWARD THROUGH THE PPU AND RE. LATERAL SPREADING IS MINOR

⑧ CARBON TETRACHLORIDE ADVERSELY IMPACTS GROUNDWATER

SOIL COLUMN CONTAMINATION

- HIGH CONCENTRATION — PU/AM SOME CARBON TETRACHLORIDE
- MEDIUM CONCENTRATION — PU/AM SOME CARBON TETRACHLORIDE
- HIGHEST CONCENTRATION — CARBON TETRACHLORIDE
- CARBON TETRACHLORIDE VAPOR (4C)
- LOWEST CONCENTRATION — CARBON TETRACHLORIDE

HYDROGEOLOGIC NOTATIONS

- H1 — HANFORD GRAVEL
- H2 — HANFORD SAND
- PPU/EP — PLIO PLEISTOCENE/EARLY PALOUSE SOIL
- RE — RINGOLD UNIT E
- MOISTURE FRONT/ CONTAMINANT PATHWAY
- WATER TABLE DEPTH BELOW GROUNDSURFACE
- DISCONTINUOUS SILT STRINGERS

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HANFORD ENVIRONMENTAL RESTORATION PROGRAM

CONCEPTUAL MODEL PLUTONIUM/ORGANIC-RICH PROCESS CONDENSATE GROUP

chemical interactions with the sediment particles (Price et al. 1979). Plutonium and americium in the carbon tetrachloride-complexant solution were carried downward by the organic phase and concentrated in the finer grained units and at boundaries between major sedimentary units.

Based on data provided in this section and Appendix A, the 216-Z-1A Crib was selected as the typical waste site because of its plutonium and carbon tetrachloride inventory and its current level of characterization. The 216-Z-9 Crib was selected as the worst case waste site because of its having the highest plutonium inventory and a high carbon tetrachloride inventory and its current level of characterization. The representative sites are summarized in Table 4-3.

4.5 ORGANIC-RICH PROCESS CONDENSATE/PROCESS WASTE GROUP

4.5.1 Group Description

Organic-rich process condensates and process wastes are primarily associated with solvent-extraction techniques used to separate plutonium and uranium in aqueous solutions from acid-dissolved irradiated fuel rod process liquids. This type of process relies on extracting the two metals using an organic carrier rising through a denser, aqueous material onto which plutonium and uranium preferentially attach. A second solvent-extraction column reverses the process where a slightly acidic stream removes the plutonium and uranium from the organic phase. This type of process was used most commonly at the REDOX and PUREX facilities as well as the URP at 221-U. This waste type is also associated with the B Plant fission product recovery operations and with Z Plant plutonium finishing operations.

The REDOX process used hexone (methyl isobutyl ketone) as the organic solvent, whereas the PUREX process used TBP as the solvent with a kerosene-like NPH as a diluent. Both the URP and B Plant operations used TBP. Z Plant used DBBP as the organic solvent and carbon tetrachloride as the diluent. A number of smaller organic waste streams were associated with the 200 Areas. Small-scale testing of the REDOX, PUREX, and isotope recovery processes was performed in the Semiworks facility using irradiated fuel rods. In addition to the solvent extractions themselves, regeneration of certain chemical constituents released quantities of organics to the ground. In particular, ammonia regeneration at PUREX (216-A-36A/B) released a waste stream with small quantities of TBP organic material. However, these sites had a much higher uranium product content and were placed in another group. Process wastes rich in hexone were discharged near REDOX, and a TBP-rich U Plant liquid was discharged to the ground.

One other process condensate associated with the 241-A Tank Farms ventilation system was determined to be organic-rich. At the start of operations, 241-A-431 used a direct contact condenser to capture the volatile components in the ventilation gases. The gases were injected into a tank where cold water was misted in from the top of the vessel, removing most of the volatile contaminants. The liquid waste, with a considerable amount of both organic contaminants and radionuclides, was then discharged to the 216-A-8 and 216-A-24 Cribs. The organic-rich process condensate and process wastes discharged to the soil column are of interest because of their potential to increase mobility of the contaminants. Laboratory tests have

shown increased mobility of plutonium, strontium, and other radionuclides when complexed with TBP, DBBP, and other complexants (Serne and Wood 1990). The magnitude of the effect is not reported.

4.5.2 Known and Suspected Contamination

The primary wastes of concern are the organic compounds hexone, TBP and NPH, as well as uranium, plutonium, and fission products. The liquid waste tank condensate contained the highest concentrations of cesium-137. The tank sludge retains the strontium-90. Sodium dichromate was used at REDOX for preparation and cleaning of hexone and is found in the 216-S-13 Crib. The 216-S-14 Trench was used for discharge of unknown amounts of hexone from the initial cold test runs of the solvent extraction process. However, no reports of radiological contamination are found. Mixed reports are noted for the discharge of 26,500 L of "interfacial crud" with organic wastes from the 276-U Solvent Storage Area to the 216-U-15 Trench. The tar-oil-like "interfacial crud" resulted from an accumulation of degradation products of the organic solvent at the interface with the aqueous phases in the solvent-extraction columns. This discharge was likely TBP-NPH in nature rather than hexone as is shown in the database, because U Plant solvent-extraction chemistry was TBP-based. The 216-A-7 Crib received the inventory of TBP-NPH from the PUREX Plant. The 216-A-2 Crib received organic wastes from PUREX. The 216-C-4 Crib received radiologically contaminated organic wastes from the 276-C Solvent Handling Facility. Reportedly, the wastes came from the PUREX solvent-extraction process and strontium, cerium, promethium, and technetium solvent-extraction recovery processes in the Semiworks Building.

The moderate amounts of uranium and plutonium and small amount of fission products discharged to the waste sites in this group (except the 216-A-8 and 216-A-24 Cribs) do not appear to have caused a wide distribution in the soil column. However, the 216-A-8 Crib received 368 kg of uranium and 320,000 kg of ammonium carbonate. The carbonate could have combined with the uranium providing increased mobility as an anion, but the moderate amounts of liquid may have minimized its distribution. The 216-A-8 and 216-A-24 Cribs received large amounts of fission products and small to moderate amounts of organic wastes. The large amounts of liquid may have moved the moderately mobile strontium-90 deeper into the soil column. Hexavalent chromium is known to be very mobile, and the discharge of large volumes of liquid at the 216-S-13 Crib may have distributed it deep into the soil.

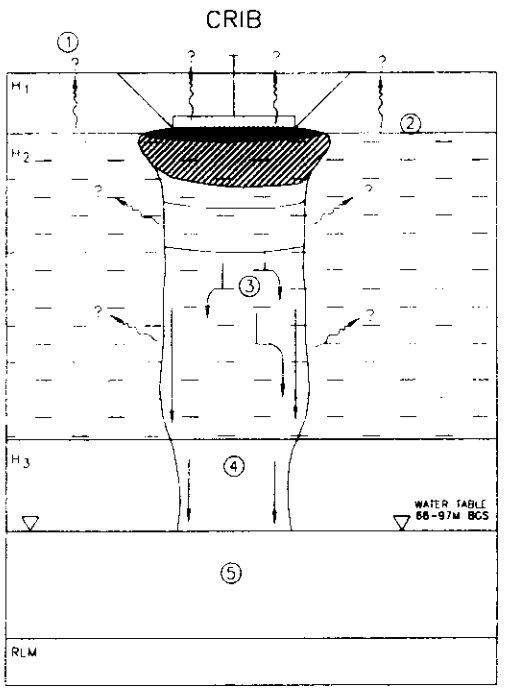
4.5.3 Conceptual Model Summary

The conceptual model for the Organic-Rich Process Condensate/Process Waste Group is shown in Figure 4-6. Organic-rich process condensates and process wastes were disposed to the subsurface. The organic components are not particularly soluble in water and are believed to be residing in the soil beneath the disposal sites at various depths. The organic material may have formed a nonaqueous-phase liquid and may be held in (or on) the soil. Biodegradation and vaporization may have reduced the quantities of organics originally discharged.

The fission products strontium-90 and cesium-137 are known to sorb onto soil and, barring interference from the organic components, should be retained near the point of disposal.

Figure 4-6. Organic-Rich Process Condensate/Process Waste Group Conceptual Model.

2W:083096A



CONTAMINATION

- HIGH
- MEDIUM
- LOW

HYDROGEOLOGIC NOTATIONS

H_1	HANFORD GRAVEL, UPPER UNIT
H_2	HANFORD SAND
H_3	HANFORD GRAVEL, LOWER UNIT
R; M	RINGOLD LOWER MUD UNIT

ORGANIC VAPORS

DISCONTINUOUS SILT STRINGERS

WATER TABLE DEPTH BELOW GROUNDSURFACE

MOISTURE FRONT/ CONTAMINANT PATHWAY

① ALKALINE LOW SALT, HIGH ORGANIC SOLUTIONS CONTAINING URANIUM, Pu-239/240, Cs-137, AND Sr-90 WERE DISCHARGED TO THE CRIB/SEDIMENT COLUMN.

② PARTICULATES IN SOLUTION (i.e. Pu-239/240) SETTLE OUT AT THE BOTTOM OF THE CRIB. Cs-137, Pu-239/240, URANIUM, AND Sr-90 SHOULD SORB TO SEDIMENT IN THE BOTTOM OF THE CRIB. THE HIGHEST CONCENTRATION BE SHOULD WITHIN 6M OF THE CRIB BOTTOM AND DECREASE WITH DEPTH. URANIUM COMPLEX WITH CARBONATES AND BECOME MORE MOBILE. ORGANICS MAY COMPLEX WITH RADIONUCLIDES TO INCREASE ISOTOPE MOBILITY.

③ THE WETTING FRONT AND MOBILE CONTAMINANT MOVE VERTICALLY DOWNWARD IN H1 WITH SPREADING OCCURRING ON TOP OF H2 AND ALONG SILT STRINGERS. ORGANICS SUSPECTED TO HAVE VOLATILIZED OR BIODEGRADED TO NON-DETECTABLE LEVELS SHORTLY AFTER RELEASE TO SOIL COLUMN.

④ WASTE WATER WITH TRACE QUANTITIES OF CONTAMINANTS MOVE VERTICALLY DOWN THROUGH H3.

⑤ WASTE WATER MAY IMPACT GROUNDWATER.

U.S DEPARTMENT OF ENERGY DOE FIELD OFFICE, RICHLAND HANFORD ENVIRONMENTAL RESTORATION PROGRAM	CONCEPTUAL MODEL ORGANIC-RICH PROCESS CONDENSATE GROUP

However, large liquid volumes may have driven the contaminants deeper into the soil. If competing ions such as calcium, magnesium, and potassium are present with sufficient ionic strength, they may prevent sorption of strontium-90 and cesium-137. If these cations are in the liquids disposed later, they may desorb the fission products. In addition, if the cation-exchange capacity of the soil is low, strontium-90 and cesium-137 may travel deeper into the soil to sorb. If large amounts of sodium in relation to calcium and magnesium were disposed to clayey soils, the sodium may disperse the soil. This would significantly reduce the permeability of the soil and may cause the liquids to move horizontally instead of vertically downward. This would cause a widening of the contaminant plume.

The 216-S-13 Crib was selected as the "typical" crib for the hexone organic waste from REDOX, and the 216-A-2 Crib was selected as being representative of the TBP/NPH organics from PUREX. Both received high inventories of the respective solvents along with moderate amounts of radionuclides. In addition, the 216-S-13 Crib received a large inventory of sodium dichromate. The 216-A-8 Crib was selected as the "worst case" site based on its significant inventory of organic solvents and the highest inventories of radionuclides in the group. The representative sites are summarized in Table 4-3.

4.6 FISSION PRODUCT-RICH PROCESS CONDENSATE/ PROCESS WASTE GROUP

4.6.1 Group Description

Fission products are the highly radioactive isotopes generated during the fissioning of uranium in nuclear reactors. Although a large suite of beta- and gamma-emitting fission products are known, the ones of greatest concern are cesium-137 and strontium-90. Other fission products were also present in significant quantities but, like ruthenium-106, have decayed away because of their short half-lives. Fission products were generated during the fuel rod enrichment cycle and were released when the fuel elements were decladded or dissolved in sodium hydroxide or nitric acid. From this point on, fission products were common throughout all types of waste streams.

Because of their radioactivity, the high-level fission product-rich wastes were separated and placed in tanks for storage and decay. Less concentrated fission product wastes were discharged to the soil column through two reverse wells and nine cribs (Table A-1, Appendix A). The disposal sites are located primarily in the 200 East Area; three sites are located in the 200 West Area. The sites in this group include the 216-B-11A and 216-B-11B Reverse Wells, and the 216-B-50, 216-B-57, 216-B-62, 216-C-6, 216-S-3, 216-S-9, 216-S-21, and 216-T-19 Cribs. The sites in this group are those that generally received more than 20 Ci of fission products (either cesium-137 or strontium-90) and contained lower quantities of plutonium, uranium, and organic wastes than those in the plutonium, uranium, or organic-rich groups. Most of the waste streams in this group were low salt neutral/basic, although the 216-B-50 and 216-B-57 Cribs contained some quantities of inorganic compounds.

Process wastes and process condensate wastes were generated during the various separations plant processing operations. Concentrators, waste evaporators, dissolvers, and tank farm in-tank solidification (ITS) units used condensers and deentrainers to condense boiled-off vapors and entrained liquids as process condensate. In addition, canyon process vessel off-gasses were vented via a vessel vent system to condensers where the vapors were condensed as process condensate that was subsequently discharged to cribs.

Process wastes also contained significant quantities of fission products. Nitric acid was recovered from the solvent extraction aqueous waste stream that contained the highly radioactive fission products. Acid recovery at most plants was a double or single distillation. The acid vapors were condensed and passed through an adsorber, then sent to a vacuum fractionator to produce 60% nitric acid, or, if the vacuum fractionator was not in use, 30% acid. The acid was recycled back to the dissolvers. The condensate escaping from these steps and the tailings from the vacuum fractionator were discharged to the cribs. Ammonia scrubbers at REDOX and PUREX were used to scrub the off-gasses from dissolvers when they were used for decladding of aluminum jackets. These process condensates had a high potential for containing fission products.

4.6.2 Known and Suspected Contamination

The primary COCs in this group are the fission products cesium-137 and strontium-90. Co-contaminants of secondary concern include plutonium and uranium. The quantities disposed to these sites ranged from 21 to 847 Ci of cesium-137, from 2 to 978 Ci of strontium-90, from 0.3 to 144 kg of uranium, and from 0.2 to 178 g of plutonium. There is no record of technetium-99 being discharged to this waste group, but it is assumed that it accompanied uranium as a contaminant.

In addition, inorganic wastes were discharged to some of these cribs. The 216-B-50 and 216-B-57 Cribs received high salt, neutral to basic waste tank process condensate from the ITS Units 1 and 2, respectively. The 216-B-62 Crib received process condensate from 221-B (B Plant) through 1993. The 216-S-9 Crib received acidic (30,000 kg of nitric acid) REDOX process condensate.

4.6.3 Conceptual Model Summary

Process condensates and process wastes containing fission products along with lesser amounts of plutonium and uranium were disposed to the subsurface in aqueous solutions. The moderate amounts of uranium and plutonium discharged to the 216-B-11A and 216-B-11B Reverse Wells along with no report of chemicals and moderate amounts of liquid would indicate little movement of the contaminants in the vadose zone. Minor amounts of fission products were discharged to these reverse wells.

The large amount of liquids and some carbonates discharged to the 216-B-50 Crib would indicate increased mobility for uranium. However, because only a trace amount of uranium was reported, it is doubtful that the uranium is of concern or that it reached the groundwater. Large amounts of liquid were discharged to the 216-B-57 Crib, with large amounts of cesium-137 (low amounts of

plutonium and uranium), which might provide a mechanism for transport toward the groundwater. However, cesium-137 has a high K_d and is thought to be tightly bound in the soil beneath the crib. The 216-B-62 Crib received large amounts of liquid and moderate amounts of fission products with only traces of plutonium and uranium. The 216-S-9 Crib received moderate amounts of water, plutonium, and uranium and higher amounts of fission products from the REDOX Plant. The only chemical discharge reported was a large amount of nitric acid, which may interfere with the cation-exchange capacity of the soil, but it would be neutralized by the salts of calcium, magnesium, and sodium found in the soil.

Process condensate disposal sites generally received large volumes of liquids with lower concentrations of fission products (and plutonium and uranium). Strontium-90 and cesium-137 are known to sorb (moderately to well) onto soil and thus should be retained near the point of disposal. However, the high volume of liquids may have driven the contaminants deeper into the soil. If competing ions such as calcium, magnesium, and potassium are present with sufficient ionic strength, they may prevent sorption of strontium-90 and cesium-137; or, if these cations are in the liquids disposed later, they may desorb the fission products. In addition, if the cation-exchange capacity of the soil is low, strontium-90 and cesium-137 may travel deeper to be sorbed by the soil. If large amounts of sodium in relation to calcium and magnesium were disposed to fine-grained soils, the sodium may disperse the soil. This significantly reduces the permeability of the soil and may cause the liquids to move horizontally instead of vertically downward. This would cause a widening of the contaminant plume.

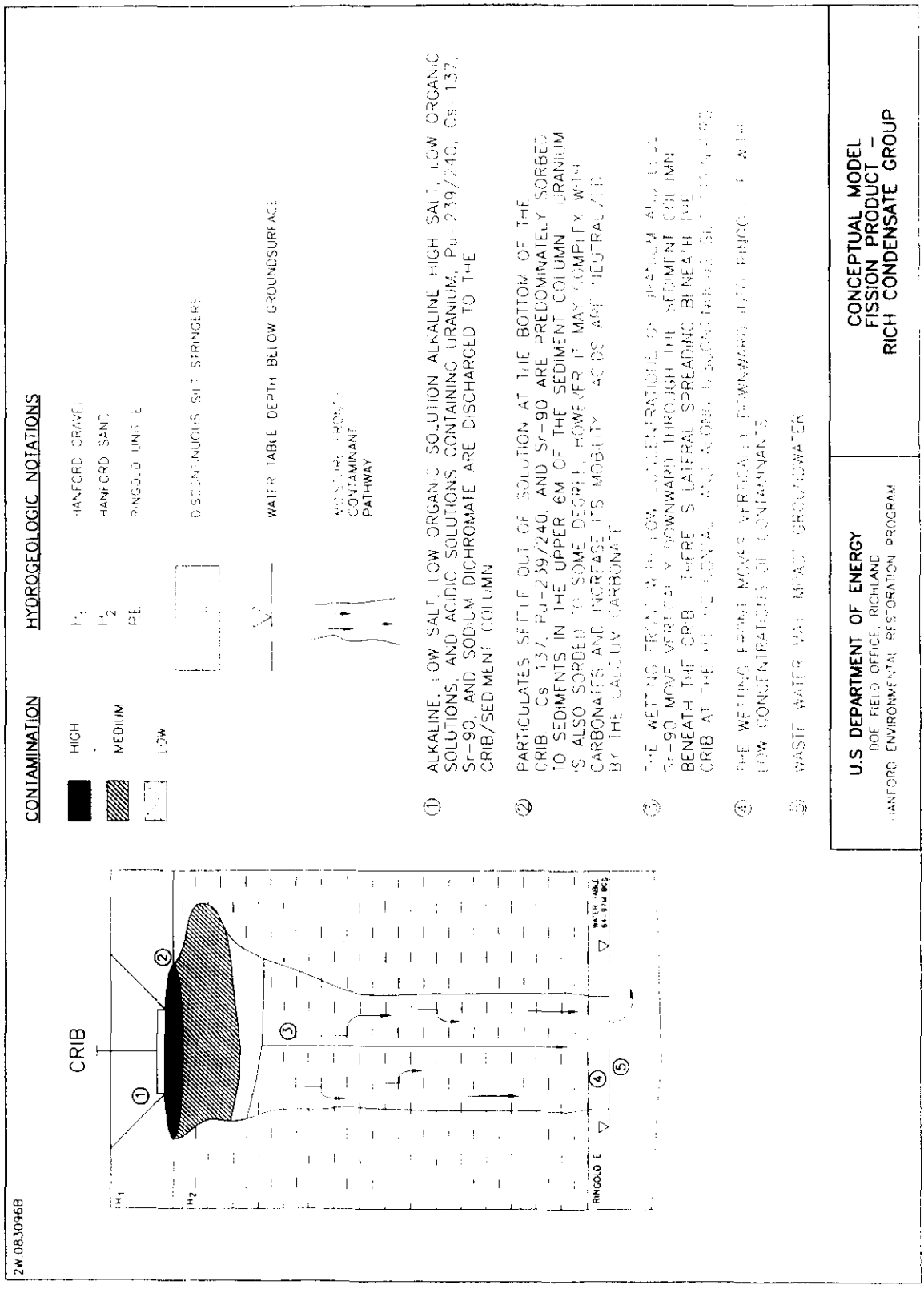
The 216-S-9 Crib is the most contaminated site in this group; it has been selected as the "worst case" site for this group. The 216-B-57 Crib is selected as the "typical" waste site for this group and has been characterized under 200-BP-1 Operable Unit activities. The conceptual model for the fission product-rich process condensate/process waste group is shown in Figure 4-7. The representative sites are summarized in Table 4-3.

4.7 GENERAL PROCESS CONDENSATE/PROCESS WASTE GROUP

4.7.1 Group Description

The wastes discharged to this group of process condensate/process waste sites are very low-inventory liquids discharged by the processing facilities. These sites have low inventories of all radionuclides and have received mostly low salt, neutral/basic liquids. Liquid volumes discharged to the cribs are significant as at the 216-A-45, 216-A-37-1, and 216-U-16 Cribs, which each received more than 300,000,000 L of wastewater. The sites in this group received less than 20 Ci of fission products (cesium-137 or strontium-90) and low quantities of plutonium, uranium, and organics. Inorganic content is not reported with the exception of several streams that received low levels of nitrates. The wastes in this group were discharged to the soil column through 11 cribs and 2 french drains (Table A-1, Appendix A). The disposal sites are located in both the 200 East Area and 200 West Area. The sites in this group include the 216-A-34, 216-A-37-1, 216-A-45, 216-C-3, 216-C-5, 216-C-7, 216-C-8, 216-C-10, 216-S-23, 216-T-20, 216-U-16, and 216-U-17 Cribs, and the 216-S-4 French Drain.

Figure 4-7. Fission Product-Rich Process Condensate/Process Waste Group Conceptual Model.



All wastes in this group were in contact with various contamination separation process steps or originated from some form of waste volume reduction process. Depending on their volatility/ solubility, radionuclides were entrained in the vapors and droplets of the heated wastes. The vapors were condensed in either contact or surface condensers and the condensate discharged to cribs. The pH and salt content of a few wastes in this group are acidic or high salt. Most of the sites received process condensate wastes, but the 216-C-7 and 216-C-8 Cribs received process wastes. The 207-A South Retention Basin and the 216-A-37-1 Crib are RCRA TSD units.

4.7.2 Known and Suspected Contamination

The primary COC in this group is uranium; the highest inventories are 54 kg in the 216-C-5 Crib, 45 kg in the 216-C-3 Crib, and 32 kg in the 216-A-37-1 Crib. The 216-C-3 Crib received a large volume of acidic wastes with small amounts of fission products. The 216-C-5 Crib received high salt wastes from cold runs in the 201-C Building. All of the C Cribs in this group received either high salt or acidic wastes. The REDOX disposal sites (216-S-4 French Drain and the 216-S-21 and 216-S-23 Cribs) may have received significant amounts of short-lived beta-emitting fission products, but there is no record of any residual amounts. The maximum amount of fission products reported in this group is 8 Ci of strontium-90 and 3.5 Ci of cesium-137.

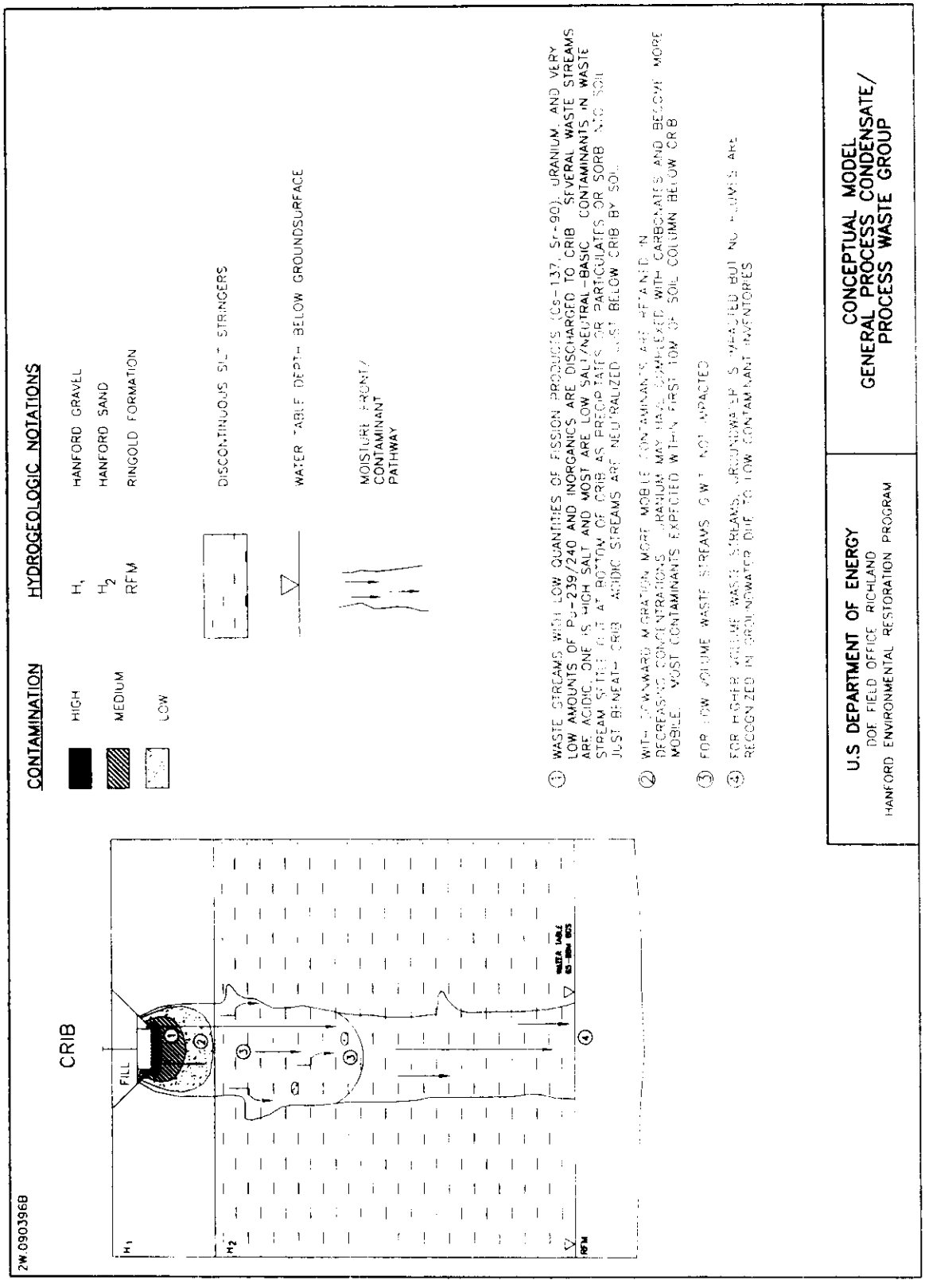
There are no chemicals of significance. Sodium dichromate was used at REDOX for preparation and cleaning hexone and oxidation of plutonium from plutonium IV to plutonium VI, but little is found in the disposal sites. The nitrate that is present at these facilities is in small amounts and not considered to constitute a significant threat to human health or the environment.

4.7.3 Conceptual Model Summary

Contaminant distributions are illustrated in Figure 4-8. Process condensates and process wastes with minor amounts of uranium and small amounts of fission products were disposed to the subsurface and, because of the relatively moderate amounts of liquid discharged, are thought to be residing at shallow depths beneath the disposal sites. The fission products strontium-90 and cesium-137 are known to sorb (moderately and actively, respectively) onto soil and thus should be retained near the point of disposal. There do not appear to be any competing ions such as calcium, magnesium, and potassium to prevent sorption of strontium-90 and cesium-137.

The 216-C-3 and 216-C-5 Cribs are the most contaminated sites in this group. Both sites contain moderate amounts of uranium and only minimal amounts of plutonium and fission products. No significant chemical inventories have been reported. At the 216-S-4 French Drain, more fission products have been reported because of the nature of the REDOX process condensate coming from the cascade tanks in the 241-S Tank Farms. Because of the group's generally low inventory, only the 216-C-3 Crib was selected as the "typical" site for this group based on its uranium and strontium inventory.

Figure 4-8. General Process Condensate/Process Waste Group Conceptual Model.



4.8 TANK WASTE GROUP

Three types of waste streams were processed by facilities in the Tank and Scavenged Waste Groups: (1) the cascaded first- and second-cycle bismuth phosphate ($BiPO_4$) decontamination wastes, (2) wastes from tank 5-6 cell drainage in the 221-B and 221-T Buildings and tank residuals from the 224-B and 224-T plutonium concentration facilities, and (3) wastes from cesium and strontium scavenging performed in either the 221-U Building or the 241-CR Vault. Descriptions of the tank waste groups that received the cascaded $BiPO_4$-type waste and the groups that received intermediate-level waste from cell drainage from tank 5-6 at 221-B and 221-T and tank residuals from 224-B and 224-T are provided in Section 4.8.1. A number of sites around the 241-B and 241-T Tank Farms received waste from both the second-cycle decontamination and the intermediate-level streams. The Scavenged Waste Group is discussed in Section 4.9.

4.8.1 Group Description

The cascaded first- and second-cycle $BiPO_4$ decontamination wastes were generated in B Plant and T Plant by the $BiPO_4$ process to extract and purify plutonium from irradiated nuclear fuel. Both decontamination wastes were high ionic strength (e.g., high salt), neutral to basic pH wastes containing about 10% and 1% of the initial inventory of cesium-137 and strontium-90 and lesser amounts of plutonium and uranium. The first- and second-cycle $BiPO_4$ decontamination wastes were discharged to a series of underground tanks in the B and T Plant tank farms and then to the vadose zone via trenches, cribs, and cribs/tile fields near the tank farms. The tanks were arranged in a cascade configuration to facilitate settling out of suspended solids and precipitates from the waste before it was discharged to the soil column. Fifteen cribs received cascaded first-cycle $BiPO_4$ decontamination waste: the 216-B-35 to B-38, 216-B-40, and 216-B-41 Cribs; and the 216-T-14 to 216-T-17 and 216-T-21 to 216-T-25 Cribs. The 216-T-5 Trench and 216-B-8TF and 216-T-7TF Cribs received cascaded second-cycle $BiPO_4$ decontamination waste as well as intermediate-level wastes described below. The 216-T-19 Crib also received second-cycle supernatant but has been grouped with the Plutonium/Organic-Rich Process Condensate/Process Waste Group. Carbon tetrachloride was disposed to the 216-T-19 Crib in the 1970's.

Discharges of first-cycle wastes to each trench were halted before the calculated specific (moisture) retention capacity of the soil column was reached; the typical volume of waste disposed was 20% to 40% of the pore volume. Discharges of second-cycle wastes were not limited according to specific retention capacity of the soil column, but volumes of waste discharged usually did not exceed the pore volume.

Intermediate-level wastes with significant quantities of plutonium and fission products from the 221, 224-B, and 224-T facilities were discharged to a number of cribs and several reverse wells. These waste streams were passed through settling tanks (i.e., 241-B-361 and 241-T-361) before being discharged to the soil column. Alternately, some of the waste was cascaded through the 208,180-L (55,000-gal), 200 series tanks at the 241-B and 241-T Tank Farms. Discharges to the soil occurred at the following nine waste sites (listed in order of use): the 216-B-5 Reverse Well; the 216-B-7A/7B, 216-B-8, and 216-B-9 Cribs; and the 216-T-3 Reverse Well and the 216-T-6, 216-T-32, 216-T-7, and 216-T-5 Cribs. The wastes from tank 5-6 were sometimes considered to

be low ionic strength (e.g., low salt), high pH, although reported quantities of inorganic constituents suggest a high salt designation. These streams also contained significant amounts of fission products and inorganic constituents. Wastes discharged from the 224 facilities were considered to be high salt, neutral/basic and also contained large quantities of inorganics. No organics are known to be associated with the $BiPO_4$ process.

Information regarding sites that received the first- and second-cycle $BiPO_4$ decontamination waste, wastes from tank 5-6, cell drainage from 221-B and 221-T, and tank residuals from 224-B and 224-T is available in the B Plant AAMS report (DOE-RL 1993e), the T Plant AAMS report (DOE-RL 1992b), the 200 East AAMS report (DOE-RL 1993a), the 200 West AAMS report (DOE-RL 1993c), and the *200-BP-5 Operable Unit Treatability Test Report* (DOE-RL 1996b). Waite (1991) provides a good description of waste site usage.

4.8.2 Known and Suspected Contamination

The waste inventories for first- and second-cycle $BiPO_4$ decontamination waste sites are presented in Table A-1, Appendix A. The wastes contained relatively low quantities of uranium, low to significant concentrations of plutonium, and high levels of strontium-90 and cesium-137. Inorganic wastes at these sites include nitrate, nitrite, sodium, sulfate, phosphate, fluoride, sodium oxalate, sodium aluminate, and sodium silicate. The nitrate content dominates the inorganic contaminants, ranging up to $2.3 \times 10^{+6}$ kg. The intermediate-level waste stream inventories indicate small to significant quantities of uranium, large quantities of plutonium, and minor to high concentrations of strontium-90 and cesium-137. The waste streams tended to have significant concentrations of short-lived beta emitters and ruthenium-106; most have decayed away in the 40 years since these sites were last used. Inorganic wastes at these sites include nitrate, nitrite, sodium, sulfate, phosphate, fluoride, sodium oxalate, sodium aluminate, and sodium silicate. The nitrate content also dominates the inorganic constituents here, up to $1.2 \times 10^{+6}$ kg.

Data from Maxfield (1979) suggest that some quantity of decontamination and construction waste went to the 216-B-7A/B Crib. Depending on the nature of the decontamination waste, some detergents or other chemical may have been released to this site and may have mobilized some of the contaminants.

The specific retention capacity trenches that received the first-cycle $BiPO_4$ decontamination waste are not thought to have contaminated groundwater because waste volume received is less than calculated pore volume. The remaining sites, those that received second-cycle $BiPO_4$ decontamination waste and the wastes from the 221-B/T and 224-B/T Buildings, may have and in some cases are known to have contaminated groundwater. The volume of waste disposed at many of this group's sites exceeded the soil column pore volume, and in the case of the 216-B-5 Reverse Well, wastes were discharged into the aquifer.

4.8.3 Conceptual Model Summary

These waste sites did not generally receive large quantities of water; therefore, contaminants are expected to be concentrated close to the bottom of the cribs (Figure 4-9). Plutonium is expected to be nearest to the crib with strontium and uranium present at greater depths. However, the presence of $BiPO_4$ wastes in this group may serve to immobilize uranium. Because of inventory, uranium concentrations are expected to be low in relation to the other radionuclides of concern. Nitrate will have migrated throughout the soil column, with greatest concentrations near the leading edge of the wetted front. Most of the sites in this group that received greater volumes of liquid are expected to have had a minor impact on groundwater. The 216-B-5 and 216-T-3 Reverse Wells have discharged significant quantities of radionuclides at depths closer to or below the water table (Figure 4-10). At the 216-B-5 Reverse Well site, plutonium, strontium, and cesium have contaminated the groundwater. Migration from these sites is occurring, but the rate of migration is low based on past groundwater monitoring activities (DOE-RL 1996b). When combined with the radionuclide decay rates, no current risk to human health or the environment is expected (BHI 1995). The abundance of inorganics in the waste streams is expected to impact migration of some of the contaminants such as strontium and uranium. The effect of contamination solutions on radionuclide migration potential is unclear because quantities discharged are not known.

Based on process knowledge and the data presented in Appendix A, two representative waste sites were chosen for this group. The 216-B-38 Specific Retention Trench received a high inventory of fission products from a cascaded-tank supernatant waste stream. The 216-B-7A/7B Crib system is considered to be the "worst case" site because it received the highest combined quantities of plutonium, cesium, and strontium from an intermediate-level waste stream. Equivalent sites are found for the 216-T sites related to $BiPO_4$ processing in the 200 West Area. The 216-B-5 Reverse Well is considered as the second choice "worse case" site because of its high radiological inventory, which was discharged just above the groundwater table, and its current level of characterization.

4.9 SCAVENGED WASTE GROUP

4.9.1 Group Description

During the late 1940's and early 1950's, a limited supply of uranium was available to fabricate new fuel rods for the 100 Area reactors. It was also noted that the available tank space for the existing process facilities was being filled faster than new tank farms could be built. In an effort to solve both problems, the unused 221-U Canyon Building was retrofitted to accommodate the URP. This process removed the uranium metal from the BiPO4's process waste that had been stored in the tank farms. Also, more waste tank space was expected to become available as a result of this process.

Figure 4-9. Tank Waste Group Crib and Specific Retention Trench Conceptual Model.

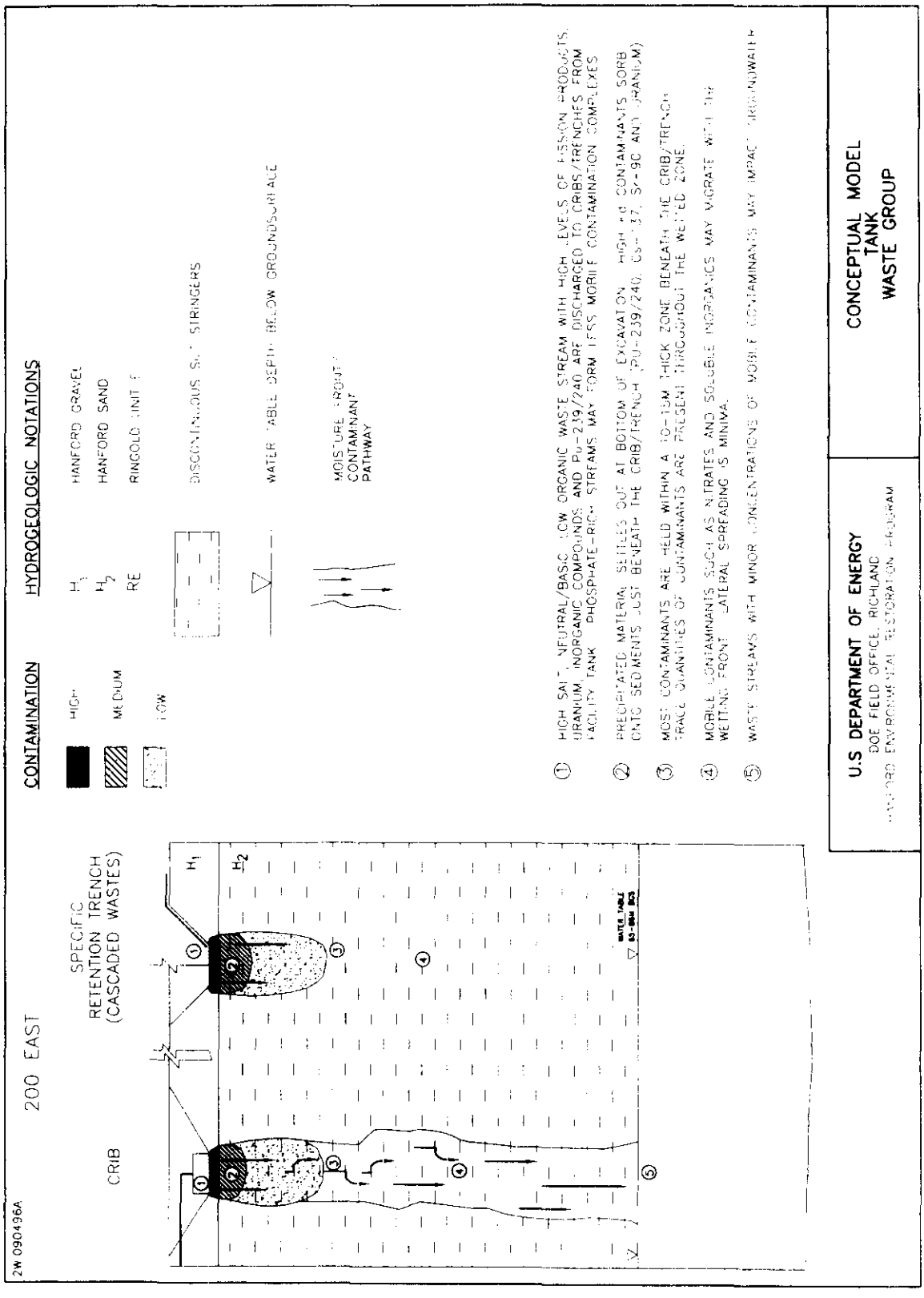
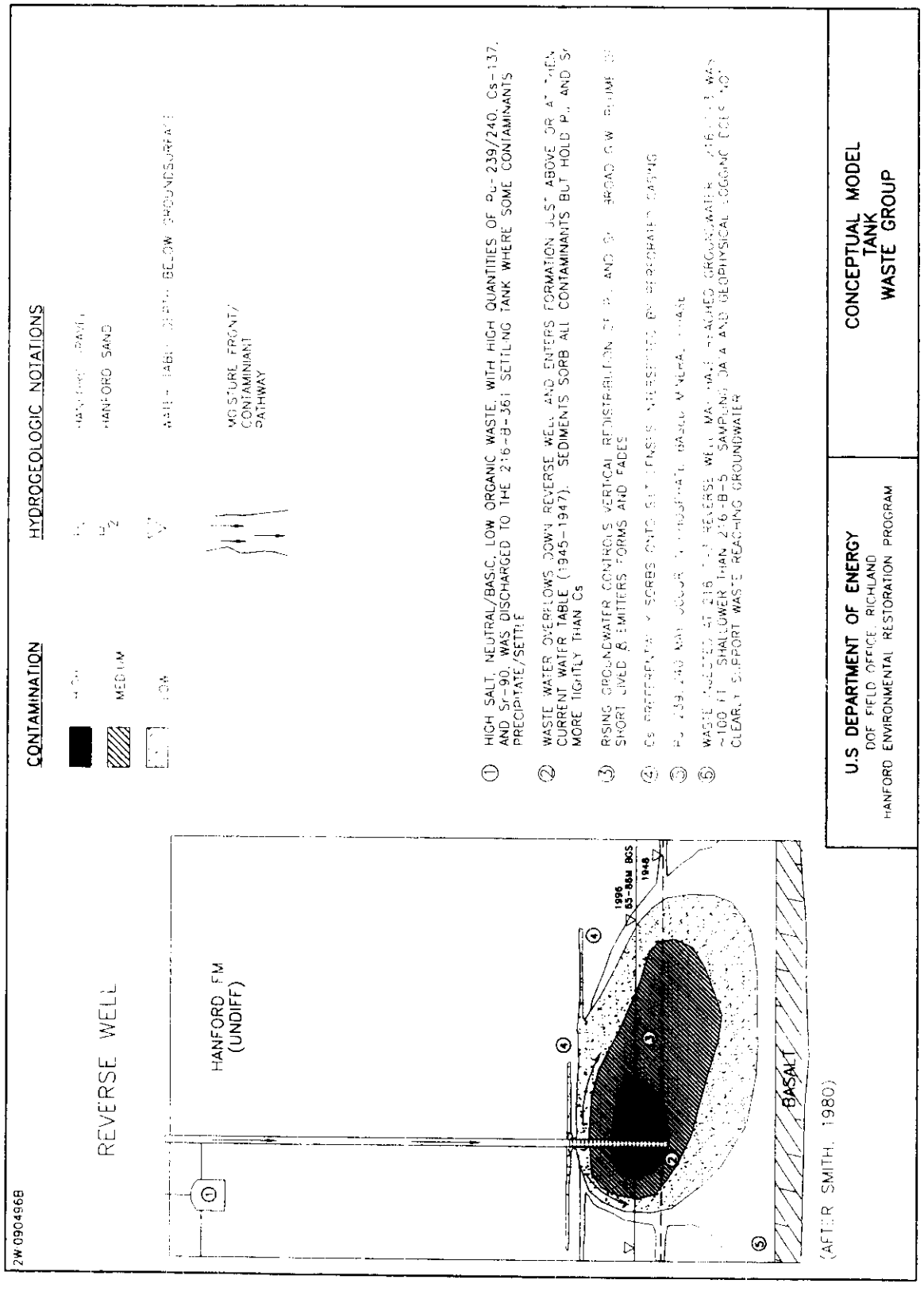


Figure 4-10. Tank Waste Group Reverse Well Conceptual Model.



Shortly after the URP operation began (1951), it was discovered that the process actually generated more waste than it removed from the tank farms. The waste stream was recognized as being high in fission products such as cesium-137 and strontium-90 and not suitable for disposal to the ground. A ferrocyanide-based cesium-137 and strontium-90 precipitation, or scavenging, process sequence was developed as a late-stage step of the URP and implemented at 221-U in October 1953. The fission product-depleted waste was then regarded as meeting standards allowing disposal to the ground. Scavenging was also conducted at the 244-CR Vault, inside the 241-C Tank Farms.

Both waste streams were disposed to the ground at two crib systems, the 216-B-43 through 216-B-50 Cribs (BY Cribs) and at the 216-B-14 to 216-B-19 Cribs (BC Cribs) located south of the 200 East Area. The wastes from early U Plant operation were disposed to the BY Cribs, located north of the 241-BY Tank Farm in the 200 East Area. The BY Cribs were in service between November 1954 and December 1957 and initially operated as an uncontrolled waste discharge. However, cobalt-60 contamination was found in the groundwater beneath the cribs in 1956, and more responsible disposal practices were implemented. A series of specific retention trenches (216-B-20 to 216-B-34) was also built in the BC area and were designed to receive only a fraction of the liquid capable of being stored in the soil column pore space. The BC cribs/trenches were active from January 1956 to January 1958. The 216-B-51 French Drain, located north of the 241-B Tank Farm, was used to dispose of a small quantity of pipeline flush water from the BC Cribs.

In addition to the "metal" waste, the less contaminated first-cycle decontamination waste from the $BiPO_4$ process was also scavenged at the 221-T Building in late 1953 and from mid-1955 through 1956. The waste was routed to three 241-TY Tank Farm tanks for precipitation prior to going to the ground. It is unclear if the three separate tanks were used in a cascade arrangement or as individual overflow vessels. The resulting supernatant waste was discharged to two cribs, 216-T-18 and 216-T-26. The 216-T-18 Crib received enough wastewater to saturate the soil column to groundwater, and the 216-T-26 Crib received 18 times the water of the available soil column pore space.

Construction of the cribs used in this group varied considerably. Both the 216-T-18 and 216-T-26 Cribs were constructed of concrete beams covered with concrete slabs. The BY Cribs were each constructed of four concrete culverts buried on end in a gravel-filled pit. The BC Cribs were constructed of concrete blocks capped with two concrete form walls fabricated of steel. The BC Trenches were excavations 3 m (10 ft) wide by 152 m (500 ft) long by approximately 1.8 m (~6 ft) deep. Several small dams were added to segment the bottom, ensuring more even distribution of the contaminated waste that was admitted to each segment by a series of pipes and hoses. The trenches were backfilled after discharges met the calculated specific retention volume. Information regarding sites that received cesium- and strontium-scavenged waste is available in the B Plant AAMS report (DOE-RL 1993e), the T Plant AAMS report (DOE-RL 1992b), the 200 East AAMS report (DOE-RL 1993a), the 200 West AAMS report (DOE-RL 1993c), the *200-BP-5 Operable Unit Treatability Test Report* (DOE-RL 1996b), and the *Feasibility Study Report for the 200-BP-1 Operable Unit* (DOE-RL 1994).

Drilling and sampling of the vadose zone at the BY Cribs was done between 1991 and 1993 during Phase 1 of the 200-BP-1 remedial investigation (DOE-RL 1994). Up to three borings were completed at each crib. Maximum contaminant concentrations generally occur 4.5 to 9 m (15 to 30 ft) below the ground surface and decrease rapidly past 15 m (50 ft). However, contamination is found at a maximum depth of 72 m (236 ft) below the surface. Maximum contamination by plutonium-239/240, total uranium, strontium-90, and cesium-137 is most frequently found immediately below the crib infiltration gravels at depths of 5 to 7 m (18 to 22 ft) below the surface. Cyanide is the most commonly found nonradioactive contaminant. It occurs in more than half of the borings at concentrations up to 248.5 mg/kg. Generally, the distribution of cyanide in the soil column is similar to the radionuclides; most detections occur in the 4.8- to 10.6-m (16- to 35-ft) interval below the ground surface.

The BC Cribs and Trenches area is the site of one of the most significant unplanned releases in the 200 Areas. Approximately 10 km^2 (4 mi^2) has been designated as a Soil Contamination Area. In 1958, radioactively contaminated rabbit and coyote feces were found scattered on the ground up to 4 km (2.5 mi) south, east, and west of the BC area. One theory suggests that an animal burrowed into the 216-B-23 Trench, thereby exposing a radioactive salt layer that was ingested by rabbits. Defecation by the rabbits and coyotes spread the contamination over an area of approximately 10 km^2 (4 mi^2). Monthly and quarterly surface surveillances indicate the contamination is currently fixed beneath a good growth of vegetation. Recent surveillance activity has shown that the contamination was originally spread over a 39-km^2 (15-mi^2) area (McKinney and Markes 1997), and the enlarged area has been posted. Groundwater contamination has not been detected in monitoring wells associated with the BC area.

4.9.2 Known and Suspected Contamination

Primary COCs are uranium, technetium-99, cesium-137, strontium-90, and ferrocyanide. Secondary COCs are plutonium and cobalt-60. The inventories of the primary and secondary COCs at the 200 East Area sites range from 0.5 to 25 g of plutonium, 2.3 to 680 kg of uranium, 7.91 to 1,570 Ci of cesium-137, and 2.8 to 1,200 Ci of strontium-90. Cobalt-60 was discovered in the BY Cribs groundwater in 1956, but the amount released is unknown. Technetium-99 was recognized in 1985 as a groundwater plume associated with releases to the BY Cribs, but the quantities released are also unknown. The 216-T-18 and 216-T-26 Cribs have smaller quantities of uranium, greater quantities of plutonium, and similar quantities of cesium-137 and strontium-90 than the 200 East Area facilities.

Ferrocyanide is a characteristic inorganic contaminant at these sites, with inventories ranging from 800 to 6,000 kg. Other inorganic contaminants at these sites are nitrate, phosphate, sulfate, and sodium. The inventories for these contaminants range up to $2.1 \times 10^{+6}$ kg of nitrate, $2.3 \times 10^{+5}$ kg of phosphate, $1.5 \times 10^{+5}$ kg of sulfate, and $8.6 \times 10^{+5}$ kg of sodium. The COCs are in the soil column beneath the facilities, in the upper soil horizons in the area surrounding the BC Cribs, and have entered the groundwater at the BY Cribs area. Kasza (1994) and Smith (1980) have discussed evidence for a dense saline plume from the BY Cribs, potentially rich in fission products, residing on the top of the basalt.

Spectral gamma geophysical logging in existing boreholes does not indicate significant lateral spreading of contamination in the vadose zone. Contamination of the uppermost soil horizons is widespread in and around the BC Cribs area due to the unplanned release. Geophysical logging at the BC Trenches indicates contamination in the upper 9 to 12 m (30 to 40 ft) of the soil column with no evidence of groundwater contamination. Geophysical logging indicates that soil column beneath the BC Cribs (216-B-14 through 216-B-19) is contaminated in the uppermost 30 m (100 ft). The logging suggests that groundwater contamination may have occurred at the 216-B-14 and 216-B-16 Cribs. Geophysical logging near the 216-B-51 French Drain (located inside 200 East Area, north of the 241-B Tank Farm) shows little evidence of contamination. Geophysical logging nearest the 216-B-42 Trench indicates contamination in the 7- to 19-m (23- to 62-ft) depth interval of the soil column but no contribution to groundwater contamination. Geophysical logging indicates the soil column at the 216-T-26 Crib is contaminated from the base of the crib to a depth of 30 to 34 m (100 to 110 ft), and to a depth of approximately 23 m (75 ft) at 216-T-18. Groundwater contamination at the 216-T-26 area is attributed to the nearby 216-T-28 Crib.

4.9.3 Conceptual Model Summary

The conceptual model for the Scavenged Waste Group is shown in Figure 4-11. The distribution of radionuclides is known to be deeper than that of other groups due in part to the high ionic strength of the disposed solutions. High-density liquids have been proposed as one hypothesis to account for the high concentrations resulting from disposal of minimal volumes of waste. Several radionuclides, technetium-99 and cobalt-60, have been reported in the groundwater at or downgradient of the BY Cribs where the amount of water released was not significantly greater than the pore volume of the soil column. These contaminants have formed mobile plumes. Cobalt-60 is considered to be mobilized by complexing with the ferrocyanide, which itself exists as a minor plume in the same area. The more immobile radionuclides are found throughout the vadose zone but are concentrated within the upper 15 m (50 ft) beneath the waste site. Materials such as ferrocyanide and nitrate, which are found throughout the soil column, are concentrated in the upper regions of the soil column but have also reached the groundwater. Plutonium concentrations are expected to be at or below detection level in soil samples.

Two representative waste sites have been identified for the Scavenged Waste Group. The 216-B-46 Crib was selected for its significant radionuclide inventory and its current level of characterization. However, the eight BY Cribs will be used for characterization as needed. The 216-T-26 Crib was chosen because of its high contaminant inventory. Table 4-3 summarizes the representative sites.

4.10 STEAM CONDENSATE GROUP

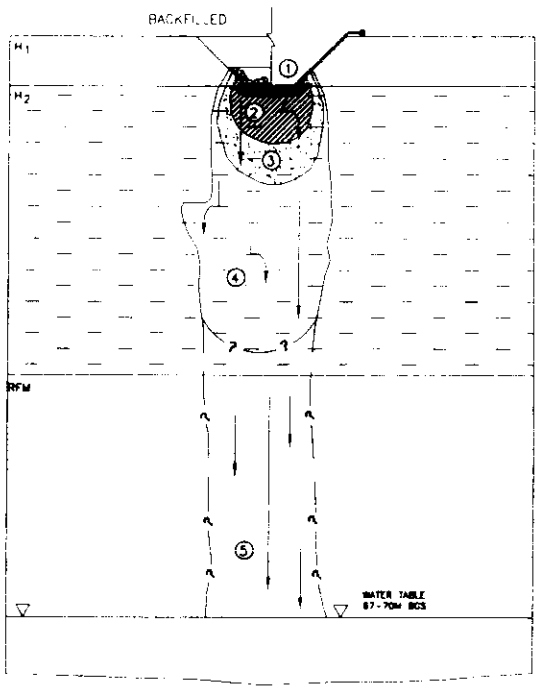
4.10.1 Group Description

The Steam Condensate Group consists primarily of cribs that have received noncontact condensed water from steam used for heating/boiling process solutions, providing power to emergency exhaust turbines in the event of electrical power failure, and heating and ventilation

Figure 4-11. Scavenged Waste Group Conceptual Model.

2W:090396C

SPECIFIC RETENTION TRENCHES
(CRIBS ALSO USED FOR DISPOSAL)



CONTAMINATION

- HIGH
- MEDIUM
- LOW

HYDROGEOLOGIC NOTATIONS

- H_1 HANFORD GRAVEL
- H_2 HANFORD SAND
- RFM RINGOLD FORMATION
- CRM CONTINUOUS SILT STRINGERS
- WATER TABLE DEPTH BELOW GROUNDSURFACE
- MOISTURE FRONT/ CONTAMINANT PATHWAY

① HIGH SALT, NEUTRAL/BASIC LOW ORGANIC WASTE STREAM WITH HIGH LEVELS OF URANIUM, Cs-137, AND Sr-90, MINOR AMOUNTS OF Pu-239/240, AND HIGH LEVELS OF INORGANICS AND FERROCYANIDES ARE DISCHARGED TO TRENCH THROUGH OVER GROUND PIPELINES OR TO CRIBS.

② WASTE STREAM SOLIDS SETTLE INTO SOIL BENEATH TRENCH. Cs-137, URANIUM AND Sr-90 SORB ONTO FINER FRACTION OF SOIL.

③ MORE MOBILE CONTAMINANTS (U, FeCN), MIGRATE VERTICALLY DOWNWARD BENEATH THE TRENCH. LOCAL SILT LENSES MAY CONCENTRATE CONTAMINANTS AT AND WITHIN FINER-GRAINED MATERIAL. LATERAL SPREADING IS MINIMAL. MOST CONTAMINANT MASS IS WITHIN 12-18M OF BOTTOM OF TRENCH OR CRIB.

④ DEPTH OF CONTAMINANTS AND ZONE OF WETTING IS PROPORTIONAL TO VOLUME OF WASTE RELEASED. VOLUME OF WASTE DISPOSED WAS CALCULATED NOT TO REACH GROUNDWATER.

⑤ SEVERAL SPECIFIC RETENTION FACILITIES IDENTIFIED AS POTENTIALLY CONTAMINATING GROUNDWATER. GEOPHYSICAL LOGGING AT 216-B-14 AND 216-B-16 CRIBS IDENTIFIED DEEP PENETRATING CONTAMINANTS.

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equipment operations. Steam condensate did not become a separate waste stream in separations plant until the startup of continuous-operation plants such as REDOX, URP, and PUREX. Phases of the B Plant isotope recovery operations also used continuously supplied steam. In most cases, these were high-volume liquid streams that were disposed to large, high percolation capacity cribs. $BiPO_4$ process steam condensates at B and T Plant were incorporated into the larger cooling water waste streams, along with the chemical sewers, and sent to the ponds. The $BiPO_4$ noncontact wastewater was collected in large (207-type) retention basins and sampled before being released to the pond/ditch system.

Like cooling water, steam condensate did not normally come into direct contact with contaminated process liquids. Instead, steam circulated through coils in a process vessel where it was used to heat solutions to increase processing efficiency. The spent steam was condensed in an offline vessel and then discharged. Because the steam was corrosive to the piping, pin-hole leaks or more serious failures developed, cross-contaminating the waste stream. As a result, cribs were used to prevent contamination releases to the more accessible environment at the ponds.

Table A-1, Appendix A lists 12 cribs in the Steam Condensate Group. The 216-A-6, 216-A-30, and 216-A-37-2 Cribs are located east of PUREX; the 216-S-5/6 Cribs are located west-southwest of S Plant; and the 216-B-55 Crib is located west of B Plant. The 216-T-36 Crib, located south of the 241-T Tank Farm, also received small volumes of steam condensate along with decontamination waste and miscellaneous wastes. Liquid volumes received by these cribs range from 1 to 7 billion liters of wastewater, or a waste liquid to soil column pore volume ratio of from 35.6 to 224 times over the periods of crib operation. Unplanned releases occurred (Maxfield 1979) where overflows at the 216-A-6 and 216-S-5 Cribs resulted in aboveground pooling. Temporary trenches were excavated to contain/divert the overflow. In an attempt to prevent crib overflows, diversion boxes, retention basins, and additional cribs were added to assist with the effluent volume.

4.10.2 Known and Suspected Contamination

The data presented in Table 4-1 indicate that a considerable amount of contaminants may have accumulated over the course of operations. The steam condensate wastes in the 200 East Area were low salt, neutral to basic discharges, whereas the REDOX steam condensate in the 200 West Area was more acidic. The 216-S-5 Crib received both cooling water and steam condensate from REDOX for 3 years. However, the radiological inventory suggests a better match with the Steam Condensate Group based on comparison of contaminants with the 216-S-6 Crib inventory.

Each major site is estimated to have received 160 to 300 kg of uranium, 70 to 600 g of plutonium, and up to 320 Ci of cesium/strontium fission products. Significant quantities of ruthenium-106 and gross beta emitters were also discharged along with detectable quantities of cobalt-60. However, the short half-lives of these radionuclides combined with the end dates of operations suggest that these radionuclides may be important only at the 200 East Area sites. Chemical inventories were generally very low with only nitrates reported at relatively minor levels. In-plant releases to these streams are not noted. Arsenic is reported to be a groundwater

contaminant beneath the 216-A-6, 216-A-30 and 216-A-37-2 Cribs, but it is not clear that the contamination came from these cribs.

4.10.3 Conceptual Model Summary

The conceptual model for the Steam Condensate Group is shown in Figure 4-12. Inventory information for steam condensate waste sites indicate that the crib systems have received significant quantities of radiological contaminants such as uranium, plutonium, and fission products. Because the steam condensate systems are, ideally, closed-loop and should not be contaminated, the presence of contaminants indicates some form of loop failure at all sites. As a result, other radionuclides and organic/inorganic chemicals/compounds are expected to be found but in unknown quantities. In general, all the sites received large volumes of water relative to the pore space available in the soil column, suggesting that the contaminants are distributed through a large portion of the soil column.

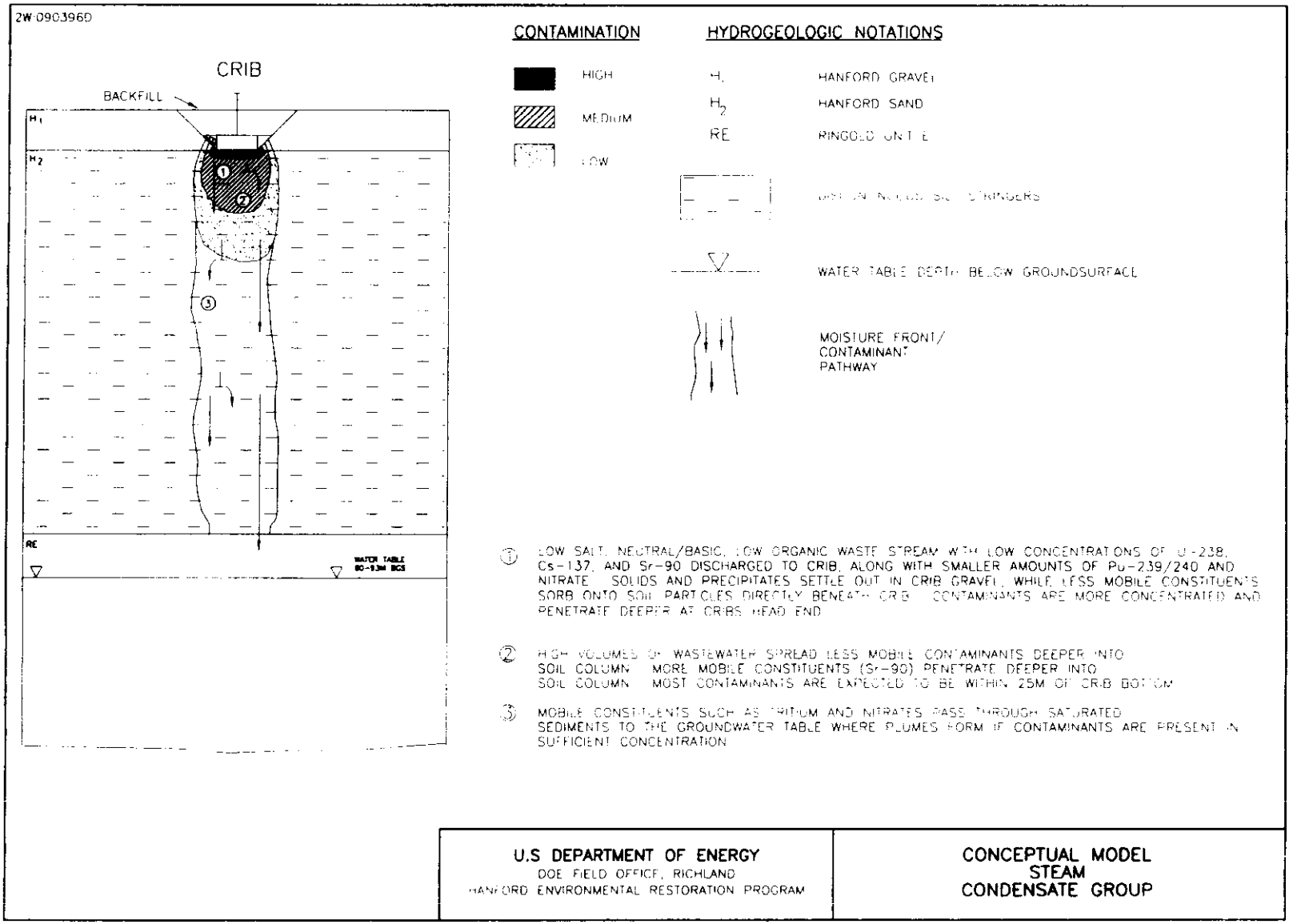
The 200 East Area waste streams at PUREX and B Plant are classified as low salt and with a neutral to basic pH. The REDOX waste was characterized as acidic (without indicating the pH). As a result, some differences are expected in the position of the radionuclides in the soil column. For high-volume, neutral to basic waste streams, uranium would be expected to form moderate to weak compounds in the soil column at depths up to 15 to 20 m below the bottom of the crib and should remain relatively stable over time barring additional disposal events. For high-volume, acidic streams, uranium and other contaminants would be expected to lie deeper in the soil column.

Plutonium distribution is dependent on the waste stream and the organic content of the process wastes that leaked into the steam condensate from heat exchange units. At B Plant, PUREX, and REDOX, organic compounds, although unreported, are suspected to be present and are likely to have enhanced the migration of plutonium. Likewise, at REDOX sites, the acidic stream is thought to have facilitated the plutonium migration potential. However, the small quantity of plutonium in the waste streams for the overall area of the cribs suggests that most plutonium, if detectable, will be in the first 3 m (10 ft) below the crib.

The fission products cesium and strontium are expected to be somewhat limited in vertical extent. The neutral to basic, low salt streams argue for retention high in the soil column, but the presence of calcium carbonates in some of the sediments suggests competition for sorption sites in the soil column and deeper migration for strontium. Likewise, the presence of both acids and organics may have lowered sorption capacity and caused deeper penetration into the sediment column. Combined with the high-volume discharges, cesium and strontium in the steam condensates are expected to be located 23 to 30 m (75 to 100 ft) within the bottom of the crib.

The 216-S-5 and 216-A-6 Cribs were selected as representative sites for the Steam Condensate Group based on the high inventories of radionuclides and the large volumes of wastes each site received. Additionally, each site has received unplanned releases from plant operations. See Table 4-3 for a summary of representative sites.

Figure 4-12. Steam Condensate Group Conceptual Model.



4.11 CHEMICAL SEWER GROUP

4.11.1 Group Description

Chemical sewer wastes were generated at many of the separation/concentration processes conducted at the large canyon buildings. Early chemical sewer wastes were combined with the larger cooling water and steam condensate streams at the $BiPO_4$ and uranium recovery processes and discharged to ponds and ditches. With the advent of continuous solvent extraction processes at Hanford, new plants such as REDOX, PUREX, and the 1970's cesium/strontium recovery operations at B Plant were designed with separated chemical sewers and separate waste disposal sites. In most cases, these sites were aboveground pond or ditch structures.

It is clear that, by the original design definitions, these streams were designed to serve nonradioactive operations in the plants at areas such as operating galleries, service areas, aqueous makeup galleries, and maintenance areas. The plants discharged out-of-specification chemical batches, noncontaminated floor drain waste liquids, nonradiological process wastes, nonprocess steam condensates, noncontaminated vessel coil waste, and other wastes into these streams, which also received a quantity of raw water to dilute any chemical additions. These streams became contaminated with generally low levels of radionuclides at some unspecified time and by unknown processes.

The primary waste sites in this group are the 216-A-29 Ditch (which fed into the 216-B-3 Pond main lobe), the 216-B-63 Ditch, and the 216-S-10/S-11 Pond/Ditch complex. All of these sites have been active from their start date to the 1994-1995 time frame and, except for the 216-S-11 Pond, are RCRA TSD units. This regulatory classification implies release of known hazardous wastes to the structures in the post-1980 time frame. Several chemical releases to these facilities have been reported. The A-29 Ditch is scheduled for characterization as part of the 200-BP-11 Operable Unit (DOE-RL 1993d).

The ditches were typically 1.8 m (6 ft) wide at their base, 2 to 6 m (8 to 20 ft) deep depending on local topography, and 427 to 1,981 m (1,400 to 6,500 ft) long. The ponds at S-10/S-11 were relatively small, 2 and 0.6 ha (5 and 1.5 acres), respectively. These sites received about 380 to 1,900 L/min (100 to 500 gal/min) of wastewater during normal plant operations. It should be noted that, up to about 1990, the 216-S-10/S-11 Pond/Ditch system received 380 to 560 L/min of raw water from the high tower overflow, as a freeze-protection measure, which far exceeded the waste volume from the inactive S Plant. Waste diversion capabilities were incorporated to route 216-A-29 waste to the 216-A-42 Retention Basin in the event of a process upset. No other associated structures are known for this waste group.

Vegetation and algae growth was known for most surface water sites, and radionuclide uptake and concentration is known for these sites. Most ponds and ditches were dredged at least once over their life to control vegetation growth. Associated spoils have been buried near the boundaries of the facilities.

No specific chemistry characterization is applied to any of these streams, suggesting that the liquids are mostly raw water possessing neutral characteristics. The occasional chemical releases

to the waste stream can be expected to have temporarily altered the pH and ionic nature of the waste stream. However, much of this effect is expected to be reduced through mixing during flow through the sewer lines.

4.11.2 Known and Suspected Contamination

Waste inventories for these streams are not well documented because there were no known requirements for sampling of nonradioactive contaminants. Very low levels of fission products, plutonium, and small quantities of uranium are known at these facilities, except for the 216-S-10/11 Pond/Ditch system where more than 215 kg of uranium was reportedly discharged. However, records of ditch and pond stabilization activities (Maxfield 1979) indicate that a considerable amount of surface contamination occurs along the ditch banks and the pond bottom. No chemical inventories are available for these sites. There are reports of an unintended discharge of aluminum nitrate nonohydrate to the 216-S-10 system, which plugged the soil column at the ponds and required excavation of finger ditches to improve percolation.

The Hanford Part A Permit Application (DOE-RL 1993f) lists some contaminants by hazardous waste designations. For example, the PUREX chemical sewer is reported to have discharged 16 kg of cadmium and 141 kg of hydrazine to the A-29 Ditch. The S-10 Ditch received 455 kg of wastes that included sodium nitrate, aluminum nitrate, sodium hydroxide, sodium phosphate, sodium fluoride, and potassium chromate from the REDOX plant. Similarly, B Plant discharged $34 \times 10^{+6}$ L of wastewater containing unknown quantities of sodium hydroxide and sulfuric acid. These sites are classified as RCRA facilities due the ignitability, corrosive, or dangerous waste properties attributed to the individual compounds.

Sodium hydroxide and sulfuric acid were discharged to the A-29 ditch daily, from inception to 1986. Other chemicals in the stream include, but are not limited to, oxalic acid, nitric acid, hydrogen peroxide, calcium nitrate, potassium permanganate, sodium carbonate solution, hydrazine HN solution, potassium hydroxide, sodium nitrate, hydrazine, and sodium nitrite. Various organic process chemicals were discharged into the sewer stream, although in small amounts. These constituent masses are minimal quantities when compared to the total overall mass of water in the system.

4.11.3 Conceptual Model Summary

The conceptual model for the Chemical Sewer Group is shown in Figure 4-13. Because of the unknown quantities and types of contaminants discharged to the ditches, it is difficult to quantify or speculate on the distribution of constituents in the subsurface. Chemical sewer waste sites are expected to show limited distribution of contaminants in the soil column. Of the chemicals discharged to the soil column, only the heavy metal compounds such as chromium and cadmium can be expected to pose a threat to groundwater. Most of the known contaminants are expected to be located within several feet of the ditch/pond bottom. Also, most of the contaminants are expected to be found in the upstream half of the ditches and will be somewhat deeper than those further along the ditch. Concentrations of the contaminants in the subsurface are expected to be low for all constituents. Groundwater impacts have not been clearly demonstrated at these sites.

Figure 4-13. Chemical Sewer Group Conceptual Model.

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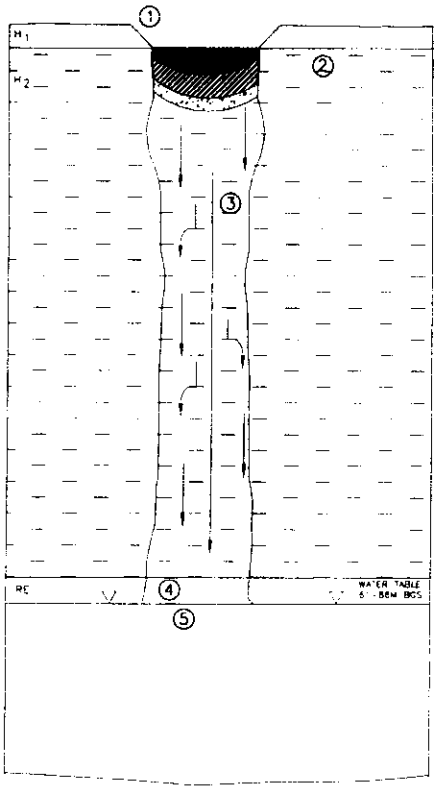
DITCH



CONTAMINATION

- HIGH
- MEDIUM
- LOW

HYDROGEOLOGIC NOTATIONS

- H_1 HANFORD GRAVEL
- H_2 HANFORD SAND
- RE RINGOLD UNIT E
- DISCONTINUOUS SILT STRINGERS
- WATER TABLE DEPTH BELOW GROUNDSURFACE
- MOISTURE FRONT/ CONTAMINANT PATHWAY

① HIGH VOLUMES OF ALKALINE, LOW SALT, LOW ORGANIC, AND ALKALINE HIGH SALT, LOW ORGANIC AND ACIDIC SOLUTIONS CONTAINING LOW CONCENTRATIONS OF URANIUM, AND MINOR AMOUNTS OF Pu-239/240, Cs-137, AND Sr-90 WERE DISCHARGED TO THE DITCH

② COARSE PARTICULATES SETTLE OUT OF SOLUTION AT THE BOTTOM OF THE DITCH. Cs-137, Pu-239/240, AND Sr-90 ARE PREDOMINATELY SORBED TO SEDIMENTS IN THE UPPER 10M OF THE SEDIMENT COLUMN. URANIUM IS ALSO SORBED TO SOME DEGREE, HOWEVER COMPLEXING WITH CARBONATES MAY INCREASE ITS MOBILITY.

③ THE WETTING FRONT AND CONTAMINANTS MOVE VERTICALLY DOWNWARD THROUGH THE SEDIMENT COLUMN BENEATH THE DITCH. THERE IS MINOR LATERAL SPREADING BENEATH THE DITCH ALONG H2 AND DISCONTINUOUS SILT STRINGERS

④ THE WETTING FRONT MOVES VERTICALLY DOWNWARD INTO RINGOLD E WITH LOW CONCENTRATIONS OF INORGANICS

⑤ WASTE WATER MAY IMPACT GROUNDWATER

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Two representative waste sites for this group have been selected. The 216-A-29 Ditch was selected as the "worst case" site due to the inventory suggested by the Hanford Part A Permit Application (DOE-RL 1993f). The 216-S-10 Ditch was selected as a "typical" case, based on the same reference, for its presumed chemical inventory received over a lesser number of years. The 216-S-10 facility has a documented radiological inventory as well. Representative sites are summarized in Table 4-3.

4.12 U-POND/Z-DITCHES COOLING WATER GROUP

4.12.1 Group Description

The sites in this group received waste from a large number of streams that did not contact the process chemistry, but flowed near it in pipes or coils to either heat or cool the liquids. Cooling water streams from the 200 West Area facilities contributed the major volume of effluent sent to the 216-U-10 Pond. Steam condensates and chemical sewer waste (laboratory wastes, laundry waste, steam plant waste, and sump drainage) were also discharged to the 216-U-10 Pond.

The U-Pond/Z-Ditch Cooling Water Group encompasses those sites that received low-level radionuclide and minor chemical waste products in a generally uncontaminated stream. From 1944 to 1985, the U Pond and associated ditches percolated $1.65 \times 10^{+11}$ L of liquid from the PFP, URP, and laboratory facilities located in 200 West Area. In addition, effluents from the contaminated laundry facility, the 207-U Retention Basin, and the 284-W Powerhouse were distributed to the 216-U-10 Pond via the 216-U-14 Ditch. Effluent from the 231-Z and 234-5Z Plants was distributed to the 216-U-10 Pond via the Z Ditches. The Z Ditches are composed of the 216-Z-1D Ditch (1944 to 1959), the 216-Z-11 Ditch (1959 to 1971), the 216-Z-19 Ditch (1971 to 1981), and the 216-Z-20 Crib (1981 to 1995). Although not a ditch, the 216-Z-20 Crib is included here because of its long, narrow configuration and close proximity to the other ditches.

216-U-10 Pond overflow was distributed to the 216-U-11 Trench, the 216-U-9 Ditch, and three finger trenches excavated into the eastern bank of U Pond. Each trench was dug to accommodate a specific overflow event and is listed in WIDS as unplanned releases UPR-200-W-104, UPR-200-W-105, and UPR-200-W-106.

The 216-U-10 Pond system, including the Z Ditches, was characterized as part of the *Focused Feasibility Study for the 200-UP-2 Operable Unit* (DOE-RL 1996c). The Z Ditches, but not the 216-Z-20 Crib, were interim stabilized in 1981. The 216-U-10 Pond was stabilized during 1985 after all of the slightly contaminated soils from the finger trench overflow ditches were removed and spread over the interior of the pond surface. The 207-U Retention Basin has been posted as a Surface Contamination Area since its closure in 1994. These disposal sites are also addressed in the *Limited Field Investigation for the 200-UP-2 Operable Unit* (DOE-RL 1995b), the *RCRA Field Investigation/Corrective Measures Study Work Plan for the 200-UP-2 Operable Unit* (DOE-RL 1993i), the U Plant AAMS report (DOE-RL 1992c), and the 200 West AAMS report (DOE-RL 1993c). The 216-Z-20 Crib has been discussed most recently in *Groundwater Impact Assessment Report for the 216-Z-20 Crib, 200 West Area* (Johnson 1993). The 216-U-14 Ditch

was also the subject of a RCRA groundwater interim assessment (Singleton and Lindsey 1994), which included limited characterization drilling and test pits.

4.12.2 Known and Suspected Contamination

As described in the U Plant AAMS report (DOE-RL 1992c), the majority of the plutonium, uranium, and transuranics discharged from the PFP and URP facilities has been retained in the ditch/trench/crib structures and did not make it into the 216-U-10 Pond, under which the inventory in Appendix A is listed. It is estimated that the pond and ditch sediments may contain up to 8.2 kg plutonium, 1,500 kg uranium, 15.3 Ci cesium-137, and 22.6 Ci strontium-90, along with 0.492 Ci americium-241 and various transuranics and/or activation products, based on plant discharge records. The 216-U-10 Pond's inventory cannot be accurately determined because of the number of influent sources, discharge volumes, and the variety of contributing facilities and processes. It is estimated that the 216-Z-1D, 216-Z-11, and 216-Z-19 Ditches received 0.14, 8.07, and 0.14 kg, respectively, of plutonium during their active lifetimes. The majority of plutonium and americium-241 discharged has been retained in the ditch(es). Neither the plutonium nor americium-241 has been detected below 14 m from ground surface. The majority of the COCs are retained within the first 0.3 m (1 ft) of sediment below all the Z Ditch bottoms. Marked concentration increases are located at or near the pond/ditch interface, but are believed to be the result of flooding of the main pond rather than anything carried down in the ditch.

Inventories for the 216-U-14 Ditch are included in the 216-U-10 Pond data and are not separable. A single incident in 1986 resulted in the disposal of approximately 102,600 kg of corrosive solution (3,013 L of reprocessed HNO_3, pH<2) containing 45 kg of uranium to the 216-U-14 Ditch (DOE-RL 1992c). Groundwater monitoring revealed an increase in the uranium concentrations during the following year after the spill, indicating some migration through the vadose zone. Singleton and Lindsey (1994) notes that uranium was found at concentrations slightly above drinking water standards in a perched zone above the water table.

Distribution of the contaminants throughout the pond indicates that americium, cesium, and plutonium tend to be located near the discharge point of the waste stream, but uranium and strontium are more evenly distributed throughout the pond. A large percentage of radionuclides are sorbed in an organic-rich horizon at what would have been the actual bottom of the pond. However, large quantities of solution, including acidic waste, were responsible for mobilizing some of the uranium through the vadose zone and into the groundwater (as demonstrated by the groundwater sample data). There are no upgradient sources for the uranium; therefore, it is assumed to have come from the pond system.

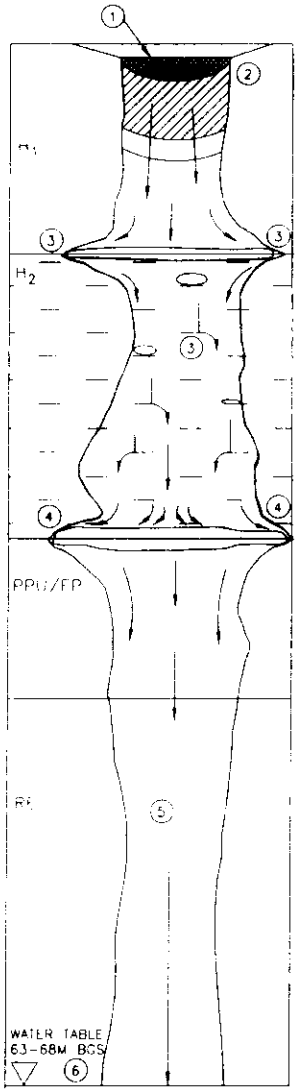
4.12.3 Conceptual Model Summary

The conceptual model for the U-Pond/Z-Ditches Cooling Water Group is shown in Figure 4-14. The steam condensate/cooling water/chemical sewer waste stream that was disposed to the 216-U-10 Pond was derived from the PFP and URP facilities in addition to the 200 West Area powerhouse, laundry, and other support facilities. The main delivery system was a series of open ditches that transected the Hanford formation, a gravel and sand unit that typically has high rates of infiltration. The streams were usually high volume but contained very low levels of

Figure 4-14. U-Pond/Z-Ditches Cooling Water Group Conceptual Model.

2W:083096E

PONDS & DITCHES



CONTAMINATION

- HIGH
- MEDIUM
- LOW

HYDROGEOLOGIC NOTATIONS

H_1	HANFORD GRAVEL
H_2	HANFORD SAND
PPU/EP	PLIO-PLEISTOCENE/EARLY PALOUSE SOIL
RE	RINGOLD UNIT E
	DISCONTINUOUS SILT STRINGERS
	WATER TABLE DEPTH BELOW GROUNDSURFACE
	MOISTURE FRONT / CONTAMINANT PATHWAY

1. HIGH VOLUME OF ALKALINE LOW SALT, LOW ORGANIC SOLUTIONS CONTAINING TRACE AMOUNTS OF NITRATE, URANIUM, PU-239/240, Am-241, Cs-137, and Sr-90 ARE DISCHARGED TO THE POND/SEDIMENT COLUMN
2. PARTICULATES IN SOLUTION (i.e. Pu-239/240, Am-241) SETTLE OUT IN THE BOTTOM OF THE POND. MOST OF THE DISSOLVED CONTAMINANT IN SOLUTION WITH Kds>10 (e.g.) URANIUM, Cs-137, Sr-90 WILL SORB TO SEDIMENTS WITHIN 2M OF THE POND BOTTOM. SOME URANIUM COMPLEXES WITH CARBONATES AND MOVES WITH THE WETTING FRONT. NITRATE (Kd=0) WILL MOVE WITH THE WETTING FRONT
3. THE WETTING FRONT AND REMAINING CONTAMINANT IN SOLUTION MOVE VERTICALLY DOWNWARD THROUGH THE SEDIMENT COLUMN BENEATH THE POND WITH SOME SPREADING ON TOP OF H2 AND ALONG DISCONTINUOUS SILT STRINGERS
4. LATERAL SPREADING OF THE WETTING FRONT AND REMAINING CONTAMINANT MAYBE MORE PRONOUNCED IN THE PPU/EP COMPARED TO H2. CONTAMINATION IN THIS ZONE IS VERY LOW COMPARED TO THE BOTTOM OF THE DITCH. ONLY Sr-90 AND URANIUM IS DETECTED ASSOCIATED WITH PPU/EP
5. THE WETTING FRONT MOVES VERTICALLY DOWN INTO RINGOLD UNIT E WITH URANIUM AND NITRATE AS THE POTENTIAL CONTAMINANTS OF CONCERN
6. URANIUM AND NITRATE MAY IMPACT GROUNDWATER

U.S DEPARTMENT OF ENERGY DOE FIELD OFFICE, RICHLAND HANFORD ENVIRONMENTAL RESTORATION PROGRAM	CONCEPTUAL MODEL U-POND / Z DITCHES COOLING WATER GROUP

radionuclides and chemical wastes. Vegetation and algae within the pond and ditch system is expected to have concentrated some of the radionuclides. Low-mobility contaminants such as americium, cesium, and plutonium were adsorbed close to the junction of the pond and ditches and retained in the near surface. Strontium was expected to be more mobile in the soil column but was found to be concentrated at and just below the original pond bottom. Moderate-to-highly mobile species (technetium and uranium) were carried to the pond system and infiltrated the bottom of the pond. The high volume of liquid exceeded the soil column pore volume capacity and is believed to have carried much of the mobile contaminants to the groundwater. Acidic discharges also may have remobilized small amounts of previously sorbed uranium. Nitrates and other chemicals were not reported in the stream in concentrations that would indicate a threat to human health and the environment. Potential mobilization effects of radionuclides by detergent is recognized. However, radionuclide concentrations for waste streams in the upper end of the ditch were low. When coupled with the ditch's long length and percolation capacity, the detergent is not expected to have a significant effect at B Pond.

Some lateral spreading is expected in the sediments below the ditches, crib, and pond as a consequence of finer grained layers encountered during migration of fluids to the water table. Additional spreading is accomplished due to large-volume flushing of the sediments as indicated by the ratio (25-150:1) of liquid waste received to the pore volume in the soils.

Based on process knowledge and the data in Appendix A, three sites were selected as representative sites for the U-Pond/Z-Ditches Cooling Water Group. The 216-U-14 Ditch was selected as a representative site for its suspected high contaminant inventory, laundry detergent waste discharges, and current level of characterization. The 216-Z-11 Ditch was selected for the opportunity to document its suspected high contaminant inventory and known high volumes of liquid discharged to the ditch and pond. The 216-U-10 Pond was selected as the "worst case" site for its current level of characterization under the 200-UP-2 Operable Unit limited field investigation activities and previous characterization activities, the reported high contaminant inventory, and the large quantities of liquid waste discharged to the site. Representative sites are summarized in Table 4-3.

4.13 GABLE MOUNTAIN/B-POND AND DITCH COOLING WATER GROUP

4.13.1 Group Description

Cooling water and other noncontact waste streams in the 200 East Area discharged to a complex of retention basins, diversion structures, ditches, and large ponds that are grouped under the Gable Mountain/B-Pond system. The 216-A-25 Pond (Gable Mountain Pond) had a surface area of 29 ha (71 acres); the 216-B-3 Pond (B Pond) had a surface area of 14 ha (35 acres). The two ponds received the bulk of the effluent flow from the PUREX Plant, B Plant, 242-A Evaporator, 204-AR Vault, 244-AR Vault, the 284-E Powerhouse, the 283 Water Treatment Plant, and other smaller facilities. Between the years 1957 and 1984, flows between the two ponds were split approximately 3:1 favoring the Gable Mountain Pond system. Prior to 1957 and after 1984, B Pond received most of the active waste streams. B Pond was expanded in 1980 to increase its percolation capabilities with the addition of the 216-B-3A and B-3B lobes. The 216-B-3C lobe

was constructed in 1985. The 216-E-28 Contingency Pond (216-E-25 in WIDS) was constructed in 1986 to receive diverted overflow liquids in event of B Pond failure, but has never been used. Currently, the 216-A-25 and 216-B-3 Main Ponds have been backfilled and surface stabilized. The 216-B-3A and B-3B lobes are inactive, and the 216-B-3C lobe continues to receive negligibly contaminated water through underground pipelines from B Plant. A new pond is currently active northeast of the 216-B-3C lobe and receives plant-treated liquid wastes from the 200 East and 200 West Area facilities. It is not related to B Pond operations. The 216-B-3 main lobe and the 216-B-3A, 216-B-3B, and 216-B-3C lobes are RCRA TSD units.

Six ditches transported cooling water and other wastes to the B-3 pond system. The 216-B-2-1, 216-B-2-2, and 216-B-2-3 Ditches connected to the 216-B-3-1, 216-B-3-2, and 216-B-3-3 Ditches. Percolation of wastewater occurred in the ditches before the water reached the ponds. Following a significant unplanned release event from B Plant or PUREX, the ditches were taken out of service and replaced with a new ditch. The contaminated ditches were backfilled and later surface stabilized. The 216-B-3-3 Ditch downstream from its intersection with the 216-A-29 Ditch is a RCRA TSD unit.

Although the PUREX wastes entered the 216-B-3-3 Ditch/B-3 Pond complex through the 216-A-29 Ditch (PUREX Chemical Sewer), the ditch has been discussed in the Chemical Sewer Group (see Section 4.11). PUREX wastewater was transported to Gable Mountain Pond via a 106-cm (42-in.) underground pipeline. Nonradioactive waste streams from the 284-E Powerhouse and the 283-E Water Treatment Plant were conveyed to the Gable Mountain/B Pond system by an open ditch connected to an underground pipeline. This effluent continues to discharge to the remaining 216-B-3C Pond.

Waste streams to the ponds were mostly from noncontact sources but did get radionuclides from processing leaks. At least four unplanned releases have been documented involving the 202-A and 221-B Building operations. As described in Section 4.11, the chemical sewer streams contained a large variety of chemicals, many of which were hazardous materials that resulted in some of the wastes disposal sites being designated as RCRA TSD units. The majority of the wastewater was either treated or raw water from the Columbia River. While operational, the 216-A-25 Pond received 3.07×10^{11} L and the 216- B-3 Pond received 2.4×10^{11} L of effluents from the 200 East Area facilities.

The 216-N-8 West Lake has been considered in this waste group, although it is a naturally occurring surface water body. Before the Hanford Site was constructed, the pond intermittently formed as a result of seasonal precipitation. During the years of Hanford operations, significant discharge of liquid wastes from the 200 East and 200 West Area facilities caused an increase in the water-table elevation. The year-round increase of West Lake's water level and its associated contaminants is thought to be the result of the water-table changes.

In addition, the 216-C-9 Pond has been placed in this group, primarily because of geographic similarities. The 216-C-9 Pond was originally excavated for the 221-C Canyon Building foundation and was converted to a liquid waste disposal site when Semiworks activities focused on hot testing of separations processes such as PUREX, REDOX, and fission products recovery

using existing, smaller facilities. Large quantities of water have been discharged to this site, but radionuclide inventory is very low.

All backfilled ditches in this group have been surface-stabilized and posted as underground contamination areas. The active retention basins are posted as contaminated areas. During 1989, characterization of the B Pond area was performed to determine the stratigraphy and flow components of the aquifer(s) and identify any significant amounts of dangerous wastes in the groundwater. These data are reported in the *200-BP-11 Operable Unit RFI/CMS and 216-B-3 Main Pond, 216-B-63 Trench, and 216-A-29 Ditch Work/Closure Plan* (DOE-RL 1993d); other pertinent documents include the *200-BP-5 Operable Unit Treatability Test Report* (DOE-RL 1996b), the *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit* (DOE-RL 1996d), and the *Groundwater Impact Assessment Report for the 216-B-3 Pond* (Johnson et al. 1993). Additional data for the ponds and ditches along with the associated facility disposal streams are available in the B Plant AAMS report (DOE-RL 1993e), the PUREX AAMS report (DOE-RL 1993h), the 200 East AAMS report (DOE-RL 1993a), and the *PUREX Plant Cooling Water Stream-Specific Report* (WHC 1990) .

4.13.2 Known and Suspected Contamination

Radionuclide contaminant inventory is presented in Table A-1, Appendix A, and includes B Pond; the overflow ponds; and the 216-B-3-1, 216-B-3-2, and 216-B-3-3 Ditches. Totals for these units are 370 kg uranium, 250 g plutonium, 93.5 Ci cesium-137, 101 Ci strontium, and 3.96 Ci americium with 1.42 Ci ruthenium. The 216-B-2-1 Ditch has a reported inventory equal to the B Pond, whereas the 216-B-3-2 and 216-B-3-3 Ditches each have reported inventories of 0.22 kg uranium, 0.04 g plutonium, 0.3 Ci cesium, and 147 Ci strontium. The 216-A-25 Pond is reported to contain 878 kg of uranium, 428 g of plutonium, 204 Ci of cesium, and 257 Ci of strontium. Technetium has not been reported at theses sites, but is assumed to be associated with uranium. Transuranics were discharged also, but in small amounts, usually as sewer and sump collective discharges. The chemical sewer stream, however, contains a variety of constituents, some of which have been released in reportable quantities, including hydrazine, sulfuric acid, and sodium hydroxide.

The large volumes of water (typically maintained at a pH range of 4 to 10) saturated the immediate area in the vadose zone and transported the mobile constituents to the groundwater while creating a groundwater mound. Radionuclides with low mobility (plutonium, americium, and to some degree cesium) will be retained nearer the surface in the ditch(es), while others will be flushed along as more mobile entities (uranium, technetium, strontium, ruthenium) into the pond and subsequently into the groundwater. Technetium has not been observed in groundwater samples around this system but elsewhere is associated with uranium; in this discussion it is considered to be a suspected contaminant. The geologic section in the 200 East Area does not have a caliche "aquitard," but fining of sediments is known beneath the B Pond system that may have retarded the downward groundwater flow and increased lateral spread.

4.13.3 Conceptual Model Summary

The conceptual model for the Gable Mountain/B-Pond and Ditch Cooling Water Group is shown in Figure 4-15. The combined cooling water, steam condensate, and chemical sewer waste streams discharged to the Gable Mountain and B Pond(s) originated primarily from the PUREX and B Plant facilities. The streams were designed to be uncontaminated but often contained limited quantities of radionuclides and chemicals. These contaminants accumulated in the sediments over time. Additionally, vegetation and algae within the ponds and ditches tended to collect and concentrate radionuclides. At least four unplanned releases resulted in significant amounts of radionuclides contaminating the waste stream and entering the ditch/pond system. The contaminated ditches were sampled, backfilled, and covered to contain the contamination. New ditches were constructed to replace the contaminated ones. The plutonium, americium, and some cesium were fixed in the ditches near the ditch/pond junctions; uranium, strontium, ruthenium, and some cesium proceeded to the pond and thence to the groundwater. Most of the less mobile radionuclides are expected to be found within the top 5 to 10 m of sediment beneath the pond. More mobile contaminants traveled through the soil column and into the groundwater and are expected to be present only in trace concentrations. The very low concentrations of radionuclides in the large volumes of wastewater discharged to the broad areas of these waste sites will tend to reduce contaminant detection in the soil column.

Lateral spreading of contaminants in the vadose zone has resulted from high-volume discharges to the ponds that exceeded the soil column pore volume capacity and forced an increased wetted area in the vadose zone. Mounding of groundwater is known under B Pond. Lateral spreading was enhanced due to the occurrence of local finer grained sediments and remnant subcrops of Ringold Formation that act as perching or spreading horizons for percolating waters/solutions. These two occurrences account for the widespread dispersion of some contaminants.

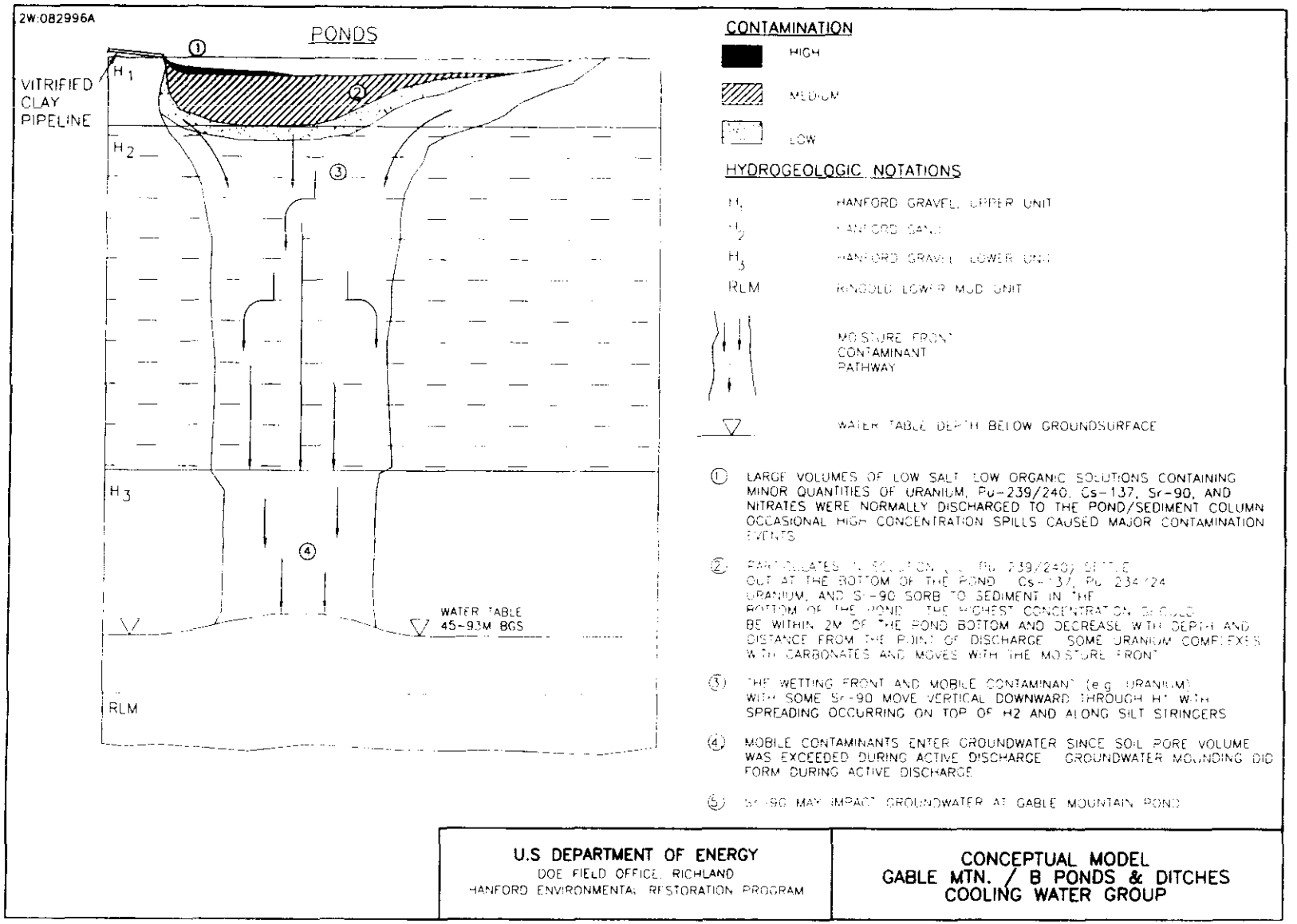
The 216-B-3 Pond system and the 216-B-2 and 216-B-3 Ditch systems are the subject of a limited field investigation for the 200-BP-11 Operable Unit. For the purposes of this document, the 216-B-2-2 Ditch has been chosen as a typical waste site for this group because of the suspected inventory resulting from unplanned release UPR-200-E-138, which released 1,000 Ci of strontium-90 to the soil column. The 216-A-25 Gable Mountain Pond was selected because of its high radionuclide inventory and the large quantity of liquid wastes released to the pond. Table 4-3 summarizes the representative waste sites.

4.14 200 NORTH POND COOLING WATER GROUP

4.14.1 Group Description

The 200 North Pond Cooling Water Group consists of three ponds and four trenches that received cooling water from the 212-N, 212-P, and 212-R Buildings. From 1944 through 1952, the facilities were used as interim storage facilities for "green" irradiated fuel elements from the active nuclear reactors in the 100 Areas. The fuel rods were transported by special railroad wellcars to the 200 North Area in lead-shielded casks. The casks contained "buckets" of fuel elements, which were placed into the 212 Building's storage basins. Groundwater pumped from

Figure 4-15. Gable Mountain/B-Pond and Ditch Cooling Water Group Conceptual Model.



wellhouses circulated into the basins to cool the fuel where it remained to allow for decay of short-lived radionuclides, particularly iodine-131 and neptunium-239. The cooling water was then discharged via underground pipelines to the 216-N-1, 216-N-4, and 216-N-6 Ponds.

In 1952 when activities in the 200-N facilities ceased, the fuel storage basins of each of the 212 Buildings were rinsed clean to remove sludge and residual water. About 7.6 x 10^6 L of sludge/water was pumped into the 216-N-3, 216-N-5, and 216-N-7 Trenches located northwest of each facility via temporary pipelines. The trenches were 3 to 6 m (10 to 20 ft) wide and 15 to 24 m (50 to 80 ft) long. The 216-N-2 Trench was constructed in 1947 to accommodate undefined "special testing." When the trenches were taken out of service, the overground pipelines were placed into the trench and the units were backfilled with clean soil. Additional data are available in the 200 North AAMS report (DOE-RL 1993b).

Each building has been used since for storage of contaminated waste or materials, but no additional liquid wastes have been discharged. A limited radiological characterization of the ponds (216-N-1, 216-N-4, and 216-N-6) was done in 1979. Trenches were cut across the head end of each pond. No contamination was detected at the 216-N-1 Trench, and no radiological posting was considered necessary. Slight contamination was detected at the bottom of the trenches at the 216-N-4 and 216-N-6 Ponds. These sites were posted with Underground Radioactive Material signs. The posting remains the same today (Maxfield 1979).

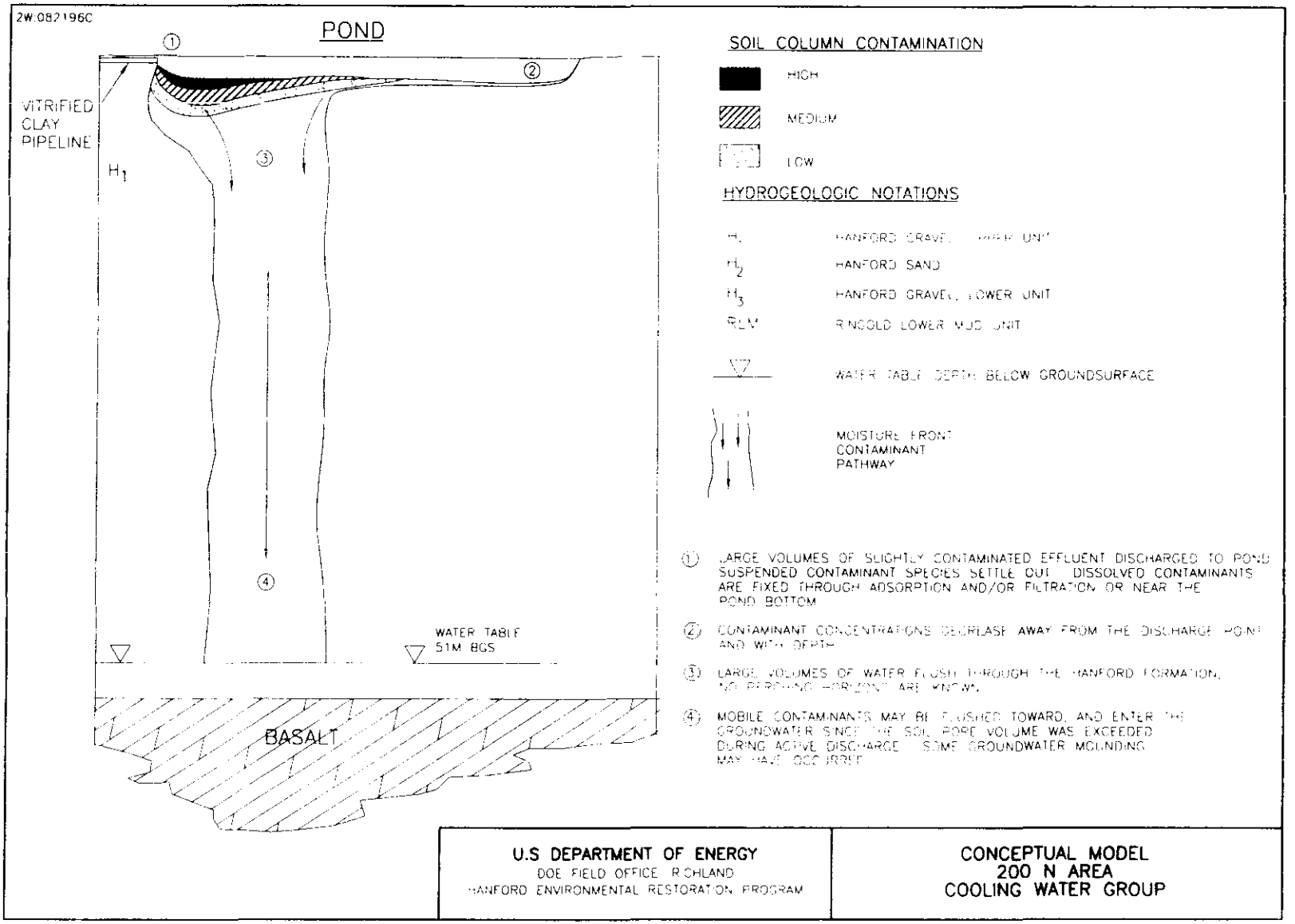
4.14.2 Known and Suspected Contamination

Each pond received approximately 9.46 x 10^8 L of cooling water over 8 years of operation. The water itself was extracted from wells located east of the 200 North Area; the water was not treated. The cooling water became slightly contaminated due to particulate contamination from the fuel elements/casks and/or because of breakage or leakage through the aluminum cladding. The storage process was used to reduce the radioactivity of gaseous fission products and allowed the decay of short-lived radionuclides. As shown in Table A-1, Appendix A, the 216-N-4 and 216-N-6 Ponds received small and nearly equal quantities of uranium, along with minute quantities of plutonium and fission products. Annual surface radiological surveys have not detected any surface contamination. Four trenches (216-N-2, 216-N-3, 216-N-5, and 216-N-7) are reported to have received equally minute quantities of cesium-137 and strontium-90 but no plutonium or uranium. No inventory of organic or inorganic compounds is available for these sites.

4.14.3 Conceptual Model Summary

The conceptual model for the 200 North Pond Cooling Water Group is shown in Figure 4-16. Water passing through the cooling basins came in contact with the fuel elements and picked up small quantities of contaminants. All liquids were dispensed through underground pipelines to ponds for percolation into the soils in quantities sufficient to saturate the soil column beneath the sites. The total inventory for each pond is minimal, and the distribution of the contaminants is expected to be concentrated near the pipeline outfall for each pond. The bulk of the contamination is expected to be at or just below the pond bottom with trace amounts diminishing to zero at depths of 3 to 5 m below the pond.

Figure 4-16. 200 North Pond Cooling Water Group Conceptual Model.



In 1952, each of the three facilities emptied the water and sludge from the storage basins via overground pipelines to the trenches. When the pumping was complete, the pipeline was placed in the bottom of the trench and the trench was backfilled. The total amount of contaminant distributed was minimal and is expected to be concentrated in the sludge. Annual surface radiological surveys have not detected any surface contamination.

From data presented in Table A-1, Appendix A, the 216-N-4 Pond is selected as the typical waste site. The basis for selection is the high volume of waste liquid received. The representative waste sites are summarized in Table 4-3.

4.15 S-PONDS/DITCHES COOLING WATER GROUP

4.15.1 Group Description

The cooling water stream from the REDOX process in the 202-S Canyon Building was discharged to a series of surface ponds and ditches. For approximately 3 years, cooling water comprised part of the liquid waste discharged to the 216-S-5 and 216-S-6 Cribs (Section 4.10). The ponds covered a broad area west-southwest of the 200 West Area and received at least 4.7×10^{10} L of water. The waste stream was first passed through the 207-S Retention Basin (or one of the diversion boxes following 207-S abandonment) before being discharged to the ponds and ditches. Pinhole leaks and piping and coil failures are primary mechanisms for waste stream contamination. Inventory and discharge data are provided in Table A-1, Appendix A.

At the start of REDOX operations in October 1951, cooling water and 202-S Plant steam condensate was discharged to the 17-acre 216-S-17 Pond along with the plant steam condensate for the first 2.5 years of S Plant operations. A series of process coil leaks seriously contaminated the retention basin and the pond. Unknown quantities of naphtha, copper sulfate, sodium chlorate, and 2,4-D were added as herbicides. When these actions failed to control surface contamination, the 216-S-17 Pond was deactivated and the waste streams went to the 216-S-5 Crib through new diversion structures (216-S-172, 2904-S-160, and 2904-S-171). The crib flooded within 2 months, and an emergency surface trench was constructed to receive the overflow. By November 1954, the newly constructed 216-S-6 Crib began receiving some of the steam condensate from the 216-S-5 Crib. The 216-S-16 Pond and the 1,700-ft-long 216-S-16 Ditch were completed in September 1957. The volume of cooling water was reduced in 1969 and the unwetted area stabilized. However, the 216-S-16 Pond continued to receive some liquids until the early 1970's when the waste stream was shut off. The entire area was surface stabilized in 1975.

During the years the 216-S-16 Pond was active, it underwent a series of expansions. Several areas outside the initial pond were wetted by embankment washouts and were then surrounded by new embankments. In addition, a network of ditches was cut to provide additional percolation capacity and to provide an overflow capacity for the U-10 Pond system. It is unclear how much water these ditches received or if any waste from the U-10 Pond system ever reached the 216-S-16 Pond area. In 1965 the pond received waste from at least one 202-S coil failure.

This waste was reported to contain slightly higher concentrations of short-lived radionuclides such as niobium/zirconium and ruthenium-103,106 (Maxfield 1979).

The S Plant and 200 West Groundwater AAMS reports (DOE-RL 1992a, 1993c) contain descriptions of the S Pond and Ditch system. Some characterization related to RCRA groundwater interim assessment has been performed at the 216-S-10/11 Ponds and Ditch, several thousand meters to the east.

4.15.2 Known and Suspected Contamination

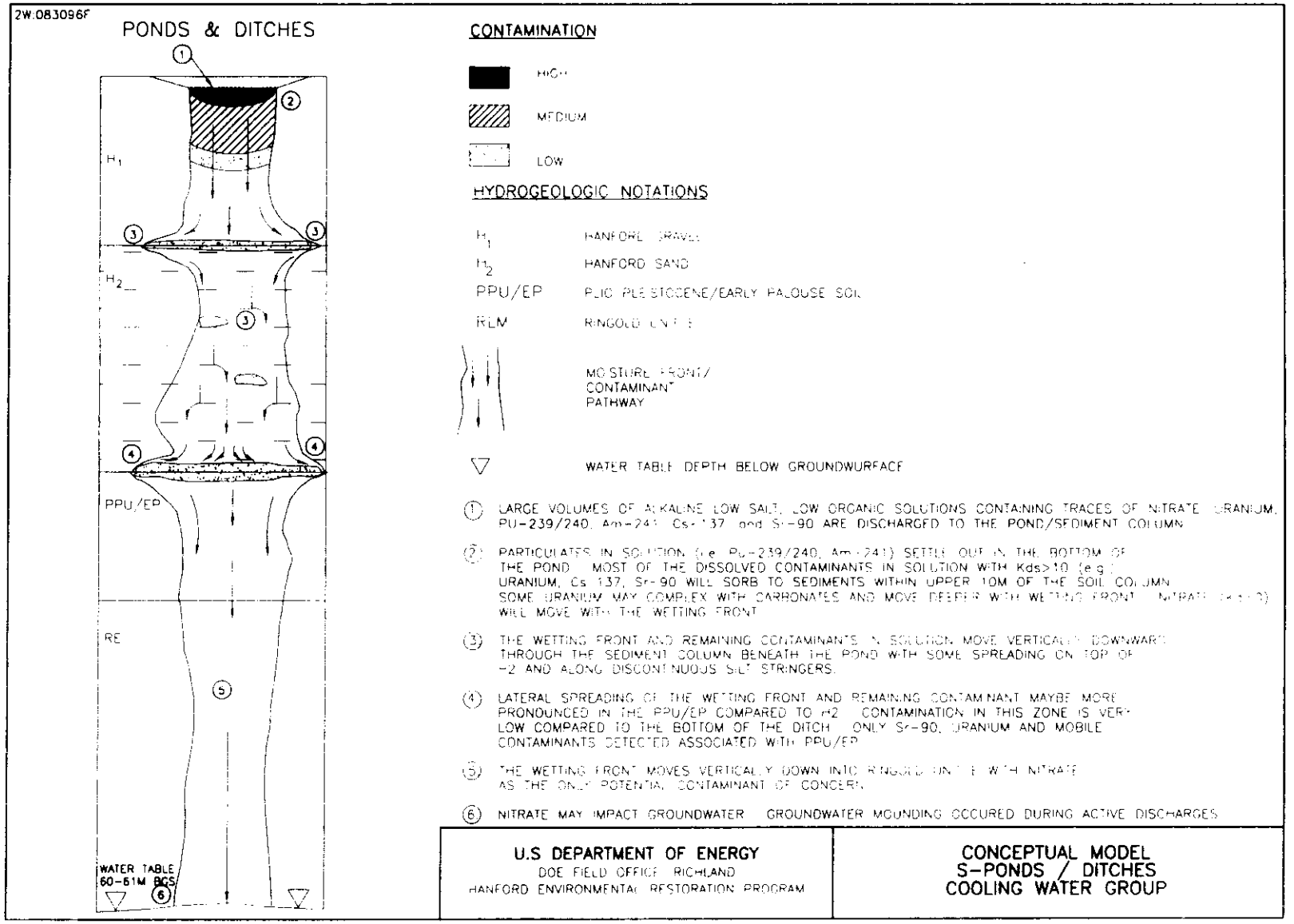
During operations, significant quantities of uranium, plutonium, and fission products (cesium-137, ruthenium-106, strontium-90, plus unidentified short-lived beta emitters) were released to the soil column at these waste sites. High uranium content and small quantities of nitrate are reported to have been released to the groundwater; it is expected that the pinhole leaks and coil failures would have released substantial quantities of process liquids. Potential contaminants from the process system include hexone, nitric acid, sulfuric acid, and sodium hydroxide. Waste stream characteristics are not designated, implying that it was primarily raw water and did not require treatment (neutralization) before discharge to the ground. Additions of the herbicides to the 216-S-17 Pond are reported in Maxfield (1979), but the quantities used are unknown.

4.15.3 Conceptual Model Summary

The cooling water from the 202-S Plant was initially mixed with the steam condensate stream, which added moderate quantities of fission products and plutonium to the 216-S-17 Pond inventory. Following separation of the two waste streams, the 216-S-16 Ditch and Pond received the most representative form of the cooling water (Figure 4-17). Radionuclides entered the cooling water by pinhole leaks in process vessel piping and during process upsets from coil failures. The material flowed from S Plant to the ponds and ditches in underground pipelines, retention basins, or diversion boxes. The wastewater was stilled in the large ponds, either at the outfall of the pipeline or at the junction of the ditch and pond.

Radioactive material settled out in the pond as a fine particle, as a colloid, or dissolved in the cooling water. Most of the material infiltrated into the soil and began binding up in the soil column. Plutonium and cesium quickly attached to the sediments at and just below the bottom of the pond and are expected to be concentrated within the first 1 and 3 m of sediment, respectively. Strontium penetrated more deeply, to about 10 m, into the sediments as it competed with mobilized calcium in the carbonate-rich soil. Uranium is the most mobile of the radionuclides and forms carbonate and hydroxide compounds within the first 25 to 30 m of the bottom of the pond or ditch. Strontium and uranium are expected to dominate the buildup of radionuclides at and immediately above fine-grained carbonate-rich lenses and directly above the Plio-Pleistocene caliche layer. Most of the contaminants are expected to be found in the first lobe of the 216-S-16 Pond because it was closest to the ditch. Radionuclides are expected to be found in the ditch sediments, but in smaller concentrations than that found in pond sediments.

Figure 4-17. S-Ponds/Ditches Cooling Water Group Conceptual Model.



Based on the data in Table A-1, Appendix A, the 216-S-17 Ditch/Pond system is selected as the representative site for this group. The inventory, high volume of liquid wastes received, and number of unplanned releases supported this selection. The representative waste sites are summarized in Table 4-3.

4.16 T-PONDS/DITCHES COOLING WATER GROUP

4.16.1 Group Description

The T-Pond/Ditches Cooling Water Group received waste from the 221-T and 224-T Buildings, which were involved with bismuth phosphate separation of irradiated fuel cells and plutonium purification, respectively. The $BiPO_4$ process operated from 1944 to 1956. Wastes supplied to this group were generated from heat exchangers, coolant coils, spills, and sumps from processing and daily operations. In addition, the cooling water stream was supplemented with steam condensate and chemical sewer wastes. All streams were intended to be noncontact liquid wastes. These wastes were distributed to either the 216-T-1 Ditch or, for eventual disposal into the 216-T-4A and 216-T-4B Ponds, the 216-T-4 Ditch. The 207-T Retention Basin was operated to hold the low-level wastes prior to release to the T-4 ditch/pond system. During 1954, radioactive sludge removed from 207-T was placed into the 216-T-12 Trench. The trench, which was active for 1 month, was then closed, chained off, and placarded. Additional cleanouts of basin sludge have been disposed to four vertical holes located east of the basin. These holes have been chained off and placarded for contamination.

Various tests using nonradioactive elements were conducted in the head end of the 221-T facility from 1966 to 1990. Waste from this area was sent to the 216-T-1 Ditch. However, since 1957 the main function of this building has been decontamination and refurbishment of equipment. Currently it provides for the decontamination, reclamation, and/or decommissioning of equipment, and is still active. Discharges continue to the 216-T-4-2 Ditch from air conditioning filter units, steam condensate, compressor coolant water, and drains, although the discharges are minimal.

The 224-T Building was inactive until the 1970's when it was converted to a plutonium scrap storage facility. The scrap was removed in 1985 and the building converted to a Transuranic Waste Storage and Assay Facility. These data are available in the T Plant and 200 West Groundwater AAMS reports (DOE-RL 1992b, 1993c). Recent characterization data are presented in the *Groundwater Impact Assessment Report for the 216-T-4-2 Ditch* (WHC 1995) and the *Groundwater Impact Assessment Report for the 216-T-1 Ditch* (Sweeny et al. 1995).

4.16.2 Known and Suspected Contamination

The 216-T-1 Ditch received generally low volumes of wastewater and contaminants from 1944 to 1995. The 216-T-4A and 216-T-4B Ponds are considered as one unit, and all radiologic inventories for these two ponds are reported as the 216-T-4 Pond. The 216-T-4B Pond was constructed after the 216-T-4A Pond became contaminated from a number of leaks from the 221-T Building; it is separated from the 216-T-4A Pond by a 0.5-m earthen dike. The

216-T-4-1D Ditch supplied liquid effluent to the 216-T-4A Pond until it was closed in 1972. The 216-T-4-2 Ditch was constructed to handle the effluent to the 216-T-4B Pond from 1972 to 1995, although no water flow has been seen in the pond since 1977. The two ditches shared the first 15.2 m before becoming individual units. This ditch and pond system received 4.25 x 10^{10} L of low-level waste in a mildly contaminated stream. The recorded inventory, inclusive of the ponds and the trenches that supply them, is 6.2 Ci of cesium-137, 3.4 Ci of strontium-90, and 3.7 g of plutonium, with no reported uranium. The single-use 216-T-12 Trench is reported to have received 4.3 Ci of cesium-137, 3.4 Ci of strontium-90, and 1 g of plutonium from the 207-T Retention Basin.

4.16.3 Conceptual Model Summary

The conceptual model for the T-Ponds/Ditches Cooling Water Group is shown in Figure 4-18. The 221-T and associated buildings were originally used for bismuth phosphate separation of irradiated fuel cells and plutonium purification from 1944 to 1956. Solutions from the coolant waters and steam condensate, along with the sumps, drains, and sewers, were sent to the 216-T-4A Pond via the 216-T-4-1 Ditch until 1972 when the contaminant levels around the edge of the pond were considered too high and the ditch was closed. Another ditch, the 216-T-4-2 Ditch, was constructed to deliver solution to the new 216-T-4B Pond; discharges to the newer system concluded in 1995.

Contaminated soils from the 216-T-4A Pond and the 216-T-4-1D Ditch, to a depth of 0.6 m maximum, were removed during 1973 and sent to the 218-W-2A Burial Ground, which may have included part of the ditches. Removal of these soils from the waste discharge system may account for the lack of contamination during the recent characterization studies of the 216-T-4-2 Ditch, which has received nonradiological solutions since 1972.

Based on the data in Table A-1, Appendix A, the 216-T-4A Pond is selected as the representative site for this group. The high volume of liquid waste received and its inventory support this selection. The representative waste sites are summarized in Table 4-3.

4.17 200 AREAS CHEMICAL LABORATORY WASTE GROUP

The 200 Areas Chemical Laboratory Waste Group consists of the wastes sites associated with facilities at the 222 Laboratories for the B, T, U, and S Plants and may include waste from the 231-Z Plutonium Isolation Building. Laboratory discharges from PUREX were sent to cribs that also received ventilation stack waste and were grouped into the Miscellaneous Waste Group (Section 4.21). Laboratory wastes from 234-5Z Plant operations were sent to 216-Z-10 and 216-Z-12 waste sites and are discussed in Sections 4.3 and 4.4, respectively. Sites at the 231-Z Building are included in this group based on available descriptions. However, the processes generating the waste are not clear because, after 1953, plutonium refining was transferred from 231-Z to 234-5Z. Thereafter, the 231-Z facility was used by Hanford laboratories and the Pacific Northwest National Laboratory for "laboratory" wastes. The nature

Figure 4-18. T-Ponds/Ditches Cooling Water Group Conceptual Model.

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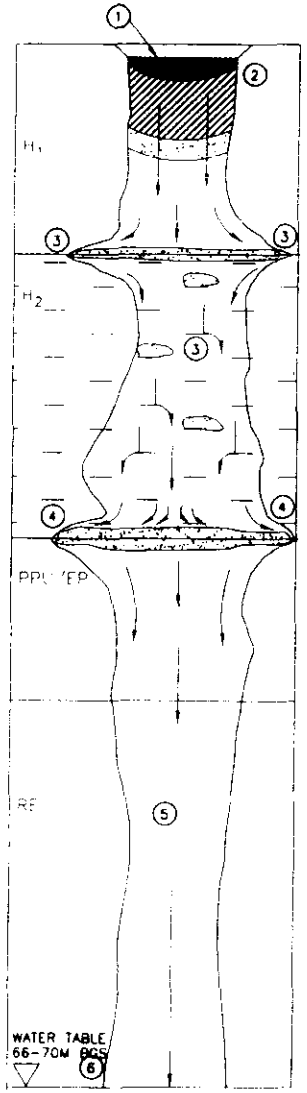
PONDS & DITCHES



CONTAMINATION

- HIGH
- MEDIUM
- LOW

HYDROGEOLOGIC NOTATIONS

H_1	HANFORD GRAVEL
H_2	HANFORD SAND
PPU/EP	PRIO PLEISTOCENE/EARLY PALOUSE SOIL
RF	RINGOLD UNIT E
	DISCONTINUOUS SILT STRINGERS
	WATER TABLE DEPTH BELOW GROUNDSURFACE
	MOISTURE FRONT, CONTAMINANT PATHWAY

1. ALKALINE LOW SALT, LOW ORGANIC SOLUTIONS CONTAINING TRACES OF NITRATE, URANIUM, Pu-239/240, Am-241, Cs-137, and Sr-90 ARE DISCHARGED TO THE FACILITY/SEDIMENT COLUMN
2. PARTICULATES IN SOLUTION (i.e. Pu-239/240,Am-241) SETTLE OUT IN THE BOTTOM OF THE POND. MOST OF THE DISSOLVED CONTAMINANTS IN SOLUTION WITH Kds>10 (e.g.) URANIUM, Cs-137, Sr-90 WILL SORB TO SEDIMENTS WITHIN 2M OF THE POND BOTTOM. SOME URANIUM MAY COMPLEX WITH CARBONATES AND MOVE DEEPER WITH THE WETTING FRONT. NITRATE (Kd=0) WILL MOVE WITH THE WETTING FRONT. REMOVAL OF 0.6M OF SOIL FROM BOTTOM OF DITCH IN 1973 REDUCED AMOUNT OF CONTAMINANTS AVAILABLE FOR REMOBILIZATION OR SOLUTION TRANSPORT
3. THE WETTING FRONT AND REMAINING CONTAMINANTS IN SOLUTION MOVE VERTICALLY DOWNWARD THROUGH THE SEDIMENT COLUMN BENEATH THE POND WITH SOME SPREADING ON TOP OF H2 AND ALONG DISCONTINUOUS SILT STRINGERS
4. LATERAL SPREADING OF THE WETTING FRONT AND REMAINING CONTAMINANT MAY BE MORE PRONOUNCED IN THE PPU/EP COMPARED TO H2. CONTAMINATION IN THIS ZONE IS VERY LOW COMPARED TO THE BOTTOM OF THE DITCH. ONLY STRONTIUM 90, URANIUM AND MOBILE CONTAMINANTS DETECTED ASSOCIATED WITH PPU/EP
5. THE WETTING FRONT MOVES VERTICALLY DOWN INTO RINGOLD UNIT E WITH NITRATE AS THE ONLY POTENTIAL CONTAMINANTS OF CONCERN
6. NITRATE MAY IMPACT GROUNDWATER

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of activities in this building are largely unknown, and site groupings may not be correct. Also, the 216-Z-7 and 216-S-20 Cribs are known to have received waste from the 300 Area laboratories, but the quantities and inventory are unknown and do not warrant regrouping.

4.17.1 Group Description

The 222 Area analytical laboratories provided analytical services supporting B, T, and U Plant complexes at the start of facility operations. The 222-S Laboratory initially supported REDOX operations but evolved over the years to become the major onsite laboratory for other functions as well. The laboratories generated both solid and liquid waste. Solid wastes consisted mainly of samples and empty containers and were usually managed at nearby caissons or burial grounds for the B and T laboratories (see Section 4.19). Liquid wastes consisted mainly of sample disposal, decontamination, ventilation, and hood waste. Liquid wastes were typically discharged directly to the sediment column in cribs, reverse wells, french drains, and ponds. For the 222-B, S, and T laboratories, specific waste site types received specific waste streams. For example, reverse wells received low-volume, liquid wastes from the radiological side of the laboratory buildings, whereas cribs received higher volume, decontamination sink and sample "slurper" wastes. The 207-SL Retention Basin was used at the 222-S Laboratory until 1995 when it and the S-26 Crib were taken out of service. Contaminants disposed of at these facilities contain one or more of the following wastes: uranium, plutonium, americium-241, cesium-137, strontium-90, sodium dichromate, nitric acid, sulfuric acid, nitrates, and sulfates. Decontamination solutions are also assumed to be part of the waste stream.

"Laboratory" wastes are noted as being discharged to several waste sites around the 231-Z Isolation Building from Battelle Northwest, Pacific Northwest National Laboratory, and General Electric testing conducted after construction of the 234-5Z Plant. Many of these waste sites are grouped as process condensates/process wastes, but available descriptions are too vague to determine whether the wastes are actually derived from analytical laboratory processes.

Information on the 200 Areas Chemical Laboratory Waste Group is provided in the B Plant AAMS report (DOE-RL 1993e), the S Plant AAMS report (DOE-RL 1992a), the T Plant AAMS report (DOE-RL 1992b), the U Plant AAMS report (DOE-RL 1992c), and Maxfield (1979). More recently, the 216-U-4 Reverse Well and the 216-U-4A/4B French Drains were characterized as part of a limited field investigation activity for the 200-UP-2 Operable Unit, the results of which are presented in the *Limited Field Investigation for the 200-UP-2 Operable Unit* (DOE-RL 1995b).

4.17.2 Known and Suspected Contamination

The type, amount, and volume of chemical laboratory waste discharged to the sediment column is given in Table A-1, Appendix A. Primary radioactive COCs in this effluent stream are cesium, strontium, plutonium, and uranium with minor americium. The largest quantities of cesium (200 Ci), strontium (200 Ci), and plutonium (124 Ci) in this waste group were disposed at the 216-Z-7 Crib. The largest quantity of uranium (154 kg) was discharged to the 216-S-19 Pond. The largest quantities of nonradioactive contaminants include 6,000 kg of nitric acid, 200 kg of sodium dichromate, 10,000 kg of sulfuric acid, and 10,000 kg of nitrate. The largest

quantities of acids and sodium dichromate were disposed to the 216-T-2 Reverse Well. The largest amount of nitrate was disposed at the 216-T-28 Cribs.

4.17.3 Conceptual Model Summary

Liquid chemical laboratory waste that contained up to 154.6 kg uranium, 200 Ci cesium, 200 Ci strontium, 124 Ci plutonium, and hazardous waste was discharged directly to the sediment column in ponds, ditches, trenches, cribs, and french drains. After these contaminants are released to the sediment column, contaminant transport pathways may include the following: soil column to groundwater, volatilization, uptake by plants and animals, wind, and direct exposure.

The chemical laboratory waste stream is characterized mainly as alkaline, low salt, low organic oxidized mixtures. Because a limited amount of sample data are available to determine the distribution of contaminants in the sediment column, contaminant profiles are speculated on here based on their chemical and physical properties and investigations conducted in the 200-UP-2 Operable Unit. The following general conclusions are made. Radiological contamination is predominantly distributed directly beneath the waste unit. The main body of radiological contamination is distributed within 6 m (20 ft) of the release point/bottom of the facility. Contamination generally decreases with depth, although contaminant levels may increase as associated with finer grained facies. Mobile contaminants with low distribution coefficients (e.g., sodium dichromate, nitrates, sulfates) have moved through the sediment column and likely impact groundwater where the effluent/pore volume is high. Acid has been neutralized in the upper section of the sediment column due to the presence of calcium carbonate and the lack of organics. Mobility of some of the radionuclides may have been improved at sites that also received decontamination wastes generated from washing equipment. A general conceptual model applicable to the chemical laboratory waste stream is shown in Figure 4-19.

Based on process knowledge and data in Appendix A, the 216-S-20 Crib was selected as the typical waste site. It was in use the longest of waste sites that received laboratory wastes and has significant inventories of radionuclides and known inorganic wastes. The 216-Z-7 Crib was selected as the "worst case" site based on high inventories of plutonium, cesium, and strontium concentrated into smaller quantities of liquid than at other sites. In addition, both sites are known to have received unknown quantities of liquid waste with unknown but suspected high inventories of contaminants. It is unclear if the inventories listed in Appendix A include 300 Area waste inventories. Table 4-3 summarizes the representative waste sites for this group.

4.18 300 AREA CHEMICAL LABORATORY WASTE GROUP

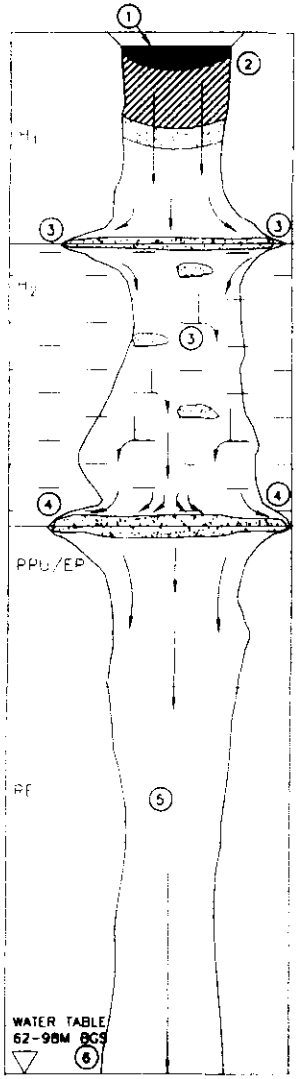
4.18.1 Group Description

Analytical laboratories in the 300 Area provided services that supported fuel fabrication activities but grew to encompass a number of hot-cell-based analytical activities. Waste generated by 320-series laboratories consisted mainly of liquid sample disposal and decontamination waste.

Figure 4-19. 200 Area Chemical Laboratory Waste Group Conceptual Model.

2W 083096H

VARIOUS DISPOSAL FACILITIES



CONTAMINATION

- HIGH
- MEDIUM
- LOW

HYDROGEOLOGIC NOTATIONS

- H1 — HANFORD GRAVEL
- H2 — HANFORD SAND
- PPU/EP — PLIO-PLEISTOCENE/EARLY PALOUSE SOIL
- RE — RINGOLD UNIT E
- DISCONTINUOUS SILT STRINGERS
- WATER TABLE (DEPTH BELOW GROUND SURFACE)
- MOISTURE FRONT / CONTAMINANT PATHWAY

1. ALKALINE LOW SALT LOW ORGANIC SOLUTIONS CONTAINING SODIUM DICHROMATE, NITRATE, SULFATE, URANIUM, Pu-239/240, Am 241, Cs-137, and Sr-90 ARE DISCHARGED TO THE FACILITY/SEDIMENT COLUMN
2. PARTICULATES IN SOLUTION (i.e. Pu-239/240, Am-241) SETTLE OUT IN THE BOTTOM OF THE POND. MOST OF THE DISSOLVED CONTAMINANTS SOLUTION WITH Kds>10 (e.g.) URANIUM, Cs 137, Sr-90 WILL SORB TO SEDIMENTS WITHIN 6M OF THE CRIB BOTTOM SOME URANIUM COMPLEXES WITH CARBONATES AND MOVES WITH THE WETTING FRONT NITRATE (Kd=0) WILL MOVE WITH THE WETTING FRONT ACIDS ARE NEUTRALIZED DUE TO PRESENCE OF CALCIUM CARBONATE
3. THE WETTING FRONT AND REMAINING CONTAMINANTS IN SOLUTION MOVE VERTICALLY DOWNWARD THROUGH THE SEDIMENT COLUMN BENEATH THE CRIB WITH SOME SPREADING ON TOP OF H2 AND ALONG DISCONTINUOUS SILT STRINGERS
4. LATERAL SPREADING OF THE WETTING FRONT AND REMAINING CONTAMINANT MATRIX MORE PRONOUNCED IN THE PPU/EP COMPARED TO H2 CONTAMINATION IN THIS ZONE IS VERY LOW COMPARED TO THE BOTTOM OF THE CRIB ONLY MOBILE CONTAMINANTS DETECTED ASSOCIATED WITH PPU/EP
5. THE WETTING FRONT MOVES VERTICALLY DOWN INTO RINGOLD UNIT E WITH NITRATE SODIUM DICHROMATE AND SULFATES AS THE ONLY POTENTIAL CONTAMINANTS OF CONCERN
6. MOBILE CONTAMINANTS MAY IMPACT GROUNDWATER

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The waste was managed in part within the 340 Retention and Neutralization Complex. Liquid wastes from this group that were too contaminated for disposal in the 300 Area were trucked to the 200 Areas and discharged directly to the sediment column in cribs and trenches.

Contaminants disposed of contain one or more of the following wastes: uranium, plutonium, cesium-137, strontium-90, and nitrates. This waste stream is similar to the 200 Area chemical laboratory group effluent, with the exception of the acid and sodium dichromate component. The waste was usually adjusted to a neutral or alkaline state. Another important waste stream from the 300 Area was a batch of 309 reactor cooling water that was seriously contaminated when a fuel rod ruptured.

Wastes to the 200 Areas were disposed to four specific retention trenches in the 216-BC Cribs area and to a number of cribs in the 200 West Area (see Table A-1, Appendix A). In addition, the 216-Z-7 and 216-S-20 Cribs received 300 Area laboratory wastes, but quantities and inventories are not known.

4.18.2 Known and Suspected Contamination

The type, amount, and volume of chemical laboratory waste discharged to the sediment column is given in Table A-1, Appendix A. Primary radioactive COCs in this effluent stream are cesium, strontium, plutonium, and uranium. The largest quantities of cesium (193 Ci), uranium (386 kg or 0.13 Ci), and nitrate (10,000 kg) in this waste group were disposed at the 216-T-28 Crib. The largest quantities of plutonium (110 g) and strontium (178 Ci) were disposed at the 216-T-34 Crib.

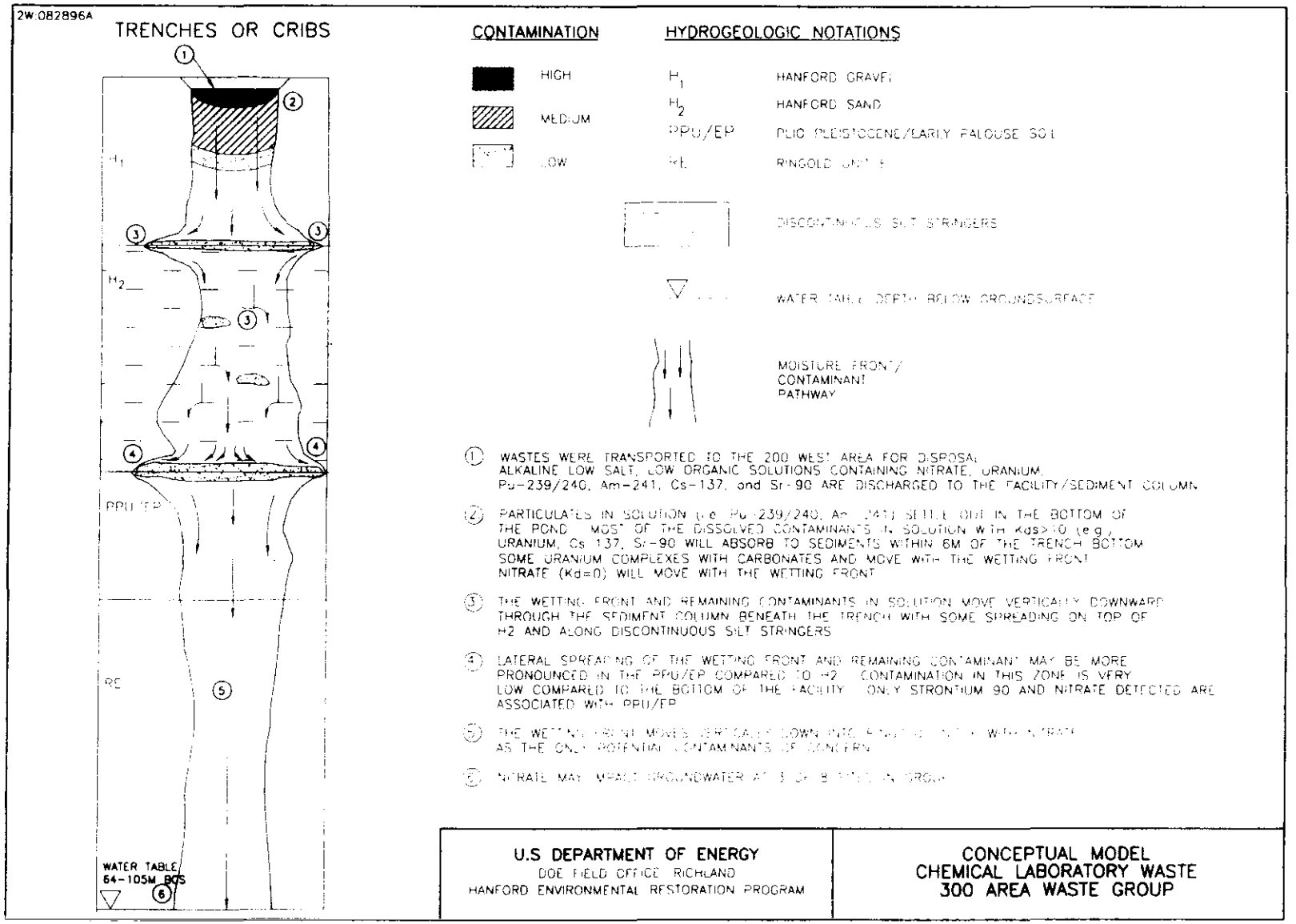
4.18.3 Conceptual Model Summary

Liquid chemical laboratory waste containing up to 386 kg uranium (0.13 Ci), 193 Ci cesium, 178 Ci strontium, 110 Ci plutonium and 10,000 kg of nitrate was discharged directly to the sediment column in trenches and cribs in the 200 Areas.

Radiological contamination is predominately distributed directly beneath the waste units. The main body of radiological contamination is distributed within 6 m (20 ft) of the release point/bottom of the facility. Contamination generally decreases with depth, although contaminant level may increase when associated with finer grained facies. Mobile contaminants with low distribution coefficients have moved through the sediment column and likely impact groundwater where the effluent to pore volume ratio is high. A general conceptual model applicable to the chemical laboratory waste stream is shown in Figure 4-20.

The 216-B-58 Trench was selected as a representative site because of its typical inventory. The 216-T-28 Crib was selected based on its high inventory and the volume of liquid received. These sites are also listed in Table 4-3.

Figure 4-20. 300 Area Chemical Laboratory Waste Group Conceptual Model.



4.19 RADIOACTIVE LANDFILLS AND DUMPS GROUP

4.19.1 Group Description

All of the 200 Area low-level radiological waste burial grounds (218 Sites) are located inside the 200 East and 200 West Area fenced boundaries. Each burial ground consists of one or more narrow trench. Sizes of the burial grounds range from less than 0.4 to 14 ha (1 acre to 34 acres). Trench length was proportional to the size of the burial ground; some were more than 244 m (800 ft) long and 15 m (50 ft) wide at the top. The average burial trench depth is 3 to 6 m (10 to 20 ft).

Most 200 Area burial grounds are inactive facilities that have been backfilled and surface stabilized with at least 0.6 m (2 ft) of clean dirt and seeded with grasses. Seven active burial sites remain in the 200 East and 200 West Areas. Space is available for expansion in the 218-W-5 and 218-W-6 (not used to date) Burial Grounds. The 218-W-5 Burial Ground has trenches designated for low-level radiological waste and low-level mixed waste. The low-level mixed waste trenches have been constructed with a polyethylene liner.

Pipe storage units, caissons, and vaults were used for small packages of remote-handled, highly radioactive and TRU waste. A pipe storage unit (i.e., dry well) is formed by welding a column of bottomless 208-L (55-gal) drums together and burying the column vertically. Caissons and dry waste vaults are wood or concrete receptacles that have angled chutes for depositing waste. The 218-W-4A Burial Ground contains six pipe storage units that received 300 Area laboratory waste and list plutonium in their inventory. 218-W-4B has 10 concrete caissons that received waste from 200 Area facilities, the 300 Area, and the 100-N Area. Three of the ten caissons are designated as alpha caissons and contain mostly TRU waste. The other caissons received a combination of high-activity beta-gamma waste and TRU waste. In addition, each early 200 Area laboratory facility had dry waste vaults dedicated for its own use.

Prior to 1970, the burial ground site was considered to be the location of final disposition for packaging of solid wastes. Packaging was designed for transport with little regard for long-term integrity. Early Hanford radiological waste was contained in wood or cardboard boxes, 208-L (55-gal) drums, and steel cans that were randomly dumped into the trenches. The waste was not separated by waste or contaminant type. The waste was considered dry waste and did not contain any significant volumes of liquid. Occasionally, small volumes of bottled, highly contaminated liquid were placed inside a 208-L (55-gal) drum and the drum filled with concrete. The concrete shielded the radiation and stabilized the liquid waste. The "concrete drums" were placed in the trenches along with the other wastes. Other types of dry waste include large pieces of contaminated equipment, rags, discarded laboratory items (rubber gloves and glassware), lead bricks, contaminated dirt, high-efficiency particulate air filters, plastic sheeting, concrete cell cover blocks, dead animals, pipes, and tools. In a few cases, a site received a "218" number but was not a typical burial ground. These burial sites contain contaminated material buried in place following repair to a facility.

In 1963, an effort began to dispose of all Hanford TRU waste in the 200 Areas. The decision to handle TRU waste in this manner was based on the fact that most of the 200 Area Plateau is

more than 61 m (200 ft) above groundwater as compared to the 100 and 300 Areas where average depth to groundwater is considerably less (15 to 18 m [50 to 60 ft]). Also, a flood scenario applied to waste sites located near the Columbia River indicated that such an occurrence would expose much of the solid waste. After 1967, all low-level radiological and TRU waste from the 300 Area and 100-N Area was shipped to the 200 Area burial grounds.

The 200 Area burial grounds also received waste other than waste from the Hanford Site. Waste shipments from offsite sources included soil from the Nevada Test Site, Navy submarine reactor cores, and Three-Mile Island waste. The variety of sources from which the waste was generated complicates the issues associated with waste inventory. Facility waste volume estimates range from less than 100 m^3 to 130,000 m^3. At the 218-W-2 Burial Ground, 126 kg of plutonium is reported, and 440,000 Ci of beta-gamma contaminants is reported for the 218-W-3 Burial Ground (RHO 1977). The 218-E-10, 218-E-12B, 218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, and 218-W-5 Burial Grounds are RCRA TSD units.

4.19.2 Known and Suspected Contamination

Before 1960, detailed inventory records were not maintained. Specific information about the early burial grounds is often not available. Based on process knowledge, contaminants expected to be found in the 200 Area burial grounds include uranium, cesium-137, strontium-90, plutonium-239/240, americium-240, cobalt-60, technetium-99, and ruthenium-106. Only contaminants with a half-life of 20 years or more would present significant potential risk. A variety of chemical waste may be in the 200 Area burial ground waste. However, chemical inventory was not considered a recordkeeping issue until the late 1980's. Waste acceptance criteria prior to 1980 varied and were not well defined. Burial records are now strictly maintained, and waste is segregated into low-level radioactive waste, radioactive mixed waste, and TRU waste categories.

4.19.3 Conceptual Model Summary

The conceptual model for contamination in the 200 Area burial grounds reflects the generally dry state of the material (Figure 4-21). Most contamination is expected to be confined within the limits of the excavated trenches. Minor penetration of contaminants into the trench subsurface is expected to a depth of up to 3 m (10 ft), driven by instances of ponding snowmelt or rainwater above or at the bottom of the trench. Contaminant penetration will be localized and irregular. Surface contamination is expected at shallow depths below and at the top of stabilizing soil covers, where plants, animals, and insects have brought the material to the surface. Contamination of the trench backfill is expected as a result of the failure of disposal packages and biointrusion. Infiltration of rainfall and snowmelt is expected to concentrate this material in the lower portions of the trench. Ejection of contaminants at surface collapses will have produced a localized concentration around the subsequently backfilled voids.

The 218-W-1A Burial Ground was selected as a representative site based on its age and inventory of low-level solid wastes. The 218-W-2A and 218-W-4A TRU Burial Grounds had high and the highest inventories, respectively. The selections are also presented in Table 4-3.

Figure 4-21. Radioactive Landfills and Dumps Group Conceptual Model.

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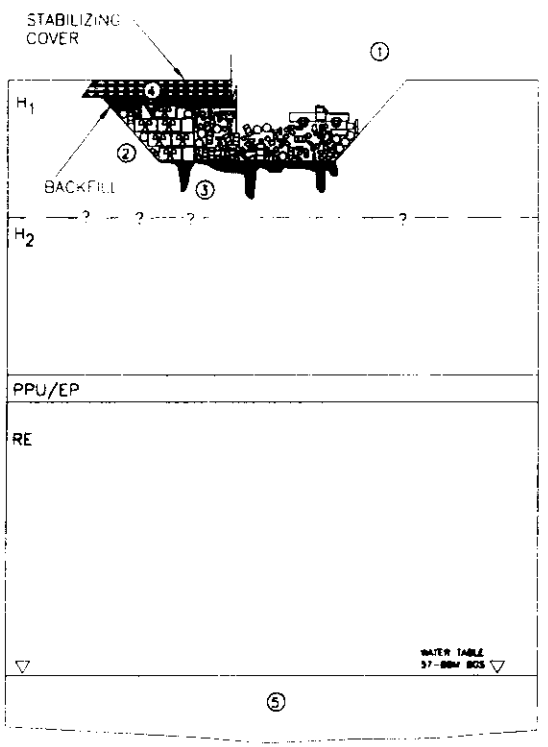
LANDFILLS & DUMPS



HYDROGEOLOGIC NOTATIONS

H_1	HANFORD GRAVEL
H_2	HANFORD SAND
PPU/EP	PRIO PLEISTOCENE/EARLY PALOUSE
RE	RINGOLD UNIT E
■	CONTAMINATION
	CONTAMINATE PATHWAY
▽	WATER TABLE DEPTH BELOW GROUNDSURFACE

① SOLID WASTE IS HAULED TO BURIAL GROUNDS IN CARDBOARD BOXES, WOODEN BURIAL BOXES, AND DRUMS WRAPPED IN PLASTIC

② RAINFALL AND SNOW MELT ENTER WASTE EITHER WHILE IN TRENCH IS OPEN OR AFTER BACKFILLING.

③ MOBILIZED WASTES REACH BURIAL GROUND TRENCH FLOOR AND SLOWLY INFILTRATE INTO SOIL COLUMN. CONTAMINATION IS EXPECTED TO BE SHALLOW (~3M) AND DISCONTINUOUS BOTH ALONG AND ACROSS TRENCH

④ BURIAL BOX COLLAPSE PRODUCES LOCAL SURFACE CONTAMINATION WITHIN AND/OR OUTSIDE TRENCH. CONTAMINATION IS CLEANED UP, VOID SPACE IS FILLED AND STABILIZING SOIL COVER IS INSTALLED

⑤ GROUNDWATER HAS NOT BEEN IMPACTED BY THESE FACILITIES

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4.20 NONRADIOACTIVE LANDFILLS AND DUMPS GROUP

4.20.1 Group Description

A number of nonradiological landfills and dump sites have been created during the construction and operation of 200 Area facilities. A few sites were excavated, engineered structures and operated in a manner to contain waste releases. However, most sites were simply accumulation points for materials not regarded at the time to be potentially hazardous. In addition, most of these sites were not well identified and inventories were not normally kept. A list of waste sites currently in this group is provided in Table A-1, Appendix A.

Nonengineered landfills and dump sites generally consist of surface areas or pits containing a variety of miscellaneous noncontaminated items. Examples include wire, pipes, cans, cardboard, concrete and wood, and construction debris. Most of the contents were randomly dumped and are not contained. The coal-fired steam-generating plants produced large quantities of ash that was discarded into ash pits that later grew into aboveground surface mounds. The ash was found to be nonhazardous. Nonradiological waste including tumbleweeds, office waste, paint, and solvents was sometimes burned in pits to reduce the volume. Several unplanned releases at burn pits have been reported when radiological material was mistakenly burned. The contamination was usually removed or stabilized at the time of discovery. Both the 200 East and 200 West Area burn pits were used to detonate shock-sensitive and potentially explosive chemicals. The sites were clean closed in accordance with RCRA standards in 1995.

Three engineered structures have been constructed to receive nonradiological waste from the 200 Areas including the Solid Waste Landfill (SWL), Nonradioactive Dangerous Waste Landfill (NRDWL), and the Old Central Landfill. All three are inactive and located southeast of the 200 Areas, off the plateau. The Old Central Landfill consists of a single trench that was used for 9 months in 1973. In 1986, a small amount of low-level radiological contamination was found on the site surface, and the trench was posted as an Underground Radioactive Material Area. The 600 NRDWL and the 218-W-6 Burial Ground are RCRA TSD units. The 200-E8 Borrow Pit Demolition Site and the 200-W Ashpit Demolition Site have been clean closed.

4.20.2 Known and Suspected Contamination

The SWL, active until March 1996, used a series of unlined trenches to dispose of primarily sanitary solid waste. The solid waste consisted of office waste paper (40%), construction and demolition debris (30%), asbestos materials (10%), bulky office items (appliances and furniture, 10%), and other (food, industrial waste, medical waste, inert material, 10%). The SWL inventory is estimated at approximately 382,500 m^3 (500,000 yd^3) of waste. In addition, up to 5,000,000 L of sewage and an estimated 380,000 L of wastewater from 1100 Area vehicle maintenance catch tanks were disposed to the ground at separate liquid waste trenches (DOE-RL 1993g). Adjacent to the SWL is the NRDWL, a RCRA TSD unit that received dangerous waste, primarily laboratory waste materials, and asbestos. Records indicate that liquid wastes were brought to the site in 208-L (55-gal) drums and laboratory packs filled with absorbents.

4.20.3 Conceptual Model Summary

Vadose zone and groundwater contamination, primarily volatile organic compounds, has been reported at the SWL and NRDWL (DOE-RL 1993g, 1995a). Volatile organic compound contamination is primarily attributed to the 1100 Area catch tank liquids disposed to liquid trenches in the SWL. Conceptual models for contaminant migration at nonradiological waste sites are shown in Figures 4-22 and 4-23. The Old Central Landfill and West Lake Dumping Area were selected as representative sites for engineered landfills and nonengineered dumps, respectively (Table 4-3).

4.21 MISCELLANEOUS WASTE GROUP

4.21.1 Group Description

The Miscellaneous Waste Group consists of the remaining radioactive waste sites not included in the other waste stream groupings. In addition, three waste cribs, 216-A-38-1, 216-B-56, and 216-B-61, were built but never used. Waste streams discharged to sites within this group are the most varied in terms of waste stream sources but are generally characterized by low volumes and low levels of contamination. Organic contaminants are not listed, and only small quantities of inorganics, including sodium dichromate, are noted in the inventories. An indicator of low volumes is that many of the waste streams went to french drain sites. Four french drains at the 241-A-431 Tank Ventilation System are not included in Miscellaneous Waste Group because they reside inside the 241-A Tank Farms: the 216-A-16/A-17 French Drains, which received floor and stack drainage, and the 216-A-23A/A-23B French Drains, which received deentrainer tank condensate and backflush waste. Many of the sites, which are listed in Table A-1, Appendix A, are associated with ventilation system liquid wastes. Operations at a number of these sites, particularly those associated with ventilation systems, may have continued until recent times.

Decontamination sites were concentrated around T Plant following its transition from $BiPO_4$ separations processing to equipment decontamination. Five 216-T trenches and crib received decontamination wastewater. Four were later cleaned out when the contaminated soil was sampled, collected, and hauled to a burial ground. These streams were low volume and slightly contaminated with radioactive materials. Other decontamination sites are known at the 216-U-13 Crib, which was cleaned out, and the 216-S-18 Crib. Except for the 216-T-33 Trench, the T and the 216-U-13 trenches were exhumed and the contaminated soil hauled to a burial ground before being backfilled. In addition, the S-18 Trench was backfilled.

Ventilation systems were a key function of both of the major processing plants as well as for a number of smaller process operations. The ventilation system received the canyon and cell ventilation air, air from equipment vent headers, and gases formed during processing.

Figure 4-22. Nonradioactive Landfills and Dumps Group Conceptual Model, Landfills.

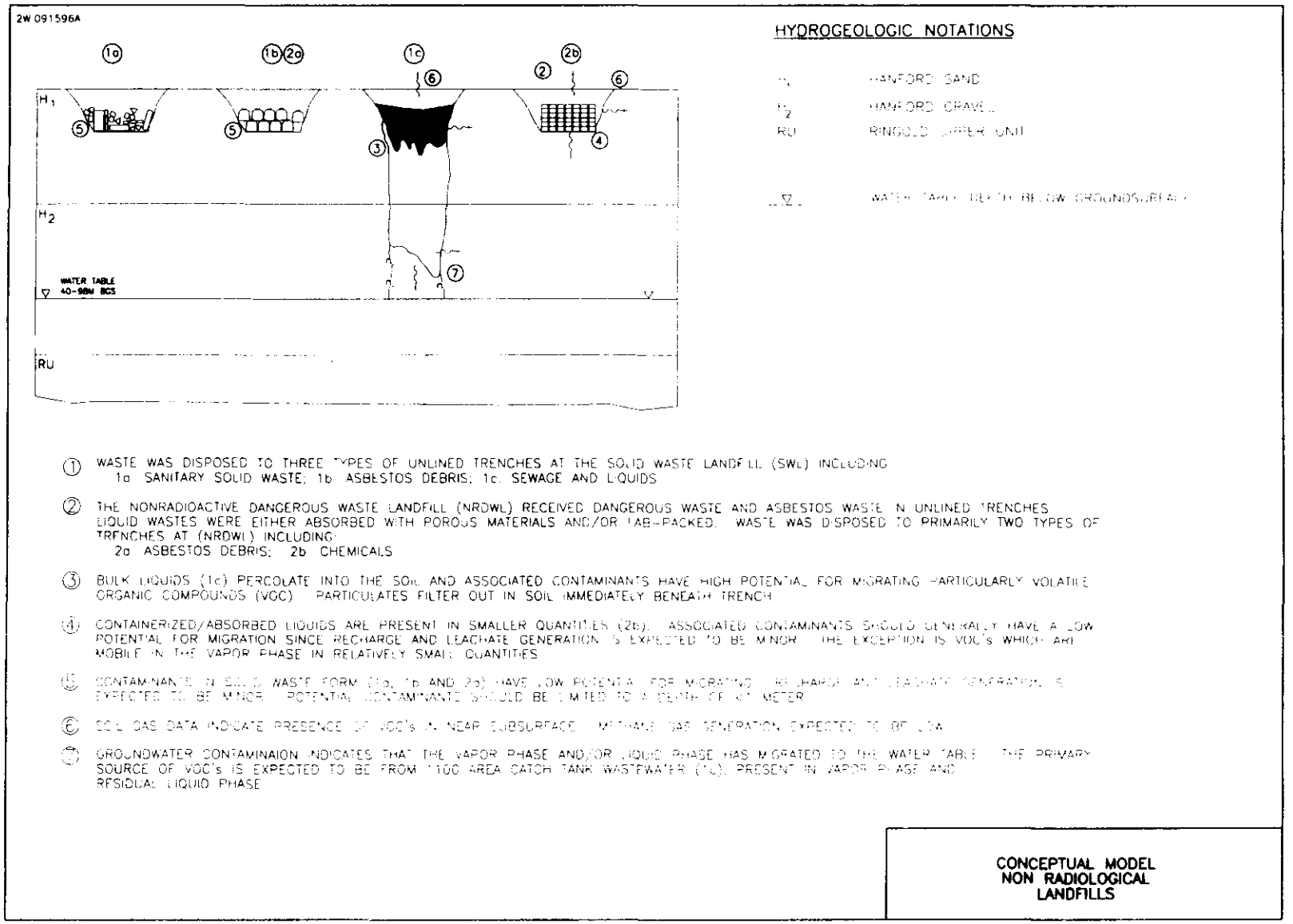
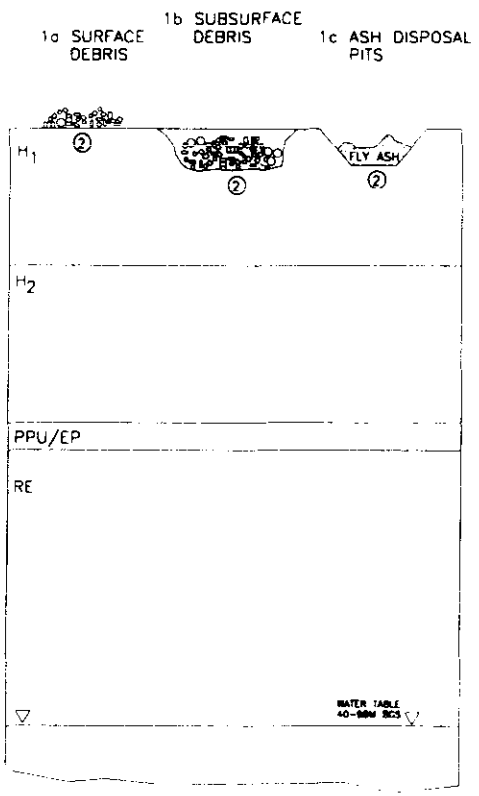


Figure 4-23. Nonradioactive Landfills and Dumps Group Conceptual Model, Dump Sites.

2W.091396A



HYDROGEOLOGIC NOTATIONS

H_1	HANFORD GRAVEL
H_2	HANFORD SAND
PPU/EP	PLIO PLEISTOCENE/EARLY PALOUSE
RE	RINGOLD UNIT E
▽	WATER TABLE DEPTH BELOW GROUNDSURFACE

① NONRADIOLOGICAL DUMP SITES CAN BE GROUPED IN 3 CATEGORIES
- a. SURFACE DEBRIS SITES THAT MAY INCLUDE BUILDING RUBBLE, ASBESTOS AND MISCELLANEOUS TRASH
- b. SHALLOW EXCAVATIONS FILLED WITH DEBRIS SIMILAR TO ABOVE AND COVERED WITH SOIL
- c. TRENCHES EXCAVATED FOR DISPOSAL OF FLY ASH

② CONTAMINANTS IN THIS SOLID WASTE GROUP HAVE A LOW POTENTIAL FOR MIGRATION BECAUSE THERE IS NOT A SIGNIFICANT SOURCE OF RECHARGE (i.e. RAINFALL/SNOWMELT), THEREFORE, POTENTIAL CONTAMINATES SHOULD EXTEND TO A DEPTH <1 METER BELOW THE BOTTOM OF THE FACILITY

③ GROUNDWATER IS NOT IMPACTED BY DOE/RL PRACTICES

U.S DEPARTMENT OF ENERGY DOE FIELD OFFICE, RICHLAND HANFORD ENVIRONMENTAL RESTORATION PROGRAM	CONCEPTUAL MODEL NONRADIOACTIVE DUMP SITES

Radiological releases were an important operational concern, and the exhaust air system employed both filters and a tall stack (291 structures) to capture particulates and contaminants in the vapor phase. At the PUREX Plant, a number of french drains received small volumes of potentially to slightly contaminated wastes from equipment associated with the fan house building (216-A-26/26A), stack sampling laboratory, and ventilation plenum. However, several cribs (216-A-4/A-21/A-27) received significant volumes of waste directly from the stack itself, along with PUREX laboratory cell drainage and sump drainage. However, there are insufficient data to determine which of the waste streams contributed to the inventory of these cribs. At the B, S, T, and U Plants, filters as well as stacks were used to trap particulates and condense moisture, but continuous-use liquid waste disposal sites (french drains) are only known at B Plant (216-B-13) and T Plant (216-T-29). Three pairs of french drains received liquid waste from the 291-Z stack system.

The remaining sites in this group are a collection of mostly french drain-type sites where small quantities of liquid and contaminants have been disposed to the soil column. At least four recently reported french drains at the Semiwork's Critical Mass Laboratory and one at the Semiworks Gatehouse have been posted for radioactivity; all could have potentially received radioactive materials. The PUREX facility has several other numbered waste sites for steam traps and process condensate sampler pit wastes. One tank farm spill discharged outside the 241-AX Tank Farm limits (216-A-39) may have been removed by construction of the 241-AN Tank Farms. Two small cribs at the 203-A Uranyl Nitrate Storage Facility received potentially significant quantities of uranium from the building's sumps. At 299-E24-111, a field test site, a number of shallow holes were drilled around a shallow injection well at a location adjacent to the unused 216-A-38-1 Crib. Short-lived cesium-134 ($T^{1/2}$=2.1 years) and strontium-85 ($T^{1/2}$=65 days) tracers were injected into the ground along with a suite of chemicals, and downward migration was tracked with geophysical logging. U Plant has several small waste sites, one that received waste from a condenser unit at the 241-U Tank Farms and another that received floor drainage from the 221-U Building.

4.21.2 Known and Suspected Contamination

Inventories for these waste streams are, with some exceptions, generally unknown. Uranium was present in the combined 291-A stack wastes at inventories of 65 to 400 kg per site. These same sites contained inventories of plutonium ranging from 95 to 150 g and fission products ranging from 4.4 to 85 Ci. For the remaining sites, uranium inventories are generally less than 20 kg, plutonium inventories are 5 g or less, and fission products are mostly less than 1 Ci for either cesium or strontium. Other fission products such as cobalt-60 and ruthenium-106 are reported at these sites, sometimes at significant levels, but are expected to have decayed to negligible levels over time. Sodium dichromate was discharged to the ground at the 291-A stack cribs in quantities of 100 to 300 kg. Nitrates were reported for a number of the streams in generally small quantities, and small quantities of other chemicals were associated with a few waste streams. At the 291-A Cribs, considerable quantities of ammonium nitrate and greater than average quantities of nitrates, sodium, and sulfates were reported. Most of the latter materials are not expected to have significant impacts on contaminant movement.

4.21.3 Conceptual Model Summary

Wastewater entering the french drains was discharged at a shallow depth (4 to 6 m [15 to 20 ft]) below the ground surface (Figure 4-24). Most of the radiological contaminants are held in the soil at depths just below the structure itself for plutonium and to 3 to 6 m (10 to 20 ft) below the french drain for cesium and strontium. Uranium is expected to be spread throughout the soil column but is not expected to have reached the groundwater. Minor lateral spreading is possible at the french drain sites, but their generally long periods of operation coupled with low discharge rates indicate a near-vertical zone of saturation.

Decontamination wastes discharged to the 200 West Area trenches are expected to be similar to that for the french drains. The volume of water is generally not known but is assumed to be small. Because most of the trenches were exhumed, only low levels of contaminants are expected to be found at the sites. Because of the greater size of the trenches, the penetration of radionuclides into the soil column is expected to be as limited as for the french drains. However, the possible use of decontamination solutions may have lessened the natural retardation factors of the soil column, and contaminants may be found deeper in the sediments.

The PUREX cribs associated with this group have received significantly more wastewater than pore volume; thus, contamination is expected to be found deeper in the soil column. The higher concentrations of uranium in the waste stream are expected to be concentrated beneath the cribs but will occur at lower concentrations throughout the soil column. Plutonium should be located directly beneath the crib bottom in the three PUREX cribs, but will be hard to detect at the other sites because of the low inventories. Cesium will be found closely grouped with plutonium, while strontium will be spread throughout a greater thickness of soil. Chromium is expected to have migrated through the soil column and to the groundwater. The small quantities discharged amongst the large volume of wastewater are expected to make detection of the chromium in the vadose zone difficult.

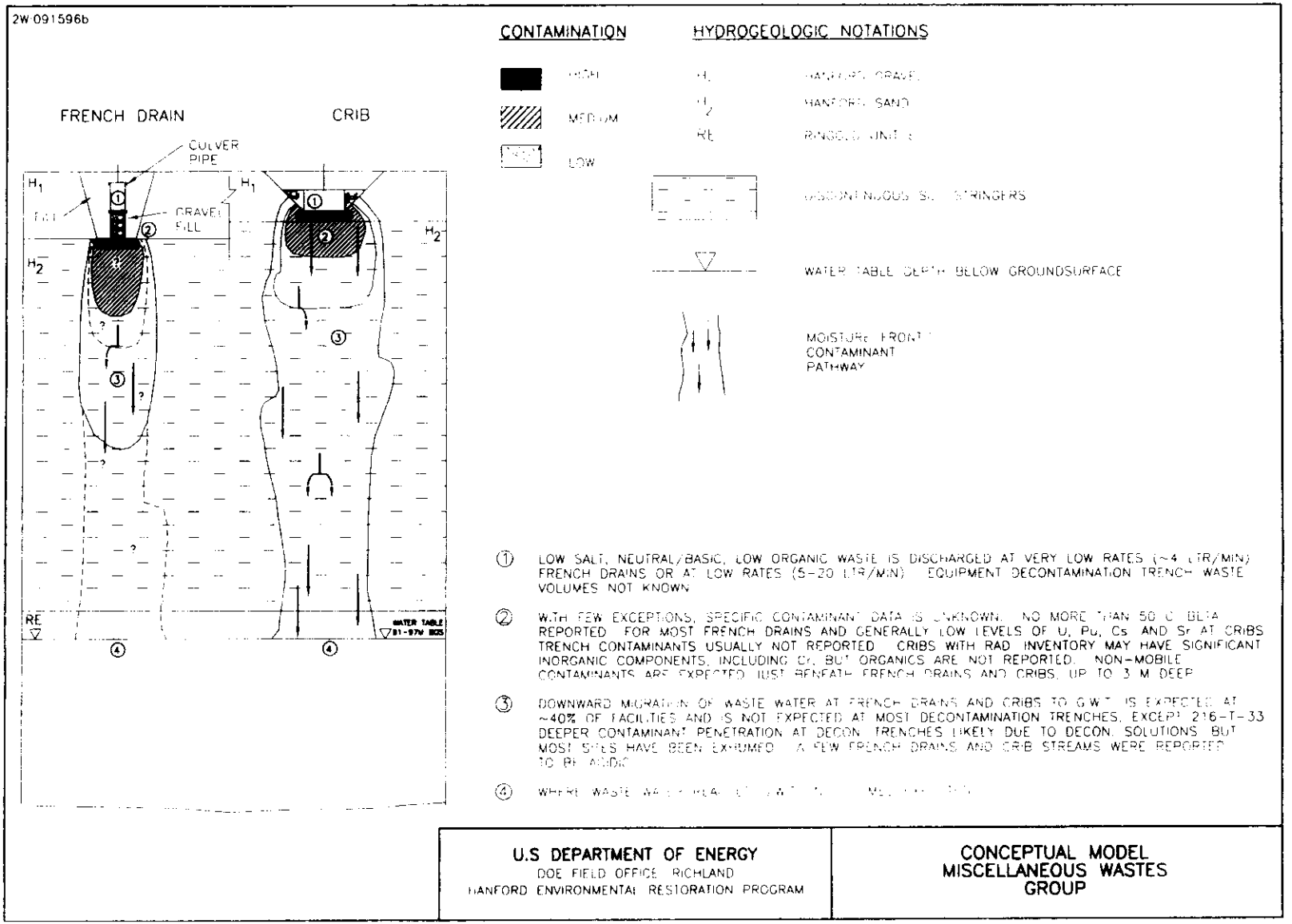
The 216-T-33 Trench was selected as a representative site for equipment decontamination waste streams because of its inventory and high amount of liquid waste. The 216-U-3 French Drain received a low inventory of contaminants and is regarded as an easily characterized site. The 216-A-4 Crib received the highest contaminant inventory of the group and is regarded as a representative site for stack liquid wastes. These selections are summarized in Table 4-3.

4.22 SEPTIC TANKS AND DRAIN FIELDS GROUP

4.22.1 Group Description

This group consists of about 50 active and inactive septic systems designed to receive shower water, kitchen wastewater, janitorial sink wastewater, human sewage, and similar liquid wastes. The sites typically consist of a large-capacity holding tank that overflows to a gravel-filled drain field. Occupied buildings have a dedicated septic tank/drain field or share with an adjacent structure(s). The volume and inventory of waste discharged to these sites is not tracked.

Figure 4-24. Miscellaneous Waste Group Conceptual Model.



There is very little opportunity for radioactive or chemical contamination to reach the soil column through these structures. The only possible routes for contamination are change room shower drains and janitorial sinks. Contamination may be detectable in the receiving sites but will be at very minute levels.

Septic tanks and drain fields have been used from the start of 200 Area operations at the Hanford Site and will continue for the foreseeable future. New septic systems are being built for new office trailers or to replace older existing structures. Although septic systems are one of the few continuing sources of liquids discharged to the soil column, there is little opportunity for discharges from these structures to mobilize contaminants in the ground. Only a few systems were located within 30 m (100 ft) of a soil column disposal facility, and new structures are now being located at generally greater distances. Investigations conducted at the 216-U-1/2 Cribs did not indicate any remobilization of the contaminants from waste received by an adjacent drain field.

A conceptual model has not be developed for this waste site group because the liquid is nonradioactive and nonhazardous.

4.23 TANKS/BOXES/PITS/LINES GROUP

4.23.1 Group Description

Virtually all of the materials associated with separations processing are handled in liquid form. As a result, an extensive network of pipelines encased in closed concrete boxes, diversion boxes, catch tanks, valve pits, retention basins, vaults, and related structures was used to transport process wastes from the separations facilities to the single- and double-shell tanks as well as evaporators. An encased cross-site transfer line connected the 200 East and 200 West Areas. Structures designed to handle high-level radioactive wastes were given the "241" numerical prefix, whereas those structures that handled low-level radioactive wastes were designated as "207" or "216" structures. Most diversion boxes associated with cribs are not labeled and are generally considered to be part of the crib. Only one crib diversion box, the 216-A-524 structure at the 216-A-24 Crib, is reported in WIDS. A large number of the "241" structures located inside the boundaries of the six 200 Area tank farm operable units are not considered in this document. However, it is those "241" structures outside of the tank farm operable units that comprise the waste sites included in the Tanks/Lines/Pits/Boxes Group. Additionally, other facilities (240-, 242-, 243-, 244-) with associated tanks, lines, and diversion boxes or valve pits are considered in this group. The sites in this group are listed in Table A-1, Appendix A. A number of unplanned releases associated with these waste sites are included in this group.

The "216" structures were located near to and used to control/divert flow between parallel waste sites receiving the same low-level waste stream. Alternately, for larger cribs, flow was often routed into lower sections by a parallel crib distribution line. The "207" retention basins were used to temporarily hold large volumes of cooling water or laboratory liquid wastes. When

laboratory analyses verified that the waste met release criteria, the liquid was discharged to the ground. In both cases, these structures have been placed into the same group as the waste site(s) that ultimately received the waste. In addition, the pipelines connecting waste sites to either the facilities or the diversion/control structures are considered to be part of that waste site. A number of Unplanned releases associated with these structures have been grouped accordingly.

The "241" Tanks/Lines/Boxes/Pits located inside the boundary of tank farm operable units are considered to be beyond the scope of this document but are listed in Table B-1, Appendix B. The structures and associated releases placed in the Tanks/Lines/Boxes/Pits Group are discussed in this document for completeness and to ensure that all sites that may be addressed in the future are covered. Conceptual models have not been developed for this group because, except for unplanned releases, there is no characteristic release of contaminants. Responsibility for cleanup of most units is unclear, except where already agreed to. Many of the "241" structures may be used as part of the tank farm cleanup. Any "241" structures close to any characterization/ remediation sites need to be considered in the appropriate plans. The 241-CX-70 and 241-Z-TK-D5 Tanks are RCRA TSD units.

4.24 UNPLANNED RELEASES GROUP

4.24.1 Group Description

Unplanned releases are liquid spills to the ground surface or subsurface or airborne releases of particulate matter to the ground surface. The early definition of an unplanned release was exclusively a release of radioactive material. These releases were given site numbers beginning with the prefix UPR. More recently, releases of nonradiological, hazardous materials have also become part of the criteria defining unplanned releases. New releases, whether radiological or hazardous, are usually cleaned up shortly after they occur. Those not cleaned up are numbered, submitted to the WIDS database as a "Discovery Item," and evaluated for acceptance as waste sites. The numbers assigned to recent unplanned releases no longer include the UPR prefix.

Many of the 283 unplanned release sites in the 200 Areas resulted from the spread of highly radioactive liquids from waste transfer pipeline, process facilities, or tank farms. Less frequently, liquid waste sites and burial grounds were the locales where a release of usually less contaminated liquids or solids started or ended. Causes for the releases were attributed to administrative or equipment failures or to operator error. Many of the unplanned releases are either not posted or are currently tracked under Radiation Area Remedial Action (RARA) Program activities because of radionuclide decay of the contaminants, physical removal or cleanup of the site, or they are located within other waste site boundaries and are not individually distinguishable. However, all of the unplanned releases are documented and tracked in the WIDS database.

For this document, unplanned releases have been linked to waste sites and site groups in one of three ways. In all cases, it is recognized that an unplanned release has a location or facility at which the waste originated and a location where it was released. Where a release/spill contaminated the ground either within a facility (burial ground, tank farm, or crib) or adjacent to

the facility boundary, that unplanned release has been tied to that structure. Table C-1, Appendix C lists unplanned releases by their location description and contamination source. In many cases, the contamination source is unknown. Characterization and remediation strategies will need to rely on historical information and process knowledge to make assumptions where documentation is lacking.

- Unplanned releases in which liquid/solid was sent to a crib, pond, retention basin, ditch, or burial ground are grouped with the receiving waste site. The inventory from that release may or may not have been reported in the waste site's inventory. Also, incidents resulting from a spill or process upset at a liquid or solid waste facility are similarly linked to that site in its grouping. Approximately 15 documented releases clearly increased the inventory of related waste sites, and an additional 34 can be connected to waste sites.

- The unplanned releases associated with tank farm operable units are listed with the "241" structures in Appendix B. Releases from single-shell tank leaks, spills at diversion boxes, or line leaks inside the tank farm operable unit boundaries are placed here.

- Unplanned releases such as liquid spills, stack particulate fallout, and contamination migration caused by plant radionuclide uptake or animal intrusion at unknown locations are placed in the Unplanned Releases Group. The majority of the documented unplanned releases are of this type. Unplanned releases from underground radioactive transfer lines are described as releases to the ground. However, difficulties were encountered in relating the release locations to a specific structure based on available information, especially when the release occurred near a tank farm fenceline. A number of unplanned releases in this group may be linked to structures in the Tanks/Lines/Boxes/Pits Group with further research.

Forty-nine unplanned releases are associated with liquid waste sites (cribs, ponds, french drains) or solid waste burial grounds. Some of the unplanned releases remained within the source site boundary, but some also contaminated the ground surface adjacent to the source site boundary. Eighty-eight unplanned releases are associated with tank farm activities. Fifty-five unplanned releases are located within the tank farm site boundaries, and the others contaminated the ground adjacent to the fenceline. The remaining 146+ unplanned releases are related to general operations in the 200 East and 200 West Areas or are located in the 600 Area. Twenty-five unplanned releases are tracked by the RARA program. The RARA list includes unplanned release sites that have been surface stabilized and receive regular surveillance inspections. These unplanned release sites are physically marked and posted with proper radiological and hazard warning signs and are listed in Table A-1, Appendix A.

Because of the variety of spills and releases, conceptual models will not be developed for any of the unplanned releases. Unplanned releases do not impact the development of conceptual models because a release at a site should not affect the whole group's model. Unplanned releases have been used to select representative sites within this document's preceding waste site groups.

Specific release inventories for unplanned releases are not available. In general, most unplanned releases discharged wastes with higher concentrations to sites or areas of little or no contamination. For most liquid releases, the spill consisted of high-level process solutions or tank wastes escaping from individual tanks, diversion boxes, or pipelines, either by leaks or overflow of the vessel. As such, the wastes would be highly radioactive with fission products, uranium, and/or plutonium and would be rich in inorganic and/or organic chemicals. For stack releases or releases from collapsing burial ground boxes, particulate contamination would become airborne and would fall both inside and outside the burial ground or adjacent to the stack on previously uncontaminated ground.

5.0 GROUP PRIORITIZATION AND REPRESENTATIVE WASTE SITES

The prioritization criteria and process described in the 200 Areas Soil Remediation Strategy (DOE-RL 1996a) were used to develop priority rankings for each waste site group. The criteria included impacts to groundwater, the presence of mobile and/or long-lived contaminants at the waste site, the current level of understanding of site process streams and contaminant migration behavior, and site locations with respect to 200 Area Plateau boundaries. Also included in the prioritization criteria were factors addressing the ease of characterization and remediation allowing progress to be made expeditiously and whether the group was suitable for testing of promising technologies. Each criterion was given a weighted score ranging from low to high; low received 1 point and high received 5 points or zero when the criterion was not applicable. The assigned scores were summed to establish a ranking for the waste site groupings. The results are summarized in Table 5-1. Table 5-2 lists the prioritized sites in descending order, along with the scores for each.

5.1 GROUNDWATER IMPACTS

The prioritization criteria for impacts to groundwater included past, present, and future impacts; the future impacts criteria was weighted high, the present impact criteria was weighted medium, and the past impacts weighted low. The evaluation of the groupings for past impacts was based on both the volume of liquid released to the waste site and the inventory of contaminants within that volume of waste. If the volume of waste was less than the pore volume of the soil column (see Appendix A), past impact to groundwater was considered to have not occurred. If the waste volume was equal to or greater than the pore volume, the potential existed, and the inventory data were reviewed to determine whether any significant mobile contaminants were present. Past impacts were designated only for eight of the waste site groups. The Scavenged Waste Group had two specific retention cribs where geophysical data suggested contamination had reached groundwater in the past; thus, this group was designated as having impacted groundwater.

The current impact evaluation focused on plumes above the drinking water standards that are known to exist and are attributable to a group of sites. Only three groups (the Uranium-Rich and the Plutonium-Rich Process Condensate/Process Waste Groups and the Scavenged Waste Group) were identified as having current impacts. Where no present groundwater impacts were identified and no rationale existed for future impacts, the groupings were not listed as having potential future impacts. The only current impact groups that are considered to have potential for future impacts are the Plutonium/Organic-Rich Process Condensate/Process Waste Group and the Scavenged Waste Group because of groundwater plumes associated with some of the facilities. At the 200-UP-1 Operable Unit, the pump-and-treat program is successfully removing uranium and technetium-99 such that no future impacts are anticipated. A pump-and-treat program at the 200-ZP-1 Operable Unit is extracting carbon tetrachloride, chloroform, and trichloroethylene originally released at cribs within the Plutonium/Organic-Rich Process Condensate/Process Waste Group. The quantities and chemical behavior of the carbon tetrachloride associated with this group are expected to have long-term impacts on groundwater.

Table 5-1. Waste Site Group Prioritization Ratings. (sheet 1 of 3)

Specific Criteria	Criteria Ranking	Uranium-Rich Process Waste (Section 4.2)	Plutonium Process Waste (Section 4.3)	Plutonium/ Organic-Rich Process Waste (Section 4.4)	Organic-Rich Process Waste (Section 4.5)	Fission Product-Rich Process Waste (Section 4.6)	General Process Waste (Section 4.7)	Tank Waste (Section 4.8)	Scavenged Waste (Section 4.9)
Groundwater has been impacted in the past.	Low	1	0	1	0	0	0	0	1
Groundwater is presently being impacted.	Medium	3	0	3	0	0	0	0	3
Groundwater will be impacted in the immediate future (5 to 10 years).	High	0[a]	0	5	0	0	0	0[b]	5
Mobile contaminants (versus less mobile contaminants) are present.	Medium-high	4	0	4	0	0	0	4	4
Driving forces exist that are external to the waste sites (within 100 ft of site).	Low	0?	0?	0?	0?	0?	0?	0?	0?
Characterization information, including historical data, is limited or nonexistent.	Medium	0	0	0	3	0	0	3	0
The chemistry-promoting contaminant migration (increasing mobility) is poorly understood.	Medium-high	0	0	4	4	0	0	0	0
Good representative sites (maximum number of sites addressed) are available. (Number of representative sites/total number of sites in group)	High	2[c] (4/23)	1 (2/6)	2[d] (2/8)	1 (3/10)	2 (2/8)	4 (1/14)	4[e] (3/28)	5 (2/34)[f]
Long-lived (versus short-lived) contaminants are present.	Low	1	1	1	1	1	1	1	1
Sites pose a current risk (surface threat); assumes Radiation Area Remedial Action Program provides short-term action to lower its priority.	Low	0	0	0	0	0	0	0	1
Low levels of contamination are expected over a large area.	Medium	0	0	0	0	0	0	0	3
Sites are located near perimeter of plateau/outside the 200 Area fencelines (versus inside the fenceline).	Medium	0	0	0	0	0	0	0	3
Easier (versus more difficult) to characterize and/or remediate.	High	0	0	0	0	0	0	0	5
Suitable for testing promising technologies.	Medium	3	0	3	3	0	0	0	0
Overall Numerical Score		14	2	23	12	3	5	10	28

NOTE: Rating Criteria Scoring: Low Yes = 1, Medium Yes = 3, Medium-High Yes = 4, High Yes = 5; No = 0; NR = Not Rated
[a]Remnant uranium in groundwater.
[b]Immobile 216-B-5 contaminants not included.
[c]Two sites, 216-U-1/2 and 216-U-8, already characterized.
[d]Four sites, 216-Z1A, 216-Z-9, 216-Z-12, and 216-Z-18, have been characterized.
[e]One site, 216-B-5, has been characterized.
[f]Additional 200-BP-1 sites also characterized but not counted as representative sites.

Table 5-1. Waste Site Group Prioritization Ratings. (sheet 2 of 3)

Specific Criteria	Criteria Ranking	Steam Condensate (Section 4.10)	Chemical Sewer (Section 4.11)	U-Pond/ Z-Ditches Cooling Water (Section 4.12)	Gable Mt./ B-Pond and Ditch Cooling Water (Section 4.13)	200 North Pond Cooling Water (Section 4.14)	S-Ponds/ Ditches Cooling Water (Section 4.15)	T-Ponds/ Ditches Cooling Water (Section 4.16)
Groundwater has been impacted in the past.	Low	1	0	1	1	0	1	1
Groundwater is presently being impacted.	Medium	0	0	0	0	0	0	0
Groundwater will be impacted in the immediate future (5 to 10 years).	High	0	0	0	0	0	0	0
Mobile contaminants (versus less mobile contaminants) are present.	Medium-high	4	4	4	4	4	4	4
Driving forces exist that are external to the waste sites (within 100 ft of site).	Low	0?	0?	0?	0?	0?	0?	0?
Characterization information, including historical data, is limited or nonexistent.	Medium	0	3	0	0	0	0	0
The chemistry-promoting contaminant migration (increasing mobility) is poorly understood.	Medium-high	0	4	0	0	0	0	0
Good representative sites (maximum number of sites addressed) are available. (Number of representative sites/total number of sites in group)	High	2 (2/11)	1 (2/6)	1[g] (3/9)	4 (2/21)	3 (1/7)	3 (1/7)	3 (1/7)
Long-lived (versus short-lived) contaminants are present.	Low	1	1	1	1	1	1	1
Sites pose a current risk (surface threat); assumes Radiation Area Remedial Action Program provides short-term action to lower its priority.	Low	0	0	0	0	0	0	0
Low levels of contamination are expected over a large area.	Medium	0	3	3	3	3	3	3
Sites are located near perimeter of plateau/outside the 200 Area fencelines (versus inside the fenceline).	Medium	0	3	0	3	3	3	0
Easier (versus more difficult) to characterize and/or remediate.	High	0	5	5	5	5	5	5
Suitable for testing promising technologies.	Medium	0	0	0	0	0	0[h]	0
Overall Numerical Score		8	24	15	20	19	20	17

NOTE: Rating Criteria Scoring: Low Yes = 1, Medium Yes = 3, Medium-High Yes = 4, High Yes = 5; No = 0; NR = Not Rated
[g]All selected sites characterized; 216-U-10 Pond, 216-U-14 Ditch, and 216-Z-1D/216-Z-11.
[h]Buried asphalt cover for 216-S-16 Pond as a possible study for barrier stabilization data.

Table 5-1. Waste Site Group Prioritization Ratings. (sheet 3 of 3)

Specific Criteria	Criteria Ranking	200 Area Chemical Laboratory (Section 4.17)	300 Area Chemical Laboratory (Section 4.18)	Radioactive Landfills and Dumps (Section 4.19)	Nonradio-active Landfills and Dumps (Section 4.20)	Miscellan-eous Waste (Section 4.21)	Septic Tanks and Drain Fields (Section 4.22)	Tanks/ Boxes/Pits/ Lines (Section 4.23)	Unplanned Releases (Section 4.24)
Groundwater has been impacted in the past.	Low	0	0	0	0	0	NR	NR	NR
Groundwater is presently being impacted.	Medium	0	0	0	0	0	NR	NR	NR
Groundwater will be impacted in the immediate future (5 to 10 years).	High	0	0	0	0	0	NR	NR	NR
Mobile contaminants (versus less mobile contaminants) are present.	Medium-high	0	0	0	0	0	NR	NR	NR
Driving forces exist that are external to the waste sites (within 100 ft of site).	Low	0?	0?	0?	0?	0?	NR	NR	NR
Characterization information, including historical data, is limited or nonexistent.	Medium	3	3	0[i]	0[j]	3	NR	NR	NR
The chemistry-promoting contaminant migration (increasing mobility) is poorly understood.	Medium-high	0	4	0	0	4	NR	NR	NR
Good representative sites (maximum number of sites addressed) are available. (Number of representative sites/total number of sites in group)	High	4 (2/18)	2 (2/8)	4[i] (3/35)	5 (2/35)	4 (3/42)	NR	NR	NR
Long-lived (versus short-lived) contaminants are present.	Low	1	1	1	1[j]	0	NR	NR	NR
Sites pose a current risk (surface threat); assumes Radiation Area Remedial Action Program provides short-term action to lower its priority.	Low	0	0	0	0	0	NR	NR	NR
Low levels of contamination are expected over a large area.	Medium	0	0	0	0	0	NR	NR	NR
Sites are located near perimeter of plateau/outside the 200 Area fencelines (versus inside the fenceline).	Medium	0	3	0	0[k]	0	NR	NR	NR
Easier (versus more difficult) to characterize and/or remediate.	High	0	5	0	0	5	NR	NR	NR
Suitable for testing promising technologies.	Medium	0	0	3	3	0	NR	NR	NR
Overall Numerical Score		8	18	8	9	16	NR	NR	NR

NOTE: Rating Criteria Scoring: Low Yes = 1, Medium Yes = 3, Medium-High Yes = 4, High Yes = 5; No = 0; NR = Not Rated
[i]No field evidence for contaminant migration into soil column.
[j]Choose three sites: TRU Caisson, High Rad Burial Ground and Typical Burial Ground; or by years of operation, e.g., 1950's, 1960's, 1970's.
[k]Solid Waste Landfill and Nonradioactive Dangerous Waste Landfill are excluded.

Table 5-2. Waste Group Prioritization.

Waste Group	Prioritization Score
Scavenged Waste Group (Section 4.9)	28
Chemical Sewer Group (Section 4.11)	24
Plutonium/Organic-Rich Process Waste Group (Section 4.4)	23
Gable Mtn/B-Pond & Ditches Cooling Water Group (Section 4.13)	20
S-Ponds/Ditches Cooling Water Group (Section 4.15)	20
200 North Pond Cooling Water Group (Section 4.14)	19
300 Area Chemical Laboratory Waste Group (Section 4.18)	18
T-Ponds/Ditches Cooling Water Group (Section 4.16)	17
Miscellaneous Waste Group (Section 4.21)	16
U-Pond/Z-Ditches Cooling Water Group (Section 4.12)	15
Uranium-Rich Process Waste Group (Section 4.2)	14
Organic-Rich Process Waste Group (Section 4.5)	12
Tank Waste Group (Section 4.8)	10
Nonradioactive Landfills and Dumps Group (Section 4.20)	9
Steam Condensate Group (Section 4.10)	8
200 Area Chemical Laboratory Waste Group (Section 4.17)	8
Radioactive Landfills and Dumps Group (Section 4.19)	8
General Process Waste Group (Section 4.7)	5
Fission Product-Rich Process Waste Group (Section 4.6)	3
Plutonium Process Waste Group (Section 4.3)	2
Septic Tanks and Drain Fields Group (Section 4.22)	Not ranked
Tanks/Boxes/Pits/Lines Group (Section 4.23)	Not ranked
Unplanned Releases Group (Section 4.24)	Not ranked

A vapor extraction program at the 200-ZP-2 Operable Unit is also treating carbon tetrachloride in the vadose zone.

The Scavenged Waste Group includes the 216-BY Cribs, which have historically released a plume of technetium, cobalt, cyanide, and nitrate to the groundwater. Although that plume continues to migrate north, wells at the 216-BY Cribs site also have high levels of technetium in the groundwater, indicating a continuing source. The long half-life of technetium and the elevated concentrations in the plume indicate the potential for continuing exceedance of the drinking water standards. A treatability test was conducted at the 200-BP-5 Groundwater Operable Unit that targeted both the 216-BY Cribs plumes and a strontium-90/cesium-137/ plutonium-239,240 plume around the 216-B-5 Reverse Well. Because of the K_d factor associated with the latter plume, no risk to human health or the environment was anticipated in 200 years (BHI 1995). Appendix D depicts current groundwater plumes in the 200 Areas based on maximum contaminant level contours.

The inventory table in Appendix A was also reviewed to establish which groups had mobile contaminants (uranium, technetium, nitrates, and sodium dichromate). Eleven groups were considered to have mobile contaminants. The presence of an external driving force (defined as a source of water recharge from man-made systems within 30 m [100 ft] of the waste site) was not identified for any of the groups.

5.2 CHARACTERIZATION INFORMATION AND CHEMISTRY KNOWLEDGE

As discussed in Section 1.0, the waste site groupings and conceptual models were established using predominantly historical information based on process knowledge. When the prioritization criteria were developed, there was a concern that some groups may need to be ranked higher in priority. The concern also existed that once the chemical processes were reviewed, there could be a potential for unique chemistry for some sites that could change the mobility of contaminants within the vadose zone. In applying these criteria, both criteria were considered applicable to only four groups (Organic-Rich Process Waste/Process Condensate Group, Chemical Sewer Group, 300 Area Chemical Laboratory Waste Group, and Miscellaneous Waste Group). These groups were selected because of the complexity and the limited information available regarding what was actually disposed at the waste sites. For the Organic-Rich Process Waste/Process Condensate Group, very limited data are available to indicate the effect of organics on radionuclide mobilization. For the Chemical Sewer Group, the 300 Area Chemical Laboratory Waste Group, and the Miscellaneous Waste Group, information is very limited or not found regarding the constituents and characteristics of the wastes discharged to the ground. Additional literature searches may be needed. For the Miscellaneous Waste Group, many of the sites were not sampled, and a qualitative contaminant list can only be developed from process knowledge. Four other groups (Plutonium/Organic-Rich Process Condensate/Process Waste Group, Tank Waste Group, Scavenged Waste Group, and 200 Areas Chemical Laboratory Waste Group) were identified as having one of the criterioa applicable. The lack of chemistry knowledge applied to the Plutonium/Organic-Rich Process Waste/Process Condensate Group because of the uncertainty in the effect that the organics have in the mobility of the radionuclides. The lack of characterization criteria was applicable to the other three groups because of the lack of

information on the multiple streams that have been introduced to the waste sites within these groups.

5.3 IMPLEMENTABILITY AND PROGRESS

Several criteria were developed to prioritize sites that will maximize use of resources or at which an action can be performed in a safe and cost-efficient manner. Groups received a higher priority if (1) contamination was at low levels near the surface, (2) sites were located outside the 200 Area fencelines, or (3) sites were easier to characterize and/or remediate. Five groups were identified as meeting all three criteria. In general, the Gable Mountain/B-Pond, S-Pond, and 200 North Pond Cooling Water Groups lay outside the 200 Area fencelines, had low amounts of contaminants spread over broad areas, and were regarded as easier to characterize because the collection of data through the use of test pits rather than deep boreholes was considered to be applicable. The Scavenged Waste Group and the Steam Condensate Waste Group met these same three criteria. The U Pond and T Pond Cooling Water Groups and the 300 Area Chemical Laboratory Waste Group met two of the three criteria but are located inside the 200 Area fenceline. The Miscellaneous Waste Group met the easier-to-characterize criterion (test pits versus drilling characterization) because most sites are relatively small and contamination is expected to be located near the surface.

Another important consideration to implementability and progress was the representative sites covered a larger number of sites as addressed in the criterion, good representative sites. A graded scoring method has been developed for this prioritization criterion. The scoring rates each waste group based on the number of representative waste management units required to adequately represent the total number of waste management units in each group. The groups rated highest for this criterion are those at which characterization of only one or two sites is considered to be sufficient for a group containing many waste sites. Groups with a ratio of 1:15 or above were given a score of 5 points, sites with a ratio above 1:9 were given a score of 4 points, sites with a ratio of 1:6 or greater were given a score of 3 points, sites with a ratio of 1:4 to 1:5.75 were given a score of 2 points, and sites with smaller ratios were given a score of 1 point. This divided the range of ratios into five approximately equal populations.

5.4 OTHER CONSIDERATIONS

Three criteria (long-lived contaminants, current surface threat, and technology testing) addressed other considerations that are considered important to the ranking process. Sites with the presence of long-lived contaminants should be prioritized over sites with only short-lived contaminants, sites that pose a current surface threat should be considered before sites that do not pose a surface threat, and sites that may aid in the development of alternative technologies should be ranked higher than sites that may not. Applying these first two criteria resulted in little or no changes in the overall priorities (all but one group had the same ranking for each criterion), and applying the third criterion resulted in the identification of five groups that may be used for technology development. These technology development opportunities relate to testing of alternative

characterization techniques, testing of immobilization of deep contamination, and testing of technologies for removal of organic contamination from the vadose zone.

In summary, both the groundwater impacts and implementability criteria are applicable to the highest ranked group, the Scavenged Waste Group. However, the next two priority groupings scored very close to the Scavenged Waste Group. The Chemical Sewer Group was ranked second highest because of the lack of knowledge regarding process information and poor understanding of contaminant migration coupled with the disposal to more easily characterized ditches and ponds. The Plutonium/Organic-Rich Process Condensate/Process Waste Group was ranked next highest because of the groundwater impacts and the potential for testing alternate technologies to remove the carbon tetrachloride. Sites within this group are being remediated. The five cooling water groups were rated next in priority because of the relative ease of characterizing the surface liquid waste disposal sites and their locations, generally outside of the 200 Area fencelines. The rating for the 300 Area Chemical Laboratory Waste Group was in the same range as the cooling water groups because of the lack of knowledge of process chemistry and contaminant migration controls in the soil column. Because of the waste's presumed shallower depth in specific retention facilities, the 300 Area Chemical Laboratory Group waste sites are also considered to be more easily characterized by nondrilling techniques. The remaining 11 groups had a mix of criteria that were applicable to the groupings, and these groupings clearly fall below the 9 groupings previously discussed.

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APPENDIX A

WASTE SITE/CATEGORY GROUPINGS

APPENDIX A
WASTE SITE/CATEGORY GROUPINGS

Table A-1 presents the liquid or solid waste receiving sites and ancillary structures in the waste site groups discussed in Section 4.0. The table presents known inventories of important radionuclides, key inorganic chemicals, and the known organic chemicals released to the ground. The chemical and radiological inventory was selected from a broader suite of data based on the importance of the contaminants to either human health or the environment. As a result, radionuclides such as tritium and iodine-129 were not considered for inclusion. Likewise, a broader suite of inorganic chemical inventory was not included in this table. This information has been noted in those sections where larger quantities of inorganic compounds are known.

The table also reports data based on aggregate area management study (AAMS) reports, in cubic meters, for the volumes of liquid waste received by the sites as well as the calculated volume of soil column pore volume beneath the waste sites. These latter data were presented in Table 2-6 of the AAMS reports as a range of pore volumes based on 10% and 30% porosity. At a conservative 10% porosity calculation, a majority of the sites were identified as potentially affecting the groundwater. This document has used the 30% value as more representative of natural soil column conditions, especially in the geologically young Hanford formation. The purpose of providing these data is to clearly demonstrate those sites that have had liquid releases that contributed significant quantities of liquid wastes to the vadose zone and, potentially, to the groundwater. Although not presented, ratios of the liquid waste volume divided by the soil column pore volume are easily computed, and the magnitude of soil column flooding can be better visualized. These data are the basis for conceptual model development where high volumes of liquid waste received are expected to have produced greater spreading of contaminants in the soil column.

Inventory information provided in Table A-1 was taken from the eight 200 Area Source AAMS reports and has been augmented with data from Maxfield (1979). Radionuclide inventory calculations were decayed by the AAMS reports through 1989, unless otherwise noted in those references.

Table A-1. Waste Site/Category Groupings. (sheet 1 of 12)

Site	OU	Total U (Kg)	Total Pu (gm)	Am-241 (Ci) (a)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (Kg)	Ferro-cyanide (Kg)	Hexone (Kg)	Nitrate (Kg)	NPH (Kg)	$Na_2Cr_2O_7$ (Kg)	TBP (Kg)	Effluent Volume (m^3)	Pore Volume (m^3)	TPA App C Rev 4	Notes
Uranium-rich Process Condensate/Process Waste Group (4.2)																	
216-A-1	PO-5	1.53E+02	1.00E-01	-	4.44E-02	4.22E-02	-	-	-	80	-	-	-	96	1980	Y	
216-A-3	PO-2	1.66E+03	2.00E-01	-	4.55E-02	4.31E-02	-	-	-	-	-	-	-	3050	952	Y	
216-A-5	PO-2	2.61E+02	6.50E+01	-	1.21E+01	4.16E+01	-	-	-	1000000	-	-	-	1630049	2925	Y	
216-A-10	PO-2	2.41E+02	3.50E+02	7.73E-01	8.05E+01	8.25E+01	-	-	-	-	-	-	-	3210096	28072	Y	
216-A-18	PO-5	1.39E+03	1.00E-01	-	4.44E-02	4.20E-02	-	-	-	730	-	-	-	488	13050	Y	
216-A-19	PO-5	3.87E+04	1.00E-01	-	4.44E-02	4.20E-02	-	-	-	20000	-	-	-	1100	1232	Y	
216-A-20	PO-5	4.01E+02	1.00E-01	-	4.44E-02	4.20E-02	-	-	-	210	-	-	-	961	1274	Y	
216-A-28	PO-2	6.27E+02	-	-	-	-	-	-	-	300	-	-	-	30	191	Y	
216-A-36A/B	PO-2	2.62E+02	2.58E+02	2.17E-01	1.20E+03	1.31E+03	-	-	-	-	350	178	0.0569	318080	16327	Y	
216-B-12	BP-9	2.10E+04	3.74E+02	-	7.16E+02	7.93E+01	-	-	-	-	-	-	-	520000	18300	Y	
216-B-60	BP-6	7.20E+02	-	-	-	-	-	-	-	-	-	-	-	18.9	438	Y	
216-C-1	SO-1	3.00E+02	6.00E+00	-	4.55E-02	8.55E+01	-	-	-	-	-	-	-	23400	785	Y	
216-S-1&2	RO-2	2.25E+03	1.20E+03	-	1.10E+03	1.25E+03	-	-	-	60000	-	-	-	160000	6020	Y	
216-S-7	RO-2	2.56E+03	4.40E+02	-	7.03E+02	1.39E+03	-	-	-	110000	-	-	-	390000	8361	Y	
216-S-8	RO-2	1.93E+02	2.00E+00	-	4.92E+00	3.86E-01	-	-	-	100	-	-	-	10000	10033	Y	
216-U-1&2	UP-2	4.00E+03	4.26E+01	-	4.36E+00	2.11E+00	-	-	-	1200000	-	-	-	46200	400	Y	
216-U-5	UP-2	3.63E+02	-	-	-	-	-	-	-	200	-	-	-	4500	3300	Y	
216-U-6	UP-2	3.63E+02	-	-	-	-	-	-	-	200	-	-	-	4500	3300	Y	
216-U-8	UP-2	2.39E+04	3.70E+02	-	4.55E-02	4.31E-02	-	-	-	-	-	-	-	379000	11100	Y	
216-U-12	UP-2	2.01E+03	1.00E+00	6.45E-03	5.66E-02	5.59E+01	-	-	-	-	-	-	-	150000	1400	Y	
241-U-361	UP-2	4.00E+03	-	-			-	-	-	-	-	-	-	-	-	Y	
270-E CNT	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
270-W	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-64	BP-9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	270-E CNT
UPR-200-W-19	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	216-U-1&2
UPR-200-W-36	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-S-1&2
UPR-200-E-39	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	216-A-36B
UPR-200-E-40	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	216-A-36B
Plutonium-rich Process Condensate/Process Waste Group (4.3)																	
216-Z-4	ZP-2	5.00E-02	2.00E+00	-	3.50E-02	3.30E-02	-	-	-	-	-	-	-	11	165	Y	
216-Z-5	ZP-2	5.00E-02	3.40E+02	-	3.60E+00	1.70E+00	-	-	-	100000	-	-	-	31000	480	Y	
216-Z-6	ZP-2	5.00E-02	5.00E+00	-	3.50E-02	3.30E-02	-	-	-	130	-	-	-	96	540	Y	
216-Z-8	ZP-2	-	2.00E+00	1.37E+03	-	-	-	-	-	-	-	-	-	10	11	Y	
216-Z-10	ZP-2	-	5.00E+01	1.00E+00	-	-	-	-	-	100	-	-	-	1000	1	Y	
241-Z-TK-8	ZP-2	-	1.60E+03	-	-	-	-	-	-	-	-	-	-	-	-	Y	
Plutonium/Organic-rich Process Condensate/Process Waste Group (4.4)																	
216-T-19	TP-2	-	1.44E+01	9.82E-03	1.75E+01	2.78E+01	1406	-	-	150000	-	-	-	455000	12506	Y	
216-Z-1&2	ZP-2	8.03E+01	7.00E+03	-	4.00E-02	3.70E-02	UNK	-	-	100000	-	-	-	-	660	Y	
216-Z-1A	ZP-2	-	5.70E+04	3.43E+03	1.60E-01	1.50E-01	268000	-	-	3000	-	-	30000	5310	44100	Y	DBBP 20,300 Kg
216-Z-3	ZP-2	5.00E-02	5.70E+03	-	4.80E-02	4.50E-02	-	-	-	600000	-	-	-	178000	435	Y	
216-Z-9	ZP-2	5.00E-02	4.80E+04	8.58E+03	5.20E-02	4.90E-02	471000	-	-	500000	-	-	-	4090	2505	Y	
216-Z-12	ZP-2	5.00E-02	2.50E+04	-	5.30E-02	5.10E-02	UNK	-	-	900000	-	-	-	281000	1500	Y	
216-Z-18	ZP-2	-	2.30E+04	-	-	-	173800	-	-	500000	-	-	22000	3860	11340	Y	DBBP 15,000 Kg
241-Z-361	ZP-2	-	7.50E+04	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-103	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-Z-18
UPR-200-W-110	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-Z-1, RARA
Organic-rich Process Condensate/Process Waste Group (4.5)																	
216-A-2	PO-2	7.73E+01	1.30E+02	-	1.45E+00	9.21E-01	-	-	-	-	120000	-	70000	230	921	Y	
216-A-7	PO-5	6.74E+00	1.00E+00	-	2.31E+00	4.31E-01	-	-	-	-	180000	-	100000	326	220	Y	
216-A-8	PO-5	3.68E+02	5.00E+01	-	5.22E+02	5.15E+01	-	-	-	-	46000	-	-	1150035	35241	Y	
216-A-24	PO-5	4.97E+01	5.06E+00	-	2.68E+02	1.83E+01	-	-	-	-	30000	-	-	820025	54001	Y	
216-A-31	PO-2	2.03E+01	9.00E+00	-	8.20E+01	1.05E+00	-	-	-	-	5200	-	2900	10	1701	Y	
216-A-524	PO-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-C-4	SO-1	3.40E+00	1.00E+00	-	4.33E-02	1.18E+01	-	-	-	-	-	-	-	170	484	Y	
216-S-13	RO-2	8.92E+01	8.00E+00	-	2.77E+00	2.04E-02	-	-	10000	10000	-	10000	-	5000	2676	Y	
216-S-14	RO-3	-	-	-	-	-	-	-	-	0	-	-	-	-	-	Y	
216-U-15	UP-2	2.25E+00	1.00E-01	-	4.65E-02	4.42E-02	-	-	40000	-	-	-	13000	68	560	Y	
UPR-200-E-18	PO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	216-A-8
Fission Product-rich Process Condensate/Process Waste Group (4.6)																	
216-B-11A&B	BP-4	1.40E+01	4.00E+00	-	2.13E+01	2.01E+00	-	-	-	-	-	-	-	29600	169.2	Y	

(a) Americium-241 is present as a radioactive decay product for any site with a plutonium inventory. AM 241 values reported where analytical data is available

Page 1

Table A-1. Waste Site/Category Groupings. (sheet 2 of 12)

Site	OU	Total U (Kg)	Total Pu (gm)	Am-241 (Ci) [a]	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (Kg)	Ferro-cyanide (Kg)	Hexone (Kg)	Nitrate (Kg)	NPH (Kg)	$Na_2Cr_2O_7$ (Kg)	TBP (Kg)	Effluent Volume (m^3)	Pore Volume (m^3)	TPA App C Rev 4	Notes
216-B-50	BP-1	2.90E-01	2.39E-01	-	5.12E+01	3.39E+00	-	-	-	1500	-	-	-	54800	9685	Y	
216-B-57	BP-1	6.90E-01	1.87E-01	-	2.26E+02	1.83E+00	-	-	-	-	-	-	-	84400	5775	Y	
216-B-62	BP-9	2.75E+00	7.55E-01	1.03E-01	1.35E+02	7.46E+01	-	-	-	-	-	-	-	282000	11580	Y	
216-C-6	SO-1	5.00E-02	1.00E-01	-	4.65E-02	2.88E+01	-	-	-	-	-	-	-	530	484	Y	
216-S-3	RO-2	2.90E-01	5.00E-01	-	2.19E+01	4.14E-01	-	-	-	9	-	2	-	4200	334	Y	
216-S-9	RO-2	3.27E+01	6.50E+01	-	2.90E+02	9.63E+01	-	-	-	0	-	-	-	50300	15050	Y	
216-S-21	RO-1	4.16E+00	-	-	8.80E+01	-	-	-	-	-	-	-	-	87100	3500	Y	
General Process Condensate and Process Waste Group (4.7)																	
207-A-SOUTH	PO-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-A-34	PO-5	-	-	-	-	-	-	-	-	-	-	-	-	-	11990	Y	
216-A-37-1	PO-4	3.24E+01	2.83E-02	3.69E-04	9.47E-02	5.42E-02	-	-	-	600	-	-	-	377011	15879	Y	
216-A-45	PO-2	6.69E+00	-	1.10E-01	9.70E-03	8.34E-03	-	-	-	-	-	-	-	103003	58074	Y	
216-C-3	SO-1	4.50E+01	1.00E+00	-	4.24E-02	8.04E+00	-	-	-	-	-	-	-	5000	1211	Y	
216-C-5	SO-1	5.40E+01	1.00E+00	-	4.44E-02	4.20E+00	-	-	-	-	-	-	-	38	484	Y	
216-C-7	SO-1	1.00E-02	1.10E+00	-	5.34E-02	5.12E-02	-	-	-	-	-	-	-	60	967	Y	
216-C-10	SO-1	5.00E-02	1.50E-01	-	8.55E-02	3.45E+00	-	-	-	-	-	-	-	897	387	Y	
216-S-4	RO-1	-	-	-	-	-	-	-	-	1	-	-	-	1000	150	Y	
216-S-22	RO-3	5.00E-02	1.01E-01	-	4.78E-01	4.55E-01	-	-	-	7000	-	-	-	98	585	Y	
216-S-23	RO-2	2.90E-01	9.94E-01	-	3.47E+00	1.14E+00	-	-	-	0	-	-	-	34100	6020	Y	
216-T-20	TP-2	5.00E+00	-	-	4.40E-01	3.88E-01	-	-	-	15000	-	-	-	18.9	86	Y	
216-U-16	UP-2	1.76E+01	-	-	1.65E-02	9.20E-03	-	-	-	-	-	-	-	409000	16500	Y	
216-U-17	UP-2	1.42E+00	-	5.30E-05	-	-	-	-	-	-	-	-	-	2110	2100	Y	
Tank Waste Group (4.8)																	
216-B-5	BP-6	-	4.27E+03	-	2.92E+01	2.55E+01	-	-	-	400000	-	-	-	30600	-	Y	
216-B-7A&B	BP-4	1.80E+02	4.30E+03	-	4.32E+01	2.20E+03	-	-	-	1800000	-	-	-	43600	558	Y	
216-B-8	BP-4	4.50E+01	3.00E+01	-	1.98E+01	5.58E+00	-	-	-	1400000	-	-	-	27200	52730	Y	
216-B-9	BP-6	4.50E+01	1.74E+02	-	3.92E+00	5.52E+00	-	-	-	1000	-	-	-	36000	25990	Y	
216-B-35	BP-3	1.70E+01	1.20E+00	-	1.85E+02	9.64E+01	-	-	-	90000	-	-	-	1060	5190	Y	
216-B-36	BP-3	1.60E+01	8.00E-01	-	3.36E+02	1.99E+02	-	-	-	160000	-	-	-	1940	5190	Y	
216-B-37	BP-3	3.60E+00	2.00E+00	-	1.35E+03	6.56E+00	-	-	-	1700000	-	-	-	4320	5130	Y	
216-B-38	BP-3	4.20E+01	1.20E+00	-	2.21E+02	7.59E+02	-	-	-	120000	-	-	-	1430	5055	Y	
216-B-39	BP-3	5.80E+00	1.51E+00	-	1.92E+02	9.27E+00	-	-	-	120000	-	-	-	1540	5055	Y	
216-B-40	BP-3	3.50E+01	1.00E+00	-	1.53E+02	1.15E+02	-	-	-	130000	-	-	-	1640	4920	Y	
216-B-41	BP-3	7.50E+00	3.00E-01	-	3.86E+02	1.93E+01	-	-	-	120000	-	-	-	1440	4920	Y	
216-T-3	TP-4	-	3.35E+03	-	2.13E+01	1.86E+01	-	-	-	290000	-	-	-	11300	-	Y	
216-T-5	TP-1	5.94E+00	1.80E+02	-	3.11E+01	4.20E-01	-	-	-	140000	-	-	-	2600	953	Y	
216-T-6	TP-3	2.26E+01	3.90E+02	-	1.10E+02	1.24E+02	-	-	-	180000	-	-	-	45000	1305	Y	
216-T-7	TP-1	8.92E+00	1.30E+02	-	2.12E+01	2.40E+01	-	-	-	2300000	-	-	-	110000	8906	Y	
216-T-14	TP-3	3.03E+01	8.80E-01	-	2.04E+02	2.46E+00	-	-	-	80000	-	-	-	1000	4943	Y	
216-T-15	TP-3	2.71E+01	9.40E-01	-	4.50E+02	8.62E+00	-	-	-	80000	-	-	-	1000	4943	Y	
216-T-16	TP-3	2.20E+01	6.50E-01	-	2.27E+02	3.28E+00	-	-	-	80000	-	-	-	1000	4943	Y	
216-T-17	TP-3	2.02E+01	5.30E-01	-	1.62E+02	1.23E+00	-	-	-	60000	-	-	-	1000	4943	Y	
216-T-21	TP-1	8.90E-01	1.00E+00	-	1.74E+02	3.28E+00	-	-	-	40000	-	-	-	460	3730	Y	
216-T-22	TP-1	2.08E+00	2.00E+00	-	8.03E+02	2.09E+01	-	-	-	120000	-	-	-	1530	3730	Y	
216-T-23	TP-1	8.90E-01	1.00E+00	-	5.77E+02	1.68E+01	-	-	-	120000	-	-	-	1480	3730	Y	
216-T-24	TP-1	8.92E+00	2.00E+00	-	6.17E+02	1.64E+01	-	-	-	120000	-	-	-	1530	3730	Y	
216-T-25	TP-1	8.92E+00	1.00E+00	-	3.86E+03	1.64E+00	-	-	-	1200000	-	-	-	3000	2797	Y	
216-T-30	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
216-T-32	TP-1	2.38E+01	3.20E+03	-	9.71E+00	1.09E+01	-	-	-	1200000	-	-	-	29000	2644	Y	
241-B-361	BP-6	1.10E+00	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-T-361	TP-4	-	2.00E+03	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-7	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	216-B-9
Scavenged Waste Group (4.9)																	
200-E-14	BP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Same as 216-B-201
216-B-14	BP-2	2.20E+02	2.50E+01	-	1.14E+02	1.72E+02	-	5000	-	1500000	-	-	-	8710	17670	Y	
216-B-15	BP-2	1.00E+02	5.00E+00	-	9.24E+01	8.73E+01	-	3300	-	900000	-	-	-	6320	17670	Y	
216-B-16	BP-2	3.20E+02	1.00E+01	-	2.98E+02	3.02E+02	-	3000	-	1100000	-	-	-	5600	17670	Y	
216-B-17	BP-2	3.50E+02	1.00E+01	-	1.00E+02	6.89E+01	-	1800	-	1100000	-	-	-	3410	17670	Y	
216-B-18	BP-2	2.40E+02	1.00E+01	-	1.14E+02	8.19E+01	-	5000	-	1000000	-	-	-	8520	17670	Y	
216-B-19	BP-2	1.80E+02	1.00E+01	-	1.26E+02	8.83E+01	-	3400	-	1500000	-	-	-	6400	17670	Y	
216-B-20	BP-2	3.50E+02	1.30E+00	-	6.64E+02	3.40E+02	-	2500	-	1100000	-	-	-	4680	13670	Y	

(a) Americium-241 is present as a radioactive decay product for any site with a plutonium inventory. AM 241 values reported where analytical data is available

Table A-1. Waste Site/Category Groupings. (sheet 3 of 12)

Site	OU	Total U (Kg)	Total Pu (gm)	Am-241 (Ci) (a)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (Kg)	Ferro-cyanide (Kg)	Hexone (Kg)	Nitrate (Kg)	NPH (Kg)	$Na_2Cr_2O_7$ (Kg)	TBP (Kg)	Effluent Volume (m^3)	Pore Volume (m^3)	TPA App C Rev 4	Notes
216-B-21	BP-2	6.80E+02	1.03E+01	-	1.69E+02	3.18E+02		-	-	-	-	-	-	4670	13950	Y	
216-B-22	BP-2	4.20E+02	2.60E+00	-	2.05E+01	1.76E+02	-	2500	-	900000	-	-	-	4740	13800	Y	
216-B-23	BP-2	1.60E+02	1.80E+00	-	5.09E+01	6.25E+01	-	2400	-	1000000	-	-	-	4520	13390	Y	
216-B-24	BP-2	2.50E+02	7.70E+01	-	5.86E+01	7.80E+01	-	2500	-	600000	-	-	-	4700	13670	Y	
216-B-25	BP-2	1.50E+02	2.00E+00	-	2.55E+01	8.83E+01	-	2000	-	500000	-	-	-	3760	13260	Y	
216-B-26	BP-2	5.90E+02	2.50E+00	-	4.38E+02	4.75E+02	-	3100	-	800000	-	-	-	5880	13390	Y	
216-B-27	BP-2	3.40E+02	7.00E+01	-	1.58E+01	2.63E+02	-	2300	-	600000	-	-	-	4420	13390	Y	
216-B-28	BP-2	3.00E+02	5.60E+00	-	1.07E+01	4.95E+01	-	2700	-	1000000	-	-	-	5050	13530	Y	
216-B-29	BP-2	3.40E+02	1.10E+00	-	2.74E+01	8.48E+01	-	2600	-	700000	-	-	-	4840	13530	Y	
216-B-30	BP-2	8.80E+01	2.10E+00	-	1.57E+03	2.65E+02	-	2500	-	1100000	-	-	-	4780	13530	Y	
216-B-31	BP-2	1.20E+02	-	-	-	-	-	2500	-	1100000	-	-	-	4740	13530	Y	
216-B-32	BP-2	1.10E+01	2.60E+00	-	5.86E+01	1.13E+02	-	2500	-	1000000	-	-	-	4770	13530	Y	
216-B-33	BP-2	2.00E+01	1.18E+01	-	1.27E+02	1.81E+01	-	2500	-	1700000	-	-	-	4740	13530	Y	
216-B-34	BP-2	8.50E+01	5.70E+00	-	7.91E+00	1.81E+01	-	2600	-	1900000	-	-	-	4870	13530	Y	
216-B-42	BP-3	6.80E+02	1.00E+01	-	4.27E+01	4.63E+02	-	800	-	210000	-	-	-	1500	5265	Y	
216-B-43	BP-1	1.40E+01	5.00E-01	-	1.30E+02	5.74E+02	-	1100	-	400000	-	-	-	2120	10200	Y	
216-B-44	BP-1	5.30E+00	1.50E+01	-	3.09E+02	1.20E+03	-	3000	-	800000	-	-	-	5600	9885	Y	
216-B-45	BP-1	8.80E+00	1.00E+01	-	6.66E+02	1.18E+03	-	2600	-	90000	-	-	-	4920	9885	Y	
216-B-46	BP-1	1.90E+02	2.00E+01	-	8.89E+01	6.31E+02	-	4000	-	1200000	-	-	-	6700	9730	Y	
216-B-47	BP-1	6.80E+00	5.00E+00	-	6.66E+01	2.61E+02	-	2000	-	700000	-	-	-	3710	10355	Y	
216-B-48	BP-1	2.30E+00	5.00E+00	-	2.00E+02	5.47E+02	-	2200	-	1000000	-	-	-	4090	10042	Y	
216-B-49	BP-1	3.20E+02	1.50E+01	-	1.82E+02	1.14E+03	-	4000	-	1500000	-	-	-	6700	9885	Y	
216-B-51	BP-4	-	-	-	-	-	-	-	-	190	-	-	-	1	135	Y	
216-B-52	BP-2	3.00E+01	1.90E+01	-	1.60E+02	4.92E+00	-	5000	-	2100000	-	-	-	8530	15710	Y	
216-BY-201	BP-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-T-18	TP-2	2.68E+01	1.80E+03	-	2.42E+01	2.80E+00	-	-	-	80000	-	-	-	1000	699	Y	
216-T-26	TP-2	1.50E+02	5.90E+01	-	7.56E+01	2.82E+02	-	6000	-	1000000	-	-	-	12000	680	Y	
Steam Condensate Group (4.10)																	
207-A-NORTH	PO-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
207-Z	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-A-6	PO-4	1.64E+02	3.56E+01	-	1.05E+02	4.41E+01	-	-	-	10000	-	-	-	3400102	23024	Y	
216-A-30	PO-4	2.97E+02	7.31E+01	1.98E-01	1.17E+02	1.02E+02	-	-	-	16000	-	-	-	7110213	31758	Y	
216-A-37-2	PO-4	5.11E+01	-	9.82E-02	2.04E-01	3.07E-01	-	-	-	-	-	-	-	1090033	30569	Y	
216-B-55	BP-9	6.71E+00	6.53E-01	3.80E-06	1.37E+01	7.23E+00	-	-	-	-	-	-	-	1230000	18220	Y	
216-B-64	BP-9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-S-5	RO-1	2.71E+02	5.80E+02	-	2.64E+01	5.41E+01	-	-	-	100	-	-	-	4100000	73746	Y	
216-S-6	RO-1	2.71E+02	4.73E+02	-	1.15E+02	2.04E+02	-	-	-	140	-	-	-	4470000	35117	Y	
216-S-25	RO-1	1.67E+02	4.66E-02	-	6.47E-02	4.10E-02	-	-	-	1	-	-	-	288000	9615	Y	
216-T-36	TP-1	1.18E+00	2.48E+00	-	3.79E+00	4.36E+00	-	-	-		-	-	-	522	3810	Y	
UPR-200-E-19	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	216-A-6
UPR-200-E-21	PO-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-A-6
UPR-200-E-29	PO-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-A-6
Chemical Sewer Group (4.11)																	
216-A-29	BP-11	-	-	-	-	-	-	-	-	-	-	-	-	10400312	43024	Y	
216-B-63	BP-11	2.12E+01	5.73E-01	3.48E-02	6.25E-01	2.41E+00	-	-	-	-	-	-	-	7200000	10940	Y	
216-S-10D	RO-1	1.99E+02	1.00E-01	1.52E-02	1.24E+00	1.07E+00	-	-	-	-	-	-	-	4340000	22575	Y	
216-S-10P	RO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-S-11	RO-1	2.08E+01	3.10E-01	-	8.20E-01	8.14E-01	-	-	-	-	-	-	-	2230000	109265	Y	
216-W-LWC	SS-2	-	-	-	-	-	-	-	-	-	-	-	-	1200000	5922	Y	
U Pond/Z-Ditches Cooling Water Group (4.12)																	
207-U	UP-2	4.50E+01	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-U-9	RO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-U-10	UP-2	1.88E+00	8.00E+03	4.92E-01	1.10E+01	1.10E+01	-	-	-	-	-	-	-	165000000	1800000	Y	
216-U-11	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-U-14	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-Z-1D	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	1000	2400	Y	
216-Z-11	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-Z-19	UP-2	-	-	-	-	-	1	-	-	-	-	-	-	-	-	Y	
216-Z-20	UP-2	-	1.46E-01	1.01E+00	8.64E-02	6.30E-02	-	-	-	3400	-	-	-	3800000	22000	Y	
UPR-200-W-18	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-U-9
UPR-200-W-104	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-U-10, RARA

(a) Americium 241 is present as a radioactive decay product for any site with a plutonium inventory. AM-241 values reported where analytical data is available

Page 3

Table A-1. Waste Site/Category Groupings. (sheet 4 of 12)

Site	OU	Total U (Kg)	Total Pu (gm)	Am-241 (Ci) (a)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (Kg)	Ferro-cyanide (Kg)	Hexone (Kg)	Nitrate (Kg)	NPH (Kg)	$Na_2Cr_2O_7$ (Kg)	TBP (Kg)	Effluent Volume (m^3)	Pore Volume (m^3)	TPA App C Rev 4	Notes
UPR-200-W-105	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-U-10, RARA
UPR-200-W-106	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-U-10, RARA
UPR-200-W-107	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-U-10, RARA
UPR-200-W-111	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		207-U
UPR-200-W-112	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		207-U
UPR-200-W-139	RO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-U-10
Gable Mtn/B-Pond & Ditch Cooling Water Group (4.13)																	
200-E PD	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
207-B	BP-8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-A-9	PO-2	2.20E-01	5.00E-01	-	4.65E+00	1.10E+01	-	-	-	300000	-	-	-	981029	20054	Y	
216-A-25	IU-6	8.78E+02	4.28E+02	5.28E-04	2.04E+02	2.57E+02	-	-	-	-	-	-	-	307000000	689620	Y	
216-A-40	PO-2	-	-	-	-	-	-	-	-	1	-	-	-	946	18215	Y	
216-A-42	PO-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-B-2-1	BP-11	-	2.50E+02	3.96E+00	9.35E+01	1.01E+02	-	-	-	-	-	-	-	149000000	111360	Y	
216-B-2-2	BP-11	-	4.20E-02	-	3.14E-01	1.47E+02	-	-	-	-	-	-	-	49700	73800	Y	
216-B-2-3	BP-11	-	-	-	3.14E-01	4.32E+02	-	-	-	-	-	-	-	-	-	Y	
216-B-3	BP-11	3.70E+02	2.50E+02	3.96E+00	9.35E+01	1.01E+02	-	-	-	-	-	-	-	240000000	2282510	Y	
216-B-3-1	BP-11	-	-	-	-	-	-	-	-	-	-	-	-	149000000	24111	Y	
216-B-3-2	BP-11	-	-	-	-	-	-	-	-	-	-	-	-	149000000	69700	Y	
216-B-3-3	BP-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-B-3A	BP-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-B-3B	BP-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-B-3C	BP-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-B-59	BP-6	-	-	-	1.20E-02	2.89E-02	-	-	-	-	-	-	-	-	-	Y	
216-C-9	SO-1	-	3.36E-01	-	7.03E-01	2.43E+00	-	-	-	-	-	-	-	1030000	193700	Y	
216-C-9 Pond Diversion Box	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
216-E-28	BP-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-N-8	IU-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-14	BP-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	216-B-3
UPR-200-E-32	BP-8	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-B-3,216-B-2-1
UPR-200-E-34	BP-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-B-3, 216-A-25
UPR-200-E-51	BP-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-B-3
UPR-200-E-59	PO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-A-40
UPR-200-E-138	BP-8	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-B-3
200 North Pond Cooling Water Group (4.14)																	
212-N to 216-N-1 Pipeline	NO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
212-P to 216-N-4 Pipeline	NO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
212-R to 216-N-6 Pipeline	NO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
216-N-1	NO-1	-	-	-	-	-	-	-	-	-	-	-	-	946000	68930	Y	
216-N-2	NO-1	-	-	-	7.65E-02	6.87E-02	-	-	-	-	-	-	-	7570	737	Y	
216-N-3	NO-1	-	-	-	8.81E-02	7.77E-02	-	-	-	-	-	-	-	7570	1473	Y	
216-N-4	NO-1	4.48E+00	1.00E+00	-	8.13E-02	7.13E-02	-	-	-	-	-	-	-	946000	130340	Y	
216-N-5	NO-1	-	-	-	8.81E-02	7.77E-02	-	-	-	-	-	-	-	7570	1738	Y	
216-N-6	NO-1	4.48E+00	1.00E+00	-	8.13E-02	7.13E-02	-	-	-	-	-	-	-	946000	97120	Y	
216-N-7	NO-1	-	-	-	8.81E-02	7.77E-02	-	-	-	-	-	-	-	7570	1554	Y	
S-Ponds/Ditches Cooling Water Group(4.15)																	
207-S	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-S-16D	RO-1	-	-	-	-	-	-	-	-	10	-	-	-	400000	20067	Y	
216-S-16P	RO-1	3.12E+03	-	-	3.00E+01	4.51E+01	-	-	-	-	-	-	-	40700000	2258146	Y	
216-S-17	RO-1	1.34E+02	3.00E+00	-	1.27E+01	1.59E+01	-	-	-	140	-	-	-	6440000	1529712	Y	
216-S-172	RO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2904-S-160	RO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2904-S-170	RO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2904-S-171	RO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-13	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-S-17
UPR-200-W-15	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-S-17
UPR-200-W-47	RO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-S-16P
UPR-200-W-59	RO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-S-17
UPR-200-W-95	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		207-S, RARA
T-Ponds/Ditches Cooling Water Group (4.16)																	
207-T	TP-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	

(a) Americium 241 is present as a radioactive decay product for any site with a plutonium inventory. AM-241 values reported where analytical data is available

Table A-1. Waste Site/Category Groupings. (sheet 5 of 12)

Site	OU	Total U (Kg)	Total Pu (gm)	Am-241 (Ci) (a)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (Kg)	Ferro-cyanide (Kg)	Hexone (Kg)	Nitrate (Kg)	NPH (Kg)	$Na_2Cr_2O_7$ (Kg)	TBP (Kg)	Effluent Volume (m^3)	Pore Volume (m^3)	TPA App C Rev 4	Notes
216-T-1	TP-4	5.94E+00	1.00E-01	-	3.87E-02	3.63E-02	-	-	-	-	-	-	-	178000	37712	Y	
216-T-4-1D	TP-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-T-4-2	TP-3	-	-	-	-	-	-	-	-	1	-	-	-	-	-	Y	
216-T-4A	TP-3	-	-	-	-	-	-	-	-	-	-	-	-	42500000	13668	Y	
216-T-4B	TP-3	6.90E+02	3.71E+00	-	6.23E+00	3.37E+00	-	-	-	-	-	-	-	-	-	Y	
216-T-12	TP-3	4.46E+01	1.00E+00	-	4.34E+00	2.05E+00	-	-	-	-	-	-	-	5000	214	Y	
200 Areas Chemical Laboratory Waste Group (4.17)																	
207-SL	RO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2101-M POND	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
216-A-15	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	10000	29	Y	
216-B-6	BP-6	-	-	-	-	-	-	-	-	-	-	100	-	6000	1.4	Y	
216-B-10A	BP-6	9.10E+00	9.80E+00	-	4.01E-01	1.89E+00	-	-	-	1000	-	100	-	9990	465	Y	
216-B-10B	BP-6	-	0.00E+00	-	1.00E-04	2.00E-04	-	-	-	-	-	-	-	28	465	Y	
216-S-19	RO-1	1.55E+02	2.08E+01	-	1.29E+00	1.30E+00	-	-	-	-	-	-	-	1330000	254952	Y	
216-S-20	RO-3	3.87E+01	1.71E+02	-	5.65E+01	2.27E+01	-	-	-	20000	-	-	-	135000	6020	Y	
216-S-26	RO-3	-	-	5.80E-04	3.09E-03	1.83E-03	-	-	-	30	-	-	-	164000	7023	Y	
216-T-2	TP-4	-	-	-	-	-	-	-	-	-	-	200	-	6000	-	Y	
216-T-8	TP-4	5.94E+00	5.00E+00	-	4.01E-02	3.76E-01	-	-	-	-	-	10	-	500	1120	Y	
216-U-4	UP-2	-	-	-	-	-	-	-	-	400	-	-	-	-	0.4	Y	
216-U-4A	UP-2	8.83E+00	9.00E-03	-	1.85E-01	1.59E-02	-	-	-	900	-	-	-	545	20	Y	
216-U-4B	UP-2	-	5.40E-02	-	1.97E-01	1.65E-03	-	-	-	10	-	-	-	33	11	Y	
216-Z-7	ZP-2	4.46E+00	2.00E+03	-	2.00E+02	2.00E+02	-	-	-	20000	-	-	-	79000	30800	Y	
216-Z-16	ZP-2	-	7.20E+01	-	-	-	-	-	-	-	-	-	-	100000	2250	Y	
216-Z-17	ZP-2	1.40E-01	5.00E+01	-	-	-	-	-	-	-	-	-	-	37000	3330	Y	
CTFN 2703-E	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-124	RO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-S-19
300 Areas Chemical Laboratory Waste Group (4.18)																	
216-B-53A	BP-2	2.30E+01	1.00E+02	-	5.59E-02	5.38E-02	-	-	-	1	-	-	-	549	1630	Y	
216-B-53B	BP-2	9.10E+00	5.00E+00	-	3.70E+00	5.06E+00	-	-	-	1	-	-	-	15.1	4120	Y	
216-B-54	BP-2	9.10E+00	5.00E+00	-	5.47E-02	5.25E-02	-	-	-	100	-	-	-	999	5470	Y	
216-B-58	BP-2	9.10E+00	6.70E+00	-	4.40E+00	5.55E+00	-	-	-	10	-	-	-	413	5640	Y	
216-T-27	TP-2	5.94E+00	1.30E+01	-	5.59E+01	7.53E+01	-	-	-	1000	-	-	-	7190	680	Y	
216-T-28	TP-2	3.87E+02	7.00E+01	-	1.93E+02	1.06E+02	-	-	-	10000	-	-	-	42300	680	Y	
216-T-34	TP-4	5.94E+00	1.07E+02	-	1.57E+02	1.78E+02	-	-	-	1000	-	-	-	17300	6209	Y	
216-T-35	TP-4	4.76E+01	6.62E+01	-	1.17E+01	1.14E+01	-	-	-	1000	-	-	-	5720	12671	Y	
Radioactive Landfills and Dumps Group (4.19)																	
200-W CSLA	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
218-C-9	SO-1	-	1.00E-04	-	8.10E+00	-	-	-	-	-	-	-	-	-	-	Y	
218-E-1	PO-2	4.00E+02	9.00E+02	-	8.17E-01	7.17E-01	-	-	-	-	-	-	-	-	-	Y	
218-E-2	BP-10	3.00E+02	8.00E+02	-	2.13E+02	1.87E+02	-	-	-	-	-	-	-	-	-	Y	
218-E-2A	BP-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
218-E-3	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
218-E-4	BP-10	1.00E+00	1.00E+01	-	9.40E+02	8.33E-02	-	-	-	-	-	-	-	-	-	Y	
218-E-5	BP-10	1.00E+02	6.20E+02	-	7.07E+01	6.27E+01	-	-	-	-	-	-	-	-	-	Y	
218-E-5A	BP-10	1.20E+02	1.38E+03	-	1.65E+02	1.47E+02	-	-	-	-	-	-	-	-	-	Y	
218-E-7	BP-6	1.00E+00	1.00E+00	-	4.96E+00	4.36E+00	-	-	-	-	-	-	-	-	-	Y	
218-E-8	PO-6	2.00E+00	2.00E+01	-	1.02E-01	9.06E-02	-	-	-	-	-	-	-	-	-	Y	
218-E-9	BP-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
218-E-10	BP-10	8.00E+02	4.90E+03	-	9.31E+05	7.66E+05	-	-	-	-	-	-	-	-	-	Y	
218-E-12A	PO-6	9.90E+02	8.93E+03	-	1.10E+01	9.06E+00	-	-	-	-	-	-	-	-	-		
218-E-12B	PO-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
218-E-13	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
218-E-14	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
218-E-15	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
218-W-1	ZP-3	7.00E+02	9.40E+04	-	1.63E+00	1.44E+00	-	-	-	-	-	-	-	-	-	Y	
218-W-1A	ZP-3	8.98E+02	2.00E+03	-	3.59E+02	3.59E+02	-	-	-	-	-	-	-	-	-	Y	
218-W-2	ZP-3	1.40E+03	1.26E+05	-	4.86E+00	4.10E+00	-	-	-	-	-	-	-	-	-	Y	
218-W-2A	ZP-3	2.00E+03	-	-	2.77E+03	2.47E+03	-	-	-	-	-	-	-	-	-	Y	
218-W-3	ZP-3	6.99E+04	6.60E+04	-	9.15E+00	8.15E+00	-	-	-	-	-	-	-	-	-		
218-W-3A	ZP-3	1.50E+04	2.93E+04	-	3.02E+05	1.01E+05	-	-	-	-	-	-	-	-	-		
218-W-3AE	ZP-3	-	1.22E+02	-	1.43E+04	4.24E+03	-	-	-	-	-	-	-	-	-		

(a) Americium-241 is present as a radioactive decay product for any site with a plutonium inventory. AM-241 values reported where analytical data is available

Table A-1. Waste Site/Category Groupings. (sheet 6 of 12)

Site	OU	Total U (Kg)	Total Pu (gm)	Am-241 (Ci) [a]	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (Kg)	Ferro-cyanide (Kg)	Hexone (Kg)	Nitrate (Kg)	NPH (Kg)	$Na_2Cr_2O_7$ (Kg)	TBP (Kg)	Effluent Volume (m^3)	Pore Volume (m^3)	TPA Appl C Rev 4	Notes
216-W-4A	ZP-3	5.00E+05	3.54E+04	-	3.93E+01	3.54E+01	-	-	-	-	-	-	-	-	-	Y	
216-W-4B	ZP-3	5.69E+03	5.61E+04	-	1.88E+04	1.01E+05	-	-	-	-	-	-	-	-	-		
216-W-4C	ZP-3	-	3.83E+05	-	1.65E+05	1.11E+05	-	-	-	-	-	-	-	-	-		
216-W-5	ZP-3	-	1.54E+02	-	1.50E+03	1.35E+03	-	-	-	-	-	-	-	-	-		
216-W-7	RO-3	7.00E-01	7.00E-01	-	3.92E+01	3.48E+01	-	-	-	-	-	-	-	-	-	Y	
216-W-8	TP-4	2.97E+00	3.00E-01	-	6.40E+00	5.63E+00	-	-	-	-	-	-	-	-	-	Y	
216-W-9	RO-2	-	-	-	9.21E-04	8.15E-04	-	-	-	-	-	-	-	-	-	Y	
216-W-11	ZP-3	-	-	-	2.00E-03	9.00E-04	-	-	-	-	-	-	-	-	-	Y	
291-C-1	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
600-25	NO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-24	PO-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-		218-E-12A
UPR-200-E-30	PO-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-		218-E-12A
UPR-200-E-35	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	218-E-13
UPR-200-E-53	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		218-E-1
UPR-200-E-61	BP-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	218-E-10
UPR-200-W-11	ZP-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	218-W-1
UPR-200-W-16	ZP-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-		218-W-4A
UPR-200-W-26	ZP-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-		218-W-4A
UPR-200-W-45	ZP-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-		218-W-2A
UPR-200-W-53	ZP-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-		218-W-4A
UPR-200-W-63	TP-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	218-W-2A
UPR-200-W-72	ZP-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-		218-W-4A
UPR-200-W-84	ZP-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-		218-W-1
UPR-200-W-134	ZP-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-		218-W-1
UPR-200-W-158	ZP-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-		218-W-1A
Non-Radioactive Landfills and Dumps Group (4.20)																	
200 CP	BP-9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
200-E BP	PO-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
200-E PAP	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
200-E-1	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
200-E-2	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
200-E-10	PO-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
200-E-12	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
200-E-13	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
200-E8 BPDS	PO-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
200-N-3	NO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
200-W ADB	SS-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
200-W ADS	SS-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
200-W BP	SS-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
200-W PAP	SS-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
200-W-1	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
200-W-2	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
200-W-3	SS-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
200-W-6	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
200-W-10	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
200-W-11	RO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
218-E-6	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
218-W-6	ZP-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
222-SD	RO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
600 CL	IU-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
600 NDWL	IU-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
600 OCL	IU-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
600-38	NO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
600-40	IU-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
600-51	NO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
600-70	RO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
616-WS-1	IU-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
622-1	IU-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
628-2	IU-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
OCSA	IU-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
Z PLANT BP	ZP-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	

(a) Americium-241 is present as a radioactive decay product for any site with a plutonium inventory. AM-241 values reported where analytical data is available.

Table A-1. Waste Site/Category Groupings. (sheet 7 of 12)

Site	OU	Total U (Kg)	Total Pu (gm)	Am-241 (Ci) [a]	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (Kg)	Ferro-cyanide (Kg)	Hexone (Kg)	Nitrate (Kg)	NPH (Kg)	$Na_2Cr_2O_7$ (Kg)	TBP (Kg)	Effluent Volume (m^3)	Pore Volume (m^3)	TPA App C Rev 4	Notes
UPR-200-E-106	PO-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-		200-E BP
Miscellaneous Waste Group (4.21)																	
200-E-4	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
200-W PP	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
209-E-WS-1	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
209-E-WS-2	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-A-4	PO-2	3.95E+02	1.40E+02	-	6.93E+00	4.39E+00	-	-	-	300	-	110	-	6210	948	Y	
216-A-11	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	100	11	Y	
216-A-12	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	100	11	Y	
216-A-13	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	100	17	Y	
216-A-14	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	1	12	Y	
216-A-21	PO-2	1.93E+02	1.50E+02	-	7.85E+01	7.51E+00	-	-	-	9000	-	300	-	77902	2373	Y	
216-A-22	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	10	68	Y	
216-A-26	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	31	Y	
216-A-26A	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	1	17	Y	
216-A-27	PO-2	6.75E+01	9.65E+01	-	3.24E+01	2.45E+01	-	-	-	-	-	200	-	23201	4996	Y	
216-A-32	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	4	1337	Y	
216-A-33	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	70	Y	
216-A-35	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	10	70	Y	
216-A-38-1	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	18489	Y	Not Used
216-A-41	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	10	237	Y	
216-B-4	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	10	2.3	Y	
216-B-13	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	21	118	Y	
216-B-56	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Not Used
216-B-61	BP-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Not Used
216-C-2	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	235	Y	
216-T-9	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-S-12	RO-3	5.94E+00	1.00E+00	-	4.34E-01	4.10E-01	-	-	-	-	-	-	-	68	3010	Y	
216-S-18	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-T-10	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-T-11	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-T-13	TP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-T-29	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	74	2697	Y	
216-T-31	TP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-T-33	TP-4	5.94E+00	5.00E+00	-	2.67E-01	2.56E-01	-	-	-	-	-	-	-	1900	671	Y	
216-U-3	UP-2	1.80E+01	1.00E-01	-	4.34E-01	4.10E-02	-	-	-	-	-	-	-	791	39	Y	
216-U-7	UP-2	1.40E+02	-	-	-	-	-	-	-	-	-	-	-	7	7	Y	
216-U-13	UP-2	3.50E-01	1.00E-01	-	4.44E-02	4.20E-02	-	-	-	-	-	-	-	11	10000	Y	
216-Z-13	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-Z-14	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-Z-15	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-Z-21	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
2704-C-WS-1	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2718-E-WS-1	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
299-E24-111	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-13	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	216-A-4
UPR-200-E-15	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	216-A-4
UPR-200-E-17	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		216-A-22
UPR-200-W-30	RO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	216-S-12
Septic Tank and Drain Fields Group (4.22)																	
2607-FSM	IU-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
200-E-5	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
200-E-6	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
200-E-7	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
200-E-9	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
200-E-24		-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-E1	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-E3	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-E4	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-E5	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-E6	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	

(a) Americium 241 is present as a radioactive decay product for any site with a plutonium inventory. AM-241 values reported where analytical data is available

Table A-1. Waste Site/Category Groupings. (sheet 8 of 12)

Site	OU	Total U (Kg)	Total Pu (gm)	Am-241 (Ci) [a]	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (Kg)	Ferro-cyanide (Kg)	Hexone (Kg)	Nitrate (Kg)	NPH (Kg)	$Na_2Cr_2O_7$ (Kg)	TBP (Kg)	Effluent Volume (m^3)	Pore Volume (m^3)	TPA App C Rev 4	Notes
2607-E7A	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-E7B	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-E8	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-E9	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-E11	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
2607-E12	PO-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-EA	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-EC	PO-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-EE	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-EH	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-EK	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-EM	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-EP	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-EQ	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-ER	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-FSN	IU-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-GF	SS-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-N	NO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-P	NO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-R	NO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-W1	SS-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-W2	SS-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-W3	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-W4	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-W5	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-W6	RO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-W7	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-W8	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-W9	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-WA	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-WC	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
2607-WL	ZP-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
2607-WWA	ZP-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-WZ	RO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-Z	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
2607-Z8	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
600 NSTFST	IU-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
622-R ST	IU-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
6607-1	IU-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
6607-2	IU-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
6607-3	IU-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
6607-5	IU-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
Sanitary Cnb	RO-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
TFS OF 218-E-4	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
Tanks/Lines/Pits/Boxes Group (4.23)																	
200-W-7	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
200-W-16	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
209-E-WS-3	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
216-TY-201	TP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
224-B	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
231-W-151	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
231-Z-151 Sump	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
240-S-151	RO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
240-S-152	RO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
240-S-302	RO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-A-151	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-A-152CT Catch Tank		-	-	-	-	-	-	-	-	-	-	-	-	-	-		
241-A-302A	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-A-302B	PO-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-B-154	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
241-B-302B	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	

(a) Americium-241 is present as a radioactive decay product for any site with a plutonium inventory. AM-241 values reported where analytical data is available

Table A-1. Waste Site/Category Groupings. (sheet 9 of 12)

Site	OU	Total U (Kg)	Total Pu (gm)	Am-241 (Ci) [a]	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (Kg)	Ferro-cyanide (Kg)	Hexone (Kg)	Nitrate (Kg)	NPH (Kg)	$Na_2Cr_2O_7$ (Kg)	TBP (Kg)	Effluent Volume (m^3)	Pore Volume (m^3)	TPA App C Rev 4	Notes
241-BX-154	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-BX-156	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-BX-302B	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-BX-302C	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-C-154	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
241-C-302A Catch Tank		-	-	-	-	-	-	-	-	-	-	-	-	-	-		
241-CX-TK-70	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-CX-TK-71	SO-1	-	-	-	4.96E-02	9.30E+01	-	-	-	-	-	-	-	-	-	Y	
241-CX-TK-72	SO-1	-	2.00E+02	-	1.50E+04	2.80E-06	-	-	-	-	-	-	-	-	-	Y	
241-ER-151	BP-9	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
241-ER-152	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
241-ER-311	BP-9	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
241-ER-311A	BP-9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-S-151	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-S-302A	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-SX-302	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-TX-152	TP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-TX-154	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-TX-155	TP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-TX-302B	TP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-TX-302BR	TP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-TX-302C	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-U-151	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-U-152	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-U-302	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
241-UX-154	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-WR VAULT	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-Z Diversion Box No 1		-	-	-	-	-	-	-	-	-	-	-	-	-	-		
241-Z Diversion Box No 2		-	-	-	-	-	-	-	-	-	-	-	-	-	-		
241-Z-TK-D5	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
244-S RT	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
276-S-TK-141	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
276-S-TK-142	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
600 NSTFUT	IU-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
HSVP	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
Unplanned ReleasesGroup (4.24)																	
UN-200-E-161		-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-216-W-25, RAD EMMIS.		-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-E-9	BP-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-63	BP-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-89	BP-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-E-110	BP-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-95	BP-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-112	BP-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-92	BP-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-93	BP-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-600-21	BP-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-83	BP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-144	BP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
200-E-26	BP-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-E-1	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-2	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-3	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-41	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-44	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-45	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-52	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-54	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-55	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-69	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-77	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-		

(a) Americium-241 is present as a radioactive decay product for any site with a plutonium inventory. AM-241 values reported where analytical data is available.

Table A-1. Waste Site/Category Groupings. (sheet 10 of 12)

Site	OU	Total U (Kg)	Total Pu (gm)	Am-241 (Ci) [a]	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (Kg)	Ferro-cyanide (Kg)	Hexone (Kg)	Nitrate (Kg)	NPH (Kg)	$Na_2Cr_2O_7$ (Kg)	TBP (Kg)	Effluent Volume (m^3)	Pore Volume (m^3)	TPA App C Rev 4	Notes
UPR-200-E-78	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-E-80	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-85	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-87	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-90	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-103	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-140	BP-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-84	BP-9	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-600-12	IU-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-600-20	IU-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-N-1	NO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-N-2	NO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-10	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-11	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-12	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-20	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-22	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-25	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-26	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-28	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-31	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-33	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-42	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-49	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-58	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-60	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-65	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-88	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-96	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-97	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-114	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-117	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-142	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-143	PO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-66	PO-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
200-E-18	PO-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-E-56	PO-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-67	PO-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-145	PO-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
200-E-8	PO-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-E-50	PO-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-E-62	PO-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-20	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-W-32	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-34	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-41	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-42	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-49	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-50	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-51	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-W-52	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-69	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-82	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-83	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-108	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-109	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-114	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-123	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-127	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-165	RO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-35	RO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	

(a) Americium-241 is present as a radioactive decay product for any site with a plutonium inventory. AM-241 values reported where analytical data is available

Page 10

Table A-1. Waste Site/Category Groupings. (sheet 11 of 12)

Site	OU	Total U (Kg)	Total Pu (gm)	Am-241 (Ci) [a]	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (Kg)	Ferro-cyanide (Kg)	Hexone (Kg)	Nitrate (Kg)	NPH (Kg)	$Na_2Cr_2O_7$ (Kg)	TBP (Kg)	Effluent Volume (m^3)	Pore Volume (m^3)	TPA App C Rev 4	Notes
UPR-200-W-43	RO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-56	RO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-57	RO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-W-61	RO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-87	RO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-W-96	RO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-W-116	RO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-137	RO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
241-C Waste Line Unplanned	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
241-C Waste Line Unplanned	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-E-36	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-37	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-98	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-E-141	SO-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-37	SS-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-W-70	SS-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-W-88	SS-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-5	TP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-W-14	TP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-28	TP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-W-29	TP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-99	TP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-113	TP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-131	TP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-W-135	TP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-167	TP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-7	TP-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-166	TP-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
200-W-9	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-W-2	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-3	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-4	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-21	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-W-27	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-38	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-40	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-W-58	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-65	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-67	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-73	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-77	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-85	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-98	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-102	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-160	TP-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-W-8	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-33	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-39	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-46	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-48	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-55	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-60	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-68	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-78	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-86	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-101	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-115	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
UPR-200-W-117	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-118	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-125	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-138	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		

(a) Americium-241 is present as a radioactive decay product for any site with a plutonium inventory. AM-241 values reported where analytical data is available

Table A-1. Waste Site/Category Groupings. (sheet 12 of 12)

Site	OU	Total U (Kg)	Total Pu (gm)	Am-241 (Ci) (a)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (Kg)	Ferro-cyanide (Kg)	Hexone (Kg)	Nitrate (Kg)	NPH (Kg)	$Na_2Cr_2O_7$ (Kg)	TBP (Kg)	Effluent Volume (m^3)	Pore Volume (m^3)	TPA App C Rev 4	Notes
UPR-200-W-161	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-162	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-163	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-164	UP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-23	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-74	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-75	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-79	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-89	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-90	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-91	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-130	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-159	ZP-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	
UPR-200-W-44	ZP-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	

Notes
1 All inventories taken from the 200 area Source Aggregate Area Managment Study Reports. Table 2-2 Radionuclide Wast Inventory Summary or Table 2-3 Chemical Waste Inventory Summary
2 All Radionuclide inventories decayed through 1989 unless otherwise noted in AAMSR
3 "-" in Columns indicates data not available.

(a) Americium-241 is present as a radioactive decay product for any site with a plutonium inventory. AM-241 values reported where analytical data is available.

APPENDIX B

TANK FARM OPERABLE UNIT WASTE SITES

APPENDIX B
TANK FARM OPERABLE UNIT WASTE SITES

Table B-1 lists all the waste sites reported in the Waste Information Data System database from the six tank farm operable units (200-BP-7, 200-PO-3, 200-RO-4, 200-TP-5, 200-TP-6, and 200-RO-3). Included in Table B-1 are four french drain sites (216-A-16, 216-A-17, 216-A-23A, 216-A-23B) in the 200-PO-3 Operable Unit and the 216-S15 site in the 200-RO-4 Operable Unit, which are reported to be within the bounds of the operable units. Waste site types include single- and double-shell tanks, diversion boxes, catch tanks, valve pits, and similar facilities used for transferring and transporting high-level liquid wastes to and from the 241-Tank Farms. Also included are the unplanned releases tied to facilities and operations in the six operable units.

Table B-1. Tank Farm Operable Unit Waste Sites. (sheet 1 of 4)

SiteCode	OU	WMU Type
200-E-11	BP-7	Unplanned Release
200-E-15	BP-7	Diversion Box
241-B-151	BP-7	Diversion Box
241-B-152	BP-7	Diversion Box
241-B-153	BP-7	Diversion Box
241-B-252	BP-7	Diversion Box
241-B-301B	BP-7	Tanks
241-B-TK-101	BP-7	Tanks
241-B-TK-102	BP-7	Tanks
241-B-TK-103	BP-7	Tanks
241-B-TK-104	BP-7	Tanks
241-B-TK-105	BP-7	Tanks
241-B-TK-106	BP-7	Tanks
241-B-TK-107	BP-7	Tanks
241-B-TK-108	BP-7	Tanks
241-B-TK-109	BP-7	Tanks
241-B-TK-110	BP-7	Tanks
241-B-TK-111	BP-7	Tanks
241-B-TK-112	BP-7	Tanks
241-B-TK-201	BP-7	Tanks
241-B-TK-202	BP-7	Tanks
241-B-TK-203	BP-7	Tanks
241-B-TK-204	BP-7	Tanks
241-BR-152	BP-7	Diversion Box
241-BX-153	BP-7	Diversion Box
241-BX-302A	BP-7	Tanks
241-BX-TK-101	BP-7	Tanks
241-BX-TK-102	BP-7	Tanks
241-BX-TK-103	BP-7	Tanks
241-BX-TK-104	BP-7	Tanks
241-BX-TK-105	BP-7	Tanks
241-BX-TK-106	BP-7	Tanks
241-BX-TK-107	BP-7	Tanks
241-BX-TK-108	BP-7	Tanks
241-BX-TK-109	BP-7	Tanks
241-BX-TK-110	BP-7	Tanks
241-BX-TK-111	BP-7	Tanks
241-BX-TK-112	BP-7	Tanks
241-BXR-151	BP-7	Diversion Box
241-BXR-152	BP-7	Diversion Box
241-BXR-153	BP-7	Diversion Box
241-BY-TK-101	BP-7	Tanks
241-BY-TK-102	BP-7	Tanks
241-BY-TK-103	BP-7	Tanks
241-BY-TK-104	BP-7	Tanks
241-BY-TK-105	BP-7	Tanks
241-BY-TK-106	BP-7	Tanks
241-BY-TK-107	BP-7	Tanks
241-BY-TK-108	BP-7	Tanks
241-BY-TK-109	BP-7	Tanks
241-BY-TK-110	BP-7	Tanks
241-BY-TK-111	BP-7	Tanks
241-BY-TK-112	BP-7	Tanks
241-BYR-152	BP-7	Diversion Box
241-BYR-153	BP-7	Diversion Box
241-BYR-154	BP-7	Diversion Box
242-B	BP-7	Building
242-B-151	BP-7	Diversion Box
244-BX RT	BP-7	Tanks
244-BXR VAULT	BP-7	Tanks
2607-EB	BP-7	Septic System
UPR-200-E-101	BP-7	Unplanned Release
UPR-200-E-105	BP-7	Unplanned Release
UPR-200-E-108	BP-7	Unplanned Release
UPR-200-E-109	BP-7	Unplanned Release
UPR-200-E-116	BP-7	Unplanned Release
UPR-200-E-127	BP-7	Unplanned Release
UPR-200-E-128	BP-7	Unplanned Release
UPR-200-E-129	BP-7	Unplanned Release
UPR-200-E-130	BP-7	Unplanned Release
UPR-200-E-131	BP-7	Unplanned Release
UPR-200-E-132	BP-7	Unplanned Release
UPR-200-E-133	BP-7	Unplanned Release
UPR-200-E-134	BP-7	Unplanned Release
UPR-200-E-135	BP-7	Unplanned Release
UPR-200-E-38	BP-7	Unplanned Release
UPR-200-E-4	BP-7	Unplanned Release
UPR-200-E-43	BP-7	Unplanned Release
UPR-200-E-5	BP-7	Unplanned Release
UPR-200-E-6	BP-7	Unplanned Release
UPR-200-E-73	BP-7	Unplanned Release
UPR-200-E-74	BP-7	Unplanned Release
UPR-200-E-75	BP-7	Unplanned Release
UPR-200-E-76	BP-7	Unplanned Release
UPR-200-E-79	BP-7	Unplanned Release
200-E-3	PO-3	Unplanned Release
204-AR	PO-3	Building
216-A-39	PO-3	Ditches
216-C-8	PO-3	French Drain
241-A-151DS	PO-3	Diversion Box
241-A-152	PO-3	Diversion Box
241-A-153	PO-3	Diversion Box
241-A-350	PO-3	Tanks
241-A-417	PO-3	Tanks
241-A-431	PO-3	Building
241-A-702-WS-1	PO-3	French Drain
241-A-A	PO-3	Diversion Box
241-A-B	PO-3	Diversion Box
241-A-TK-101	PO-3	Tanks
241-A-TK-102	PO-3	Tanks

Table B-1. Tank Farm Operable Unit Waste Sites. (sheet 2 of 4)

SiteCode	OU	WMU Type
241-A-TK-103	PO-3	Tanks
241-A-TK-104	PO-3	Tanks
241-A-TK-105	PO-3	Tanks
241-A-TK-106	PO-3	Tanks
241-AN-A	PO-3	Diversion Box
241-AN-B	PO-3	Diversion Box
241-AN-TK-101	PO-3	Tanks
241-AN-TK-102	PO-3	Tanks
241-AN-TK-103	PO-3	Tanks
241-AN-TK-104	PO-3	Tanks
241-AN-TK-105	PO-3	Tanks
241-AN-TK-106	PO-3	Tanks
241-AN-TK-107	PO-3	Tanks
241-AP VP	PO-3	Valve Pit
241-AP-TK-101	PO-3	Tanks
241-AP-TK-102	PO-3	Tanks
241-AP-TK-103	PO-3	Tanks
241-AP-TK-104	PO-3	Tanks
241-AP-TK-105	PO-3	Tanks
241-AP-TK-106	PO-3	Tanks
241-AP-TK-107	PO-3	Tanks
241-AP-TK-108	PO-3	Tanks
241-AR-151	PO-3	Diversion Box
241-AW-A	PO-3	Diversion Box
241-AW-B	PO-3	Diversion Box
241-AW-TK-101	PO-3	Tanks
241-AW-TK-102	PO-3	Tanks
241-AW-TK-103	PO-3	Tanks
241-AW-TK-104	PO-3	Tanks
241-AW-TK-105	PO-3	Tanks
241-AW-TK-106	PO-3	Tanks
241-AX-151	PO-3	Diversion Box
241-AX-152CT	PO-3	Tanks
241-AX-152DS	PO-3	Tanks
241-AX-155	PO-3	Diversion Box
241-AX-501	PO-3	Valve Pit
241-AX-A	PO-3	Diversion Box
241-AX-B	PO-3	Diversion Box
241-AX-TK-101	PO-3	Tanks
241-AX-TK-102	PO-3	Tanks
241-AX-TK-103	PO-3	Tanks
241-AX-TK-104	PO-3	Tanks
241-AY-151	PO-3	Diversion Box
241-AY-152	PO-3	Diversion Box
241-AY-TK-101	PO-3	Tanks
241-AY-TK-102	PO-3	Tanks
241-AZ-151CT	PO-3	Tanks
241-AZ-151DS	PO-3	Diversion Box
241-AZ-152	PO-3	Diversion Box
241-AZ-TK-101	PO-3	Tanks
241-AZ-TK-102	PO-3	Tanks
241-C-151	PO-3	Diversion Box
241-C-152	PO-3	Diversion Box
241-C-153	PO-3	Diversion Box
241-C-252	PO-3	Diversion Box
241-C-301C	PO-3	Tanks
241-C-801	PO-3	Building
241-C-TK-101	PO-3	Tanks
241-C-TK-102	PO-3	Tanks
241-C-TK-103	PO-3	Tanks
241-C-TK-104	PO-3	Tanks
241-C-TK-105	PO-3	Tanks
241-C-TK-106	PO-3	Tanks
241-C-TK-107	PO-3	Tanks
241-C-TK-108	PO-3	Tanks
241-C-TK-109	PO-3	Tanks
241-C-TK-110	PO-3	Tanks
241-C-TK-111	PO-3	Tanks
241-C-TK-112	PO-3	Tanks
241-C-TK-201	PO-3	Tanks
241-C-TK-202	PO-3	Tanks
241-C-TK-203	PO-3	Tanks
241-C-TK-204	PO-3	Tanks
241-CR-151	PO-3	Diversion Box
241-CR-152	PO-3	Diversion Box
241-CR-153	PO-3	Diversion Box
241-ER-153	PO-3	Diversion Box
242-A	PO-3	Building
244-A RT	PO-3	Tanks
244-AR LS	PO-3	Diversion Box
244-AR VAULT	PO-3	Vault
244-CR VAULT	PO-3	Vault
244-CR-WS-1	PO-3	French Drain
2607-E10	PO-3	Septic System
2607-ED	PO-3	Septic System
2607-EG	PO-3	Septic System
2607-EJ	PO-3	Septic System
GTF	PO-3	Building
GTFL	PO-3	Vault
UPR-200-E-100	PO-3	Unplanned Release 244-A
UPR-200-E-107	PO-3	Unplanned Release (244-
UPR-200-E-115	PO-3	Unplanned Release (241-
UPR-200-E-118	PO-3	Unplanned Release (241-
UPR-200-E-119	PO-3	Unplanned Release (241-
UPR-200-E-125	PO-3	Unplanned Release (241-
UPR-200-E-126	PO-3	Unplanned Release (241-
UPR-200-E-136	PO-3	Unplanned Release (241-
UPR-200-E-137	PO-3	Unplanned Release (241-
UPR-200-E-16	PO-3	Unplanned Release (241-
UPR-200-E-18	PO-3	Unplanned Release (216-
UPR-200-E-27	PO-3	Unplanned Release (244-
UPR-200-E-47	PO-3	Unplanned Release (241-
UPR-200-E-48	PO-3	Unplanned Release (241-
UPR-200-E-59	PO-3	Unplanned Release (216-

Table B-1. Tank Farm Operable Unit Waste Sites. (sheet 3 of 4)

SiteCode	OU	WMU Type
UPR-200-E-68	PO-3	Unplanned Release (241-
UPR-200-E-70	PO-3	Unplanned Release (244-
UPR-200-E-72	PO-3	Unplanned Release (241-
UPR-200-E-81	PO-3	Unplanned Release (241-
UPR-200-E-82	PO-3	Unplanned Release (241-
UPR-200-E-86	PO-3	Unplanned Release (241-
UPR-200-E-91	PO-3	Unplanned Release (241-
UPR-200-E-94	PO-3	Unplanned Release (216-
UPR-200-E-99	PO-3	Unplanned Release (244-
216-A-16	PO-5	French Drain
216-A-17	PO-5	French Drain
216-A-23A	PO-5	French Drain
216-A-23B	PO-5	French Drain
216-S-15	RO-2	Ponds
	RO-4	Tanks
	RO-4	Septic System
	RO-4	Tanks
241-S-152	RO-4	Diversion Box
241-S-302B	RO-4	Tanks
241-S-A	RO-4	Diversion Box
241-S-B	RO-4	Diversion Box
241-S-C	RO-4	Diversion Box
241-S-D	RO-4	Diversion Box
241-S-TK-101	RO-4	Tanks
241-S-TK-102	RO-4	Tanks
241-S-TK-103	RO-4	Tanks
241-S-TK-104	RO-4	Tanks
241-S-TK-105	RO-4	Tanks
241-S-TK-106	RO-4	Tanks
241-S-TK-107	RO-4	Tanks
241-S-TK-108	RO-4	Tanks
241-S-TK-109	RO-4	Tanks
241-S-TK-110	RO-4	Tanks
241-S-TK-111	RO-4	Tanks
241-S-TK-112	RO-4	Tanks
241-SX-151	RO-4	Diversion Box
241-SX-152	RO-4	Diversion Box
241-SX-401	RO-4	Building
241-SX-402	RO-4	Building
241-SX-A	RO-4	Diversion Box
241-SX-B	RO-4	Diversion Box
241-SX-TK-101	RO-4	Tanks
241-SX-TK-102	RO-4	Tanks
241-SX-TK-103	RO-4	Tanks
241-SX-TK-104	RO-4	Tanks
241-SX-TK-105	RO-4	Tanks
241-SX-TK-106	RO-4	Tanks
241-SX-TK-107	RO-4	Tanks
241-SX-TK-108	RO-4	Tanks
241-SX-TK-109	RO-4	Tanks
241-SX-TK-110	RO-4	Tanks
241-SX-TK-111	RO-4	Tanks
241-SX-TK-112	RO-4	Tanks
241-SX-TK-113	RO-4	Tanks
241-SX-TK-114	RO-4	Tanks
241-SX-TK-115	RO-4	Tanks
241-SY-A	RO-4	Diversion Box
241-SY-B	RO-4	Diversion Box
241-SY-TK-101	RO-4	Tanks
241-SY-TK-102	RO-4	Tanks
241-SY-TK-103	RO-4	Tanks
242-S	RO-4	Building
UPR-200-W-10	RO-4	Unplanned Release (203-
UPR-200-W-140	RO-4	Unplanned Release (241-
UPR-200-W-141	RO-4	Unplanned Release (241-
UPR-200-W-142	RO-4	Unplanned Release (241-
UPR-200-W-143	RO-4	Unplanned Release (241-
UPR-200-W-144	RO-4	Unplanned Release (241-
UPR-200-W-145	RO-4	Unplanned Release (241-
UPR-200-W-146	RO-4	Unplanned Release (241-
UPR-200-W-80	RO-4	Unplanned Release (244-
UPR-200-W-81	RO-4	Unplanned Release (241-
241-TX-153	TP-5	Diversion Box
241-TX-302A	TP-5	Tanks
241-TX-302X	TP-5	Tanks
241-TX-TK-101	TP-5	Tanks
241-TX-TK-102	TP-5	Tanks
241-TX-TK-103	TP-5	Tanks
241-TX-TK-104	TP-5	Tanks
241-TX-TK-105	TP-5	Tanks
241-TX-TK-106	TP-5	Tanks
241-TX-TK-107	TP-5	Tanks
241-TX-TK-108	TP-5	Tanks
241-TX-TK-109	TP-5	Tanks
241-TX-TK-110	TP-5	Tanks
241-TX-TK-111	TP-5	Tanks
241-TX-TK-112	TP-5	Tanks
241-TX-TK-113	TP-5	Tanks
241-TX-TK-114	TP-5	Tanks
241-TX-TK-115	TP-5	Tanks
241-TX-TK-116	TP-5	Tanks
241-TX-TK-117	TP-5	Tanks
241-TX-TK-118	TP-5	Tanks
241-TXR-151	TP-5	Diversion Box
241-TXR-152	TP-5	Diversion Box
241-TXR-153	TP-5	Diversion Box
241-TY-153	TP-5	Diversion Box
241-TY-302A	TP-5	Tanks
241-TY-302B	TP-5	Tanks
241-TY-TK-101	TP-5	Tanks
241-TY-TK-102	TP-5	Tanks
241-TY-TK-103	TP-5	Tanks
241-TY-TK-104	TP-5	Tanks
241-TY-TK-105	TP-5	Tanks

Table B-1. Tank Farm Operable Unit Waste Sites. (sheet 4 of 4)

SiteCode	OU	WMU Type
241-TY-TK-106	TP-5	Tanks
242-T	TP-5	Building
242-T-135	TP-5	Tanks
242-T-151	TP-5	Diversion Box
242-TA	TP-5	Tanks
244-TX RT	TP-5	Tanks
244-TXR	TP-5	Vault
2607-WT	TP-5	Septic System
2607-WTX	TP-5	Septic System
UPR-200-W-100	TP-5	Unplanned Release (241-
UPR-200-W-12	TP-5	Unplanned Release (242-
UPR-200-W-126	TP-5	Unplanned Release (241-
UPR-200-W-129	TP-5	Unplanned Release (241-
UPR-200-W-149	TP-5	Unplanned Release (241-
UPR-200-W-150	TP-5	Unplanned Release (241-
UPR-200-W-151	TP-5	Unplanned Release (241-
UPR-200-W-152	TP-5	Unplanned Release (241-
UPR-200-W-153	TP-5	Unplanned Release (241-
UPR-200-W-17	TP-5	Unplanned Release (241-
UPR-200-W-76	TP-5	Unplanned Release (241-
241-T-151	TP-6	Diversion Box
241-T-152	TP-6	Diversion Box
241-T-153	TP-6	Diversion Box
241-T-252	TP-6	Diversion Box
241-T-301	TP-6	Tanks
241-T-302	TP-6	Tanks
241-T-TK-101	TP-6	Tanks
241-T-TK-102	TP-6	Tanks
241-T-TK-103	TP-6	Tanks
241-T-TK-104	TP-6	Tanks
241-T-TK-105	TP-6	Tanks
241-T-TK-106	TP-6	Tanks
241-T-TK-107	TP-6	Tanks
241-T-TK-108	TP-6	Tanks
241-T-TK-109	TP-6	Tanks
241-T-TK-110	TP-6	Tanks
241-T-TK-111	TP-6	Tanks
241-T-TK-112	TP-6	Tanks
241-T-TK-201	TP-6	Tanks
241-T-TK-202	TP-6	Tanks
241-T-TK-203	TP-6	Tanks
241-T-TK-204	TP-6	Tanks
241-TR-152	TP-6	Diversion Box
241-TR-153	TP-6	Diversion Box
UPR-200-W-147	TP-6	Unplanned Release (241-
UPR-200-W-148	TP-6	Unplanned Release (241-
UPR-200-W-62	TP-6	Unplanned Release (241-
UPR-200-W-64	TP-6	Unplanned Release (TX/T
UPR-200-W-97	TP-6	Unplanned Release (TX/T
241-UX-302A	UP-2	Tanks
200-W-14	UP-3	Debris
200-W-4	UP-3	Burial Site

SiteCode	OU	WMU Type
241-U-153	UP-3	Diversion Box
241-U-252	UP-3	Diversion Box
241-U-301	UP-3	Tanks
241-U-A	UP-3	Diversion Box
241-U-B	UP-3	Diversion Box
241-U-C	UP-3	Diversion Box
241-U-D	UP-3	Diversion Box
241-U-TK-101	UP-3	Tanks
241-U-TK-102	UP-3	Tanks
241-U-TK-103	UP-3	Tanks
241-U-TK-104	UP-3	Tanks
241-U-TK-105	UP-3	Tanks
241-U-TK-106	UP-3	Tanks
241-U-TK-107	UP-3	Tanks
241-U-TK-108	UP-3	Tanks
241-U-TK-109	UP-3	Tanks
241-U-TK-110	UP-3	Tanks
241-U-TK-111	UP-3	Tanks
241-U-TK-112	UP-3	Tanks
241-U-TK-201	UP-3	Tanks
241-U-TK-202	UP-3	Tanks
241-U-TK-203	UP-3	Tanks
241-U-TK-204	UP-3	Tanks
241-UR-151	UP-3	Diversion Box
241-UR-152	UP-3	Diversion Box
241-UR-153	UP-3	Diversion Box
241-UR-154	UP-3	Diversion Box
244-U RT	UP-3	Tanks
244-UR VAULT	UP-3	Vault
2607-WUT	UP-3	Septic System
UPR-200-W-128	UP-3	Unplanned Release
UPR-200-W-132	UP-3	Unplanned Release
UPR-200-W-154	UP-3	Unplanned Release
UPR-200-W-155	UP-3	Unplanned Release
UPR-200-W-156	UP-3	Unplanned Release
UPR-200-W-157	UP-3	Unplanned Release
UPR-200-W-24	UP-3	Unplanned Release
UPR-200-W-6	UP-3	Unplanned Release
UPR-200-W-71	UP-3	Unplanned Release

APPENDIX C

UNPLANNED RELEASES AND RCRA TREATMENT, STORAGE, AND DISPOSAL UNITS

APPENDIX C
UNPLANNED RELEASES AND RCRA TREATMENT, STORAGE, AND DISPOSAL UNITS

Tables in this appendix are provided to delimit specific subgroups of Waste Information Data System sites for completeness of coverage. Table C-1 provides a list of all unplanned releases in the database and indicates the waste site where the release originated and the point of deposition. Table C-2 provides a list of all *Resource Conservation and Recovery Act* (RCRA) treatment, storage, and disposal (TSD) units in the 200 Areas. This list includes areas and facilities inside major processing buildings as well as tank farms and other facilities that are covered in the document.

Table C-1. List of Unplanned Releases. (sheet 1 of 5)

Site	Primary Source Facility	To
UPR-200-W-63	221-T	To the Ground
UPR-200-W-64	Unknown	To the Ground
UPR-200-W-65	221-T	To the Ground
UPR-200-W-67	2706-T	To the Ground
UPR-200-W-68	Unknown	To the Ground
UPR-200-W-69	204-S	To the Ground
UPR-200-W-7	241-T-151 241-T-152 Diversio	To the Ground
UPR-200-W-71	241-U-102 SST	To the Ground
UPR-200-W-72	218-W-4A	To the Ground
UPR-200-W-73	221-T	To the Ground
UPR-200-W-74	241-Z Building	To the Ground
UPR-200-W-75	241-Z Building	To the Ground
UPR-200-W-76	Unknown	To the Ground
UPR-200-W-77	Unknown	To the Ground
UPR-200-W-78	UO3 Plant	To the Ground
UPR-200-W-79	241-Z Treatment Tank	To the Ground
UPR-200-W-80	241-S/SX TF	To the Ground
UPR-200-W-81	241-S/SX TF	To the Ground
UPR-200-W-82	241-S-151	To the Ground
UPR-200-W-83	204-S	To the Ground
UPR-200-W-84	218-W-1 Burial Ground	To the Ground
UPR-200-W-85	Unknown	To the Ground
UPR-200-W-87	291-S HEPA Filter Housing	To the Ground
UPR-200-W-88	202-A	To the Ground
UPR-200-W-89	236-Z Building	To the Ground
UPR-200-W-90	236-Z Building	To the Ground
UPR-200-W-91	234-5Z	To the Ground
UPR-200-W-96	233-S	To the Ground
UPR-200-W-97	241-T	To the Ground
UPR-200-W-98	221-T	To the Ground
UPR-200-W-99	241-TY-153	To the Ground
UPR-200-W-36	202-S	GW
UPR-200-E-117	Unknown	N/A
UPR-200-E-41	271-Bldg.	N/A
UPR-200-E-59	216-A-40	N/A
UPR-200-E-67	N/A	N/A
UPR-200-E-97	Unknown	N/A
UPR-200-W-86	204-S	N/A
UPR-200-E-106	200-E Burning Pit	into a waste site
UPR-200-E-138	221-B	into a waste site
UPR-200-E-32	B-Plant/207-B Retention Basi	into a waste site
UPR-200-E-34	Purex (TK-F15)	into a waste site
UPR-200-E-51	Purex (TK-324)	into a waste site
UPR-200-W-110	231-Z, 234-5Z & 291-Z Bldgs	into a waste site
UPR-200-W-13	202-S	into a waste site
UPR-200-W-138	U-Plant, 221-U	into a waste site
UPR-200-W-139	216-U-10 Pond	into a waste site
UPR-200-W-15	202-S	into a waste site
UPR-200-W-18	216-U-10 Pond	into a waste site
UPR-200-W-34	202-S	into a waste site
UPR-200-W-37	Unknown	into a waste site
UPR-200-W-59	202-S	into a waste site
UPR-200-W-70	Unknown	into a waste site
UPR-200-W-8	Unknown	into a waste site
UPR-200-W-95	202-S	into a waste site

Table C-1. List of Unplanned Releases. (sheet 2 of 5)

Site	Primary Source Facility	To
UPR-200-W-151	241-TY-104 Tank	To the Ground
UPR-200-W-152	241-TY-105 Tank	To the Ground
UPR-200-W-153	241-TY-106 Tank	To the Ground
UPR-200-W-154	241-U-101 SST	To the Ground
UPR-200-W-155	241-U-104 SST	To the Ground
UPR-200-W-156	241-U-110 SST	To the Ground
UPR-200-W-157	241-U-112 SST	To the Ground
UPR-200-W-158	218-W-4A Burial Ground	To the Ground
UPR-200-W-159	Near Z-Plant	To the Ground
UPR-200-W-16	218-W-4A Burial Ground	To the Ground
UPR-200-W-160	241-TX-302	To the Ground
UPR-200-W-161	241-U Tank Farm 207-U Ret.	To the Ground
UPR-200-W-165	241-SY	To the Ground
UPR-200-W-166	241-T	To the Ground
UPR-200-W-17	241-TX	To the Ground
UPR-200-W-19	216-U-1 & 2	To the Ground
UPR-200-W-2	221-T	To the Ground
UPR-200-W-20	241-SY	To the Ground
UPR-200-W-21	221-T/241-TX-154	To the Ground
UPR-200-W-23	234-5Z Building	To the Ground
UPR-200-W-24	244-UR Vault	To the Ground
UPR-200-W-26	218-W-4A Burial Ground	To the Ground
UPR-200-W-27	221-T	To the Ground
UPR-200-W-28	241-TX-155 Diversion Box	To the Ground
UPR-200-W-29	241-T	To the Ground
UPR-200-W-3	221-T	To the Ground
UPR-200-W-30	241-S Stack	To the Ground
UPR-200-W-32	202-S	To the Ground
UPR-200-W-33	224-U	To the Ground
UPR-200-W-35	Process Line Between S & U	To the Ground
UPR-200-W-38	241-TX-154 Diversion Box	To the Ground
UPR-200-W-39	UO3 Plant	To the Ground
UPR-200-W-4	221-T	To the Ground
UPR-200-W-40	241-TX-154 & 241-TX-302	To the Ground
UPR-200-W-41	202-S	To the Ground
UPR-200-W-42	202-S	To the Ground
UPR-200-W-43	Rad Zone East of 222-S	To the Ground
UPR-200-W-44	Redox	To the Ground
UPR-200-W-45	218-W-2A Burial Ground	To the Ground
UPR-200-W-46	Burial Box	To the Ground
UPR-200-W-47	216-S-16	To the Ground
UPR-200-W-48	U-Plant	To the Ground
UPR-200-W-49	241-SX Tank Farm (release)	To the Ground
UPR-200-W-5	241-TX-155 Diversion Box	To the Ground
UPR-200-W-50	241-SX Tank Farm	To the Ground
UPR-200-W-51	241-S Tank Farms	To the Ground
UPR-200-W-52	241-S Tank Farms	To the Ground
UPR-200-W-53	218-W-4A Burial Ground	To the Ground
UPR-200-W-55	UO3 Plant	To the Ground
UPR-200-W-56	202-S Column S-Plant	To the Ground
UPR-200-W-57	233-S	To the Ground
UPR-200-W-58	221-T	To the Ground
UPR-200-W-6	241-U-151, 241-U-152	To the Ground
UPR-200-W-60	Purex	To the Ground
UPR-200-W-61	202-S	To the Ground
UPR-200-W-62	241-T-107 Tank	To the Ground

Table C-1. List of Unplanned Releases. (sheet 3 of 5)

Site	Primary Source Facility	To
UPR-200-E-89	241-BX Tank Farm	To the Ground
UPR-200-E-9	221-U Bldg., 241-BY Tanks, &	To the Ground
UPR-200-E-90	219-B Stack	To the Ground
UPR-200-E-91	N/A	To the Ground
UPR-200-E-92	N/A	To the Ground
UPR-200-E-94		To the Ground
UPR-200-E-95	N/A	To the Ground
UPR-200-E-96	291-A Stack	To the Ground
UPR-200-E-98	291-C	To the Ground
UPR-200-E-99	244-CR Vault	To the Ground
UPR-200-N-1	212 R-Bldg.	To the Ground
UPR-200-N-2	212-R Bldg.	To the Ground
UPR-200-W-10	203-S U Storage Tank	To the Ground
UPR-200-W-100	241-TX Tanks	To the Ground
UPR-200-W-101	221-U Bldg.	To the Ground
UPR-200-W-102	221-T	To the Ground
UPR-200-W-103	236-Z Building	To the Ground
UPR-200-W-104	216-U-10	To the Ground
UPR-200-W-105	216-U-10	To the Ground
UPR-200-W-106	216-U-10	To the Ground
UPR-200-W-107	216-U-10	To the Ground
UPR-200-W-108	202-S	To the Ground
UPR-200-W-109	202-S	To the Ground
UPR-200-W-11	218-W-1 Burial Ground	To the Ground
UPR-200-W-111	207-U	To the Ground
UPR-200-W-112	207-U	To the Ground
UPR-200-W-113	241-TX-155 Diversion on Box	To the Ground
UPR-200-W-114	241-SX Tank Farm, 241-SX-1	To the Ground
UPR-200-W-116	204-S Waste Storage Tank	To the Ground
UPR-200-W-117	221-U Bldg.	To the Ground
UPR-200-W-118	211-U Chemical Tank Farm	To the Ground
UPR-200-W-12	242-T	To the Ground
UPR-200-W-123	204-S Unloading Facility	To the Ground
UPR-200-W-124	222-S	To the Ground
UPR-200-W-125	276-U Solvent Storage Area	To the Ground
UPR-200-W-126	241-TX-153 Diversion Box	To the Ground
UPR-200-W-127	242-S Bldg.	To the Ground
UPR-200-W-128	241-U-103 SST	To the Ground
UPR-200-W-129	241-TX-113 Tank	To the Ground
UPR-200-W-130	231-Z-151 Sump	To the Ground
UPR-200-W-131	241-TX-155	To the Ground
UPR-200-W-132	241-UR-151 Diversion Box	To the Ground
UPR-200-W-134	218-W-1 Burial Ground	To the Ground
UPR-200-W-135	241-TX-155 Diversion Box	To the Ground
UPR-200-W-14	242-T	To the Ground
UPR-200-W-140	241-SX-107	To the Ground
UPR-200-W-141	241-SX-108	To the Ground
UPR-200-W-142	241-SX-109	To the Ground
UPR-200-W-143	241-SX-111	To the Ground
UPR-200-W-144	241-SX-112	To the Ground
UPR-200-W-145	241-SX-113	To the Ground
UPR-200-W-146	241-SX-115	To the Ground
UPR-200-W-147	241-T-103 Tank	To the Ground
UPR-200-W-148	241-T-106 Tank	To the Ground
UPR-200-W-149	241-TX-107 Tank	To the Ground
UPR-200-W-150	241-TX-155 Diversion Box	To the Ground

Table C-1. List of Unplanned Releases. (sheet 4 of 5)

Site	Primary Source Facility	To
UPR-200-E-28	Purex	To the Ground
UPR-200-E-29	216-A-6 Crib	To the Ground
UPR-200-E-3	221-B Bldg.	To the Ground
UPR-200-E-30	218-E-12A Burial Ground	To the Ground
UPR-200-E-31	241-A-151 Diversion Box	To the Ground
UPR-200-E-33	Purex RR	To the Ground
UPR-200-E-35	218-E-13	To the Ground
UPR-200-E-36	201-C Process Bldg.	To the Ground
UPR-200-E-37	201-C Process Bldg.	To the Ground
UPR-200-E-38	241-B-152 Diversion Box	To the Ground
UPR-200-E-39	216-A-36B	To the Ground
UPR-200-E-4	241-B-151 Diversion Box	To the Ground
UPR-200-E-40	216-A-36B	To the Ground
UPR-200-E-42	244-AR Diverter Tank	To the Ground
UPR-200-E-43	Pump from 102-BY	To the Ground
UPR-200-E-44	B-Plant	To the Ground
UPR-200-E-45	241-B-154 DB	To the Ground
UPR-200-E-47	241-A Tank Farm	To the Ground
UPR-200-E-48	241-A-106 Pump Pit	To the Ground
UPR-200-E-49	N/A	To the Ground
UPR-200-E-5	241-BX-102 Tank	To the Ground
UPR-200-E-50	241-C Tank Farm	To the Ground
UPR-200-E-52	221-B- Bldg.	To the Ground
UPR-200-E-53	218-E-1 Burial Ground	To the Ground
UPR-200-E-54	225-B Bldg	To the Ground
UPR-200-E-55	N/A	To the Ground
UPR-200-E-56	Unkown	To the Ground
UPR-200-E-6	241-B-153 Diversin Box	To the Ground
UPR-200-E-60	N/A	To the Ground
UPR-200-E-61	218-E-10	To the Ground
UPR-200-E-62	N/A	To the Ground
UPR-200-E-63	N/A	To the Ground
UPR-200-E-64	216-B-64 Retention Basin	To the Ground
UPR-200-E-65	241-A-151 Diversion Box	To the Ground
UPR-200-E-66	216-A-42 Retention Basin	To the Ground
UPR-200-E-68	241-C-151	To the Ground
UPR-200-E-69	221-B Bldg. & 221-B Railway	To the Ground
UPR-200-E-7	221-B Bldg. to 241-B-361 setti	To the Ground
UPR-200-E-70	244-A Lift Station	To the Ground
UPR-200-E-72	241-C	To the Ground
UPR-200-E-73	241-B-151 Diversion Box	To the Ground
UPR-200-E-74	241-B-152 Diversion Box	To the Ground
UPR-200-E-75	241-B-153 Diversion Box	To the Ground
UPR-200-E-76	B-Plant/241-B-153 Diversion	To the Ground
UPR-200-E-77	241-B-154 Diversion Box	To the Ground
UPR-200-E-78	241-B-155 Diversion Box	To the Ground
UPR-200-E-79	242-B Evaporator	To the Ground
UPR-200-E-80	B-Plant	To the Ground
UPR-200-E-81	241-CR-151	To the Ground
UPR-200-E-82	Feed Line 241-C-105 to 221-B	To the Ground
UPR-200-E-83	U-Plant	To the Ground
UPR-200-E-84	241-ER-151	To the Ground
UPR-200-E-85	B-Plant Utility Pit	To the Ground
UPR-200-E-86	244-AR Vault	To the Ground
UPR-200-E-87	224-B	To the Ground
UPR-200-E-88	Reglated Equipment Storage	To the Ground

Table C-1. List of Unplanned Releases. (sheet 5 of 5)

Site	Primary Source Facility	To
200-E-3		Unkown
200-W-9		Unkown
241-C Waste Line Unplanned Release No. 2	201-C Process Bldg.	Unkown
UN-200-E-161		Unkown
UPR-200-E-58	N/A	Unkown
UPR-216-W-25, RAD EMMIS.		Unkown
241-C Waste Line Unplanned Release No. 1	201-C Process Bldg.	To the Ground
UPR-200-E-1	221-B, 241-BX-154 Diversion	To the Ground
UPR-200-E-10	Purex RR	To the Ground
UPR-200-E-100	244-A Lift Station	To the Ground
UPR-200-E-101	N/A	To the Ground
UPR-200-E-103	221-B Bldg.	To the Ground
UPR-200-E-105	107-BYTank Farms	To the Ground
UPR-200-E-107	244-CR Vault Tank	To the Ground
UPR-200-E-108	241-B-102 Single Shell Tank (	To the Ground
UPR-200-E-109	241-B Tank Farm	To the Ground
UPR-200-E-11	Purex RR	To the Ground
UPR-200-E-110	241-BY-112 Tank	To the Ground
UPR-200-E-112	221-B Bldg./RR Track	To the Ground
UPR-200-E-114	202-A Valve Pit	To the Ground
UPR-200-E-115	241-AX-103 Pump Pit	To the Ground
UPR-200-E-116	241-BY-112 Single Shell Tank	To the Ground
UPR-200-E-118	241-C-107 SST	To the Ground
UPR-200-E-119	241-AZ-104 SST	To the Ground
UPR-200-E-12	Purex RR	To the Ground
UPR-200-E-125	241-A-104 SST	To the Ground
UPR-200-E-126	241-A-105 SST	To the Ground
UPR-200-E-127	241-B-107	To the Ground
UPR-200-E-128	241-B-110 SST	To the Ground
UPR-200-E-129	241-B-201 SST	To the Ground
UPR-200-E-13	216-A-4 Crib	To the Ground
UPR-200-E-130	241-B-203 SST	To the Ground
UPR-200-E-131	241-BX-102 SST	To the Ground
UPR-200-E-132	241-BX-102 SST	To the Ground
UPR-200-E-133	241-BX-108 SST	To the Ground
UPR-200-E-134	241-BX-103 SST	To the Ground
UPR-200-E-135	241-BY-108 SST	To the Ground
UPR-200-E-136	241-C-101 SST	To the Ground
UPR-200-E-137	241-C-203 SST	To the Ground
UPR-200-E-14	216-B-3	To the Ground
UPR-200-E-140	221-B Bldg.	To the Ground
UPR-200-E-141	2718-E Bldg.	To the Ground
UPR-200-E-142	202-A Diesel Fuel Tank	To the Ground
UPR-200-E-15	216-A-4	To the Ground
UPR-200-E-16	241-C-105 241-C-108 Transf	To the Ground
UPR-200-E-17	216-A-22 French Drain	To the Ground
UPR-200-E-18	216-A-8	To the Ground
UPR-200-E-19	216-A-6	To the Ground
UPR-200-E-2	291-B Stack	To the Ground
UPR-200-E-20	Purex RR	To the Ground
UPR-200-E-21	216-A-6 Crib	To the Ground
UPR-200-E-22	291-A Stack	To the Ground
UPR-200-E-24	218-E-12A Burial Ground	To the Ground
UPR-200-E-25	241-A-151 Diversion Box	To the Ground
UPR-200-E-26	241-A-151 Diversion Box	To the Ground
UPR-200-E-27	244-CR Vault	To the Ground

Table C-2. List of RCRA TSD Units. (sheet 1 of 4)

OU	Site Code	TSD Number
	200-E-17	S-2-8
	200-W-20	T-2-7
	221-B-TK-27-2	TS-2-3
	221-T-TK-11-R	T-2-7
	221-T-TK-5-6	T-2-7
	221-T-TK-5-7	T-2-7
	221-T-TK-5-9	T-2-7
	221-T-TK-6-1	T-2-7
BP-10	218-E-10	D-2-9
BP-11	2025-E	T-2-8
BP-11	216-A-29	D-2-3
BP-11	216-B-3	D-2-5
BP-11	216-B-3-3	D-2-5
BP-11	216-B-3A	D-2-5
BP-11	216-B-3B	D-2-5
BP-11	216-B-63	D-2-6
BP-11	UPR-200-E-34	
BP-11	UPR-200-E-51	
BP-6	200-E-16	TS-2-3
BP-6	221-B SDT	TS-2-3
BP-6	221-B-TK-26-1	TS-2-3
BP-6	221-B-TK-27-3	TS-2-3
BP-6	221-B-TK-27-4	TS-2-3
BP-6	221-B-TK-28-3	TS-2-3
BP-6	221-B-TK-28-4	TS-2-3
BP-6	221-B-TK-29-4	TS-2-3
BP-6	221-B-TK-30-3	TS-2-3
BP-6	221-B-WS-1	TS-2-3
BP-6	221-B-WS-2	TS-2-3
BP-6	241-B-154	S-2-4
BP-6	241-BX-154	S-2-4
BP-6	241-BX-155	S-2-4
BP-6	B PLANT FILTE	TS-2-3
BP-7	241-B-151	S-2-4
BP-7	241-B-152	S-2-4
BP-7	241-B-153	S-2-4
BP-7	241-B-252	S-2-4
BP-7	241-B-TK-101	S-2-4
BP-7	241-B-TK-102	S-2-4
BP-7	241-B-TK-103	S-2-4
BP-7	241-B-TK-104	S-2-4
BP-7	241-B-TK-105	S-2-4
BP-7	241-B-TK-106	S-2-4
BP-7	241-B-TK-107	S-2-4
BP-7	241-B-TK-108	S-2-4
BP-7	241-B-TK-109	S-2-4
BP-7	241-B-TK-110	S-2-4
BP-7	241-B-TK-111	S-2-4
BP-7	241-B-TK-112	S-2-4

OU	Site Code	TSD Number
BP-7	241-B-TK-201	S-2-4
BP-7	241-B-TK-202	S-2-4
BP-7	241-B-TK-203	S-2-4
BP-7	241-B-TK-204	S-2-4
BP-7	241-BR-152	S-2-4
BP-7	241-BX-153	S-2-4
BP-7	241-BX-TK-101	S-2-4
BP-7	241-BX-TK-102	S-2-4
BP-7	241-BX-TK-103	S-2-4
BP-7	241-BX-TK-104	S-2-4
BP-7	241-BX-TK-105	S-2-4
BP-7	241-BX-TK-106	S-2-4
BP-7	241-BX-TK-107	S-2-4
BP-7	241-BX-TK-108	S-2-4
BP-7	241-BX-TK-109	S-2-4
BP-7	241-BX-TK-110	S-2-4
BP-7	241-BX-TK-111	S-2-4
BP-7	241-BX-TK-112	S-2-4
BP-7	241-BXR-151	S-2-4
BP-7	241-BXR-152	S-2-4
BP-7	241-BXR-153	S-2-4
BP-7	241-BY-TK-101	S-2-4
BP-7	241-BY-TK-102	S-2-4
BP-7	241-BY-TK-103	S-2-4
BP-7	241-BY-TK-104	S-2-4
BP-7	241-BY-TK-105	S-2-4
BP-7	241-BY-TK-106	S-2-4
BP-7	241-BY-TK-107	S-2-4
BP-7	241-BY-TK-108	S-2-4
BP-7	241-BY-TK-109	S-2-4
BP-7	241-BY-TK-110	S-2-4
BP-7	241-BY-TK-111	S-2-4
BP-7	241-BY-TK-112	S-2-4
BP-7	241-BYR-152	S-2-4
BP-7	241-BYR-153	S-2-4
BP-7	241-BYR-154	S-2-4
BP-7	244-BX RT	S-2-3
BP-7	UPR-200-E-108	
BP-7	UPR-200-E-116	
BP-7	UPR-200-E-127	
BP-7	UPR-200-E-128	
BP-7	UPR-200-E-129	
BP-7	UPR-200-E-130	
BP-7	UPR-200-E-131	
BP-7	UPR-200-E-132	
BP-7	UPR-200-E-133	
BP-7	UPR-200-E-134	
BP-7	UPR-200-E-135	
BP-7	UPR-200-E-5	

Table C-2. List of RCRA TSD Units. (sheet 2 of 4)

OU	Site Code	TSD Number
BP-9	HWVP	TS-2-5
IU-3	600 NDWL	D-6-1
IU-5	241-EW-151	S-2-3
IU-5	616	S-6-1
PO-2	202-A-TK-E-F11	TS-2-6
PO-2	202-A-TK-E5	TS-2-6
PO-2	202-A-TK-F15	TS-2-6
PO-2	202-A-TK-F16	TS-2-6
PO-2	202-A-TK-F18	TS-2-6
PO-2	202-A-TK-G7	TS-2-6
PO-2	202-A-TK-U3	TS-2-6
PO-2	202-A-TK-U4	TS-2-6
PO-2	202-A-WS-1	TS-2-6
PO-2	216-A-10	D-2-2
PO-2	216-A-36B	D-2-4
PO-2	218-E-14	S-2-1
PO-2	218-E-15	S-2-1
PO-3	204-AR	T-2-3
PO-3	241-A-152	S-2-4
PO-3	241-A-153	S-2-4
PO-3	241-A-TK-101	S-2-4
PO-3	241-A-TK-102	S-2-4
PO-3	241-A-TK-103	S-2-4
PO-3	241-A-TK-104	S-2-4
PO-3	241-A-TK-105	S-2-4
PO-3	241-A-TK-106	S-2-4
PO-3	241-AN-TK-101	S-2-3
PO-3	241-AN-TK-102	S-2-3
PO-3	241-AN-TK-103	S-2-3
PO-3	241-AN-TK-104	S-2-3
PO-3	241-AN-TK-105	S-2-3
PO-3	241-AN-TK-106	S-2-3
PO-3	241-AN-TK-107	S-2-3
PO-3	241-AP-TK-101	S-2-3
PO-3	241-AP-TK-102	S-2-3
PO-3	241-AP-TK-103	S-2-3
PO-3	241-AP-TK-104	S-2-3
PO-3	241-AP-TK-105	S-2-3
PO-3	241-AP-TK-106	S-2-3
PO-3	241-AP-TK-107	S-2-3
PO-3	241-AP-TK-108	S-2-3
PO-3	241-AW-TK-101	S-2-3
PO-3	241-AW-TK-102	S-2-3
PO-3	241-AW-TK-103	S-2-3
PO-3	241-AW-TK-104	S-2-3
PO-3	241-AW-TK-105	S-2-3
PO-3	241-AW-TK-106	S-2-3
PO-3	241-AX-151	S-2-4
PO-3	241-AX-152DS	S-2-4
PO-3	241-AX-155	S-2-4
PO-3	241-AX-TK-101	S-2-4
PO-3	241-AX-TK-102	S-2-4
PO-3	241-AX-TK-103	S-2-4
PO-3	241-AX-TK-104	S-2-4
PO-3	241-AY-151	S-2-4
PO-3	241-AY-152	S-2-4
PO-3	241-AY-TK-101	S-2-3
PO-3	241-AY-TK-102	S-2-3
PO-3	241-AZ-TK-101	S-2-3
PO-3	241-AZ-TK-102	S-2-3
PO-3	241-C-151	S-2-4
PO-3	241-C-152	S-2-4
PO-3	241-C-153	S-2-4
PO-3	241-C-252	S-2-4
PO-3	241-C-TK-101	S-2-4
PO-3	241-C-TK-102	S-2-4
PO-3	241-C-TK-103	S-2-4
PO-3	241-C-TK-104	S-2-4
PO-3	241-C-TK-105	S-2-4
PO-3	241-C-TK-106	S-2-4
PO-3	241-C-TK-107	S-2-4
PO-3	241-C-TK-108	S-2-4
PO-3	241-C-TK-109	S-2-4
PO-3	241-C-TK-110	S-2-4
PO-3	241-C-TK-111	S-2-4
PO-3	241-C-TK-112	S-2-4
PO-3	241-C-TK-201	S-2-4
PO-3	241-C-TK-202	S-2-4
PO-3	241-C-TK-203	S-2-4
PO-3	241-C-TK-204	S-2-4
PO-3	241-CR-151	S-2-4
PO-3	241-CR-152	S-2-4
PO-3	241-CR-153	S-2-4
PO-3	242-A	T-2-6
PO-3	244-A RT	S-2-3
PO-3	244-AR VAULT	S-2-3
PO-3	244-CR VAULT	S-2-3
PO-3	GTF	TD-2-1
PO-3	GTFL	TD-2-1
PO-3	UPR-200-E-115	
PO-3	UPR-200-E-119	
PO-3	UPR-200-E-125	
PO-3	UPR-200-E-126	
PO-3	UPR-200-E-136	
PO-3	UPR-200-E-137	
PO-3	UPR-200-E-59	
PO-4	216-A-37-1	D-2-10
PO-5	207-A-SOUTH	S-2-7
PO-6	200-E8 BPDS	T-2-1
PO-6	218-E-12B	D-2-9
RO-1	216-S-10D	D-2-7
RO-1	216-S-10P	D-2-7

Table C-2. List of RCRA TSD Units. (sheet 3 of 4)

OU	Site Code	TSD Number
RO-2	244-S RT	S-2-3
RO-2	276-S-TK-141	TS-2-2
RO-2	276-S-TK-142	TS-2-2
RO-3	219-S-TK-101	TS-2-1
RO-3	219-S-TK-102	TS-2-1
RO-3	219-S-TK-103	TS-2-1
RO-3	222-SD	TS-2-1
RO-3	240-S-151	S-2-4
RO-3	240-S-152	S-2-4
RO-3	2727-S	S-2-5
RO-4	241-S-152	S-2-4
RO-4	241-S-TK-101	S-2-4
RO-4	241-S-TK-102	S-2-4
RO-4	241-S-TK-103	S-2-4
RO-4	241-S-TK-104	S-2-4
RO-4	241-S-TK-105	S-2-4
RO-4	241-S-TK-106	S-2-4
RO-4	241-S-TK-107	S-2-4
RO-4	241-S-TK-108	S-2-4
RO-4	241-S-TK-109	S-2-4
RO-4	241-S-TK-110	S-2-4
RO-4	241-S-TK-111	S-2-4
RO-4	241-S-TK-112	S-2-4
RO-4	241-SX-151	S-2-4
RO-4	241-SX-152	S-2-4
RO-4	241-SX-TK-101	S-2-4
RO-4	241-SX-TK-102	S-2-4
RO-4	241-SX-TK-103	S-2-4
RO-4	241-SX-TK-104	S-2-4
RO-4	241-SX-TK-105	S-2-4
RO-4	241-SX-TK-106	S-2-4
RO-4	241-SX-TK-107	S-2-4
RO-4	241-SX-TK-108	S-2-4
RO-4	241-SX-TK-109	S-2-4
RO-4	241-SX-TK-110	S-2-4
RO-4	241-SX-TK-111	S-2-4
RO-4	241-SX-TK-112	S-2-4
RO-4	241-SX-TK-113	S-2-4
RO-4	241-SX-TK-114	S-2-4
RO-4	241-SX-TK-115	S-2-4
RO-4	241-SY-TK-101	S-2-3
RO-4	241-SY-TK-102	S-2-3
RO-4	241-SY-TK-103	S-2-3
RO-4	UPR-200-W-140	
RO-4	UPR-200-W-141	
RO-4	UPR-200-W-142	
RO-4	UPR-200-W-143	
RO-4	UPR-200-W-144	
RO-4	UPR-200-W-145	
RO-4	UPR-200-W-146	
SO-1	241-C-154	S-2-4

OU	Site Code	TSD Number
SO-1	241-CX-TK-70	S-2-9
SO-1	241-CX-TK-71	S-2-9
SO-1	241-CX-TK-72	S-2-9
SS-1	2101-M POND	D-2-1
SS-2	200-W ADS	T-2-2
TP-2	241-TX-155	S-2-4
TP-4	221-T CSTF	T-2-4
TP-4	221-T-TK-15-1	T-2-7
TP-4	224-T	S-2-2
TP-5	241-TX-153	S-2-4
TP-5	241-TX-302X	S-2-4
TP-5	241-TX-TK-101	S-2-4
TP-5	241-TX-TK-102	S-2-4
TP-5	241-TX-TK-103	S-2-4
TP-5	241-TX-TK-104	S-2-4
TP-5	241-TX-TK-105	S-2-4
TP-5	241-TX-TK-106	S-2-4
TP-5	241-TX-TK-107	S-2-4
TP-5	241-TX-TK-108	S-2-4
TP-5	241-TX-TK-109	S-2-4
TP-5	241-TX-TK-110	S-2-4
TP-5	241-TX-TK-111	S-2-4
TP-5	241-TX-TK-112	S-2-4
TP-5	241-TX-TK-113	S-2-4
TP-5	241-TX-TK-114	S-2-4
TP-5	241-TX-TK-115	S-2-4
TP-5	241-TX-TK-116	S-2-4
TP-5	241-TX-TK-117	S-2-4
TP-5	241-TX-TK-118	S-2-4
TP-5	241-TXR-151	S-2-4
TP-5	241-TXR-152	S-2-4
TP-5	241-TXR-153	S-2-4
TP-5	241-TY-153	S-2-4
TP-5	241-TY-TK-101	S-2-4
TP-5	241-TY-TK-102	S-2-4
TP-5	241-TY-TK-103	S-2-4
TP-5	241-TY-TK-104	S-2-4
TP-5	241-TY-TK-105	S-2-4
TP-5	241-TY-TK-106	S-2-4
TP-5	242-T-151	S-2-4
TP-5	244-TX RT	S-2-3
TP-5	244-TXR	S-2-4
TP-5	UPR-200-W-129	
TP-5	UPR-200-W-149	
TP-5	UPR-200-W-150	
TP-5	UPR-200-W-151	
TP-5	UPR-200-W-152	
TP-5	UPR-200-W-153	
TP-6	241-T-151	S-2-4
TP-6	241-T-152	S-2-4
TP-6	241-T-153	S-2-4

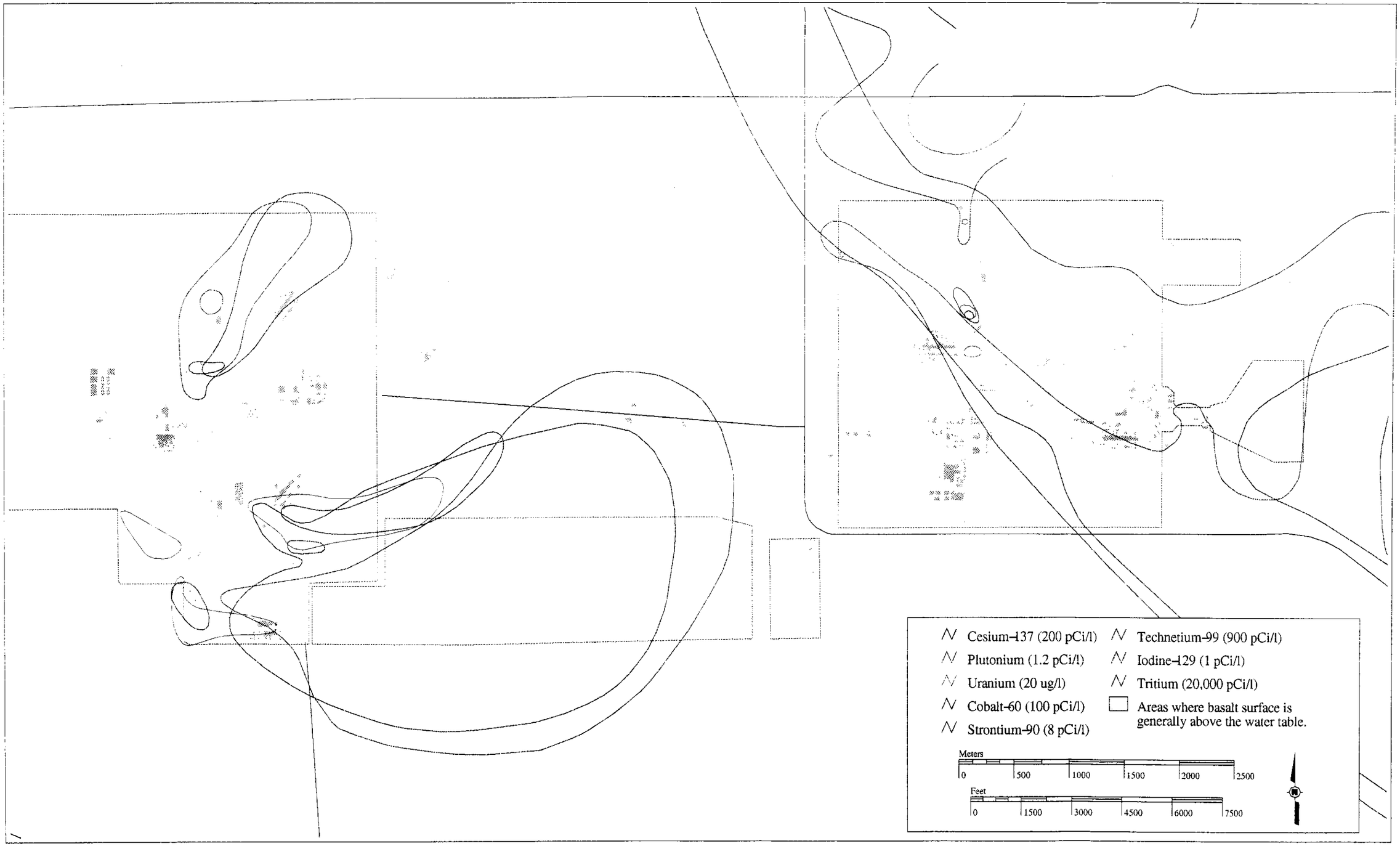
Table C-2. List of RCRA TSD Units. (sheet 4 of 4)

OU	Site Code	TSD Number
TP-6	241-T-252	S-2-4
TP-6	241-T-TK-101	S-2-4
TP-6	241-T-TK-102	S-2-4
TP-6	241-T-TK-103	S-2-4
TP-6	241-T-TK-104	S-2-4
TP-6	241-T-TK-105	S-2-4
TP-6	241-T-TK-106	S-2-4
TP-6	241-T-TK-107	S-2-4
TP-6	241-T-TK-108	S-2-4
TP-6	241-T-TK-109	S-2-4
TP-6	241-T-TK-110	S-2-4
TP-6	241-T-TK-111	S-2-4
TP-6	241-T-TK-112	S-2-4
TP-6	241-T-TK-201	S-2-4
TP-6	241-T-TK-202	S-2-4
TP-6	241-T-TK-203	S-2-4
TP-6	241-T-TK-204	S-2-4
TP-6	241-TR-152	S-2-4
TP-6	241-TR-153	S-2-4
TP-6	UPR-200-W-147	
TP-6	UPR-200-W-148	
UP-2	216-U-12	D-2-8
UP-3	241-U-153	S-2-4
UP-3	241-U-252	S-2-4
UP-3	241-U-TK-101	S-2-4
UP-3	241-U-TK-102	S-2-4
UP-3	241-U-TK-103	S-2-4
UP-3	241-U-TK-104	S-2-4
UP-3	241-U-TK-105	S-2-4
UP-3	241-U-TK-106	S-2-4
UP-3	241-U-TK-107	S-2-4
UP-3	241-U-TK-108	S-2-4
UP-3	241-U-TK-109	S-2-4
UP-3	241-U-TK-110	S-2-4
UP-3	241-U-TK-111	S-2-4
UP-3	241-U-TK-112	S-2-4
UP-3	241-U-TK-201	S-2-4
UP-3	241-U-TK-202	S-2-4
UP-3	241-U-TK-203	S-2-4
UP-3	241-U-TK-204	S-2-4
UP-3	241-UR-151	S-2-4
UP-3	241-UR-152	S-2-4
UP-3	241-UR-153	S-2-4
UP-3	241-UR-154	S-2-4
UP-3	244-U RT	S-2-3
UP-3	UPR-200-W-128	
UP-3	UPR-200-W-154	
UP-3	UPR-200-W-155	
UP-3	UPR-200-W-156	
UP-3	UPR-200-W-157	
ZP-2	241-Z	T-2-5
ZP-3	218-W-3A	D-2-9
ZP-3	218-W-3AE	D-2-9
ZP-3	218-W-4B	D-2-9
ZP-3	218-W-4C	D-2-9
ZP-3	218-W-5	D-2-9
ZP-3	218-W-6	D-2-9
ZP-3	RMWSF	TS-2-4
ZP-3	WRAP	TS-2-4

APPENDIX D

GROUNDWATER PLUME MAPS

Radiological Groundwater Plumes in and around 200 West and 200 East Areas



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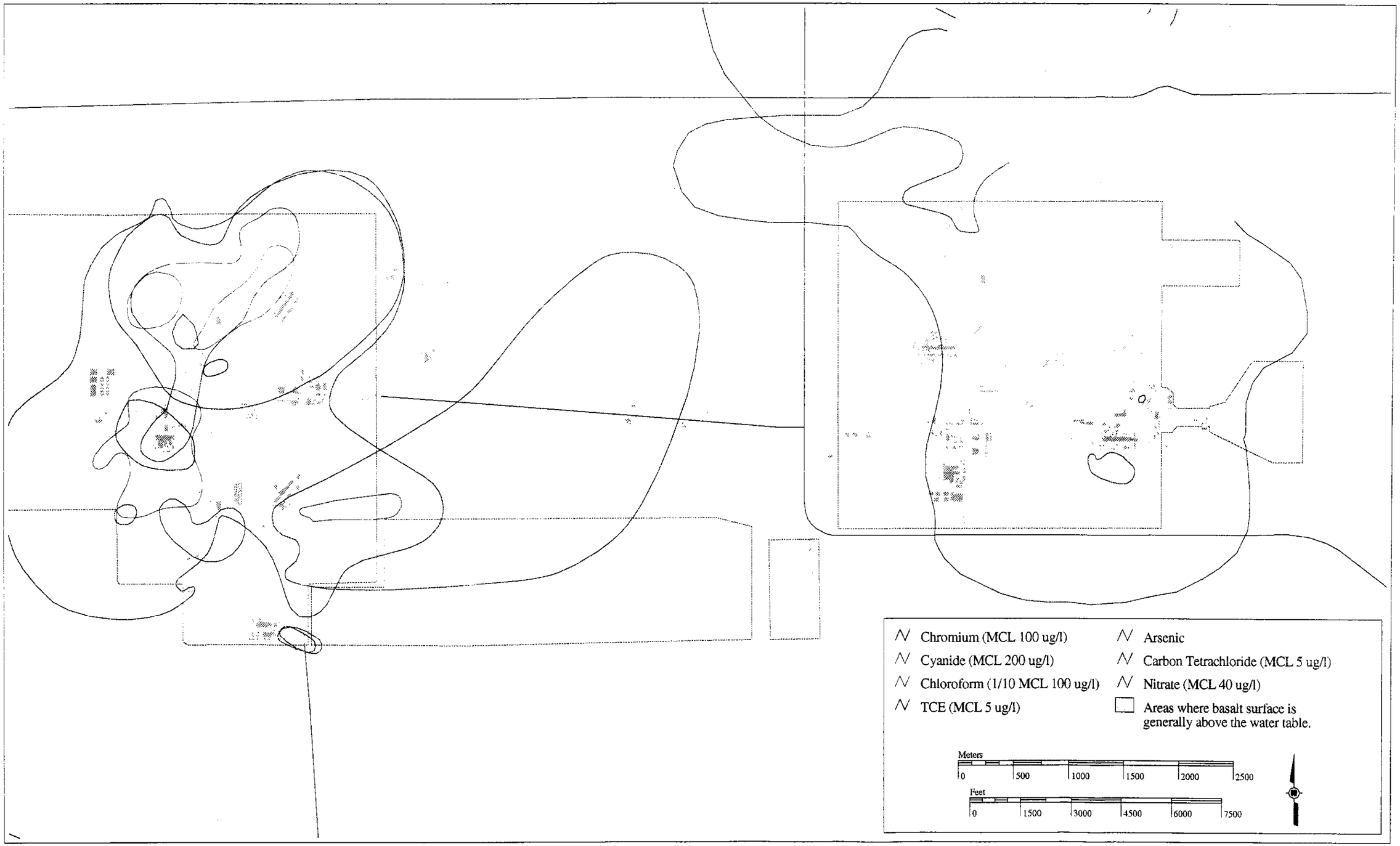
Chemical Groundwater Plumes in and around 200 West and 200 East Areas



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