START

0021190

DOE/RL-92-04
Draft A

UC-630

PUREX Source Aggregate Area Management Study Report

Date Published
May 1992

JUN 1992
RECEIVED
EDMC

9 2 1 2 5 1 5 0 0 0 2

United States
Department of Energy
P.O. Box 550
Richland, Washington 99352

Approved for Public Release

TRADEMARK DISCLAIMER

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy.

Printed in the United States of America

DISCLM-4.CHP (1-91)

CONTENTS

Page

1.0 INTRODUCTION 1-1
1.1 OVERVIEW 1-1
1.1.1 Tri-Party Agreement 1-2
1.1.2 Hanford Site Past Practice Strategy 1-2
1.2 200 NPL SITE AGGREGATE AREA MANAGEMENT STUDY PROGRAM 1-4
1.2.1 Overall Approach 1-4
1.2.2 Process Overview 1-5
1.3 PURPOSE, SCOPE, AND OBJECTIVES 1-9
1.4 QUALITY ASSURANCE 1-11
1.5 ORGANIZATION OF REPORT 1-11

2.0 FACILITY, PROCESS AND OPERATIONAL HISTORY DESCRIPTIONS . . . 2-1
2.1 LOCATION 2-1
2.2 HISTORY OF OPERATIONS 2-1
2.3 FACILITIES, BUILDINGS, AND STRUCTURES 2-3
2.3.1 Plants, Buildings, and Storage Areas 2-8
2.3.2 Tanks and Vaults 2-13
2.3.3 Cribs and Drains 2-45
2.3.4 Reverse Wells 2-63
2.3.5 Ponds, Ditches, and Trenches 2-63
2.3.6 Septic Tanks and Associated Drain Fields 2-66
2.3.7 Transfer Facilities, Diversion Boxes, and Pipelines 2-68
2.3.8 Basins 2-77
2.3.9 Burial Sites 2-78
2.3.10 Unplanned Releases 2-80
2.4 WASTE GENERATING PROCESSES 2-81
2.4.1 PUREX Process 2-82
2.4.2 Waste Volume Reduction Process 2-84
2.4.3 Tank Farm Condensate 2-84
2.5 INTERACTIONS WITH OTHER AGGREGATE AREAS OR OPERABLE UNITS 2-85
2.6 INTERACTION WITH RESOURCE CONSERVATION AND RECOVERY ACT PROGRAM 2-86
2.7 INTERACTIONS WITH OTHER HANFORD PROGRAMS 2-86

3.0 SITE CONDITIONS 3-1
3.1 PHYSIOGRAPHY AND TOPOGRAPHY 3-1
3.2 METEOROLOGY 3-2
3.2.1 Precipitation 3-3
3.2.2 Winds 3-3
3.2.3 Temperature 3-3

CONTENTS (cont.)

Page

3.3 SURFACE HYDROLOGY 3-4
3.3.1 Regional Surface Hydrology 3-4
3.3.2 Surface Hydrology of the Hanford Site 3-4
3.3.3 PUREX Plant Aggregate Area Surface Hydrology 3-5
3.4 GEOLOGY 3-6
3.4.1 Regional Tectonic Framework 3-6
3.4.2 Regional Stratigraphy 3-8
3.4.3 200 East Area and PUREX Plant Aggregate Area Geology 3-14
3.5 HYDROGEOLOGY 3-19
3.5.1 Regional Hydrogeology 3-19
3.5.2 Hanford Site Hydrogeology 3-20
3.5.3 PUREX Plant Aggregate Area Hydrogeology 3-29
3.6 ENVIRONMENTAL RESOURCES 3-31
3.6.1 Flora and Fauna 3-32
3.6.2 Land Use 3-36
3.6.3 Water Use 3-37
3.7 HUMAN RESOURCES 3-37
3.7.1 Demography 3-37
3.7.2 Archaeology 3-37
3.7.3 Historical Resources 3-38
3.7.4 Community Involvement 3-38

4.0 PRELIMINARY CONCEPTUAL SITE MODEL 4-1
4.1 KNOWN AND SUSPECTED CONTAMINATION 4-1
4.1.1 Affected Media 4-3
4.1.2 Site Specific Data 4-9
4.2 POTENTIAL IMPACTS TO HUMAN HEALTH AND THE ENVIRONMENT 4-30
4.2.1 Release Mechanisms 4-31
4.2.2 Transport Pathways 4-32
4.2.3 Conceptual Model 4-38
4.2.4 Characteristics of Contaminants 4-39

5.0 HEALTH AND ENVIRONMENTAL CONCERNS 5-1
5.1 CONCEPTUAL FRAMEWORK FOR RISK-BASED SCREENING 5-2
5.2 POTENTIAL EXPOSURE SCENARIOS AND HUMAN HEALTH CONCERNS 5-3
5.2.1 External Exposure 5-3
5.2.2 Ingestion of Soil or Inhalation of Fugitive Dust 5-4
5.2.3 Inhalation of Volatiles 5-5

CONTENTS (cont.)

Page

5.2.4 Migration to Groundwater 5-5
5.3 ADDITIONAL SCREENING CRITERIA 5-6
5.4 SUMMARY OF SCREENING RESULTS 5-7

6.0 IDENTIFICATION OF POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR THE PUREX PLANT AGGREGATE AREA 6-1
6.1 INTRODUCTION 6-1
6.2 CONTAMINANT-SPECIFIC REQUIREMENTS 6-3
6.2.1 Federal Requirements 6-3
6.2.2 State of Washington Requirements 6-6
6.1.3 National Pollutant Discharge Elimination System (WAC 173-220 and 40 CFR 122) and Water Quality Standards 6-9
6.3 LOCATION-SPECIFIC REQUIREMENTS 6-9
6.4 ACTION-SPECIFIC REQUIREMENTS 6-10
6.4.1 Federal Requirements 6-10
6.4.2 State of Washington Requirements 6-17
6.5 OTHER CRITERIA AND GUIDANCE TO BE CONSIDERED 6-19
6.5.1 Health Advisories 6-19
6.5.2 International Commission of Radiation Protection/ National Council on Radiation Protection 6-19
6.5.3 EPA Proposed Corrective Actions for Solid Waste Management Units 6-19
6.6 POINT OF APPLICABILITY 6-19
6.7 ARARs EVALUATION 6-20

7.0 PRELIMINARY REMEDIAL ACTION TECHNOLOGIES 7-1
7.1 PRELIMINARY REMEDIAL ACTION OBJECTIVES 7-2
7.2 PRELIMINARY GENERAL RESPONSE ACTIONS 7-4
7.3 TECHNOLOGY SCREENING 7-5
7.4 PRELIMINARY REMEDIAL ACTION ALTERNATIVES 7-7
7.4.1 Development of Remedial Alternatives 7-7
7.4.2 Alternative 1--Engineered Multimedia Cover with or without Vertical Barriers 7-10
7.4.3 Alternative 2--In Situ Grouting or Stabilization of Soil 7-10
7.4.4 Alternative 3--Excavation, Soil Treatment, and Disposal 7-11
7.4.5 Alternative 4--In Situ Vitrification of Soil 7-11
7.4.6 Alternative 5--Excavation, Above-Ground Treatment and Geologic Disposal of Soil with TRU Radionuclides 7-12
7.4.7 Alternative 6--In Situ Soil Vapor Extraction for VOCs 7-12

CONTENTS (cont.)

Page

7.5 PRELIMINARY REMEDIAL ACTION ALTERNATIVES APPLICABLE TO WASTE MANAGEMENT UNITS AND UNPLANNED RELEASE SITES 7-13

8.0 DATA QUALITY OBJECTIVES 8-1
8.1 DECISION TYPES (STAGE 1 OF THE DQO PROCESS) 8-1
8.1.1 Data Users 8-2
8.1.2 Available Information 8-3
8.1.3 Evaluation of Available Data 8-9
8.1.4 Conceptual Model 8-11
8.1.5 Aggregate Area Management Study Objectives and Decisions 8-11
8.2 DATA USES AND NEEDS (STAGE 2 OF THE DQO PROCESS) 8-13
8.2.1 Data Uses 8-14
8.2.2 Data Needs 8-16
8.2.3 Data Gaps 8-20
8.3 DATA COLLECTION PROGRAM (STAGE 3 OF THE DQO PROCESS) 8-21
8.3.1 General Rationale 8-22
8.3.2 General Strategy 8-23
8.3.3 Investigation Methodology 8-23
8.3.4 Data Evaluation and Decision Making 8-28

9.0 RECOMMENDATIONS 9-1
9.1 DECISION MAKING CRITERIA 9-2
9.1.1 Expedited Response Action Path 9-4
9.1.2 Limited Field Investigation and Interim Remedial Measure Paths 9-6
9.1.3 Final Remedy Selection Path 9-7
9.2 PATH RECOMMENDATIONS 9-8
9.2.1 Proposed Sites for Expedited Response Actions 9-8
9.2.2 Proposed Sites for Interim Remedial Measures 9-11
9.2.3 Proposed Sites for Limited Field Investigation Activities 9-11
9.2.4 Proposed Sites for Final Remedy Selection 9-15
9.3 SOURCE OPERABLE UNIT REDEFINITION AND PRIORITIZATION . 9-18
9.3.1 Units Deferred to Other Aggregate Areas or Programs 9-18
9.3.2 PUREX Plant Operable Unit Redefinition 9-19
9.3.3 Investigation Prioritization 9-20
9.3.4 RCRA Facility Interface 9-20
9.4 FEASIBILITY STUDY 9-21
9.4.1 Focused Feasibility Study 9-21
9.4.2 Final Feasibility Study 9-24

CONTENTS (cont.)

Page

9.5 TREATABILITY STUDIES 9-24

10.0 REFERENCES 10-1

APPENDIX A SUPPLEMENTAL DATA
APPENDIX B HEALTH AND SAFETY PLAN
APPENDIX C PROJECT MANAGEMENT PLAN
APPENDIX D PLAN

PLATES:

Plate 1 Facilities, Sites, and Unplanned Releases
Plate 2 Topography
Plate 3 Monitor Wells and Sample Locations
Plate 4 Tank Farms Enlargement

CONTENTS (cont.)

Page

FIGURES:

1-1 Hanford Site Map 1F-1
1-2 Hanford Site Past-Practice Strategy Flow Chart 1F-2
1-3 200 East Aggregate Areas 1F-3
1-4 200 West Aggregate Areas 1F-4
1-5 200 NPL Site Isolated Operable Units 1F-5
2-1 Operational and Waste-Related History 2F-1
2-2 Location of Plants, Buildings, and Storage Areas 2F-2
2-3 Locations of Tank and Vaults 2F-3
2-4 Locations of Tank and Vaults 2F-4
2-5 Location of 241-AP and 241-AW Tank Farms 2F-5
2-6 Typical Tank 2F-6
2-7 Typical Double-Shell Tank 2F-7
2-8 Location of Cribs and Drains 2F-8
2-9 Typical Crib 2F-9
2-10 Typical French Drain 2F-10
2-11 Location of Ditches and Trenches 2F-11
2-12 Location of Septic Tanks and Drain Fields 2F-12
2-13 Location of Process Lines and Transfer Facilities 2F-13
2-14 Location of Basins 2F-14
2-15 Location of Burial Sites and Burning Pits 2F-15
2-16 Location of Unplanned Releases 2F-16
3-1 Topography and Location Map for the Hanford Site 3F-1
3-2 Divisions of the Columbia Intermontane Province and Adjacent Snake River Plains Province 3F-2
3-3 Geomorphic Units Within the Central Highlands and Columbia Basin Subprovinces that Contain the Columbia River Basalt Group 3F-3
3-4 Landforms of the Pasco Basin and the Hanford Site 3F-4
3-5 Geomorphic Features Surrounding the 200 Areas 3F-5
3-6 Hanford Site Wind Roses, 1979 through 1982 . . . . . 3F-6
3-7 Hydrologic Basins Designated for the Washington State Portion of the Columbia Plateau 3F-7
3-8 Structural Provinces of the Columbia Plateau 3F-8
3-9 Structural Subprovinces of the Columbia Plateau 3F-9
3-10 Structural Elements of the Yakima Fold Belt Subprovince 3F-10
3-11 Geologic Structures of the Pasco Basin and the Hanford Site 3F-11
3-12 Generalized Stratigraphy of the Hanford Site 3F-12
3-13 Generalized Stratigraphy of the Suprabasalt Sediments Beneath the Hanford Site 3F-13
3-14 Location of Cross-sections 3F-14

CONTENTS (cont.)

Page

FIGURES (cont.):

3-15 Legend for Cross-Sections 3F-15
3-16 Geologic Cross-Section - I-I' 3F-16
3-17 Geologic Cross-Section - B-B' 3F-17
3-18 Geologic Cross-Section - C-C' 3F-18
3-19 Isopach Map of the Ringold Gravel Unit A 3F-19
3-20 Top of the Ringold Gravel Unit A 3F-20
3-21 Isopach Map of the Ringold Lower Mud Sequence 3F-21
3-22 Structure Map of the Ringold Lower Mud Sequence 3F-22
3-23 Isopach Map of the Ringold Gravel Unit E 3F-23
3-24 Structure Map of the Ringold Gravel Unit E 3F-24
3-25 Top of the Ringold Formation 3F-25
3-26 Isopach Map of the Lower Gravel Sequence 3F-26
3-27 Structure Map of the Lower Gravel Sequence 3F-27
3-28 Isopach Map of the Sandy Sequence 3F-28
3-29 Structure Map of the Sandy Sequence 3F-29
3-30 Isopach Map of the Upper Gravel Sequence 3F-30
3-31 Isopach Map of the Entire Hanford Formation 3F-31
3-32 Conceptual Geologic Hydrocolumn for the Hanford Site 3F-32
3-33 Wetting and Drying Curves for Well 299-W18-21 . . . . . 3F-33
3-34 Particle Size Distribution and Water Retention Characteristics of Soil From Hanford Site Lysimeters 3F-34
3-35 200 Areas Water Table Map, June 1990 . . . . . 3F-35
3-36 Conceptual Hydrogeologic Column for the PUREX Plant Aggregate Area 3F-36
4-1 Gamma Isoradiation Contour Map of the 200 East Area 4F-1
4-2 Surface, Underground and Migrating Map of the 200 West Area 4F-2
4-3 Conceptual Model of the PUREX Plant Aggregate Area 4F-3
7-1 Development of Candidate Remedial Alternatives for PUREX Plant Aggregate Area 7F-1
7-2 Alternative 1: Multimedia Cover 7F-2
7-3 Alternative 2: In Situ Grouting of Soil 7F-3
7-4 Alternative 3: Excavation, Treatment and Disposal 7F-4
7-5 Alternative 4: In Situ Vitrification of Soil 7F-5
7-6 Alternative 5: Excavation, Vitrification, and Geologic Disposal of Soil with TRU Radionuclides 7F-6
7-7 Alternative 6: Soil Vapor Extraction for Volatile Organic Compounds (VOCs) 7F-7
9-1 200 Aggregate Area Management Studies Decision Making Flowchart 9F-1

CONTENTS (cont.)

TABLES: Page

1-1 Overall Aggregate Area Management Study (AAMS) Schedule for the 200 NPL Site 1T-1
2-1 Summary of PUREX Plant Aggregate Area Waste Management Units 2T-1
2-2 Radionuclide Waste Inventory Summary 2T-2
2-3 Chemical Waste Inventory Summary 2T-3
2-4 Description of PUREX Plant Aggregate Area Tank Farms 2T-4
2-5 Description of Unplanned Releases 2T-5
2-6 Summary of Waste-Producing Processes in the PUREX Plant Aggregate Area . . 2T-6
2-7 Chemicals Used or Produced in Separation/Recovery Processes 2T-7
2-8 Chemicals Used in the 202-A Building Analytical Laboratory (1955-1972) 2T-8
2-9 Radionuclides and Chemicals Disposed of to PUREX Plant Aggregate Area Waste Management Units 2T-9
2-10 Listing of Treatment, Storage, and Disposal Groups/Units Within the PUREX Plant Aggregate Area 2T-10
2-11 Radiation Area Remedial Action Units in the PUREX Plant Aggregate Area 2T-11
2-12 Defense Waste Management Program Units in the PUREX Plant Aggregate Area 2T-12
3-1 Hydraulic Parameters for Various Areas and Geologic Units at the Hanford Site 3T-1
3-2 Summary of Reported Hydraulic Conductivity Values for Hanford Site Vadose Zone Sediments 3T-2
3-3 Endangered, Threatened, and Sensitive Plant Species Reported on or Near the Hanford Site 3T-3
3-4 Federal and State Classifications of Animals that Could Occur on the 200 Areas Plateau 3T-4
4-1 Summary of Known and Suspected Radionuclide Contamination 4T-1
4-2 Summary of Chemical Contamination in Various Affected Media for PUREX Plant Aggregate Area 4T-2
4-3 Types of Data Available for Each Waste Management Unit 4T-3
4-4 Summary of Air Monitoring Results 4T-4
4-5 Radiation and Dose Rate Surveys at the PUREX Plant Aggregate Area Waste Management Units 4T-5
4-6 Results of External Radiation Monitoring, 1985 through 1989 TLDs (mrem/yr) . 4T-6
4-7 Results of External Radiation Monitoring for 1990 TLDs (mrem/yr) 4T-7
4-8 Summary of Grid Soil Sampling Results (pCi/g) 4T-8
4-9 Summary of Fenceline Soil Sampling Results (pCi/g) 4T-9
4-10 Results of Surface Water Sampling (pCi/g) 4T-10
4-11 Summary of Vegetation Sampling Results (pCi/g) 4T-11
4-12 Summary of Gamma-Ray Logs that were Reviewed 4T-12
4-13 Potential for Migration of Liquid Discharges to the Unconfined Aquifer 4T-13
4-14 TRAC Inventory Data 4T-14

CONTENTS (cont.)

Page

TABLES (cont.):

4-15 Results of Analysis of Supernatant Liquid from 241-AX-102 Single-Shell Tank . 4T-15
4-16 Results of Analysis of Volatile Priority Pollutants in Vapor Samples 4T-16
4-17 Results of Analysis of Volatile Priority Pollutants in Vapor Samples and a Liquid Sample 4T-17
4-18 Results of Analysis of a Core Sample from 241-C-103 Single-Shell Tank, Riser R-2 . . . . . 4T-18
4-19 Results of Analysis of a Core Sample from 241-C-104 Single-Shell Tank 4T-19
4-20 Results of Analysis of a Core Sample from 241-C-105 Single-Shell Tank 4T-20
4-21 Results of Analysis of a Sludge Sample from 241-C-106 Single-Shell Tank 4T-21
4-22 Results of Analysis of a Sludge Sample from 241-C-105 Single-Shell Tank 4T-22
4-23 Sampling Analysis of Complexed Double-Shell Tanks 4T-23
4-24 Summary of Tank Farm Vadose Zone Well Geophysical Logging Results 4T-24
4-25 Cesium Inventories for Tank Leak Unplanned Releases 4T-25
4-26 Results of Groundwater Sampling for the 216-A-36B Crib (mg/L) 4T-26
4-27 Waste Inventory for the 216-A-36B Crib 4T-27
4-28 Average Concentrations of Radiological Parameters for PUREX (ASD) Waste Effluent and Groundwater Near the 216-A-36B Crib for 1983 through 1987 . . . 4T-28
4-29 Groundwater Parameters Measured in Monitoring Wells for the 216-A-36B Crib 4T-29
4-30 Candidate Contaminants of Potential Concern for the PUREX Plant Aggregate Area 4T-30
4-31 Summary of Known and Suspected Contamination at Each Waste Management Unit and Unplanned Release Site 4T-31
4-32 Contaminants of Potential Concern the for PUREX Plant Aggregate Area 4T-32
4-33 Soil-Water Distribution Coefficient K_d for Radionuclides and Inorganics of Concern at PUREX Plant Waste Management Units 4T-33
4-34 Mobility of Inorganic Species in Soil 4T-34
4-35 Physical/Chemical Properties of Organic Contaminants of Concern for PUREX Plant Waste Management Units 4T-35
4-36 Radiological Properties of Potential Radionuclides of Concern in PUREX Plant Waste Management Units 4T-36
4-37 Comparison of Radionuclide Relative Risks for Radionuclides of Concern at the PUREX Plant Aggregate Area 4T-37
4-38 Potential Chronic Health Effects of Chemicals Detected or Disposed of at PUREX Plant Aggregate Area 4T-38
5-1 Hazard Ranking Scores for PUREX Plant Aggregate Area 5T-1
6-1 Potential Contaminant-Specific ARARs and TBCs for Preliminary Inorganic and Organic Contaminants of Concerns 6T-1
6-2 Potential Location-Specific ARARs 6T-2

CONTENTS (cont.)

Page

TABLES (cont.):

7-1 Preliminary Remedial Action Objectives and General Response Actions 7T-1
7-2 Preliminary Remedial Action Technologies 7T-2
7-3 Screening of Process Options 7T-3
7-4 Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites 7T-4
8-1 Uses of Existing Data for PUREX Plant Aggregate Area Waste Management Units 8T-1
8-2 Data Needs for Preliminary Remedial Action Alternatives PUREX Plant Aggregate Area 8T-2
8-3 Analytical Levels for the PUREX Plant Aggregate Area 8T-3
8-4 Data Quality Objective Parameters for Chemical/Radiochemical Analyses 8T-4
8-5 Data Gaps by Site Category 8T-5
8-6 Applicable Characterization Methods at PUREX Plant Aggregate Area Waste Management Units 8T-6
9-1 Summary of the Result of Data Evaluation Assessment for PUREX Plant Aggregate Area 9T-1
9-2 PUREX Plant Aggregate Area Data Evaluation Decision Matrix 9T-2
9-3 Waste Management Units and Unplanned Releases Deferred to Other Programs . 9T-3

ACRONYMS AND ABBREVIATIONS

AAMS	aggregate area management study
AAMSR	aggregate area management study report
AEA	Atomic Energy Act
AFAN	ammonium fluoride - ammonium nitrate
AKART	all known, available, and reasonable treatment technologies
ALARA	as low as reasonably achievable
AMU	aqueous makeup unit
ANSI	American National Standards Institute
ARARs	applicable or relevant and appropriate requirements
ARCL	allowable residual contamination level
ASD	ammonia scrubber distillate
ASIL	acceptable source impact level
ASME	American Society of Mechanical Engineers
BAT	best available technology
BDAT	best demonstrated available treatment technologies
BWIP	Basalt Waste Isolation Project
CCW	constituent concentrations in waste
CCWE	constituent concentrations in waste extract
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CMS	Corrective Measures Studies
CRP	Community Relations Plan
CSL	Chemical Sewer Line
CWA	Clean Water Act
CWL	Cooling Water Line
DCG	Derived Concentration Guide
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DWMP	Defense Waste Management Program
DQO	data quality objective
EC	evaporator - crystallizer
Ecology	Washington State Department of Ecology
EDMC	Environmental Data Management Center
EHPSS	Environmental Health and Pesticide Services Section
EII	Environmental Investigations Instructions
EIMP	Environmental Information Management Plan
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ERA	expedited response actions
ERRA	Environmental Restoration Remedial Action

9 2 1 2 5 6 0 0 1 4

ACRONYMS AND ABBREVIATIONS (cont.)

ES&H	Environment, Safety, and Health
FFS	focused feasibility study
FOMP	Field Office Management Plan
FRS	final remedy selection
FS	feasibility study
FWQC	Federal Water Quality Criteria
GTR	Grout Treatment Facility
Health	Washington State Department of Health
HEDL	Hanford Engineering and Development Laboratory
HEHF	Hanford Environmental Health Foundation
HEIS	Hanford Environmental Information System
HEPA	high efficiency particulate air
HISS	Hanford Inactive Site Survey
HMS	Hanford Meteorological Station
HRS	Hazard Ranking System
HWOP	Hazardous Waste Operations Permit
HWSA	Hazardous Waste Staging Area
ICRP	International Commission on Radiological Protection
IRM	interim remedial measure
JSA	Job Safety Analysis
LDR	land disposal restriction
LFI	limited field investigation
LLRW	low-level radioactive waste
LSC	liquid scintillation counting
MCL	maximum contaminant levels
MCS	Management Control System
MEPAS	Multimedia Environmental Pollutant Assessment System
mHRS	modified Hazard Ranking System
MTCA	Model Toxics Control Act
NAAQS	National Ambient Air Quality Standards
NCP	National Contingency Plan
NCRP	National Council on Radiation Protection
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NFA	no further action
NIOSH	National Institute for Occupational Safety and Health
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
NSPS	New Source Performance Standards
OSHA	Occupational Safety and Health Administration
OSM	Office of Sample Management
P&O	pipe and operating

ACRONYMS AND ABBREVIATIONS (cont.)

PARCC	precision, accuracy, representativeness, completeness, comparability
PA	preliminary assessment
PDD	process condensate
PNL	Pacific Northwest Laboratory
PSPL	Puget Sound Power and Light Company
PUREX	plutonium uranium extraction
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RA	risk assessment
RAO	remedial action objective
RARA	Radiation Area Remedial Action
RAS	Routine Analytical Services
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
REDOX	reduction and oxidation
RI	remedial investigation
RFI	RCRA Facility Investigations
RLS	Radionuclide Logging System
ROD	record of decision
RTECS	Registry of Toxic Effects of Chemical Systems
RWP	Radiation Work Permit
SARA	Superfund Amendments and Reauthorization Act
SCIR	Surveillance and Compliance Inspection Report
SDWA	Safe Drinking Water Act
SI	site inspection
SWP	special work permit
TAP	Toxic Air Pollutant
T-BACT	toxic best available control technology
TBC	to-be-considered material
TCLP	toxicity characteristic leaching procedure
TLD	thermoluminescent dosimeter
TOC	total organic carbon
TRAC	Tracks Radioactive Components
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
TRU	transuranic
TSD	treatment, storage or disposal
UO_3	uranium trioxide
USC	U.S. Code
USGS	U.S. Geological Survey
VOC	volatile organic compound

ACRONYMS AND ABBREVIATIONS (cont.)

WAC	Washington Administrative Code
WIDS	Waste Information Data System
WIPP	Waste Isolation Pilot Plant
WISHA	Washington Industrial Safety and Health Act
WMP	Waste Management Plan
WPCA	Washington State Water Pollution Control Act
WPPSS	Washington Public Power Supply System

9 2 1 2 5 1 5 3 1 7

PUREX PLANT SOURCE AAMS EXECUTIVE SUMMARY

This report presents the results of an aggregate area management study (AAMS) for the PUREX Plant Aggregate Area in the 200 Areas of the U.S. Department of Energy (DOE) Hanford Site in Washington State. This scoping level study provides the basis for initiating Remedial Investigation/Feasibility Study (RI/FS) activities under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) or Resource Conservation and Recovery Act (RCRA) Facility Investigations (RFI) and Corrective Measures Studies (CMS) under RCRA. This report also integrates select RCRA treatment, storage or disposal (TSD) closure activities with CERCLA and RCRA past practice investigations.

Through the experience gained to date on developing work plans, closure plans, permit applications at the Hanford Site, the parties to the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) have recognized that all past practice investigations must be managed and implemented under one characterization and remediation strategy, regardless of the regulatory agency lead (as defined in the Tri-Party Agreement). In particular, the parties have identified a need for greater efficiency over the existing RI/FS and RFI/CMS investigative approaches, and have determined that, to expedite the ultimate goal of cleanup, much more emphasis needs to be placed on initiating and completing waste site cleanup through interim measures.

This streamlined approach is described and justified in The *Hanford Federal Facility Agreement and Consent Order Change Package*, dated May 16, 1991 (Ecology et al. 1991). To implement this approach, the three parties have developed the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) for streamlining the past practice remedial action process. This strategy provides new concepts for:

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

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

The *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) describes the concepts and framework for the RI/FS (or RFI/CMS) process in a manner that has a bias-for-action through optimizing the use of interim remedial actions, culminating with decisions on final remedies on both an operable-unit and aggregate-area scale. The strategy focuses on reaching early decisions to initiate and complete cleanup projects, maximizing the use of

existing data, coupled with focused short time-frame investigations, where necessary. As more data become available on contamination problems and associated risks, the details of the longer term investigations and studies will be better defined.

The strategy includes three paths for interim decision-making and a final remedy-selection process for the operable unit that incorporates the three paths and integrates sites not addressed in those paths. The three paths for interim decision-making include the ERA, IRM, and limited field investigation (LFI) paths. The strategy requires that aggregate area management study reports (AAMSRs) be prepared to provide an evaluation of existing site data to support initial path decisions. This AAMSR is one of ten reports that will be prepared for each of the ten aggregate areas defined in the 200 Areas.

The near-term past practice strategy for the 200 Areas provides for ERAs, IRMs, and LFIs for individual waste management units, waste management unit groups and groundwater plumes, and recommends separate source and groundwater operable units. Initial site-specific recommendations for each of the waste management units within the PUREX Plant Aggregate Area are provided in the report. Work plans will initially focus on limited intrusive investigations at the highest priority waste management units or waste management unit groups as established in the AAMSR. The goal of this initial focus is to establish whether IRMs are justified. Waste management units identified as candidate ERAs in Section 9.0 of the AAMS will be further evaluated following the *Site Selection Process for Expedited Response Actions at the Hanford Site* (Gustafson 1991).

While these elements may mitigate specific contamination problems through interim actions, the process of final remedy selection must be completed for the operable unit or aggregate area to reach closure. The aggregation of information obtained from the LFIs and interim actions may be sufficient to perform the cumulative risk assessment and to define the final remedy for the operable unit or aggregate area. If the data are not sufficient, additional investigations and studies will be performed to the extent necessary to support final remedy selection. These investigations would be performed within the framework and process defined for RI/FS programs.

Several integration issues exist that are generic to the overall past practice process for the 200 Areas and include the following:

Future Work Plan Scope. Although the current practice for implementing RI/FS (RFI/CMS) activities is through operable unit based work plans, individual LFI/IRMs may be more efficiently implemented using LFI-IRM-specific work plans.

Groundwater Operable Units. A general strategy recommended for the 200 Areas is to define separate operable units for groundwater affected by 200 Areas source terms. This requires that groundwater be removed from the scope of existing source operable

units and new groundwater-specific operable units be established. Recommendations for groundwater operable units will be developed in the groundwater AAMSRs.

Work Plan Prioritization. Although priorities are established in the AAMSR for operable units within the aggregate area, priorities between aggregate areas have yet to be established. The integration of priorities at the 200 Areas level is considered a prerequisite for establishing a schedule for past practice activities in the 200 Areas.

It is intended that these integration issues be resolved following the completion of all ten AAMSRs (Draft A) scheduled for September 1992. Resolution of these issues will be based on a decisions/consensus process among the U.S. Environmental Protection Agency (EPA), Washington State Department of Ecology (Ecology), and DOE. Following resolution of these issues a schedule for past practice activities in the 200 Areas will be prepared.

Background, environmental setting, and known contamination data are provided in Sections 2.0, 3.0, and 4.1. This information provides the basis for development of the preliminary conceptual model in Section 4.2 and for assessing health and environmental concerns in Section 5.0. Preliminary applicable or relevant and appropriate requirements (ARARs) (Section 6.0) and preliminary remedial action technologies (Section 7.0) are also developed based on this data. Section 8.0, provides a discussion of the data quality objectives. Data needs identified in Section 8.0 are based on data gaps determined during the development of the conceptual model, human health and environmental concerns, ARARs, and remedial action technologies. Recommendations in Section 9.0 are developed using all the information provided in the sections which precede it.

The Hanford Site, operated by the DOE, occupies about 1,450 km^2 (560 mi^2) of the southeastern part of Washington north of the confluence of the Yakima and Columbia Rivers. The Hanford Site was established in 1943 to produce plutonium for nuclear weapons using production reactors and chemical processing plants. The PUREX Plant Aggregate Area is located within the 200 East Area, near the middle of the Hanford Site. There are six operable units within the PUREX Plant Aggregate Area.

The 202-A Building (PUREX Plant) was constructed for the purpose of extracting plutonium, uranium, and neptunium contained in irradiated uranium fuel rods discharged from the Hanford Site reactors. The PUREX chemical separation processes are based on dissolving the decladded fuel rods in nitric acid and conducting multiple purification operations on the resultant aqueous nitrate solution. The process steps involve fuel-element decladding, uranium metal dissolution, solvent extraction, ion exchange and product load-out. Some effluents from the 202-A Building are routed through the 242-A Evaporator where they are concentrated prior to disposal to various waste management units.

The PUREX Plant Aggregate Area contains a large variety of waste disposal and storage facilities. High-level wastes were stored in underground single-shell and double-shell tanks. Low-level wastes such as cooling and condensate water were allowed to infiltrate into the ground through cribs, ditches, and open ponds. Based on construction, purpose, or origin, the PUREX Plant Aggregate Area waste management units fall into one of ten subgroups as follows:

- 6 (No. of waste management units) Plants, Buildings, and Storage Areas
- 60 Tanks and Vaults
- 40 Cribs and Drains
- 1 Reverse Well
- 6 Ponds, Ditches, and Trenches
- 7 Septic Tanks and Associated Drain Fields
- 30 Transfer Facilities, Diversion Boxes, and Pipelines
- 2 Basins
- 6 Burial Sites
- 63 Unplanned Releases.

Detailed descriptions of these waste management units are provided in Section 2.3.

There are several ongoing programs that affect buildings and waste management units in the PUREX Plant Aggregate Area (Section 2.7). These programs include RCRA, the Hanford Surplus Facilities Program, the Radiation Area Remedial Action (RARA) Program, the Hanford Site Single-Shell Tank Program, and the Defense Waste Management Program. One hundred and eighteen units (primarily single-shell tanks, double-shell tanks and associated transfer facilities) fall completely within the scope of one of these programs and, therefore, recommendations on these units will be made by the respective programs rather than in this AAMS. An additional sixteen waste management units will be partially addressed by an ongoing program in addition to the actions recommended in the PUREX Plant AAMS.

Discussions of surface hydrology and geology are provided on a regional, Hanford Site, and aggregate area basis in Section 3.0. The interpretation is based on a limited

number of wells and this limitation does not support a detailed delineation of waste management unit-specific features. The section also describes the flora and fauna, land use, water use, and human resources of the 200 East Area and vicinity. Groundwater of the 200 East Area is described in detail in a separate Groundwater AAMSR.

A preliminary site conceptual model is presented in Section 4.0. Section 4.1 presents the chemical and radiological data that are available for the different media types (including surface soil, vadose zone soil, air, surface water, and biota) and site-specific data for each waste management unit and unplanned release.

A preliminary assessment of potential impacts to human health and the environment is presented in Section 4.2. This assessment includes a discussion of release mechanisms, potential transport pathways, and a preliminary conceptual model of human exposure based on these pathways. Physical, radiological, and toxicological characteristics of the known and suspected contaminants at the aggregate area are also discussed.

Health and environmental concerns are presented in Section 5.0. The preliminary qualitative evaluation of potential human health concerns is intended to provide input to the waste management unit recommendation process. The evaluation includes (1) an identification of contaminants of potential concern for each exposure pathway that is likely to occur within the PUREX Plant Aggregate Area, (2) identification of exposure pathways applicable to individual waste management units and (3) estimates of relative hazard based on four available indicators of risk; the CERCLA Hazard Ranking System (HRS) and modified HRS (mHRS), surface radiation survey data, and Westinghouse Environmental Protection Group site scoring.

Potential ARARs to be used in developing and assessing various remedial action alternatives at the PUREX Plant Aggregate Area are discussed in Section 6.0. Specific potential requirements pertaining to hazardous and radiological waste management, remediation of contaminated soils, surface water protection, and air quality are discussed.

Preliminary remedial action technologies are presented in Section 7.0. The process includes identification of remedial action objectives (RAOs), determination of general response actions, and identification of specific process options associated with each option type. The process options are screened based on their effectiveness, implementability and cost. The screened process options are combined into alternatives and the alternatives are described.

Data quality is addressed in Section 8.0. Identification of chemical and radiological constituents associated with the units and their concentrations, with a view to determine the contaminants of concern and their action levels, is a major requirement to execute the

Hanford Site Past-Practice Strategy. There was found to be a limited amount of data in this regard. The section provides a summary of data needs identified for each of the waste management units in the PUREX Plant Aggregate Area. The data needs provide the basis for development of detailed DQOs in subsequent work plans.

Section 9.0 provides management recommendations for the PUREX Plant Aggregate Area based on the *Hanford Site Past-Practice Strategy*. Criteria for selecting appropriate *Hanford Site Past-Practice Strategy* paths (ERA, IRM, and final remedy selection) for individual waste management units and unplanned releases in the PUREX Plant Aggregate Area are developed in Section 9.1. As a result of the data evaluation process, 23 units were recommended for IRMs, 23 units were recommended for LFIs which could lead to IRMs and 80 units were recommended for final remedy selection. A discussion of the data evaluation process is provided in Section 9.2. Table ES-1 provides a summary of the results of the data evaluation assessment of each unit. Table ES-2 provides the decision matrix patterns each unit followed in reaching the recommendation. Recommendations for redefining operable unit boundaries and prioritizing operable units for work plan development are provided in Section 9.3. Included in Section 9.3 are the interactions with RCRA required to disposition the 216-A-29, 216-A-10, 216-A-36B and 218-E-12B RCRA TSD facilities. All recommendations for future characterization needs will be more fully developed and implemented through work plans. Sections 9.4 and 9.5 provide recommendations for focused feasibility and treatability studies, respectively.

Table ES-1. Summary of the Results of Data Evaluation Assessment for PUREX Plant Aggregate Area.

Waste Management Unit	Site Type	ERA	IRM	LFI	RA	RI	OPS	Remarks
Cribs and Drains								
216-A-1	Crib		X	X				
216-A-2	Crib					X		
216-A-3	Crib					X		
216-A-4	Crib		X	X				
216-A-5	Crib		X	X				
216-A-6	Crib		X	X				
216-A-7	Crib		X	X				
216-A-8	Crib		X	X			X	
216-A-9	Crib		X	X				
216-A-10	Crib					X		
216-A-21	Crib		X	X				
216-A-24	Crib		X	X				
216-A-27	Crib		X	X				
216-A-30	Crib		X	X				
216-A-31	Crib					X		
216-A-32	Crib					X		
216-A-36A	Crib		X	X				
216-A-36B	Crib		X	X				
216-A-37-1	Crib					X	X	
216-A-37-2	Crib		X	X			X	
216-A-38-1	Crib					X		
216-A-41	Crib					X		
216-A-45	Crib					X	X	
216-A-11	French Drain					X		
216-A-12	French Drain					X		
216-A-13	French Drain					X		
216-A-14	French Drain		X	X				
216-A-15	French Drain					X		
216-A-22	French Drain					X		
216-A-26	French Drain					X	X	
216-A-26A	French Drain					X		

Table ES-1. Summary of the Results of Data Evaluation Assessment for PUREX Plant Aggregate Area.

Waste Management Unit	Site Type	ERA	IRM	LFI	RA	RI	OPS	Remarks
Cribs and Drains								
216-A-28	French Drain		X	X				
216-A-33	French Drain					X		
216-A-35	French Drain					X		
216-C-8	French Drain		X	X				
Reverse Wells								
299-E24-111	Injection Well					X		
Ponds, Ditches and Trenches								
216-A-29	Ditch					X	X	
216-A-34	Ditch					X		
216-A-18	Trench					X		
216-A-19	Trench					X		
216-A-20	Trench					X		
216-A-40	Trench					X		
Septic Tanks and Associated Drain Fields								
2607-EA	Septic Tank/Drain Field					X	X	
2607-EC	Septic Tank/Drain Field					X	X	
2607-ED	Septic Tank/Drain Field					X	X	
2607-EG	Septic Tank					X	X	
2607-EJ	Septic Tank					X	X	
2607-EL	Septic Tank					X	X	
2607-E6	Septic Tank/Drain Field					X	X	
Basins								
207-A	Retention Basin					X	X	
216-A-42	Retention Basin					X	X	
Burial Sites								
200-E	Burning Pit		X	X				
218-E-1	Burial Ground		X	X				
218-E-8	Burial Ground		X	X				
218-E-12A	Burial Ground		X	X				
218-E-12B	Burial Ground		X	X			X	
218-E-13	Burial Ground		X	X				

Table ES-1. Summary of the Results of Data Evaluation Assessment for PUREX Plant Aggregate Area.

Waste Management Unit	Site Type	ERA	IRM	LFI	RA	RI	OPS	Remarks
Unplanned Releases								
UN-200-E-10	Unplanned Release					X		
UN-200-E-11	Unplanned Release					X		
UN-200-E-12	Unplanned Release					X		
UN-200-E-13	Unplanned Release					X		
UN-200-E-15	Unplanned Release					X		
UN-200-E-19	Unplanned Release					X		
UN-200-E-20	Unplanned Release					X		
UN-200-E-22	Unplanned Release					X		
UN-200-E-25	Unplanned Release					X		
UN-200-E-26	Unplanned Release					X		
UN-200-E-28	Unplanned Release					X		
UN-200-E-31	Unplanned Release					X		
UN-200-E-33	Unplanned Release					X		
UN-200-E-35	Unplanned Release					X		
UN-200-E-39	Unplanned Release					X		
UN-200-E-40	Unplanned Release					X		
UN-200-E-42	Unplanned Release					X		
UN-200-E-47	Unplanned Release					X		
UN-200-E-49	Unplanned Release					X		
UN-200-E-56	Unplanned Release					X		
UN-200-E-58	Unplanned Release					X		
UN-200-E-60	Unplanned Release					X		
UN-200-E-62	Unplanned Release					X		
UN-200-E-65	Unplanned Release					X		
UN-200-E-67	Unplanned Release					X		
UN-200-E-68	Unplanned Release					X		
UN-200-E-72	Unplanned Release					X		
UN-200-E-86	Unplanned Release					X		

Table ES-1. Summary of the Results of Data Evaluation Assessment for PUREX Plant Aggregate Area.

Waste Management Unit	Site Type	ERA	IRM	LFI	RA	RI	OPS	Remarks
Unplanned Releases								
UN-200-E-88	Unplanned Release					X		
UN-200-E-91	Unplanned Release					X		
UN-200-E-94	Unplanned Release					X		
UN-200-E-96	Unplanned Release					X		
UN-200-E-97	Unplanned Release					X		
UN-200-E-99	Unplanned Release					X		
UN-200-E-100	Unplanned Release					X		
UN-200-E-114	Unplanned Release					X		
UN-200-E-117	Unplanned Release					X		
UN-200-E-142	Unplanned Release					X		
UPR-200-E-17	Unplanned Release					X		
UPR-200-E-21	Unplanned Release					X		
UPR-200-E-24	Unplanned Release					X		
UPR-200-E-29	Unplanned Release					X		
UPR-200-E-30	Unplanned Release					X		
UPR-200-E-50	Unplanned Release					X		
UPR-200-E-53	Unplanned Release					X		
UPR-200-E-106	Unplanned Release					X		

Table ES-2. PUREX Plant Aggregate Area Data Evaluation Decision Matrix.

Waste Management Unit or Unplanned Release	ERA Evaluation Pathway								IRM Evaluation Pathway			LFI Path	Final Remedy
	Is an ERA Justified?	Release?	Pathway?	Quantity?	Concen-tration?	Treat-ment Avail-ability?	Adverse Conse-quences?	Opera-tional Programs?	High Priority?	Data Adequate?	Adverse Conse-quences?	Collect Data?	Data Adequate?
Cribs and Drains													
216-A-1 Crib	Y	Y	N	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-2 Crib	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-3 Crib	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-4 Crib	Y	Y	N	--	--	--	--	--	Y	N	--	Y	--
216-A-5 Crib	Y	Y	N	--	--	--	--	--	Y	N	--	Y	--
216-A-6 Crib	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-7 Crib	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-8 Crib	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-9 Crib	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-10 Crib	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-21 Crib	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-24 Crib	Y	Y	N	--	--	--	--	--	Y	N	--	Y	--
216-A-27 Crib	Y	Y	N	--	--	--	--	--	Y	N	--	Y	--
216-A-30 Crib	Y	Y	N	--	--	--	--	--	Y	N	--	Y	--
216-A-31 Crib	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-32 Crib	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-36A Crib	Y	Y	N	--	--	--	--	--	Y	N	--	Y	--
216-A-36B Crib	Y	Y	N	--	--	--	--	--	Y	N	--	Y	--
216-A-37-1 Crib	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-37-2 Crib	Y	Y	N	--	--	--	--	--	Y	N	--	Y	--
216-A-38-1 Crib	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-41 Crib	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-45 Crib	N	--	--	--	--	--	--	--	N	N	--	--	N
216-A-11 French Drain	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-12 French Drain	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-13 French Drain	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-14 French Drain	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-15 French Drain	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-22 French Drain	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-26 French Drain	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-26A French Drain	Y	Y	N	--	--	--	--	--	N	--	--	--	N

Table ES-2. PUREX Plant Aggregate Area Data Evaluation Decision Matrix.

Waste Management Unit or Unplanned Release	ERA Evaluation Pathway								IRM Evaluation Pathway			LFI Path	Final Remedy
	Is an ERA Justified?	Release?	Pathway?	Quantity?	Concen-tration?	Treat-ment Avail-ability?	Adverse Conse-quences?	Opera-tional Programs?	High Priority?	Data Adequate?	Adverse Conse-quences?	Collect Data?	Data Adequate?
Cribs and Drains													
216-A-28 French Drain	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-33 French Drain	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-35 French Drain	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-C-8 French Drain	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
Reverse Wells													
299-E34-111 Injection Well	Y	Y	N	--	--	--	--	--	N	--	--	--	N
Ponds, Ditches and Trenches													
216-A-29 Ditch	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-34 Ditch	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-18 Trench	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-19 Trench	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-20 Trench	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-40 Trench	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
Septic Tanks and Associated Drain Fields													
2607-E6 Septic Tank	N	--	--	--	--	--	--	--	N	--	--	--	N
2607-EA Septic Tank	N	--	--	--	--	--	--	--	N	--	--	--	N
2607-EC Septic Tank	N	--	--	--	--	--	--	--	N	--	--	--	N
2607-ED Septic Tank	N	--	--	--	--	--	--	--	N	--	--	--	N
2607-EG Septic Tank	N	--	--	--	--	--	--	--	N	--	--	--	N
2607-EJ Septic Tank	N	--	--	--	--	--	--	--	N	--	--	--	N
2607-EL Septic Tank	N	--	--	--	--	--	--	--	N	--	--	--	N
Basins													
207-A Retention Basins	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-42 Retention Basin	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
Burial Sites													
200-E Burning Pit	Y	Y	N	--	--	--	--	--	N	--	--	--	N
218-E-1 Burial Ground	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
218-E-8 Burial Ground	Y	Y	N	--	--	--	--	--	N	--	--	--	N
218-E-12A Burial Ground	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
218-E-12B Burial Ground	Y	Y	N	--	--	--	--	--	N	--	--	--	N

Table ES-2. PUREX Plant Aggregate Area Data Evaluation Decision Matrix.

Waste Management Unit or Unplanned Release	ERA Evaluation Pathway								IRM Evaluation Pathway			LFI Path	Final Remedy
	Is an ERA Justified?	Release?	Pathway?	Quantity?	Concen-tration?	Treat-ment Avail-ability?	Adverse Conse-quences?	Opera-tional Programs?	High Priority?	Data Adequate?	Adverse Conse-quences?	Collect Data?	Data Adequate?
Burial Sites													
218-E-13 Burial Ground	Y	Y	N	--	--	--	--	--	N	--	--	--	N
Unplanned Releases													
UN-200-E-10	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-11	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-12	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-13	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-15	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-19	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-20	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-22	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-25	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-26	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-28	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-31	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-33	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-35	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-39	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-40	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-43	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-47	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-49	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-56	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-58	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-60	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-63	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-65	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-67	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-68	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-72	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-86	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-88	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--

Table ES-2. PUREX Plant Aggregate Area Data Evaluation Decision Matrix.

Waste Management Unit or Unplanned Release	ERA Evaluation Pathway								IRM Evaluation Pathway			LFI Path	Final Remedy
	Is an ERA Justified?	Release?	Pathway?	Quantity?	Concen-tration?	Treat-ment Avail-ability?	Adverse Conse-quences?	Opera-tional Programs?	High Priority?	Data Adequate?	Adverse Conse-quences?	Collect Data?	Data Adequate?
Unplanned Releases													***
UN-200-E-91	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-94	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-96	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-97	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-99	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-100	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
UN-200-E-114	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-117	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-142	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UPR-200-E-17	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UPR-200-E-21	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UPR-200-E-24	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UPR-200-E-29	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UPR-200-E-30	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UPR-200-E-50	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UPR-200-E-53	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UPR-200-E-106	Y	Y	N	--	--	--	--	--	N	--	--	--	N

"- -" Indicates decision point not reached on pathway. Evaluation branched to lower path.

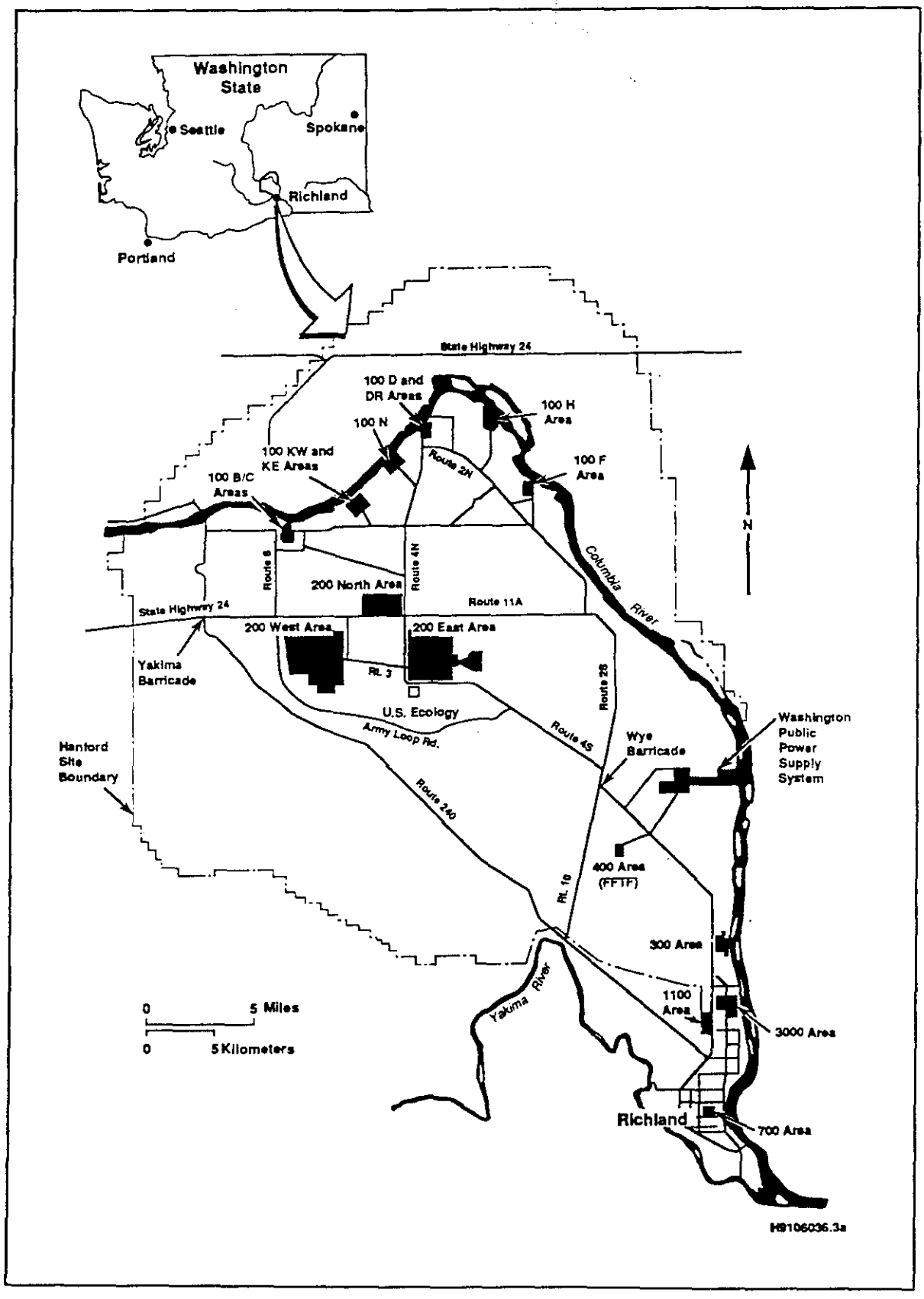


Figure 1-1. Hanford Site Map.

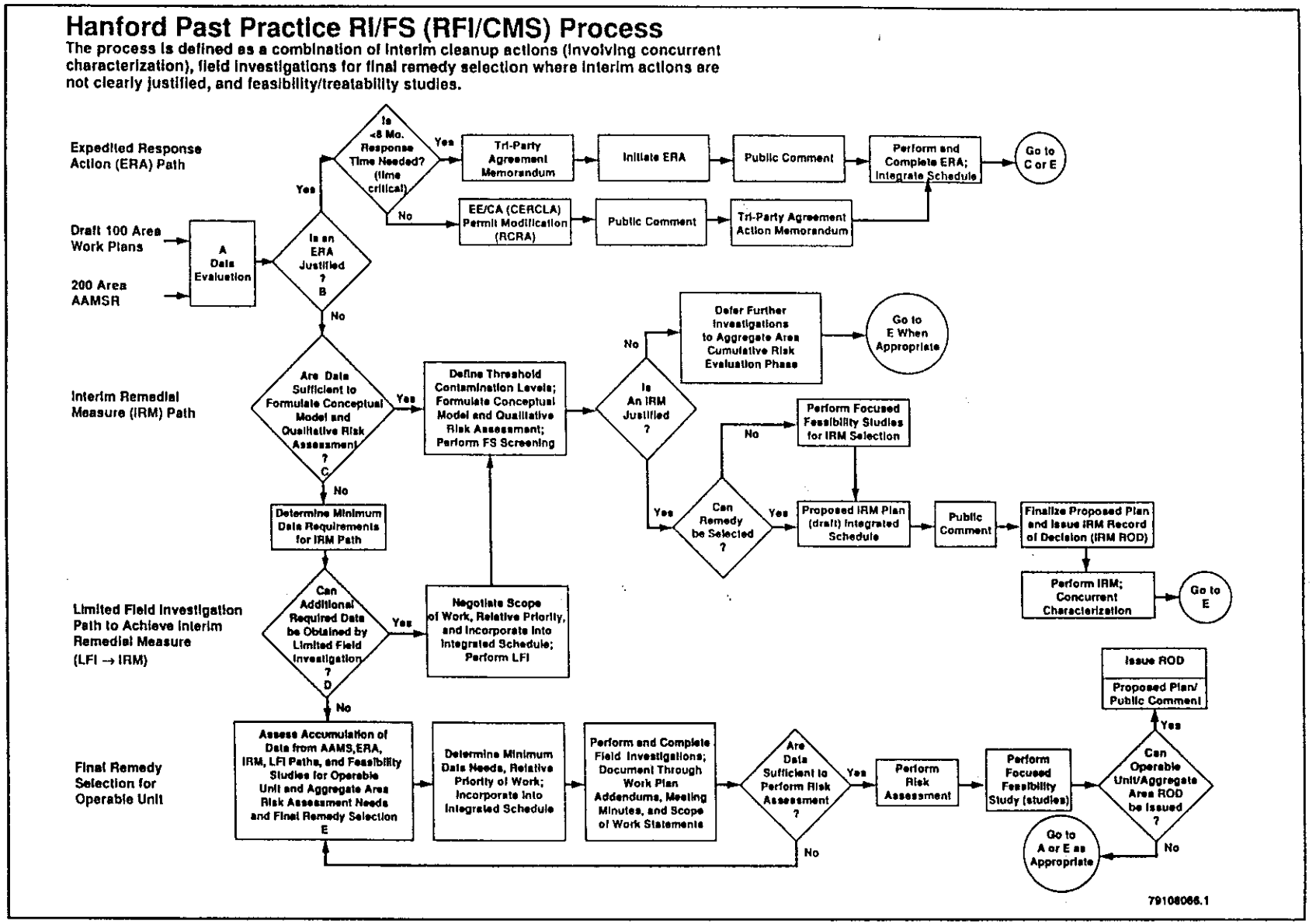


Figure 1-2. Hanford Site Past-Practice Strategy Flow Chart. (DOE/RL 1992a)

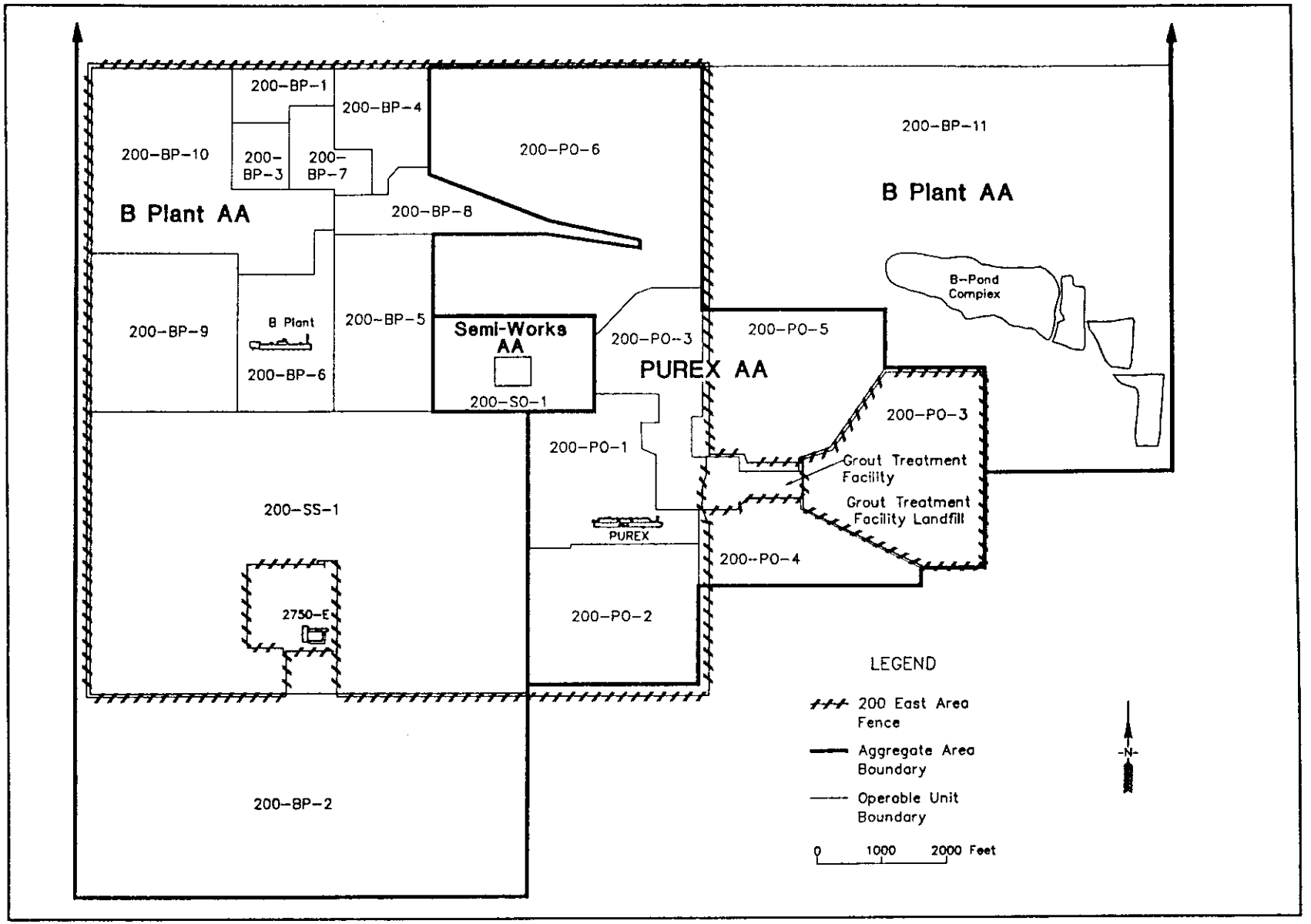


Figure 1-3. 200 East Aggregate Areas.

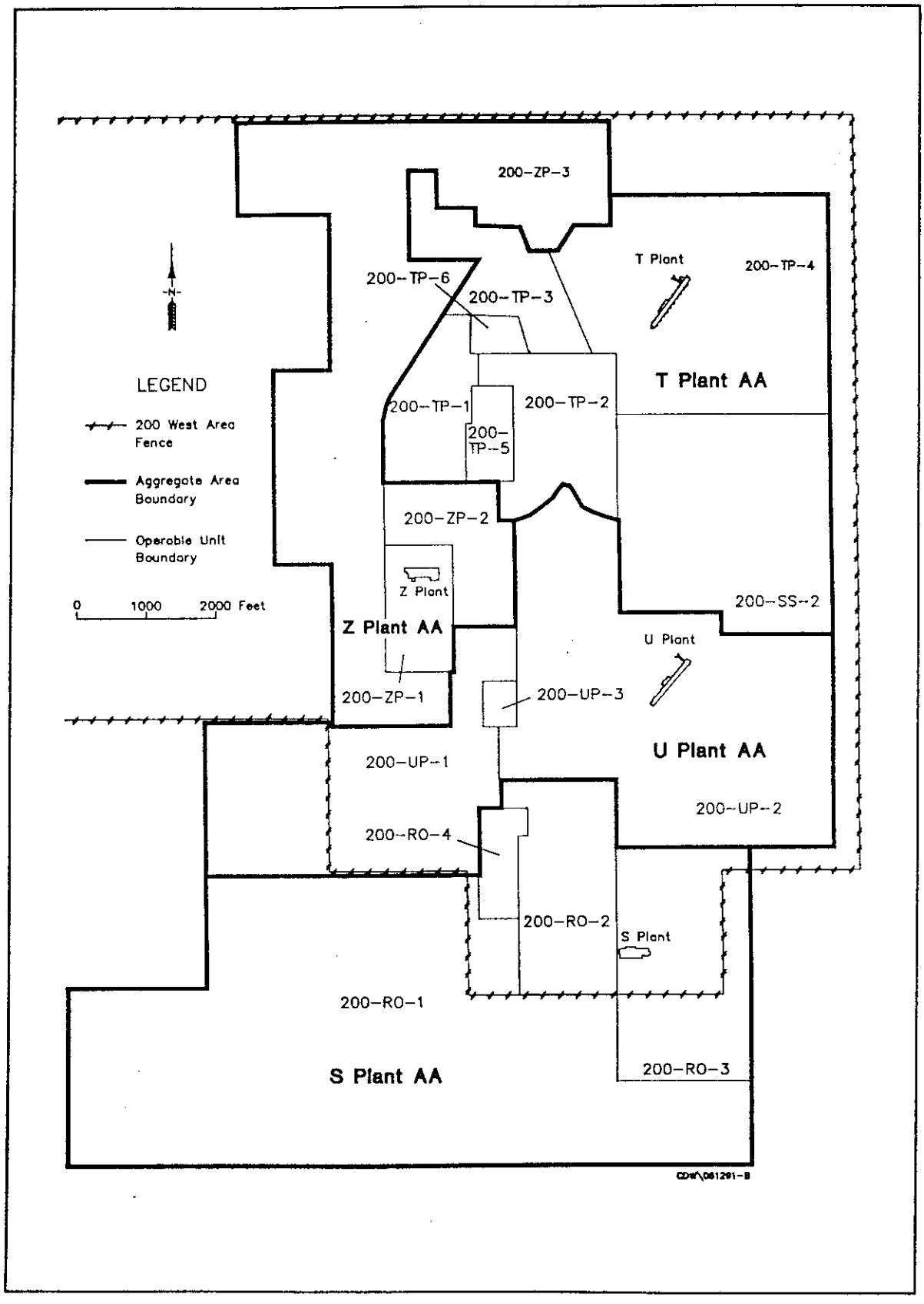


Figure 1-4. 200 West Aggregate Areas.

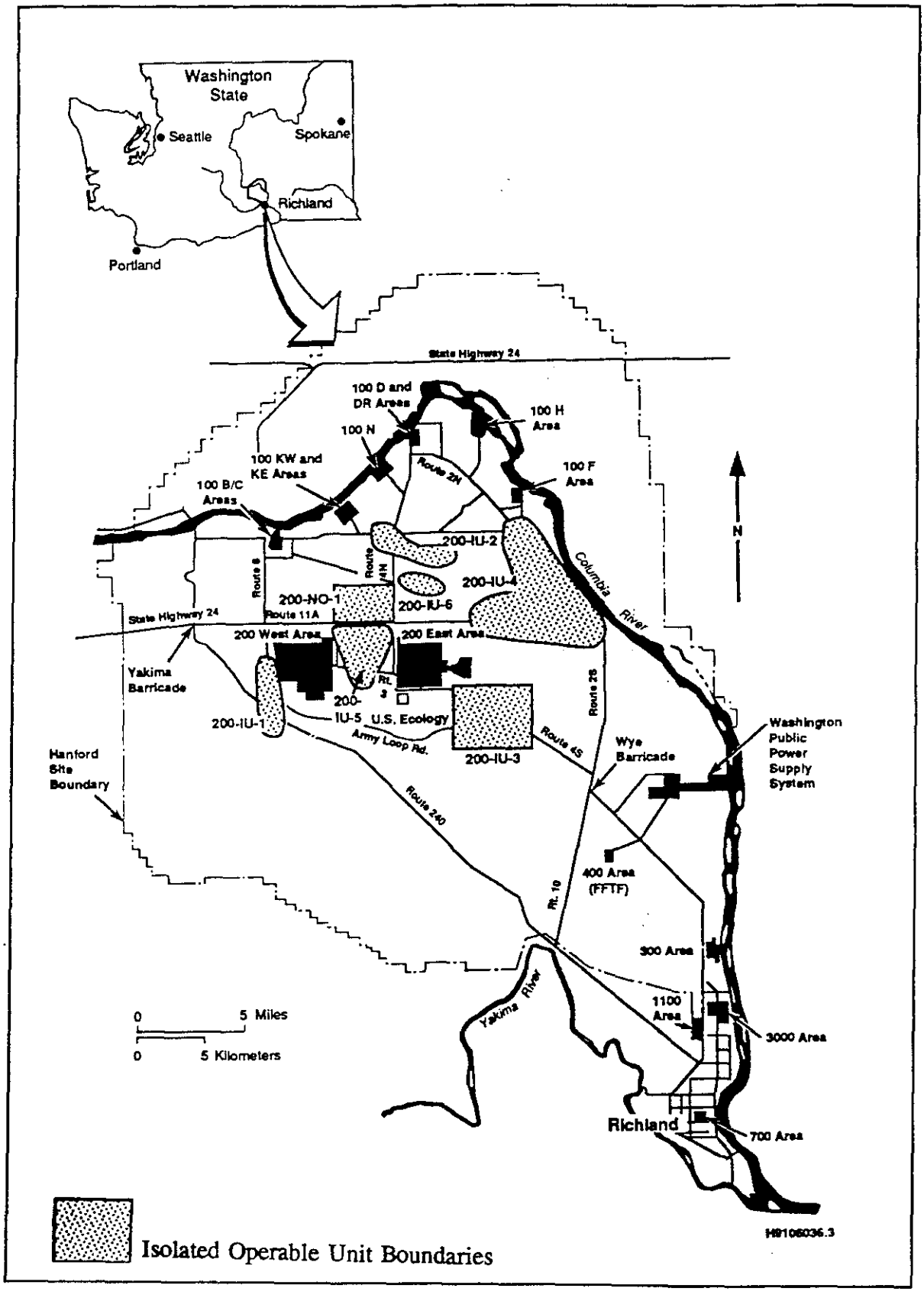


Figure 1-5. 200 NPL Site Isolated Operable Units.

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

AAMS Title	Operable Units	AAMS Type	Lead Regulatory Agency	M-27-00 Interim Milestones
U Plant	200-UP-1 200-UP-2 200-UP-3	Source	Ecology	M-27-02, January 1992
Z Plant	200-ZP-1 200-ZP-2 200-ZP-3	Source	EPA	M-27-03, February 1992
S Plant	200-RO-1 200-RO-2 200-RO-3 200-RO-4	Source	Ecology	M-27-04, March 1992
T Plant	200-TP-1 200-TP-2 200-TP-3 200-TP-4 200-TP-5 200-TP-6 S00-SS-2	Source	EPA	M-27-05, April 1992
PUREX	200-PO-1 200-PO-2 200-PO-3 200-PO-4 200-PO-5 200-PO-6	Source	Ecology	M-27-06, May 1992
B Plant	200-BP-1 200-BP-2 200-BP-3 200-BP-4 200-BP-5 200-BP-6 200-BP-7 200-BP-8 200-BP-9 200-BP-10 200-BP-11 200-IU-6 200-SS-1	Source	EPA	M-27-07, June 1992
Semi-Works	200-SO-1	Source	Ecology	M-27-08, July 1992
200 North	200-NO-1	Source	EPA	M-27-09, August 1992
200 West	NA	Groundwater	EPA/Ecology	M-27-10, September 1992
200 East	NA	Groundwater	EPA/Ecology	M-27-11, September 1992

WHC.13H/2-27-92/02267A

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) Hanford Site in Washington State is organized into numerically designated operational areas including the 100, 200, 300, 400, 600, and 1100 Areas (Figure 1-1). The U.S. Environmental Protection Agency (EPA), in November 1989, included the 200 Areas of the Hanford Site on the National Priorities List (NPL) under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980. Inclusion on the NPL initiates the Remedial Investigation (RI) and Feasibility Study (FS) process for characterizing the nature and extent of contamination, assessing risks to human health and the environment, and selection of remedial actions.

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

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

1.1 OVERVIEW

The 200 Areas, located near the center of the Hanford Site, encompasses the 200 West, East and North Areas which contain reactor fuel processing and waste management facilities.

Under the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement), signed by the Washington State Department of Ecology (Ecology), DOE, and EPA (Ecology et al. 1990), the 200 NPL Site encompasses the 200 Areas and selected portions of the 600 Area. The 200 NPL Site is divided into 8 waste area groups largely corresponding to the major processing plants (e.g., B Plant and T Plant), and a number of isolated operable units located in the surrounding 600 Area. Each waste area group is further subdivided into one or more operable units based on waste disposal information, location, facility type, and other site characteristics. The 200 NPL site includes a total of 44 operable units including 20 in the 200 East Area, 17 in the 200 West Area, 1 in the 200 North Area, and 6 isolated operable units. The intent of defining operable units was to

group associated waste management units together, such that they could be effectively characterized and remediated under one work plan.

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

This AAMS is one of ten studies that will provide the basis for past practice activities for operable units in the 200 Areas. In addition, the AAMS will be collectively used in the initial development of an area-wide groundwater model, and conduct of an initial site-wide risk assessment. Recent changes to the Tri-Party Agreement (Ecology et al. 1991), and the *Hanford Site Past-Practice Strategy* document (DOE/RL 1992a) establish the need and provide the framework for conducting AAMS in the 200 Areas.

1.1.1 Tri-Party Agreement

The Tri-Party Agreement was developed and signed by representatives from the EPA, Ecology, and DOE in May 1989, and revised in 1990 and 1991. The scope of the agreement covers all CERCLA past practice, RCRA past practice, and RCRA TSD activities on the Hanford Site. 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. To accomplish this, the Tri-Party Agreement provides a framework and schedule for developing, prioritizing, implementing and monitoring appropriate response actions.

The 1991 revision to the Tri-Party Agreement requires that an aggregate area approach be implemented in the 200 Areas based on the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a). This strategy requires the conduct of AAMS which are similar in nature to an RI/FS scoping study. The Tri-Party Agreement change package (Ecology et al. 1991) specifies that 10 Aggregate Area Management Study Reports (AAMSR) (major milestone M-27-00) are to be prepared for the 200 Areas. Further definition of aggregate areas and the AAMS approach is provided in Sections 1.2 and 1.3.

1.1.2 Hanford Site Past-Practice Strategy

The *Hanford Site Past-Practice Strategy* was developed between Ecology, EPA, and DOE to streamline the existing RI/FS and RFI/CMS processes. A primary objective of this

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

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

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

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

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

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

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

1.2 200 NPL SITE AGGREGATE AREA MANAGEMENT STUDY PROGRAM

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

1.2.1 Overall Approach

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

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

- U Plant
- Z Plant
- S Plant
- T Plant
- PUREX

- B Plant
- Semi-Works
- 200 North.

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

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

1.2.2 Process Overview

Each AAMS consists of three steps: 1) the analysis of existing data and formulation of a preliminary conceptual model, 2) identification of data needs and evaluation of remedial technologies, and 3) conduct of limited field characterization activities. Steps 1 and 2 are components of an AAMSR. Step 3 is a parallel effort for which separate reports will be produced.

The first and primary task of the AAMS investigation process involves the search, compilation and evaluation of existing data. Information collected for these purposes includes the following:

- Facility and process descriptions and operational histories for waste sources
- Waste disposal records defining dates of disposal, waste types, and waste quantities

- Sampling events of waste effluents and effected media

- Site conditions including the site physiography, geology, hydrology, meteorology, ecology, demography, and archaeology

- Environmental monitoring data for affected media including air, surface water, sediment, soil, groundwater and biota.

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

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

- U Plant Geologic and Geophysics Data Package

- Z Plant Geologic and Geophysics Data Package

- S Plant Geologic and Geophysics Data Package

- T Plant Geologic and Geophysics Data Package

- PUREX Geologic and Geophysics Data Package

- B Plant Geologic and Geophysics Data Package

- 200 N Geologic and Geophysics Data Package

- Semiworks Geologic and Geophysics Data Package

- Hydrologic Model for the 200 West Groundwater Aggregate Area

- Hydrologic Model for the 200 East Groundwater Aggregate Area

- Unconfined Aquifer Hydrologic Test Data Package for the 200 West Groundwater Aggregate Area

- Unconfined Aquifer Hydrologic Test Data Package for the 200 East Groundwater Aggregate Area

- Confined Aquifer Hydrologic Test Data Package for the 200 Groundwater Aggregate Area Management Studies

- Groundwater Field Characterization Report

- 200 West Area Borehole Geophysics Field Characterization

- 200 East Area Borehole Geophysics Field Characterization

The general scope of the topical reports related to this AAMSR is described in Section 8.0.

Information on waste sources, pathways, and receptors is used to develop a preliminary conceptual model of the aggregate area. In the preliminary conceptual model, the release mechanisms and transport pathways are identified. If the conceptual understanding of the site is considered inadequate, limited field characterization activities can be undertaken as part of the study. Field screening activities occurring in parallel with and as part of the AAMS process include the following:

- Expanded groundwater monitoring programs (non Contract Laboratory Program) at approximately 80 select existing wells to identify contaminants of concern and refine groundwater plume maps

- In situ assaying of gamma-emitting radionuclides at approximately 10 selected existing boreholes per aggregate area to develop radioelement concentration profiles in the vadose zone.

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

After the preliminary conceptual model is developed, health and environmental concerns are identified. The purpose of this determination is to provide one basis for

determining recommendations and prioritization for subsequent actions at waste management units. Potential applicable or relevant and appropriate requirements (ARARs) and potential remedial technologies are identified. In cases where the existing information is sufficient, the *Hanford Site Past-Practice Strategy* allows for a focused FS or CMS to be initiated prior to the completion of the study.

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

Each AAMSR results in management recommendations for the aggregate area including the following:

- The need for ERA, IRM, and LFI or whether to retain in the final remedy selection path
- Definition and prioritization of operable units
- Prioritization of work plan activities
- Integration of RCRA TSD closure activities
- The conduct of field characterization activities
- The need for treatability studies
- Identification of waste management units addressed entirely under other operational programs.

The waste management units recommended for ERA, IRM, or LFI actions are considered higher priority units that require rapid response. Lower priority waste management units will generally follow the conventional process for RI/FS. In spite of this distinction in the priority of sites, RI/FS activities will be conducted for all the waste management units. In the case of the higher priority waste management units, rapid response operations will be followed by conventional RI/FS activities, although these activities may be modified because of knowledge gained through the remediation activities. In the case of the

lower priority waste management units, an area-wide RI/FS will be prepared which encompasses these sites.

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

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

1.3 PURPOSE, SCOPE, AND OBJECTIVES

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

Specific objectives of the AAMS include the following:

- Assemble and interpret existing data including operational and environmental data
- Describe site conditions
- Conduct limited new site characterization work if data or interpretation uncertainty could be reduced by the work
- Develop a preliminary conceptual model
- Identify contaminants of concern, and their distribution

- Identify potential ARARs
- Define preliminary remedial action objectives, screen potential remedial technologies, and if possible provide recommendations for focused FS
- Recommend treatability studies to support the evaluation of remedial action alternatives
- Define data needs, establish general DQO and set data priorities
- Provide recommendations for ERA, IRM, LFI or other actions
- Redefine and prioritize, as data allow, operable unit boundaries
- Define and prioritize, as data allow, work plan and other past practice activities with emphasis on supporting early cleanup actions and records of decisions
- Integrate RCRA TSD closure activities with past practice activities.

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

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

1.4 QUALITY ASSURANCE

A limited amount of field characterization work is performed in parallel with preparation of the AAMS report. To help ensure that data collected are of sufficient quality to support decisions, all work will be performed in compliance with DOE Order 5700.6C Quality Assurance, (DOE 1991) as well as Westinghouse Hanford's existing QA manual, WHC-CM-4-2 (WHC 1988a) and with procedures outlined in the QA program plan, WHC-EP-0383 (WHC 1990a) specific to CERCLA RI/FS activities. This QA program plan describes the various plans, procedures, and instructions that will be used by Westinghouse Hanford to implement the QA requirements.

1.5 ORGANIZATION OF REPORT

In addition to this introduction, the AAMSR consists of the following nine sections and appendices:

- Section 2.0, Facility, Process and Operational History Descriptions, describes the major facilities, waste management units and unplanned releases within the aggregate area. A chronology of waste disposal activities is established and waste generating processes are summarized.

- Section 3.0, Site Conditions, describes the physical, environmental, and sociological setting including, geology, hydrology, ecology, meteorology, and demography.

- Section 4.0, Preliminary Conceptual Model, summarizes the conceptual understanding of the aggregate area with respect to types and extent of contamination, exposure pathways and receptors.

- Section 5.0, Health and Environmental Concerns, identifies chemicals used or disposed within the aggregate area that could be of concern regarding public health and/or the environment and describes and applies a screening process for determining the relative priority of follow-up action at each waste management unit.

- Section 6.0, Potentially Applicable or Relevant and Appropriate Requirements, identifies federal and state standards, requirements, criteria, or limitations that may be considered relevant to the aggregate area.

- Section 7.0, Preliminary Remedial Action Technologies, identifies and screens potential remedial technologies and establishes remedial action objectives for environmental media.

- Section 8.0, Data Quality Objectives, reviews QA criteria on existing data, identifies data gaps or deficiencies, and identifies broad data needs for field characterization and risk assessment. The DQO and data priorities are established.

- Section 9.0, Recommendations, provides guidance for future past practice activities based on the results of the AAMS. Recommendations are provided for ERA at problem sites, IRM, LFI, refining operable unit boundaries, prioritizing work plans, and conducting field investigations and treatability studies.

- Section 10.0, References, list reports and documents cited in the AAMSR.

- Appendix A, Supplemental Data, provides supplemental data supporting the AAMSR.

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

- Appendix B: Health and Safety Plan

- Appendix C: Project Management Plan

- Appendix D: Data Management Plan

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

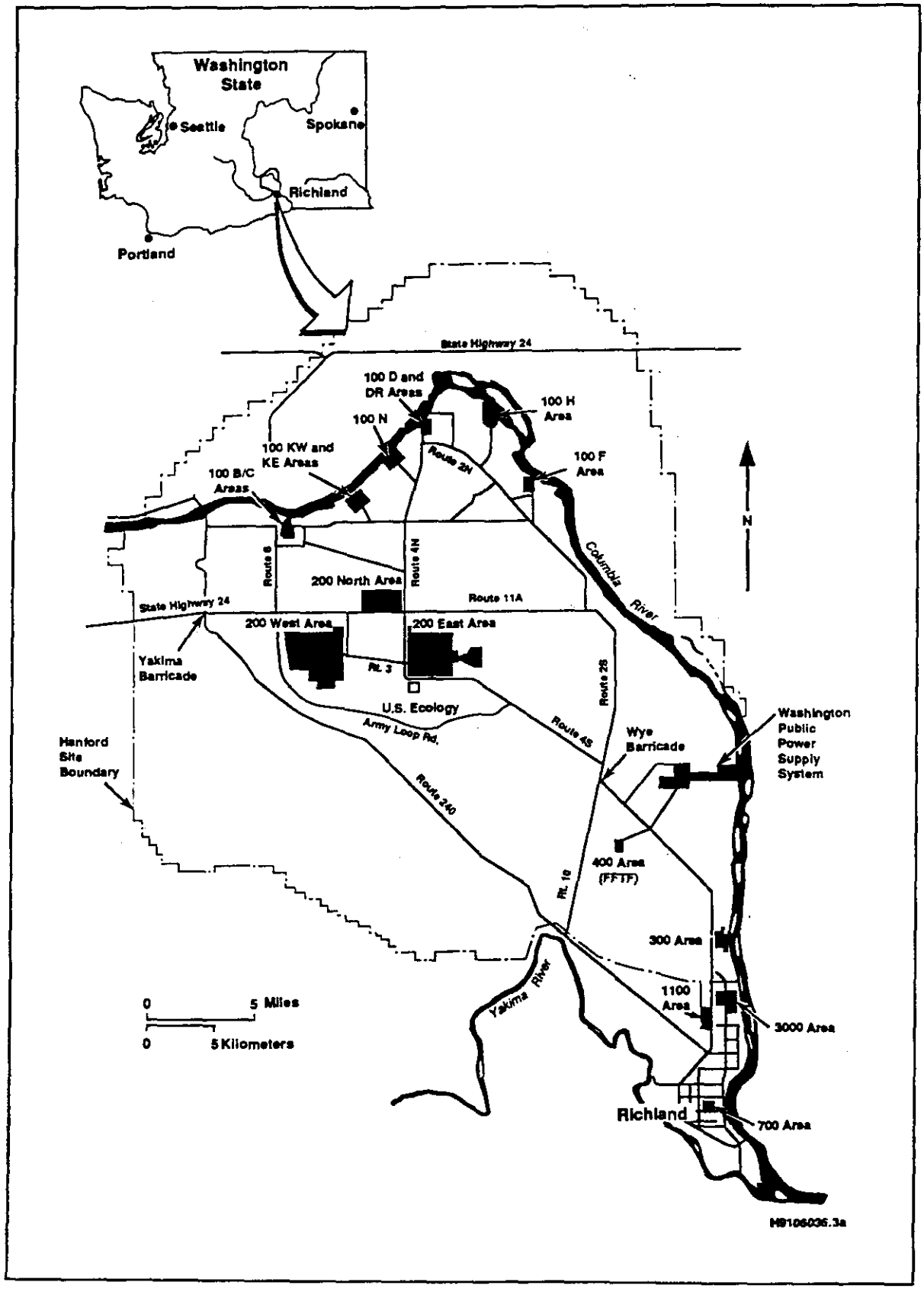


Figure 1-1. Hanford Site Map.

9 2 1 2 5 1 6 0 0 4 4

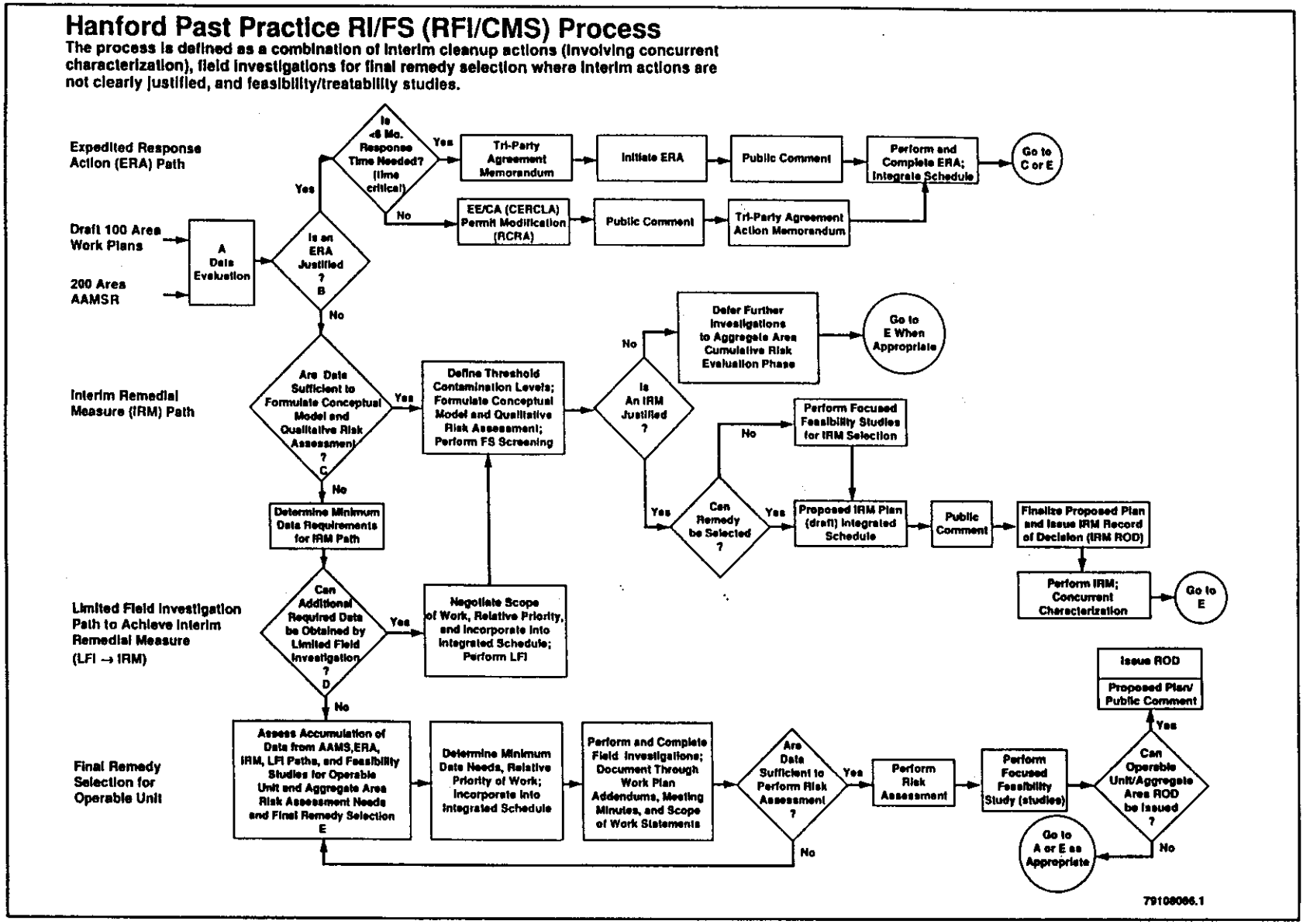


Figure 1-2. Hanford Site Past-Practice Strategy Flow Chart. (DOE/RL 1992a)

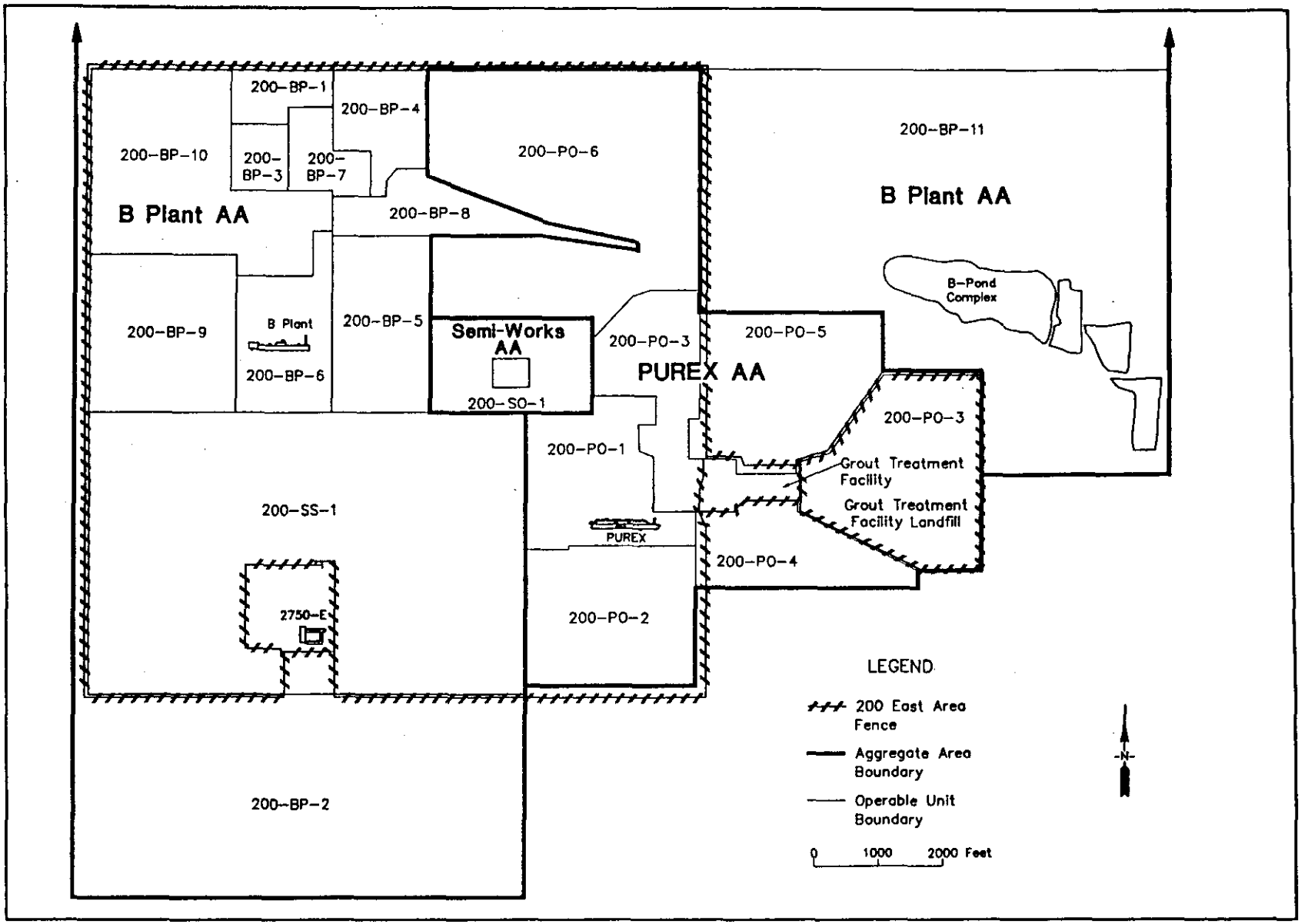


Figure 1-3. 200 East Aggregate Areas.

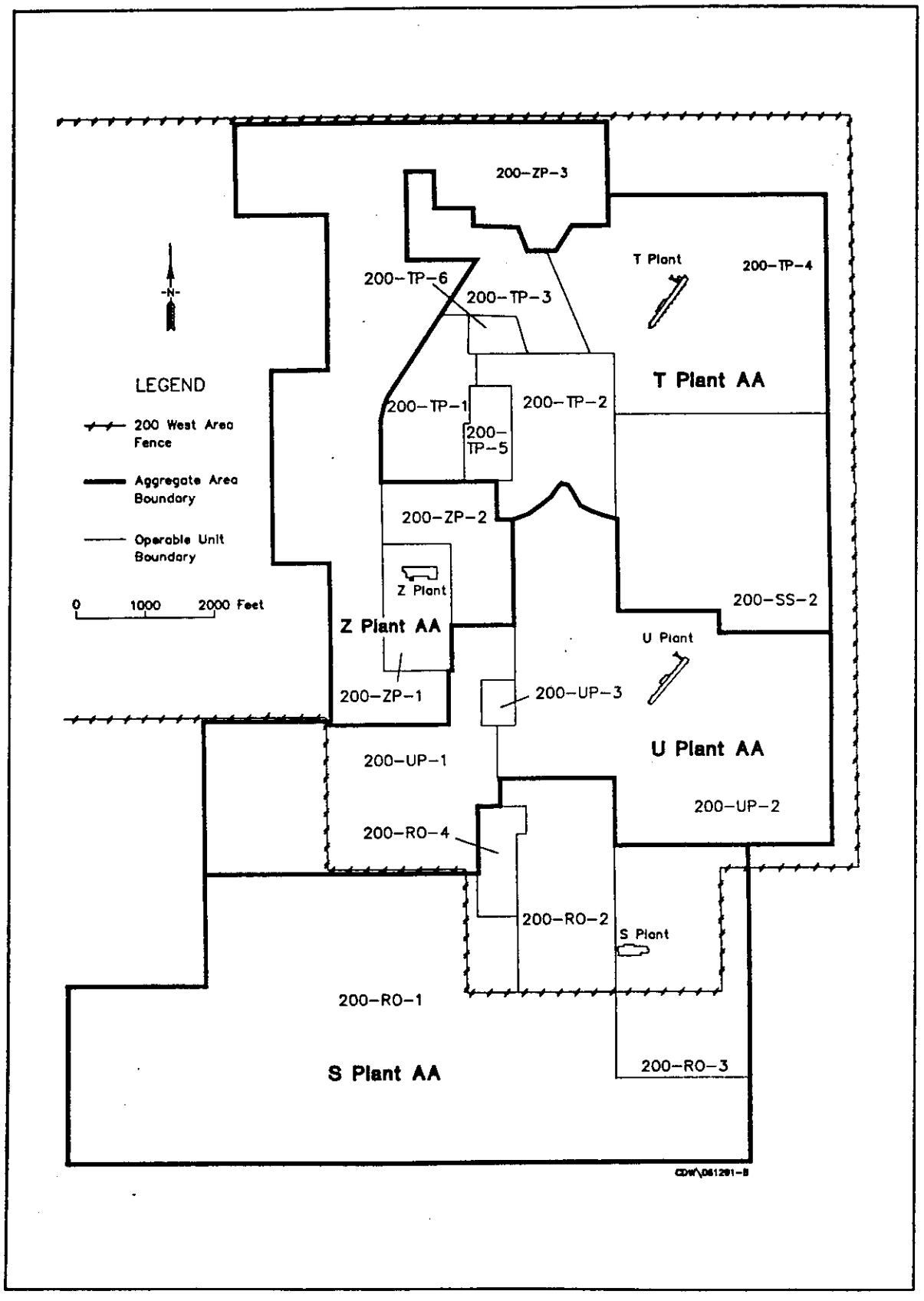


Figure 1-4. 200 West Aggregate Areas.

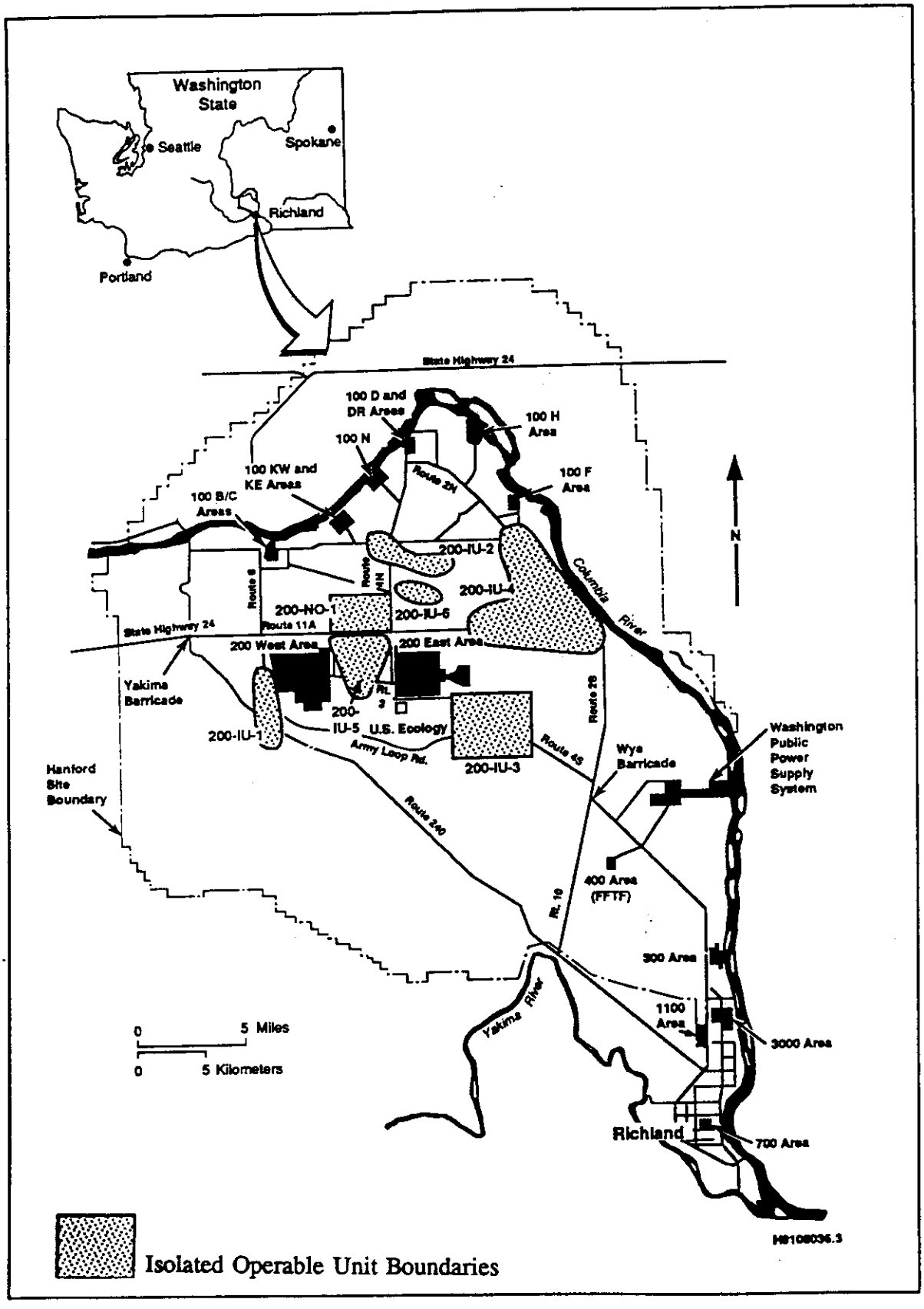


Figure 1-5. 200 NPL Site Isolated Operable Units.

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

AAMS Title	Operable Units	AAMS Type	Lead Regulatory Agency	M-27-00 Interim Milestones
U Plant	200-UP-1 200-UP-2 200-UP-3	Source	Ecology	M-27-02, January 1992
Z Plant	200-ZP-1 200-ZP-2 200-ZP-3	Source	EPA	M-27-03, February 1992
S Plant	200-RO-1 200-RO-2 200-RO-3 200-RO-4	Source	Ecology	M-27-04, March 1992
T Plant	200-TP-1 200-TP-2 200-TP-3 200-TP-4 200-TP-5 200-TP-6 S00-SS-2	Source	EPA	M-27-05, April 1992
PUREX	200-PO-1 200-PO-2 200-PO-3 200-PO-4 200-PO-5 200-PO-6	Source	Ecology	M-27-06, May 1992
B Plant	200-BP-1 200-BP-2 200-BP-3 200-BP-4 200-BP-5 200-BP-6 200-BP-7 200-BP-8 200-BP-9 200-BP-10 200-BP-11 200-IU-6 200-SS-1	Source	EPA	M-27-07, June 1992
Semi-Works	200-SO-1	Source	Ecology	M-27-08, July 1992
200 North	200-NO-1	Source	EPA	M-27-09, August 1992
200 West	NA	Groundwater	EPA/Ecology	M-27-10, September 1992
200 East	NA	Groundwater	EPA/Ecology	M-27-11, September 1992

WHC.13H/2-27-92/02267A

2.0 FACILITY, PROCESS AND OPERATIONAL HISTORY DESCRIPTIONS

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

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

2.1 LOCATION

The Hanford Site, operated by the U.S. Department of Energy (DOE), occupies about 1,450 km^2 (560 mi^2) of the southeastern part of Washington State north of the confluence of the Yakima and Columbia Rivers (Figure 1-1). The 200 East Area is a controlled area of approximately 15 km^2 (6 mi^2) near the middle of the Hanford Site. The 200 East Area is about 10 km (6 mi) from the Columbia River and 20 km (12 mi) from the nearest Hanford boundary. There are 20 operable units grouped into three aggregate areas in the 200 East Area (Figure 1-4). The PUREX Plant Aggregate Area (consisting of operable units 200-PO-1, 200-PO-2, 200-PO-3, 200-PO-4, 200-PO-5, and 200-PO-6) lies in the eastern portion of the 200 East Area (Figure 1-4). The locations of the buildings and waste management units are shown on Plate 1. Plate 2 shows the topography of the PUREX Plant Aggregate Area. The media sampling locations are depicted on Plate 3.

2.2 HISTORY OF OPERATIONS

The Hanford Site, established in 1943, was originally designed, built, and operated to produce plutonium for nuclear weapons using production reactors and chemical reprocessing plants. In March 1943, construction began on three reactor facilities and three chemical

processing facilities. After World War II, six more reactors were built. Beginning in the 1950's, waste management, energy research and development, isotope use, and other activities were added to the Hanford operation. In early 1964, a presidential decision was made to begin shut down of the reactors. Eight of the reactors were shut down by 1971. The N Reactor continued to operate primarily in weapons grade material production mode through 1987; operated secondarily in steam production mode for electricity production; and was placed on cold standby status in October 1989.

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

- 202-A Building (PUREX Plant), where recovery of uranium and plutonium from N Reactor fuels took place

- 221-B Building (B Plant), where plutonium was separated from uranium and the bulk of the fission product separation took place.

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

The major processes conducted at PUREX Plant Aggregate Area have been involved with uranium and plutonium recovery. A PUREX Plant Aggregate Area timeline is schematically illustrated in Figure 2-1.

The 202-A Building (PUREX Plant) is one of the primary PUREX Plant Aggregate Area facilities. The PUREX process is an advanced solvent extraction process that uses a tributyl phosphate in normal paraffin hydrocarbon solvent for recovering uranium and plutonium from nitric acid solutions of irradiated uranium. This process was utilized between 1955 and 1972. After 11 years of non-operation, the building resumed operations in November 1983. The 202-A Building ceased operating in 1990 and is currently in standby mode.

The 241-A Tank Farm contains six single-shell tanks constructed in the mid-1950's. Four tanks were retired in 1980, two of the tanks, 241-A-104 and 241-A-105, were retired in 1975 and 1971, respectively. These tanks received mixed waste from the plutonium extraction (PUREX) plutonium recovery process. All of the tanks are currently inactive and each has undergone initial stabilization.

The 241-AX Tank Farm contains four single-shell tanks constructed in the mid-1960's and retired in the early 1980's. These tanks received mixed waste from the 202-A Building and the 221-B Building. All of the tanks are currently inactive and each has undergone initial stabilization.

The 241-C Tank Farm contains 16 single-shell tanks constructed during the mid-1940's and retired in the late 1970's to mid-1980's. These tanks primarily received high-level waste from the bismuth phosphate process used in the 221-B Building. The tanks in the 241-C Tank Farm also received waste from the 201-C Building (Semiworks) and laboratory waste from Building 209-E (Critical Mass Laboratory). All of the tanks are currently inactive and each has undergone initial stabilization. A detailed description of the initial stabilization process is discussed in Section 2.3.2.

The 241-AN Tank Farm contains seven double-shell tanks constructed during the early-1980's. These tanks primarily receive dilute non-complexed waste and double-shell slurry feed. Waste from these tanks is processed in the 242-A Evaporator. Prior to the evaporator process, the waste is sampled and analyzed for parameters such as visual appearance, percent solids, exotherms, total organic carbon (TOC), gamma energy spectrum, pH, and for specific ions including plutonium, uranium, and americium. All of the tanks are currently active.

The 241-AP Tank Farm contains eight double-shell tanks constructed during the mid-1980's. These tanks primarily receive Ammonia Scrubber feed and dilute non-complexed customer waste. Customer waste is material that is not associated with processing plant activities. The tanks in the 241-AP Tank Farm also receive double-shell slurry feed and cladding removal waste. Prior to the evaporator process, the waste is sampled and analyzed for parameters such as visual appearance, percent solids, exotherms, total organic carbon, gamma energy spectrum, pH, and for specific ions including plutonium, uranium, and americium. All of the tanks are currently active.

The 241-AW Tank Farm contains six double-shell tanks constructed during the late-1970's. These tanks receive double-shell slurry feed, dilute non-complexed waste, delcadding supernate, and transuranic (TRU) sludge. Prior to the evaporator process, the waste is sampled and analyzed for parameters such as visual appearance, percent solids, exotherms, total organic carbon, gamma energy spectrum, pH, and for specific ions including plutonium, neptunium, technetium, and americium. All of the tanks are currently active.

The 241-AY Tank Farm contains two double-shell tanks constructed during the late-1960's. These tanks receive strontium- and cesium-depleted, neutralized high-level waste from B Plant, double-shell slurry feed, dilute non-complexed waste, and dilute complexed waste. Neutralized high-level waste is process waste from the first cycle processing of fuel rods which have been treated for disposal to underground storage tanks. Prior to the

evaporator process, the waste is sampled and analyzed for parameters such as visual appearance, percent solids, exotherms, TOC, gamma energy spectrum, pH, and for specific ions including plutonium, strontium, neptunium, and americium. All of the tanks are currently active.

The 241-AZ Tank Farm contains two double-shell tanks constructed during the mid-1970's. These tanks primarily receive dilute high-strontium waste from B Plant, double-shell slurry feed, and non-complexed waste. Prior to the evaporator process, the waste is sampled and analyzed for parameters such as visual appearance, percent solids, exotherms, TOC, gamma energy spectrum, pH. and for specific ions including plutonium, strontium, neptunium, and americium. All of the tanks are currently active.

2.3 FACILITIES, BUILDINGS, AND STRUCTURES

The PUREX Plant Aggregate Area contains a large variety of waste disposal and storage facilities that were associated with the aggregate area and, to a lesser extent, B Plant and Semiworks Aggregate Area operations. Radiologically contaminated process wastes were discharged to the soil column through cribs, trenches, and other facilities. Wastes that were not normally contaminated, but have the potential to contain radionuclides, such as cooling water and condensate water, were allowed to infiltrate into the ground through ponds and open ditches. Radiologically contaminated waste types are defined in DOE Order 5820.2A (DOE 1988a):

- High-Level Waste is defined as: highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid waste derived from the liquid, that contains a combination of transuranic waste and fission products in concentrations as to require permanent isolation.

- Transuranic waste is defined as: without regard to source or form, waste that is contaminated with alpha-emitting transuranium radionuclides with half-lives greater than 20 years and concentrations greater than 100 nCi/g at the time of assay. Heads of Field Elements can determine that other alpha contaminated wastes, peculiar to a specific site, must be managed as transuranic waste.

- Low-Level Waste is defined as: Waste that contains radioactivity and is not classified as high-level waste, transuranic waste, or spent nuclear fuel, or 11e(2) byproduct material as defined by this Order. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided the concentration of transuranic is less than 100 nCi/g.

- Byproduct Material is defined as: a) Any radioactive material (except special nuclear material) yielded in, or made radioactive by, exposure to the radiation incident or to the process of producing or utilizing special nuclear material. For purposes of determining the applicability of the Resource Conservation and Recovery Act to any radioactive waste, the term "any radioactive material" refers only to the actual radionuclides dispersed or suspended in the waste substance. The nonradioactive hazardous waste component of the waste substance will be subject to regulation under the Resource Conservation and Recovery Act. b) The tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. Ore bodies depleted by uranium solution extraction operations and which remain underground do not constitute "byproduct material."

Several different waste streams were discharged to the various waste management units in the PUREX Plant Aggregate Area. These waste streams include, but are not limited to:

- PUREX Plant Steam Condensate: The Steam Condensate (SCD) consists almost entirely of warm raw water and condensed steam that has been used to control the temperature of certain process vessels. These vessels could experience heat transfer surface failure and radionuclide release. The process consists of routing the water or steam through a coil or tube bundle to heat or cool the process vessels. The wastestream consists of raw water pumped from the Columbia River and condensed steam. Added to this mixture are (1) minute traces of radionuclides and chemical contaminants deposited from the air onto jumper (a remotely removable pipe) and nozzles when the jumpers are disconnected, (2) corrosion products from the piping used to conduct water from the Colombia River to the PUREX Plant, and, when tube failures occur, (3) elevated concentration of radionuclides arising from failure (WHC 1990b).

- PUREX Plant Cooling Water: The PUREX Cooling Water (CW) consists of 200 East raw water and steam condensate which is used to control the temperature of process vessels in the 202-A Building. In addition to the steam condensate from the 202-A Building, the CW receives air pump seal, water, liquid from the railroad tunnel door drain, and the cooling heat transfer surfaces in the 293-A Building (WHC 1990c).

- PUREX Plant Ammonia Scrubber Distillate: The Ammonia Scrubber Distillate (ASD) waste stream is generated in the PUREX Plant. The discharge is composed of two primary sources: one is from the dissolvers where Zircaloy fuel cladding is dissolved; and a second stream from the treatment of the cladding removal waste solution. Offgases from the decladding and waste treatment operations pass through four parallel ammonia scrubbers and are combined with

other minor ammonia-bearing waste streams. The combined waste stream is transferred to a concentrator where the NH_3 is distilled and the overhead condensate is discharged to designated waste management units as the ASD waste stream (WHC 1988b).

- PUREX Plant Chemical Sewer: The PUREX Plant Chemical Sewer (CS) collects wastewater from the nonradiologically controlled service areas of the 202-A Building and supporting facilities, as well as SCD and CW from the vacuum fractionator. Most of these streams are essentially clean, consisting of SCD from ventilation air heaters, water cooler drains, shower drains, and assorted floor drains. The floor drains have a potential for chemical contamination (WHC 1990d).

- PUREX Plant Process Condensate: The composition of the PUREX Plant Process Condensate (PDD) can vary depending on several factors. According to the PDD stream-specific report (WHC 1990e), the possibility of a wide variety of trace organic constituents is of primary interest. The PDD consists of water (condensed overheads from the K4 evaporator) that has been in intimate contact with process organics tributyl phosphate and normal paraffin hydrocarbons. Because these chemicals are technical grade, they contain a variety of trace impurities: butanol, butyraldehyde, acetone, methyl ethyl ketone, and others. Additionally, in the presence of the high radiation and strong chemical fields, which exist in the PUREX process, the major and minor constituents degrade and recombine. Because of variations in the PUREX process, the flow and composition of inorganics, such as nitrate and hydroxide, are also of interest.

- N Reactor Effluent: The N Reactor Effluent consists of three process water streams. These streams consist of raw, filtered, and demineralized water supplies, each with their own characteristics. The raw water process stream supplies essentially untreated river water used to quench valve leaks from the primary coolant system. The filtered water process stream consists of raw water that is chemically treated with chlorine and alum in a mix tank, piped to the coagulator where polyacrylamide is added, and then passed through sand filters. The demineralized water process stream is essentially pure water, with few ionic materials carried over from the filtered water supply from which it is derived. Traces of dissolved low-molecular weight organic compounds such as chloroform, if present in the filtered water supply, are generally carried over into the demineralized water supply (WHC 1990f).

- 242-A Evaporator Steam Condensate: The only active contributor to the 242-A Evaporator Steam Condensate waste stream is the vacuum pump seal water. Historically, there have been eleven contributors to this waste stream: the

reboiler steam condensate, the steam condensate and raw water from heating and cooling jackets, the purging system steam trap condensate, the vacuum pump seal water, the steam strainer condensate, the steam separator condensate, the steam separator strainer blowdown, the seal water pressure control valve discharge, the micro-filter catch pan drainage, the seal water pumps and filter catch pan drainage, and the R-C-1 sampler/monitor cooler raw water discharge. No chemicals are intentionally added to the 242-A Evaporator Steam Condensate system (WHC 1990g).

- 242-A Evaporator Cooling Water: A total of nine contributors feed the 242-A Evaporator Cooling Water waste stream. These nine contributors, in order of volume contribution to the stream, are as follows: condenser cooling water, air compressor cooling water, emergency steam turbine condensate, steam trap condensate, compressed air dryer discharges, water filter catch pan drainage, HVAC room floor drains, steam system relief valve discharges and, compressed air receiver condensate. The nine waste stream contributors provide the same thing as the raw water which is taken from the Colombia River. Minor contributions occur from the normal corrosion products associated with piping oxidation. No chemicals or constituents are added to the waste from the evaporator, condensers, and ancillary equipment. Octyldecylamine added to boiler makeup water is introduced in very small amounts as steam trap condensate, however, this is not a hazardous chemical (WHC 1990h).

- 242-A Evaporator Process Condensate: Process condensate constituents include carryover from boiloff of the evaporator feed and any chemicals added to the process condensate stream following evaporation in the main, inter-condensers, and after-condensers. The identification of all constituents is not possible at the present time because past sampling analysis of radioactive tanks waste did not include volatile organic analysis (WHC 1990i).

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

- Plants, Buildings, and Storage Areas (Section 2.3.1)
- Tanks and Vaults (Section 2.3.2)
- Cribs and Drains (Section 2.3.3)
- Reverse Wells (Section 2.3.4)
- Ponds, Ditches, and Trenches (Section 2.3.5)

- Septic Tanks and Associated Drain Fields (Section 2.3.6)
- Transfer Facilities, Diversion Boxes, and Pipelines (Section 2.3.7)
- Basins (Section 2.3.8)
- Burial Sites (Section 2.3.9)
- Unplanned Releases (Section 2.3.10)

Table 2-1 presents a list of the waste management units within the PUREX Plant Aggregate Area. Each waste management unit is listed as either active or inactive. Inactive waste management units do not currently receive wastes, nor are they intended to receive wastes in the future. Active waste management units are in operation and will receive wastes in the future. Units that are on standby are considered active (DOE/RL 1992a). In addition, the aggregate area contains a number of unplanned release sites. There are two varieties of unplanned releases: UNs and UPRs. Unplanned releases designated as UNs are considered separate waste management units (i.e., road spills). Unplanned releases designated as UPRs are associated with specific waste management units (i.e., UPR-200-E-66). The locations of the waste management units are shown on separate figures for each waste management group on Plate 1. Figure 2-1 summarizes the operational history of each of the waste management units (WHC 1991a, DOE/RL 1991a). Tables 2-2 and 2-3 summarize data available regarding the quantity and types of wastes disposed of to the waste management units. These data have been compiled from the Waste Information Data System (WIDS) inventory sheets (WHC 1991a) and from the Hanford Inactive Site Survey (HISS) (DOE 1986) database. These inventories include all of the contaminants reported in the databases, but do not necessarily include all of the contaminants disposed of at each site. In the following sections, each waste management unit is described within the context of one of the waste management unit types.

2.3.1 Plants, Buildings, and Storage Areas

Plants and buildings are not generally identified as past practice waste management units according to the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement, Ecology et al. 1990) and will generally be addressed under the Surplus Facilities Program. The program is responsible for the surveillance, maintenance, and decommissioning of surplus facilities within the Westinghouse Hanford Environmental Restoration Programs. Section 2.7 details interaction of the Hanford programs. Because several of the PUREX Plant Aggregate Area plants or buildings were the primary generators of waste disposed of within the PUREX Plant Aggregate Area, a description of these is provided in Section 2.3.1.1. The PUREX Plant Aggregate Area plants and buildings that are

also waste management units are addressed in Section 2.3.1.2. Some plants and buildings are or contain RCRA treatment, storage, or disposal (TSD) facilities. A description of such facilities is provided in Section 2.6. The locations of plants and buildings in the aggregate area are shown on Figure 2-2.

The 202-A Building (PUREX Plant), the 241-A-431 Building (Condenser Building), and the 293-A Building (offgas treatment and acid recovery) were the primary generators of waste within the aggregate area. This plant, and the buildings associated with it, will be described in the following sections.

Other buildings and structures located within the aggregate area are not addressed in this study and will be closed through a separate decontamination and decommissioning process. These structures include:

- 241-A-401 Condenser House (coolant building)
- 291-A Building (fan control house)
- 291-A-1 Stack (stack inside 291-A Building)
- 241-AX-801-B Building
- 203-A Building (acid pumphouse)
- 242-A Evaporator Building

2.3.1.1 Process Facilities

2.3.1.1.1 202-A Building. The 202-A Building (PUREX Plant) was one of the primary sources of waste in the PUREX Plant Aggregate Area and it is the dominant physical structure within the area.

The 202-A Building was constructed between 1953 and 1955 as a chemical separation facility and then operated until 1972. The building began operation again in November 1983 and is still considered an active site. It was the last of five Hanford Site canyon buildings to be built. The term "canyon" comes from the large size and the canyon-like appearance of the upper galleries. The main purpose for this facility was to extract plutonium, uranium, and neptunium contained in irradiated uranium fuel rods discharged from Hanford Site reactors.

The 202-A Building is a reinforced concrete structure 306 m (1,005 ft) long, 36 m (119 ft) wide at its maximum, and 30 m (100 ft) high. The structure has about 12.2 m (40 ft) of

the height below grade. The building consists of three main structural components: (1) a thick-walled, concrete canyon in which the equipment for radioactive processing is contained (in cells below grade); (2) the pipe and operating (P&O), sample, and storage galleries; and (3) a steel-and-transite annex that houses offices, process control rooms, laboratories, and the building services. The portion of the canyon below grade is subdivided into a row of process equipment cells paralleled by a ventilation air tunnel and a pipe tunnel through which intercell solution transfers are made. The air tunnel exhausts the ventilation air from the cells to the ventilation filters and stack. Running nearly the full length of the canyon building, above the cells and pipe trench, is a craneway for three gantry-type maintenance cranes. These cranes are used to handle cell cover blocks, remotely remove and replace process cell equipment, and charge irradiated fuel into the dissolvers. The galleries contain service piping to the cells, samplers for obtaining process samples, and electrical switchgear. The service section, next to the galleries, consists of two separate annexes. The larger annex contains the maintenance shops, offices, lunchroom, locker room, radiation zone entry lobby [special work permit (SWP) lobby], blower room, a switchgear room, compressor room, central control room, and the aqueous makeup unit (AMU). The smaller annex contains the analytical laboratory, the headend control room, and a switchgear room.

The PUREX chemical separation processes are based on dissolving the decladded fuel rods in nitric acid and conducting multiple purification operations on the resultant aqueous nitrate solution. The process steps involve fuel-element decladding, uranium metal dissolution, solvent extraction, ion exchange, and product load-out.

Volume one of the *Hazard Ranking System Evaluation of CERCLA Inactive Waste Sites at Hanford* (Stenner et al. 1988) provides the following generic description of these processes:

> Zirconium cladding on fuel elements is removed in an ammonium fluoride-ammonium nitrate (AFAN) solution. Ammonium fluoride reacts with the zirconium, resulting in a soluble zirconium compound. The ammonia and hydrogen evolved during decladding present a potential combustion hazard. Therefore, hydrogen is converted to ammonia by reaction with ammonium nitrate present in the AFAN solution. A majority of fuel processed through the 202-A Building was aluminum clad. This cladding was dissolved with NaOH. Gas released from the dissolver is treated to remove iodine in a silver reactor, acid vapors are absorbed, and is only then released to the atmosphere. The offgasses are treated with hydrogen peroxide to remove nitrogen oxides before being released.
>
> Declad fuel elements are dissolved in nitric acid for the solvent extraction process. An organic solvent is used to separate the uranium, plutonium and neptunium from associated fission products and from each other. The organic solvent used in a series of extraction and stripping operations is a 30% tributyl phosphate solution in a normal

paraffin hydrocarbon (kerosene) diluent. The first extraction cycle separates the bulk of the fission products from the plutonium, uranium and neptunium; the fission products remain in the aqueous phase. The organic phase is sent to the partitioning cycle where the plutonium is partitioned from the uranium and neptunium. The plutonium stream is routed through two additional solvent-extraction cycles for further purification. After purification, the plutonium stream is concentrated. From 1956 to 1972, the concentrated plutonium nitrate solution was sent to the plutonium finishing operations located in the 200 West Area. When the PUREX Plant resumed operations in 1983, another facility (the PUREX Plant) was added that produced plutonium oxide from the plutonium nitrate.

The other stream from the partition cycle, which bears the neptunium and uranium, is routed to the final uranium cycle where neptunium is separated. The aqueous neptunium stream is sent to the backcycle waste system for concentration and recycling to the solvent-extraction column. The uranium stream is routed to a column that strips the uranium from the organic stream with an aqueous nitric acid solution; concentration of the aqueous solution follows. The uranium product, uranyl nitrate hexahydrate, is then stored in tanks until it is shipped (via truck) to the Uranium Oxide (UO_3) Plant in the 200 West Area.

A portion of the concentrated neptunium solution from the final uranium cycle is sent to the neptunium recovery and purification cycle. In this cycle, neptunium is separated from the uranium, plutonium, and the remaining fission products in the neptunium stream. This separation is accomplished by a series of extractions and ion-exchange columns. The plutonium and uranium fractions are recycled to the backcycle waste stream and partitioning cycle, respectively.

Supporting process systems include organic solvent decontamination and recovery, nitric acid recovery, and waste concentration and recovery (Stenner et al. 1988).

Several unplanned release locations are in the vicinity of the 202-A Building. These are UN-200-E-13, UN-200-E-19, UN-200-E-25, UN-200-E-26, UN-200-E-28, UN-200-E-31, UN-200-E-35, UN-200-E-58, UN-200-E-65, UN-200-E-96, UN-200-E-97, UN-200-E-114, and UN-200-E-142. These unplanned releases range from contaminated tumbleweeds to leaks in a diversion box.

2.3.1.1.2 293-A Building. The 293-A Building (Offgas Treatment Facility) removes nitrogen oxides from the dissolver offgas stream then converts the nitrogen oxides to nitric acid. The nitric acid is then recycled into the PUREX process via the 206-A Building. This process does not operate during standby conditions.

2.3.1.2 Waste Management Unit Buildings

2.3.1.2.1 241-A-431 Building. The 241-A-431 Building (Tank Farm Ventilation Building) was in operation from 1955 to 1969. It is located in the southeastern corner of the 241-A Tank Farm. This building is also known as a condenser building. It contains radioactively contaminated equipment and concrete. The contamination levels are estimated at 6 Ci of beta radioactivity (WHC 1991a). This building provided offgas de-entrainment for the 241-A Tank Farm and also received the 296-A-11 Stack drainage.

The 241-A-431 Building is a concrete structure, 8 m (25 ft) high, with the lower 4.9 m (16 ft) below grade. The walls are 20 cm (8 in.) thick and the unit is divided into two sections. One section is 3 x 5 x 3 m (10 x 16 x 9 ft) high and houses the ventilation equipment. The other section is 3 x 5 x 8 m (11 x 16 x 25 ft) high and houses the de-entrainment equipment.

2.3.1.2.2 204-AR Waste Unloading Station. The 204-AR Waste Unloading Station is a two-story, structural steel, reinforced-concrete building located 91 m (300 ft) west of the 241-A Tank Farm. The facility started operating in 1982 and is still active. The waste unloading station is designed to receive various wastes via rail cars and to pump the wastes to the double-shell tank farms. The 204-AR facility provides agitation, neutralization, nitrite addition, and sampling of the tank car liquid wastes as well as hydraulic sluicing of the tank cars to remove residual solids (Bixler et al. 1981).

The facility receives wastes generated from decontamination and regeneration operations in the 100 Area; from recovery fabrication, and laboratory operations in the 300 Area; and from decontamination operations in the 400 Area. The waste is chemically adjusted in-line during pumpout to the double-shell tanks to meet corrosion specifications. A catch tank is located beneath the facility and currently contains 1,966 L (520 gal) of waste.

2.3.1.2.3 Grout Treatment Facility. The Grout Treatment Facility (GTF) is located on the eastern edge of the PUREX Plant Aggregate Area and occupies 1 km^2 (0.4 mi^2). The GTF was developed for the handling, immobilization, and disposal of waste. This provided an alternative for traditional disposal of low-level tank waste to waste management units (i.e., cribs, french drains, etc.). The Transportable Grout Treatment Equipment (TGE) consists of a dry-blended solids feed and lag storage system and of mixing and pumping equipment. The dry solids is stored and blended at the Dry Materials Receiving and Handling Facility. Double-Shell Tanks 241-AP-102 and 241-AP-104 are used as the liquid waste feed tanks. Waste materials are transferred from the waste tanks to the TGE via underground and shielded aboveground pipes. The TGE then prepares grout slurries adjacent to the near-surface disposal sites. The grout is produced by mixing the liquid waste feed stream with the dry-blend solids formulated for a specific waste stream. Following mixing, the TGE pumps the grout to a designated disposal vault. Each vault is a concrete structure 10 m by 15 m by

38 m deep (33 ft by 45 ft by 125 ft). The vaults are lined with a geomembrane liner to prevent dewatering of the grout to the environment. In addition, a leachate collection system is installed by each vault. Each vault has a capacity of approximately 5,000 m^3 of grouted waste. Grouted waste in a vault solidifies or cures in about 28 days.

2.3.1.2.4 241-C-801 Support Facility. The 241-C-801 Cesium Loadout Facility is located within the 241-C Tank Farm. This support facility started operating in 1962 and stopped operating in 1976. The building is 10 m (32 ft) long by 8 m (26 ft) wide and 8 m (28 ft) deep. The bottom 3 (9 ft) of the building is constructed of concrete while the remainder of the building is standard 22 gage prefabricated metal 4 m (12 ft) high. Trucks equipped with ion exchange casks were backed into the building and supernate was pumped from 241-C-105 to recover cesium. The casks were then sent offsite to Oak Ridge, Tennessee. The building consists of a loadout room, an operations room, and a valve pit.

2.3.1.2.5 242-A Building. The 242-A Evaporator/Crystallizer is located just north of the 241-AW Double-Shell Tank Farm. The 242-A Building contains the evaporator vessel, supporting process equipment, and the principal process components of the evaporator-crystallizer system. Section 2.4.2 explains the 242-A Evaporator waste volume reduction process in greater detail.

2.3.1.2.6 244-AR Lift Station/UPR-200-E-70. The 244-AR Lift Station is located between the 241-AX and 241-AY Tank Farms. The lift station began operating in 1975 and is still active.

A typical lift station includes a filter pit, pump pit, and a tank vault, which contains a catch tank; however, no information was found specific to the 244-AR Lift Station. The lift station is used to transport waste solutions from processing and decontamination operations.

One unplanned release (UPR-200-E-70) is associated with this unit. Contamination was spread during a jumper removal at the lift station. The contamination consisted of unknown beta/gamma with reading of 1,000 to 5,000 ct/min and an isolated area at 100,000 ct/min. The area was decontaminated to background radiation levels and stabilized.

2.3.2 Tanks and Vaults

Tanks and vaults were constructed to handle and store liquid wastes generated by uranium and plutonium processing activities. Several types of tanks are present in the aggregate area including catch tanks, settling tanks, and storage tanks. The catch tanks are generally associated with diversion boxes and other transfer units, and were designed to accept overflow and spills. Storage tanks were used to collect and store large quantities of liquid wastes.

There are three single-shell tank facilities considered within the scope of this PUREX Plant Aggregate Area Management Study: the 241-A Tank Farm, the 241-AX Tank Farm, and the 241-C Tank Farm. The 241-A Tank Farm consists of six single-shell tanks with capacities of 3,785,000 L (1,000,000 gal), the 241-AX Tank Farm consists of four single-shell tanks with capacities of 3,785,000 L (1,000,000 gal), and the 241-C Tank Farm consists of sixteen single-shell tanks, twelve with capacities of 2,017,000 L (533,000 gal) and four with capacities of 208,000 L (55,000 gal). The locations of the tanks and vaults are shown on Figures 2-3, 2-4, and 2-5. Figure 2-6 depicts a typical 2,017,000 L (533,000 gal) tank. Table 2-4 shows tank status in the PUREX Plant Aggregate Area Tank Farms. More details concerning the individual tank farms are discussed in the following sections.

There are five double-shell tank facilities considered within the scope of this PUREX Plant Aggregate Area Management Study: the 241-AN Tank Farm, the 241-AP Tank Farm, the 241-AW Tank Farm, the 241-AY Tank Farm, and the 241-AZ Tank Farm. The 241-AN Tank Farm consists of seven double-shell tanks with capacities of 4,309,200 L (1,140,000 gal), the 241-AP Tank Farm consists of eight double-shell tanks with capacities of 4,309,200 L (1,140,000 gal), the 241-AW Tank Farm consists of six double-shell tanks with capacities of 4,309,200 L (1,140,000 gal), and the 241-AY and 241-AZ Tank Farms consists of 2 double-shell tanks per farm with capacities of 3,704,400 L (980,000 gal). The locations of the tanks and vaults are shown on Figures 2-3, 2-4, and 2-5. Figure 2-7 depicts a typical double-shell tank. Table 2-4 shows tank status in the PUREX Plant Aggregate Area Tank Farms. More details concerning the individual tank farms are discussed in the following sections.

All of the tanks and vaults within the 241-A Tank Farm, the 241-AX Tank Farm, and the 241-C Tank Farm will be addressed by the single-shell tank closure program. The structure and the related contamination in the tank farm will be described in this report, but investigation and remediation strategies will be deferred to the single-shell tank closure program. The double-shell tanks are still active and are discussed in the PUREX Plant Aggregate Area Management Study due to their location within the confines of the PUREX Plant Aggregate Area and due to their involvement with other facilities, which are part of this study.

The waste contained in the tanks can occur in three forms: sludge, salt cake, or liquid. Sludge is composed primarily of insoluble metal hydroxides and hydrated oxides that precipitated from neutralized high-level waste solutions. Salt cake is composed primarily of crystallized nitrate salts (particularly sodium nitrate), the majority being produced by waste concentration operations. The liquid wastes are aqueous solutions rich in sodium hydroxide and sodium aluminate, as well as sodium nitrate. Liquid waste can be present as supernatant or interstitial fluid.

Initial stabilization interim stabilization, and interim isolation have been performed on the tanks to varying degrees, as listed in the individual tank descriptions. Prior to closure of the tanks, they must undergo a specific sequence of events. The first step (initial stabilization, also called primary stabilization) is the removal of all free standing liquid within the tank (i.e., all liquid on top of the sludge and/or salt cake). The second step is interim stabilization where all of the liquid, both interstitial and free standing, is removed through use of a salt well and a jet pump. A salt well is a slotted riser pipe inserted into the salt cake of a tank and into which a pump is placed. A tank is considered interim stabilized if it contains less than 189,000 L (50,000 gal) of drainable interstitial liquid and less than 19,000 L (5,000 gal) of supernatant liquid (Hanlon 1992). The third step is the interim isolation of the tank by sealing all accesses to the tank that are not required for long-term surveillance. After all of these steps have been taken, the tank is ready for the final process of closure. Tanks are classified as "Assumed Leakers" if it cannot be determined with 99% confidence that the tank is sound.

2.3.2.1 241-A Tank Farm. The 241-A Tank Farm consists of six buried single-shell tanks that contain mixed waste. It is located approximately 396 m (1,300 ft) northeast of the 202-A Building, directly south of the 241-AX Tank Farm. The surface elevation of the tank farm is approximately 210 m (689 ft) above mean sea level (msl), and the depth to groundwater below the tank farm is approximately 87 m (287 ft) (WHC 1991a).

The tanks were placed in service during the mid-1950's and were retired in the early 1970's or 1980's. Figure 2-1 shows the individual tanks in the 241-A Tank Farm and their operational history. They are numbered 241-A-101 through 241-A-106. All of the tanks are currently inactive and each has undergone initial stabilization and has a status of either partial interim isolation or interim isolation (WHC 1991a).

Currently, the entire tank farm, including diversion boxes 241-A-151, 241-A-152, 241-A-A, and 241-A-B, and catch tank 241-A-350, is surrounded by a chain link fence, topped with three strands of barbed wire. The tank farm is covered with gravel. Surface contamination placards are placed on the chain link fence.

The tanks are carbon-steel lined, with a reinforced concrete shell, dome, and base, less than 1 m (2 ft) thick. They are 14 m (45 ft) high with a 23 m (75 ft) diameter and have a capacity of 3,785,000 L (1,000,000 gal). The dome is generally located 2 m (7 ft) below grade, and the bottom of the tanks are 15 m (50 ft) below grade. The tanks are fourth generation in design. This means they have a increased operating depth to 9 m (31 ft) and a flat bottom compared to previous generations which had less operating depth and a dished bottom. The tanks are surrounded by radiation monitoring wells.

The tank farm was constructed to receive high-level, self-boiling waste from the PUREX plutonium recovery process. The three major types of wastes contained in the tank

farm are aluminum cladding waste, organic wash waste, and PUREX acid waste. Lesser quantities of several other types of waste were also deposited in the tank farm. These include waste fractionization waste, ion exchange waste, sluicing waste, and waste generated by the waste solidification program, such as evaporator bottoms (WHC 1991a). In addition, the vapors from the 241-A tanks are combined with those from the 241-AZ tanks and processed in the 241-AX-152DS Diverter Station and the 241-AX-155 Diversion Box. The resultant condensate is routed to the 216-A-8 Crib and the 216-A-24 Crib, or returned to 241-A or 241-AX tanks (WHC 1991a).

Table 2-4 provides a description of the tank farms in the PUREX Plant Aggregate Area and the volume of total waste and drainable waste present in each tank. Several dry wells within the tank farm are used to monitor the soil for radioactivity, and serve as one form of leak detection. In addition, groundwater monitoring wells around the 241-A Tank Farm and other PUREX Plant Aggregate Area tank farms are also used to monitor subsurface conditions.

The following sections describe in greater detail the location of the waste management units, a description of the waste management unit itself, the duration of operation, and information concerning the waste types received.

2.3.2.1.1 241-A-101 Single-Shell Tank. The 241-A-101 Single-Shell Tank is the southwestern-most tank in the 241-A Tank Farm. This tank is surrounded by thirteen active radiation monitoring wells. The tank is also equipped with automatic temperature sensors and air lift circulators.

The tank is classified as an inactive waste management unit. It operated from January 24, 1956 until November 21, 1980. The tank received PUREX carbonate wash waste; PUREX organic wash waste; PUREX high-level waste; B Plant high-level waste (waste fractionization); and supernatant containing B Plant high-level waste, PUREX high-level waste, double-shell slurry feed, and complexed and non-complexed waste from the 241-A, 241-AX, 241-BX, and 241-SX Tank Farms (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 3,596,000 L (950,000 gal) of salt cake and 11,350 L (3,000 gal) of sludge. This tank is considered "sound" and is partially interim isolated. This tank has a potential for hydrogen or flammable gas accumulation above its flammability limit.

2.3.2.1.2 241-A-102 Single-Shell Tank. The 241-A-102 Single-Shell Tank is directly to the east of the 241-A-101 Single-Shell Tank in the 241-A Tank Farm. This tank is surrounded by seven active radiation monitoring wells. The tank is also equipped with automatic temperature sensors, air lift circulators, and automatic liquid level gage, and a

radiation detection measurement system beneath the tank. The radiation detection system consists of a tube that runs beneath the tank through which a radiation monitor can be lowered.

The tank is classified as an inactive waste management unit. It operated from March 22, 1956 until November 21, 1980. The tank received PUREX carbonate wash waste; PUREX high-level waste; B Plant high-level waste (waste fractionization); and supernatant containing PUREX high-level waste, B Plant high-level waste, PUREX sludge supernatant, evaporator waste, complexed waste, and double-shell tank slurry feed from the 241-A, 241-AX, 241-AY, and 241-SX Tank Farms (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 83,270 L (22,000 gal) of salt cake, 15,140 L (4,000 gal) of supernate, and 56,775 L (15,000 gal) of sludge. This tank is considered "sound" and is partially interim isolated.

2.3.2.1.3 241-A-103 Single-Shell Tank. The 241-A-103 Single-Shell Tank is the eastern-most tank laying directly to the east of the 241-A-102 Single-Shell Tank. This tank is surrounded by eight active radiation monitoring wells. The tank is also equipped with automatic temperature sensors, air lift circulators, and an automatic liquid level gage.

The tank is classified as an inactive waste management unit. It operated from May 17, 1956 until August 14, 1980. The tank received PUREX carbonate wash waste; PUREX organic wash waste; PUREX high-level waste; B Plant high-level waste (waste fractionization); and waste fractionization ion exchange waste; and supernatant containing B Plant high-level waste, waste fractionization ion exchange waste, PUREX high-level waste, PUREX sludge supernatant, evaporator waste, complexed waste, and double slurry feed from the 241-A, 241-AX, 241-BY, and 241-C Tank Farms and 244-AR and 244-CR Vaults (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 15,120 L (4,000 gal) of supernate and 1,383,480 L (366,000 gal) of sludge. This tank is considered an "assumed leaker" and is interim isolated.

2.3.2.1.4 241-A-104 Single-Shell Tank. The 241-A-104 Single-Shell Tank is the northwestern-most tank laying directly to the north of the 241-A-101 Single-Shell Tank. This tank is surrounded by seven active radiation monitoring wells. The tank is also equipped with automatic temperature sensors, air lift circulators, and an automatic liquid level gage.

The tank is classified as an inactive waste management unit. It operated from 1958 until 1975. The tank received PUREX carbonate wash waste; PUREX organic wash waste; PUREX high-level waste; B Plant high-level (waste fractionization) and ion exchange waste;

and supernatant containing PUREX sludge supernatant from the 241-A Tank Farm and the 244-AR Vault (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 105,840 L (28,000 gal) of sludge. This tank is considered an "assumed leaker" and is interim isolated.

2.3.2.1.5 241-A-105 Single-Shell Tank. The 241-A-105 Single-Shell Tank is east of the 241-A-104 Single-Shell Tank. This tank is surrounded by seven active radiation monitoring wells. The tank is also equipped with automatic temperature sensors, air lift circulators, and an automatic liquid level gage.

The tank is classified as an inactive waste management unit. It operated from 1962 until 1971. The tank received PUREX inorganic wash waste and supernatant containing PUREX high-level waste from the 241-A Tank Farm (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 71,820 L (19,000 gal) of sludge. The tank has a high heat load of 50,000 Btu/h. This tank is considered an "assumed leaker" and is interim isolated.

2.3.2.1.6 241-A-106 Single-Shell Tank. The 241-A-106 Single-Shell Tank is the northeastern-most tank lying east of the 241-A-105 Single-Shell Tank. This tank is surrounded by eight active radiation monitoring wells. The tank is also equipped with automatic temperature sensors, air lift circulators, and an automatic liquid level gage.

The tank is classified as an inactive waste management unit. It operated from 1957 until August 14, 1980. The tank received PUREX organic and inorganic wash waste; PUREX carbonate wash waste; PUREX high-level waste; B Plant high-level waste; and supernatant containing PUREX high-level waste, B Plant high-level waste, and complexed concentrate from the 241-A Tank Farm, 244-AR Vault, and the B-302 Tanks (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 472,500 L (125,000 gal) of sludge. The tank is considered "sound" and is interim isolated.

2.3.2.2 241-AN Tank Farm. The 241-AN Tank Farm consists of seven buried double-shell steel tanks that contain mixed wastes. The tank farm is located immediately north of the AZ Tank Farm and is approximately 100 m (328 ft) southeast of the 241-C Tank Farm. The surface elevation of the tank farm is approximately 197 m (645 ft) above msl, and the depth to groundwater below the tank farm is 74 m (243 ft).

The tanks were placed in service in 1981 and are still active. Figure 2-1 shows the individual tanks in the 241-AN Tank Farm and their operational history. They are numbered 241-AN-101 through 241-AN-107. The seven 241-AN tanks are essentially identical in design except for tank 241-AN-101, which has two additional concrete pits, and tank 241-AN-107, which has 21 airlift circulator assemblies installed in the tank. The 241-AN Tank Farm consists of:

- Seven 3.78 million liter (1.0 million gal) double-shell tanks
- Associated primary tank (central) pump pits, annulus pump pits, and leak detection well pump pits
- Two valve pits
- Raw water service and flush pit
- 241-AN-271 Instrument Building
- 241-AN-701 Compressor Building.

The double-shell tanks are fabricated as three concentric tanks. The free standing primary tank contains the waste material. The primary tank is comprised of carbon steel 23 m (75 ft) in diameter and 14 m (45 ft) high at the domed center. The maximum capacity is 4,309,200 L (1.14 million gal). The primary tank rests upon a 20 cm (8 in.) layer of insulating concrete, which protects the structural concrete foundation from excessive temperature during annealing. The secondary tank, 2 m (5 ft) larger in diameter than the primary tank, creates a surrounding space called the annulus. The completely enclosed annulus serves as the containing barrier for primary tank leaks, thus preventing uncontrolled release of radionuclides to the environment. The annulus is ventilated and constantly monitored for evidence of primary tank leakage. The annulus is equipped with a continuous air monitor which is read daily and electronic leak detectors on the bottom of the tank annulus. The third tank is a concrete shell enclosing the primary and secondary tanks. The concrete shell rests on a concrete foundation 27 m (89 ft) in diameter. The foundation contains drain slots for the removal of any liquid that might leak from the secondary tank. Any liquid that reaches the foundation will drain through the slots to a leak detection well.

The 241-AN Tank Farm is used to store PUREX-generated, low-heat wastes which includes double-shell slurry feed, decladding waste, organic wash waste, cell drainage, laboratory waste, and salt well liquors pumped from single-shell tanks. Table 2-4 provides a summary of the total waste, drainable waste, flammable gas generation, and integrity of each tank. The majority of waste stored in the tank farm is supernatant liquid. One exception is

double-shell tank 241-AN-103, which contains mostly double-shell slurry feed. Figure 2-7 is a schematic of a typical double-shell tank.

Several dry wells within the tank farm are used to monitor the soil for radioactivity, and serve as one form of leak detection. In addition, groundwater monitoring wells around the 241-A, -AN, -AP, -AW, -AX, -AY, and -AZ Tank Farms are also used to monitor subsurface conditions.

All of the tanks within the 241-AN Tank Farm are equipped with leak detection systems. These systems include automatic and manual liquid-level tapes in the primary tank and annulus; three sets of 17-point conductivity probes in the annulus; an annulus exhaust radiation monitoring system; and weight factor, specific gravity, and radiation monitoring instrumentation in the leak detection pit. Annulus riser access is also available for investigative photos or swab sampling.

2.3.2.2.1 241-AN-101 Double-Shell Tank. The 241-AN-101 Double-Shell Tank is the southeastern most tank near Canton Avenue. The tank started operating in September 1981 and is currently active. The unit receives 100/300 Area customer waste, salt well liquor, and dilute noncomplexed waste.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 2,275,032 L (601,000 gal) of supernatant liquid. The tank is considered sound.

2.3.2.2.2 241-AN-102 Double-Shell Tank. The 241-AN-102 Double-Shell Tank is west of the 241-AN-101 Double-Shell Tank.

The tank started operating in September 1981 and is currently active. The unit receives dilute and concentrated complexant waste.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 3,798,900 L (1,005,000 gal) of supernatant liquid and 3,798,900L (89,000 gal) of sludge. The tank is considered sound.

2.3.2.2.3 241-AN-103 Double-Shell Tank. The 241-AN-103 Double-Shell Tank is west of the 241-AN-102 Double-Shell Tank.

The tank started operating in September 1981 and is currently active. The unit receives salt well liquor and dilute noncomplexed waste.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 52,920 L (14,000 gal) of supernatant liquid and

3,541,860 L (937,000 gal) of double-shell slurry feed. The tank is considered sound; however, the tank has a potential for hydrogen or flammable gas accumulation above its flammability limit of 177°C (350°F) (DOE 1980).

2.3.2.2.4 241-AN-104 Double-Shell Tank. The 241-AN-104 Double-Shell Tank is north of the 241-AN-101 Double-Shell Tank just west of Canton Avenue. The tank started operating in September 1981 and is currently active. The unit receives dilute noncomplexed waste and double-shell slurry feed.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 3,024,000 L (800,000 gal) of supernatant liquid and 997,920 L (264,000 gal) of sludge. The tank is considered sound; however, the tank has a potential for hydrogen or flammable gas accumulation above its flammability limit of 177°C (350°F) (DOE 1980).

2.3.2.2.5 241-AN-105 Double-Shell Tank. The 241-AN-105 Double-Shell tank is west of the 241-AN-104 Double-Shell Tank and north of the 241-AN-102 Double-Shell Tank. The tank started operating in September 1981 and is currently active. The unit receives dilute noncomplexed waste and double-shell slurry feed.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 4,263,840 L (1,128,000 gal) of supernatant liquid. The tank is considered sound; however, the tank has a potential for hydrogen or flammable gas accumulation above its flammability limit of 177°C (350°F) (DOE 1980).

2.3.2.2.6 241-AN-106 Double-Shell Tank. The 241-AN-106 Double-Shell Tank is west of the 241-AN-105 Double-Shell Tank and north of the 241-AN-103 Double-Shell Tank. The tank started operating in September 1981 and is currently active. The unit receives dilute and concentrated phosphate waste from the 100-N Area.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 3,780,000 L (1,000,000 gal) of supernatant liquid and 64,260 L (17,000 gal) of sludge. The tank is considered sound.

2.3.2.2.7 241-AN-107 Double-Shell Tank. The 241-AN-107 Double-Shell Tank is north of the 241-AN-106 Double-Shell Tank. The tank started operating in September 1981 and is currently active. The unit receives dilute and concentrated complexant wastes.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 3,556,980 L (941,000 gal) of supernatant liquid and 506,520 L (134,000 gal) of sludge. The tank is considered sound.

2.3.2.3 241-AP Tank Farm. The 241-AP Tank Farm consists of eight buried double-shell steel tanks. The tank farm is located just east of the GTF, in the center of the 4th Street Loop. The surface elevation of the tank farm is approximately 207 m (679 ft) above msl, and the depth to groundwater below the tank farm is 84 m (274 ft).

The tanks were placed in service in 1986 and are still active. Figure 2-1 shows the individual tanks in the 241-AW Tank Farm and their operational history. They are numbered 241-AP-101 through 241-AP-108. The tank farm consists of:

- Eight 3.78 million L (1.0 million gal) double-shell tanks
- Associated primary tank (central) pump pits, annulus pump pits, and leak detection well pump pits
- 241-AP Valve Pit
- Two vent pits
- Raw water service and flush pit
- Annulus Exhaust Station Building
- Primary Exhaust Station Building
- 241-AP-271 Instrument Building
- 241-AP-701 Compressor Building.

The double-shell tanks are fabricated as three concentric tanks. The free standing primary tank contains the waste material. The primary tank is comprised of carbon steel 23 m (75 ft) in diameter and 14 m (45 ft) high at the domed center. The maximum capacity is 4,309,200 L (1.14 million gal). The primary tank rests upon a 20 cm (8 in.) layer of insulating concrete which protects the structural concrete foundation from excessive temperature during annealing. The secondary tank, 2 m (5 ft) larger in diameter than the primary tank, creates a surrounding space called the annulus. The completely enclosed annulus serves as the containing barrier for primary tank leaks, thus preventing uncontrolled release of radionuclides to the environment. The annulus is ventilated and constantly monitored for evidence of primary tank leakage. The third tank is a concrete shell enclosing the primary and secondary tanks. The concrete shell rests on a concrete foundation 27 m (89 ft) in diameter. The foundation contains drain slots for the removal of any liquid that might leak from the secondary tank. Any liquid that reaches the foundation will drain through the slots to a leak detection well.

The 241-AP Tank Farm is used to store PUREX-generated, low-heat wastes which includes double-shell slurry feed, decladding waste, organic wash waste, cell drainage, laboratory waste, and salt well liquors pumped from single-shell tanks. Table 2-4 provides a summary of the total waste, drainable waste, flammable gas generation, and integrity of each tank. The waste stored in the tank farm is supernatant liquid. Figure 2-5 is a schematic of a typical double-shell tank.

Several dry wells within the tank farm are used to monitor the soil for radioactivity, and serve as one form of leak detection. In addition, groundwater monitoring wells around the 241-A, -AN, -AP, -AW, -AX, -AY, and -AZ Tank Farms are also used to monitor subsurface conditions.

All of the tanks within the 241-AP Tank Farm are equipped with leak detection systems. These systems include automatic and manual liquid-level tapes in the primary tank and annulus; three sets of 17-point conductivity probes in the annulus; an annulus exhaust radiation monitoring system; and weight factor, specific gravity, and radiation monitoring instrumentation in the leak detection pit. Annulus riser access is also available for investigative photos or swab sampling.

2.3.2.3.1 241-AP-101 Double-Shell Tank. The 241-AP-101 Double-Shell Tank is the northwestern tank just south of 4th Street. The tank started operating in October 1986 and is currently active. The unit receives PUREX ammonia scrubber feed waste.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 4,070,107 L (1,062,000 gal) of supernatant liquid. The tank is considered sound.

2.3.2.3.2 241-AP-102 Double-Shell Tank. The 241-AP-102 Double-Shell Tank is east of the 241-AP-101 Double-Shell Tank. The tank started operating in October 1986 and is currently active. The unit is the GTF feed tank. Initially, waste transferred to this unit will be dilute noncomplexed customer waste.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 503,460 L (133,000 gal) of supernatant liquid. The tank is considered sound.

2.3.2.3.3 241-AP-103 Double-Shell Tank. The 241-AP-103 Double-Shell Tank is south of the 241-AP-101 Double-Shell Tank. The tank started operating in October 1986 and is currently active. The unit receives PUREX ammonia scrubber feed waste.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 4,296,442 L (1,135,000 gal) of supernatant liquid. The tank is considered sound.

2.3.2.3.4 241-AP-104 Double-Shell Tank. The 241-AP-104 Double-Shell Tank is east of the 241-AP-103 Double-Shell Tank. The tank started operating in October 1986 and is currently active. The unit is designated as a Grout Feed Tank. The unit receives dilute noncomplexed waste.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 75,708 L (20,000 gal) of supernatant liquid. The tank is considered sound.

2.3.2.3.5 241-AP-105 Double-Shell Tank. The 241-AP-105 Double-Shell Tank is south of the 241-AP-103 Double-Shell Tank. The tank started operating in October 1986 and is currently active. The unit receives double-shell slurry feed.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 3,122,965 L (825,000 gal) of supernatant liquid. The tank is considered sound.

2.3.2.3.6 241-AP-106 Double-Shell Tank. The 241-AP-106 Double-Shell Tank is east of the 241-AP-105 Double-Shell Tank. The tank started operating in October 1986 and is currently active. The unit receives neutralized cladding removal waste.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 4,288,872 L (1,133,000 gal) of supernatant liquid. The tank is considered sound.

2.3.2.3.7 241-AP-107 Double-Shell Tank. The 241-AP-107 Double-Shell Tank is south of the 241-AP-105 Double-Shell Tank. The tank started operating in October 1986 and is currently active. The unit receives dilute, non-complexed waste.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 4,258,588 L (1,125,000 gal) of supernatant liquid. The tank is considered sound.

2.3.2.3.8 241-AP-108 Double-Shell Tank. The 241-AP-108 Double-Shell Tank is east of the 241-AP-107 Double-Shell Tank. The tank started operating in October 1986 and is currently active. The unit receives dilute, non-complexed waste.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 3,346,304 L (884,000 gal) of supernatant liquid. The tank is considered sound.

2.3.2.4 241-AW Tank Farm. The 241-AW Tank Farm consists of six buried double-shell steel tanks. It is located just west of the 241-AP Tank Farm and south of 4th Street. The surface elevation of the tank farm is approximately 212 m (695 ft) above msl, and the depth to groundwater below the tank farm is 84 m (274 ft).

The tanks were placed in service in 1980 and are still active. Figure 2-1 shows the individual tanks in the 241-AW Tank Farm and their operational history. They are numbered 241-AW-101 through 241-AW-106. The tank farm consists of:

- Six 3.78 million L (1.0 million gal) double-shell tanks
- Associated primary tank (central) pump pits, annulus pump pits, and leak detection well pump pits
- Two valve pits
- Three vent pits
- Raw water service and flush pit
- Heating ventilation and air conditioning pad
- Annulus Exhaust Station Building
- Primary Exhaust Station Building
- An electrical substation building
- 241-AW-271 Instrument Building
- 241-AW-701 Compressor Building.

The double-shell tanks are fabricated as three concentric tanks. The free standing primary tank contains the waste material. The primary tank is comprised of carbon steel 23 m (75 ft) in diameter and 14 m (45 ft) high at the domed center. The maximum capacity is 4,309,200 L (1.14 million gal). The primary tank rests upon a 20 cm (8 in.) layer of insulating concrete, which protects the structural concrete foundation from excessive temperature during annealing. The secondary tank, 2 m (5 ft) larger in diameter than the

primary tank, creates a surrounding space called the annulus. The completely enclosed annulus serves as the containing barrier for primary tank leaks, thus preventing uncontrolled release of radionuclides to the environment. The annulus is ventilated and constantly monitored for evidence of primary tank leakage. The third tank is a concrete shell enclosing the primary and secondary tanks.

The 241-AW Tank Farm is used to store PUREX-generated, low-heat wastes which includes double-shell slurry feed, decladding waste, organic wash waste, cell drainage, laboratory waste, and salt well liquors pumped from single-shell tanks. Table 2-4 provides a summary of the total waste, drainable waste, flammable gas generation, and integrity of each tank. The waste stored in the tank farm is primarily supernatant liquid.

Several dry wells within the tank farm are used to monitor the soil for radioactivity, and serve as one form of leak detection. In addition, groundwater monitoring wells around the 241-A, -AN, -AP, -AW, -AX, -AY, and -AZ Tank Farms are also used to monitor subsurface conditions.

All of the tanks within the 241-AW Tank Farm are equipped with leak detection systems. These systems include automatic and manual liquid-level tapes in the primary tank and annulus; three sets of 17-point conductivity probes in the annulus; an annulus exhaust radiation monitoring system; and weight factor, specific gravity, and radiation monitoring instrumentation in the leak detection pit. Annulus riser access is also available for investigative photos or swab sampling.

2.3.2.4.1 241-AW-101 Double-Shell Tank. The 241-AW-101 Double-Shell Tank is the northwestern tank just south of 4th Street. The tank started operating in July 1980 and is currently active. The unit receives double-shell slurry feed and dilute noncomplexed waste.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 3,934,980 L (1,040,000 gal) of supernatant liquid and 317,520 L (84,000 gal) of sludge. The tank is considered sound.

2.3.2.4.2 241-AW-102 Double-Shell Tank. The 241-AW-102 Double-Shell Tank is east of the 241-AW-101 Double-Shell Tank. The unit is designated as the 242-A Evaporator feed tank. Any waste designated for concentration is pumped to the 241-AW-102 feed tank for transfer to the 242-A Evaporator. In addition to the central pump pit, annulus pump pit, and lead detection pit, which are associated with all the 241-AW tanks, the 241-AW-102 tank has a feed pump pit and a drain pit. To provide a uniform feed to the 242-A Evaporator, tank 241-AW-102 has airlift circulators for mixing tank contents. The tank also has a dip tube assembly installed to read specific gravity.

The tank started operating in 1980 and is currently active. The tank receives double-shell tank slurry feed.

The *Tank Farm Surveillance and Waste Status Report for December1991* (Hanlon 1992) indicates that the tank contains 3,900,960 L (1,034,000 gal) of supernatant liquid and 3,780 L (1,000 gal) of sludge. The tank is considered sound.

2.3.2.4.3 241-AW-103 Double-Shell Tank. The 241-AW-103 Double-Shell Tank is south of the 241-AW-101 Double-Shell Tank. The tank started operating in 1980 and is currently active. The unit receives PUREX decladding supernate and TRU sludge.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 1,084,860 L (287,000 gal) of supernatant liquid and 1,372,140 L (363,000 gal) of sludge. The tank is considered sound.

2.3.2.4.4 241-AW-104 Double-Shell Tank. The 241-AW-104 Double-Shell Tank is east of the 241-AW-103 Double-Shell Tank. The tank started operating in 1980 and is currently active. The unit receives double-shell slurry feed and dilute noncomplexed waste.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 3,160,080 L (836,000 gal) of supernatant liquid, 676,620 L (179,000 gal) of sludge, and 419,580 L (111,000 gal) of salt cake. The tank is considered sound.

2.3.2.4.5 241-AW-105 Double-Shell Tank. The 241-AW-105 Double-Shell Tank is south of the 241-AW-103 Double-Shell Tank. The tank started operating in 1980 and is currently active. The unit receives supernate and TRU PUREX decladding sludge.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 2,290,680 L (606,000 gal) of supernatant liquid and 1,122,660 L (297,000 gal) of sludge. The tank is considered sound.

2.3.2.4.6 241-AW-106 Double-Shell Tank. The 241-AW-106 Double-Shell Tank is east of the 241-AW-105 Double-Shell Tank. The tank started operating in 1980 and is currently active. The unit is designated as the 242-A Evaporator receiver tank. Waste received in this unit may be complexed or noncomplexed waste.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 922,320 L (244,000 gal) of supernatant liquid, 748,440 L (198,000 gal) of sludge, and 321,300 L (85,000 gal) of salt cake. The tank is considered sound.

2.3.2.5 241-AX Tank Farm. The 241-AX Tank Farm consists of four buried single-shell steel tanks that contain mixed waste. It is located approximately 533 m (1,750 ft) northeast of the 202-A Building, east of the 241-AY Tank Farm, and between the 241-A and 241-AZ Tank Farms. The surface elevation of the tank farm is approximately 207 m (680 ft) above msl, and the depth to groundwater below the tank farm is approximately 80 m (262 ft) (WHC 1991a).

The tanks were placed in service during the mid-1960's and retired in the early 1980's (Table 2-2). Figure 2-1 shows the individual tanks in the 241-AX Tank Farm and their operational history. They are numbered 241-AX-101 through 241-AX-104. All the tanks are inactive and each has undergone initial stabilization and has a status of either partial interim isolated or interim isolated (WHC 1991a). Currently, many structures in the tank farm, including diversion boxes 241-AX-151, 241-AX-152DS, and catch tank 241-AX-152CT have been stabilized. The tanks are covered with gravel, generally at the level of the surrounding grade.

The tanks are carbon-steel lined, with a reinforced concrete shell, dome, and base, less than 1 m (2 ft) thick. The structures are 14 m (45 ft) high and have a capacity of 3,785,000 L (1,000,000 gal). The domes are located 2 m (7 ft) below grade and the bottom of the tanks are 16 m (52 ft) below grade. These are fifth generation tank in design. The fifth generation tanks differ from the previous generation (241-A Single-Shell Tanks) in that an additional grid of drain slots were added beneath the bottom steel liner.

Table 2-4 provides a description of the tank farms in the PUREX Plant Aggregate Area and the volume of total waste and drainable waste present in each tank. Generally, most of the waste present is salt cake with relatively minor drainable liquid.

Several dry wells within the tank farm are used to monitor the soil for radioactivity, and serve as one form of leak detection. In addition, groundwater monitoring wells around the 241-A, 241-AX, 241-AY, and 241-AZ Tank Farms are also used to monitor subsurface conditions.

2.3.2.5.1 241-AX-101 Single-Shell Tank. The 241-AX-101 Single-Shell Tank is the northeastern tank in the 241-AX Tank Farm. The tank is surrounded by eight active radiation monitoring wells. The tank is also equipped with automatic temperature sensors, air lift circulators, and an automatic liquid level gage.

The tank is classified as an inactive waste management unit. It operated from 1965 until November 12, 1980. The tank received fission product waste; PUREX organic wash waste; PUREX high-level and low-level waste; B Plant high-level waste (waste fractionization); and supernatant containing fission product waste, PUREX sludge

supernatant, organic wash waste, and double-shell slurry feed from the 241-A and 241-AX Tank Farms (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 11,355 L (3,000 gal) of sludge and 3,591,000 L (950,000 gal) of salt cake. This tank has a potential for hydrogen or flammable gas accumulation above its flammability limit of 204 °C (400 °F) (Geier 1976). The tank is considered "sound" and is partially interim isolated.

2.3.2.5.2 241-AX-102 Single-Shell Tank. The 241-AX-102 Single-Shell Tank is the southeastern tank. The tank is surrounded by 10 active radiation monitoring wells and 1 inactive well. The tank is also equipped with automatic temperature sensors, air lift circulators, and a manual liquid level gage.

The tank is classified as an inactive waste management unit. It operated from 1966 until September 8, 1980. The tank received PUREX high-level and low-level waste; PUREX organic wash waste; B Plant high-level waste (waste fractionization); and supernatant containing PUREX high-level waste, complexant concentrate, B Plant high-level waste, and complexed waste from the 241-A, 241-AX, and 241-C Tanks, 244-AR Vault, and TK-417 (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 26,495 L (7,000 gal) of sludge, 11,355 L (3,000 gal) of, supernate and 109,765 L (29,000 gal) of salt cake. The tank is considered an "assumed leaker" and is interim isolated.

2.3.2.5.3 241-AX-103 Single-Shell Tank. The 241-AX-103 Single-Shell Tank is the northwestern tank. The tank is surrounded by six active radiation monitoring wells. The tank is also equipped with automatic temperature sensors, air lift circulators, and an automatic liquid level gage.

The tank is classified as an inactive waste management unit. It operated from 1965 until September 8, 1980. The tank received PUREX high-level and low-level waste; PUREX organic and inorganic wash waste; B Plant high-level and low-level waste (waste fractionization); and supernatant containing PUREX high-level waste and sludge supernatant from 241-A, 241-AX, 241-AZ, and 241-C Tanks, 244-AR Vault, and 241-AX-152 Tank (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 7,570 L (2,000 gal) of sludge and 416,350 L (110,000 gal) of salt cake. This tank has a potential for hydrogen or flammable gas accumulation

above its flammability limit of 204 °C (400 °F) (Geier 1976). The tank is considered "sound" and is interim isolated.

2.3.2.5.4 241-AX-104 Single-Shell Tank. The 241-AX-104 Single-Shell Tank is the southwestern tank. The tank is surrounded by seven active radiation monitoring wells. The tank is also equipped with automatic temperature sensors, air lift circulators, and a manual liquid level gage.

The tank is classified as an inactive waste management unit. It operated from 1966 until 1976. The tank received PUREX high-level and low-level waste; PUREX organic and inorganic wash waste; B Plant high-level waste (waste fractionization); and supernatant containing PUREX high-level waste and sludge supernatant from the 241-A and 241-AX Tanks, and 244-AR-002 Tank (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 26,460 L (7,000 gal) of sludge. This tank has a potential for hydrogen or flammable gas accumulation above its flammability limit of 204 °C (400 °F) (Geier 1976). The tank is considered "sound" and is interim isolated.

2.3.2.6 241-AY Tank Farm. The 241-AY Tank Farm consists of two buried double-shell steel tanks. It is located west of the 241-AX Tank Farm and east of Buffalo Avenue. The surface elevation of the tank farm is approximately 206 m (676 ft) above msl, and the depth to groundwater below the tank farm is 80 m (262 ft).

The tanks were placed in service in 1971 and are still active. Figure 2-1 shows the individual tanks in the 291-AY Tank Farm and their operational history. They are numbered 241-AY-101 and 241-AY-102. The tank farm consists of:

- Two 3.78 million L (1.0 million gal) double-shell tanks
- Associated primary tank (central) pump pits, annulus pump pits, and leak detection well pump pits
- Four sluice pump pits (2 per tank)
- 241-AY-801 Instrument Building
- 241-AY-101A and B Dual Leak Detection Pit
- 241-AY-501 Diversion Box.

The double-shell tanks are fabricated as three concentric tanks. The free standing primary tank contains the waste material. The primary tank is comprised of carbon steel 23 m (75 ft) in diameter and 14 m (45 ft) high at the domed center. The maximum capacity is 4,309,200 L (1.14 million gal). The primary tank rests upon a 20 cm (8 in.) layer of insulating concrete which protects the structural concrete foundation from excessive temperature during annealing. The secondary tank, 2 m (5 ft) larger in diameter than the primary tank, creates a surrounding space called the annulus. The completely enclosed annulus serves as the containing barrier for primary tank leaks, thus preventing uncontrolled release of radionuclides to the environment. The annulus is ventilated and constantly monitored for evidence of primary tank leakage. The third tank is a concrete shell enclosing the primary and secondary tanks.

The 241-AY Tanks (also known as aging-waste tanks) are used to store high-level radioactive wastes. Currently, the 241-AY Tanks do not contain aging-waste. Table 2-4 provides a summary of the total waste, drainable waste, flammable gas generation, and integrity of each tank. The waste stored in the tank farm is supernatant liquid and sludge.

Several dry wells within the tank farm are used to monitor the soil for radioactivity, and serve as one form of leak detection. In addition, groundwater monitoring wells around the 241-A, -AN, -AP, -AW, -AX, -AY, and -AZ Tank Farms are also used to monitor subsurface conditions.

All of the tanks within the 241-AW Tank Farm are equipped with leak detection systems. These systems include automatic and manual liquid-level tapes in the primary tank and annulus; three sets of 17-point conductivity probes in the annulus; an annulus exhaust radiation monitoring system; and weight factor, specific gravity, and radiation monitoring instrumentation in the leak detection pit. Annulus riser access is also available for investigative photos or swab sampling.

2.3.2.6.1 241-AY-101 Double-Shell Tank. The 241-AY-101 Double-Shell Tank is the north tank. The tank started operating in 1971 and is currently active. The unit receives strontium and cesium depleted, neutralized, high-level waste from B Plant, dilute noncomplexed waste from single-shell tanks, dilute complexed waste, PUREX high-level waste and supernatant consisting of complexed waste from the 241-A and 241-AX Tank Farms.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 3,163,860 L (837,000 gal) of supernatant liquid and 313,740 L (83,000 gal) of sludge. The tank is considered sound.

2.3.2.6.2 241-AY-102 Double-Shell Tank. The 241-AY-102 Double-Shell Tank is the southern tank. The tank started operating in 1972 and is currently active. The unit

receives neutralized high-level waste, double-shell slurry feed, dilute noncomplexed waste, and supernatant consisting of double-shell slurry feed and noncomplexed waste from the 241-A and 241-BX Tank Farms.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 3,345,300 L (885,000 gal) of supernatant liquid and 120,960 L (32,000 gal) of sludge. The tank is considered sound.

2.3.2.7 241-AZ Tank Farm. The 241-AZ Tank Farm consists of two buried double-shell steel tanks. It is located just south of the 241-AZ Tank Farm. The surface elevation of the tank farm is approximately 203 m (666 ft) above msl, and the depth to groundwater below the tank farm is 84 m (274 ft).

The tanks were placed in service in 1976 and are still active. Figure 2-1 shows the individual tanks in the 291-AZ Tank Farm and their operational history. They are numbered 241-AZ-101 and 241-AZ-102. The tank farm consists of:

- Two 3.78 million L (1.0 million gal) double-shell tanks
- Associated primary tank (central) pump pits, annulus pump pits, and leak detection well pump pits
- 241-AZ-801A Instrument Building
- Eight sluice pump pits (4 per tank)
- 241-AZ-101/102 Dual Leak Detection Pit
- 241-AZ-152 Diversion Box
- 241-AZ-155 Contaminated Storage Pit
- 241-AZ-154 Condensate Pump Pit.

The double-shell tanks are fabricated as three concentric tanks. The free standing primary tank contains the waste material. The primary tank is comprised of carbon steel 23 m (75 ft) in diameter and 14 m (45 ft) high at the domed center. The maximum capacity is 4,309,200 L (1.14 million gal). The primary tank rests upon a20 cm (8 in.) layer of insulating concrete which protects the structural concrete foundation from excessive temperature during annealing. The secondary tank, 2 m (5 ft) larger in diameter than the primary tank, creates a surrounding space called the annulus. The completely enclosed annulus serves as the containing barrier for primary tank leaks, thus preventing uncontrolled

release of radionuclides to the environment. The annulus is ventilated and constantly monitored for evidence of primary tank leakage. The third tank is a concrete shell enclosing the primary and secondary tanks.

The 241-AZ Tanks (also known as aging-waste tanks) are used to store high-level radioactive waste. Currently, both of the 241-AZ tanks contain aging-waste. Table 2-4 provides a summary of the total waste, drainable waste, flammable gas generation, and integrity of each tank. The waste stored in the tank farm is supernatant liquid and sludge.

Several dry wells within the tank farm are used to monitor the soil for radioactivity, and serve as one form of leak detection. In addition, groundwater monitoring wells around the 241-A, -AN, -AP, -AW, -AX, -AY, and -AZ Tank Farms are also used to monitor subsurface conditions.

All of the tanks within the 241-AW Tank Farm are equipped with leak detection systems. These systems include automatic and manual liquid-level tapes in the primary tank and annulus; three sets of 17-point conductivity probes in the annulus; an annulus exhaust radiation monitoring system; and weight factor, specific gravity, and radiation monitoring instrumentation in the leak detection pit. Annulus riser access is also available for investigative photos or swab sampling.

2.3.2.7.1 241-AZ-101 Double-Shell Tank. The 241-AZ-101 Double-Shell Tank is the east tank. The tank started operating in 1976 and is currently active. The unit receives dilute high strontium waste from B Plant, complexed waste, double-shell slurry feed, noncomplexed waste, and supernatant consisting of complexed waste, double-shell slurry feed, and noncomplexed waste from the 241-A, -AX, -BX, -C Tank Farms.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 3,651,480 L (966,000 gal) of supernatant liquid and 132,300 L (35,000 gal) of sludge. The tank is considered sound.

2.3.2.7.2 241-AZ-102 Double-Shell Tank. The 241-AZ-102 Double-Shell Tank is the west tank. The tank started operating in 1976 and is currently active. The unit receives dilute high strontium waste from B Plant, complexed waste, aging waste from PUREX, and supernatant consisting of complexed waste from the 241-AX Tank Farm.

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 3,689,280 L (976,000 gal) of supernatant liquid and 343,980 L (91,000 gal) of sludge. The tank is considered sound.

2.3.2.8 241-C Tank Farm. Sixteen buried single-shell tanks make up the 241-C Tank Farm. It is located approximately 914 m (3,000 ft) north of the 202-A Building, and 152 m

(500 ft) northwest of the 241-AN Tank Farm. The surface elevation of the tank farm is approximately 197 m (645 ft) above mean sea level, and the depth to groundwater below the tank farm is approximately 74 m (243 ft) (WHC 1991a). The tanks are covered with gravel, generally at the level of the surrounding grade.

The tanks were placed in service during the mid-1940's and retired in the late-1970's to mid-1980's. They are numbered 241-C-101 through 241-C-112, and 241-C-201 through 241-C-204. All the tanks are currently inactive and each has undergone initial stabilization and has a status of either partial interim isolation or interim isolation (WHC 1991a).

Currently, the entire tank farm, including diversion boxes 241-C-153, 241-CR-151, 241-CR-152, and 241-CR-153, is surrounded by a chain link fence and topped with three strands of barbed wire. Diversion boxes 241-C-151 and 241-C-152 are outside the perimeter fence of the 241-C Tank Farm. The tank farm is covered with gravel. Surface contamination placards are placed on the chain link fence. The entire tank farm is also designated as a supplied air breathing zone. All individuals who enter the confine of the 241-C Tank Farm must be on supplied fresh air.

The tanks are carbon-steel lined with a reinforced concrete shell. Twelve of the tanks (241-C-101 through 241-C-112) have a capacity of over 2,017,000 L (533,000 gal). The domes are generally 2 m (7 ft) below grade, and the bottom of the tanks are generally 11 m (37 ft) below grade. These are first generation tanks in design. This means they have an operating depth of 5 m (17 ft) and dished bottoms.

Four of the sixteen tanks in the 241-C Tank Farm are smaller than the other tanks within the farm. These tanks (241-C-201 through 241-C-204) are also carbon-steel lined with a reinforced concrete shell. Their structure is 8 m (25 ft) tall with a capacity of 208,000 L (55,000 gal). The domes are located less than 4 m (11 ft) below grade, and the bottom of the tanks are 11 m (37 ft) below grade. The four smaller tanks are first generation design tanks. First generation design tanks have operating depths of 5 m (17 ft) and dished bottoms.

The tanks are arranged in groups of three that are designed to cascade from the southwest to the northeast, so that the bulk of the solid waste is contained in the first tank of a cascading series. Cooling of the waste material, precipitation, and gravity settling of particulate material occur in each tank. Thus, the bulk of the radionuclides collect in the bottom of a tank. Air-cooled reflux condensers were installed to prevent the heating-up of the wastes. The condensate from the condensers was returned to the tank and any non-condensible gasses were vented directly to the atmosphere (Stenner et al. 1988; WHC 1991a).

The waste stream received by the tank farm was generated largely from the bismuth phosphate process used in the 221-B Building, which operated until 1956. During this period, small amounts of waste from Building 201-C (Semiworks) were also sent to the tank farm. The 201-C Building was built in 1949 and used as a pilot plant for the reduction-oxidation process development, and later for "bench scale" PUREX process development. Laboratory waste from the 209-E Building (Critical Mass Laboratory) was also sent to the 241-C Tanks (WHC 1991a).

Between 1956 and 1972 the PUREX Plutonium Recovery Process operated at the 221-U Building and some of the organic wash waste, coating waste, and tributyl phosphate waste from this extraction process was routed to the 241-C Tank Farm. In addition, all the wastes from the two thorium campaigns run at PUREX, one in 1966 and another in 1970, were sent to the 241-C Tank Farm (WHC 1991a).

Table 2-4 provides a description of the tank farms in the PUREX Plant Aggregate Area and the volume of total waste and drainable waste present in each tank. Generally, most of the waste present is salt cake with relatively minor drainable liquid.

Several dry wells within the tank farm are used to monitor the soil for radioactivity and serve as one form of leak detection. In addition, groundwater monitoring wells around the area are also used to monitor subsurface conditions.

An incident report was filed on August 16, 1989 regarding the 241-C Tank Farm. On that morning a Radiation Protection Technologist was performing routine work in the tank farm and noticed a musty smell. The technologist held his breath and walked upwind past the 241-C Tank Farm. After exiting the tank farm, the individual experienced a headache and nausea. A similar incident occurred in January of 1989; however, unlike the previous incident, first aid was not required.

In order to characterize the situation, single-shell tanks 241-C-102 and -103 were sampled for ammonia and organic vapors. In addition, the entire tank farm was designated as a supplied air breathing zone.

2.3.2.8.1 241-C-101 Single-Shell Tank. The 241-C-101 Single-Shell Tank is the southern-most tank, and is the first tank in a three tank cascade comprised of 241-C-101, 241-C-102, and 241-C-103. Wastes flowed first into 241-C-101, next overflowed into 241-C-102, and finally flowed into 241-C-103. The tank is surrounded by four active radiation monitoring wells. The tank is also equipped with temperature sensors and a manual liquid level gage.

The tank is classified as an inactive waste management unit. It operated from 1946 until 1970. The tank received bismuth phosphate metal waste; tributyl phosphate waste; and PUREX coating waste (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 332,640 L (88,000 gal). This tank has a potential for hydrogen or flammable gas accumulation above its flammability limit. The tank is considered "sound" and is interim isolated.

2.3.2.8.2 241-C-102 Single-Shell Tank. The 241-C-102 Single-Shell Tank is northeast of the 241-C-101 Single-Shell Tank, and is the second tank in a three tank cascade comprised of 241-C-101, 241-C-102, and 241-C-103. Wastes flowed first into 241-C-101, next overflowed into 241-C-102, and finally flowed into 241-C-103. The tank is surrounded by radiation monitoring wells, however, none of the wells are active. The tank is also equipped with temperature sensors and an automatic liquid level gage.

The tank is classified as an inactive waste management unit. It operated from May 1946 until 1976. The tank received bismuth phosphate metal waste; tributyl phosphate waste; and PUREX coating waste; thorium high-level waste; PUREX organic wash waste; and supernatant containing organic wash wastes and coating wastes from 241-A, -AX, and -C tanks (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 1,602,720 L (424,000 gal) of sludge. The tank is considered "sound" and is partially interim isolated.

2.3.2.8.3 241-C-103 Single-Shell Tank. The 241-C-103 Single-Shell Tank is northeast of 241-C-102, and is the third tank in a three tank cascade comprised of 241-C-101, 241-C-102, and 241-C-103. Wastes flowed first into 241-C-101, next overflowed into 241-C-102, and finally flowed into 241-C-103. The tank is surrounded by five active radiation monitoring wells. The tank is also equipped with temperature sensors and an automatic liquid level gage.

The tank is classified as an inactive waste management unit. It is uncertain when this tank started operating. Operation of the tank ceased in 1979. The tank received PUREX coating waste; tributyl phosphate waste; and supernatant containing tributyl phosphate waste, coating, waste PUREX high-level waste, B Plant high-level waste, B Plant waste fractionization low-level waste, PUREX sludge supernatant, PUREX low-level waste, waste fractionization PUREX sludge, PUREX organic wash waste, laboratory waste, decontamination waste, REDOX ion exchange waste, REDOX high-level waste, noncomplexed waste, waste fractionization ion exchange waste, N Reactor waste, Pacific Northwest Laboratory (PNL) waste, and evaporator bottoms from 241-A, 241-B, 241-BX,

and 241-C Tank Farms. This unit was used as the receiver for operating p-10 saltwater systems within the 241-C Tank Farm (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 234,360 L (62,000 gal) of sludge and 503,405 L (133,000 gal) of supernate. The tank is considered "sound" and is partially interim isolated.

2.3.2.8.4 241-C-104 Single-Shell Tank. The 241-C-104 Single-Shell Tank is northwest of 241-C-101, and is the first tank in a three tank cascade comprised of 241-C-104, 241-C-105, and 241-C-106. Wastes flowed first into 241-C-104, next overflowed into 241-C-105, and finally flowed into 241-C-106. The tank is surrounded by seven active radiation monitoring wells. The tank is also equipped with temperature sensors and an automatic liquid level gage.

The tank is classified as an inactive waste management unit. It operated from October 1946 until 1980. The tank received PUREX coating waste; bismuth phosphate metal waste; PUREX low-level and high-level waste; thorium low-level and high-level waste; PUREX organic wash waste; and supernatant containing metal waste, PUREX organic wash waste, PUREX low-level and high-level waste, coating waste, complexed waste, PNL waste, N Reactor complexed waste, waste fractionization ion exchange waste, decontamination waste, B Plant low-level and high-level waste, evaporator bottoms; REDOX high-level waste, and tributyl phosphate waste from 241-A, 241-AX, 241-C, 241-BY, 241-TY, and 241-U Tanks (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 1,115,100 L (295,000 gal) of sludge. This tank is considered "sound" and is partially interim isolated.

2.3.2.8.5 241-C-105 Single-Shell Tank. The 241-C-105 Single-Shell Tank is northeast of the 241-C-104 Single-Shell Tank and is the second tank in a three tank cascade comprised of 241-C-104, 241-C-105, and 241-C-106. Wastes flowed first into 241-C-104, next overflowed into 241-C-105, and finally flowed into 241-C-106. The tank is surrounded by eight active radiation monitoring wells. The tank is also equipped with temperature sensors and an automatic liquid level gage.

The tank is classified as an inactive waste management unit. It is uncertain whether this tank started operating in 1946 or in 1947. Operation of the tank ceased in 1979. The tank received PUREX coating waste; tributyl phosphate waste; PUREX sludge supernatant; REDOX supernatant; and supernatant containing tributyl phosphate waste, coating waste, PUREX sludge supernate, REDOX supernatant, PUREX high-level waste, REDOX high-level waste, noncomplexed waste, B Plant waste fractionization low-level and metal wastes from 241-A, 241-AX, 241-AY, 241-B, 241-C, and 241-TX Tank Farms; and solids

containing PUREX sludge supernate, coating waste, and cesium feet from 241-AX and 241-A Tank Farms (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 567,000 L (150,000 gal) of sludge. This tank is considered "sound" and is partially interim isolated.

2.3.2.8.6 241-C-106 Single-Shell Tank. The 241-C-106 Single-Shell Tank is northeast of the 241-C-105 Single-Shell Tank, and is the third and last tank in a three tank cascade comprised of 241-C-104, 241-C-105, and 241-C-106. Wastes flowed first into 241-C-104, next overflowed into 241-C-105, and finally flowed into 241-C-106. The tank is surrounded by six active radiation monitoring wells. The tank is also equipped with temperature sensors and a manual liquid level gage.

The tank is classified as an inactive waste management unit. It is uncertain whether this tank started operating in June of 1947 or in 1951. Operation of the tank ceased in 1979. The tank received PUREX coating waste; B Plant low-level waste (waste fractionization); supernatant containing PUREX high-level waste, and tributyl phosphate waste from the 241-A and 241-C Tanks; and solids containing PUREX sludge supernatant from 241-A Tanks (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 745,650 L (197,000 gal) of sludge and 121,120 L (32,000 gal) of supernate. The tank has a high heat load of 150,000 Btu/h. This tank is considered "sound" and is partially interim isolated.

2.3.2.8.7 241-C-107 Single-Shell Tank. The 241-C-107 Single-Shell Tank is northwest of the 241-C-104 Single-Shell Tank, and is the first tank in a three tank cascade comprised of 241-C-107, 241-C-108, and 241-C-109. Wastes flowed first into 241-C-107, next overflowed into 241-C-108, and finally flowed into 241-C-109. The tank is surrounded by seven active radiation monitoring wells. The tank is also equipped with temperature sensors and an automatic liquid level gage.

The tank is classified as an inactive waste management unit. It operated from April 1946 until 1978. The tank received bismuth phosphate first-cycle waste; hot 201-C Building (Semiworks) waste; tributyl phosphate; PUREX coating waste; Hanford Laboratory Operations waste; and supernatant containing PUREX coating waste, PNL waste, N Reactor waste, laboratory waste, decontamination waste, waste fractionization ion exchange waste, and evaporator bottoms waste from the 241-C and 241-BX Tanks (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 1,273,860 L (337,000 gal) of sludge. This tank is considered "sound" and is partially interim isolated.

2.3.2.8.8 241-C-108 Single-Shell Tank. The 241-C-108 Single-Shell Tank is northeast of 241-C-107, and is the second tank in a three tank cascade comprised of 241-C-107, 241-C-108, and 241-C-109. Wastes flowed first into 241-C-107, overflowed into 241-C-108, and finally flowed into 241-C-109. The tank is surrounded by three active radiation monitoring wells. The tank is also equipped with temperature sensors and a manual liquid level gage.

The tank is classified as an inactive waste management unit. It operated from September 1947 until 1976. The tank received bismuth phosphate first-cycle waste; PUREX coating waste; tributyl phosphate waste; hot 201-C Building (Semiworks) waste; and supernatant containing tributyl phosphate waste, coating waste PUREX organic wash waste, fractionization ion exchange waste, PNL waste; N Reactor waste, laboratory waste, decontamination waste, and REDOX high-level waste from the 241-C Tanks (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 249,480 L (66,000 gal) of sludge. The tank contains ferrocyanide. This tank is considered "sound" and is interim isolated.

2.3.2.8.9 241-C-109 Single-Shell Tank. The 241-C-109 Single-Shell Tank is northeast of the 241-C-108 Single-Shell Tank, and is the third and last tank in a three tank cascade comprised of 241-C-107, 241-C-108, and 241-C-109. Wastes flowed first into 241-C-107, next overflowed into 241-C-108, and finally flowed into 241-C-109. The tank is surrounded by six active radiation monitoring wells. The tank is also equipped with temperature sensors and a manual liquid level gage.

The tank is classified as an inactive waste management unit. It is uncertain whether this tank started operating in April 1948 or in 1952. Operation of the tank ceased in 1976. The tank received bismuth phosphate first-cycle waste; tributyl phosphate waste; hot 201-C Building (Semiworks) waste, PUREX coating waste; and supernatant containing PUREX coating waste, hot Semiworks waste, evaporator bottoms, and ion exchange waste from the 241-C Tanks (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 234,670 L (62,000 gal) of sludge and 15,140 L (4,000 gal) of supernatant. The tank contains ferrocyanide. This tank is considered "sound" and is interim isolated.

2.3.2.8.10 241-C-110 Single-Shell Tank. The 241-C-110 Single-Shell Tank is northwest of the 241-C-107 Single-Shell Tank, and is the first tank in a three tank cascade comprised of 241-C-110, 241-C-111, and 241-C-112. Wastes flowed first into 241-C-110, next overflowed into 241-C-111, and finally flowed 241-C-112. The tank is surrounded by six active radiation monitoring wells. The tank is also equipped with temperature sensors and a manual liquid level gage.

The tank is classified as an inactive waste management unit. It operated from May 1946 until 1976. The tank received tributyl phosphate waste; bismuth phosphate first-cycle waste; and supernatant containing PUREX organic wash waste, ion exchange waste, coating waste, evaporator bottoms, and REDOX ion exchange waste (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 740,880 L (196,000 gal) of sludge. This tank is considered an "assumed leaker" and is partially interim isolated.

2.3.2.8.11 241-C-111 Single-Shell Tank. The 241-C-111 Single-Shell Tank is northeast of the 241-C-110 Single-Shell Tank, and is the second tank in a three tank cascade comprised of 241-C-110, 241-C-111, and 241-C-112. Wastes flowed first into 241-C-110, and then overflowed into 241-C-111 Single-Shell Tank and then flowed into 241-C-112. The tank is surrounded by six active radiation monitoring wells. The tank is also equipped with temperature sensors and a manual liquid level gage.

The tank is classified as an inactive waste management unit. It operated from August 1946 until 1976. The tank received bismuth phosphate first-cycle waste; PUREX organic wash waste; tributyl phosphate waste; PUREX coating waste; evaporator bottoms; hot 201-C Building (Semiworks) waste; and supernatant containing evaporator bottoms, coating waste, and tributyl phosphate waste from the 241-B and 241-C Tanks (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 215,460 L (57,000 gal) of sludge. The tank also contains ferrocyanide. This tank is considered an "assumed leaker" and is interim isolated.

2.3.2.8.12 241-C-112 Single-Shell Tank. The 241-C-112 Single-Shell Tank is northwest of the 241-C-111 Single-Shell Tank, and is the last tank in a three tank cascade comprised of 241-C-110, 241-C-111, and 241-C-112. Wastes flowed first into 241-C-110, next overflowed into 241-C-111, and finally flowed into 241-C-112. The tank is surrounded by six active radiation monitoring wells. The tank is also equipped with temperature sensors and a manual liquid level gage.

The tank is classified as an inactive waste management unit. It is uncertain whether this tank started operating in November 1946 or in 1952. Operations ceased in 1976. The

tank received tributyl phosphate waste; PUREX coating waste; hot 201-C Building (Semiworks) waste; and supernatant containing coating waste, tributyl phosphate waste, and ion exchange waste from the 241-C Tanks (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 393,120 L (104,000 gal) of sludge. This tank also contains ferrocyanide. This tank is considered "sound" and is partially interim isolated.

2.3.2.8.13 241-C-201 Single-Shell Tank. The 241-C-201 Single-Shell Tank is north of 241-C-103, and is the first tank in a four tank cascade comprised of 241-C-201, 241-C-202, 241-C-203, and 241-C-204. Wastes flowed first into 241-C-201, then into 241-C-202, then into 241-C-203, and then into 241-C-204. The tank is surrounded by radiation monitoring wells, however, none are currently active. The tank is also equipped with temperature sensors and a manual liquid level gage.

The tank is classified as an inactive waste management unit. It operated from 1953 until 1977. The tank received bismuth phosphate metal waste and strontium 201-C Building (Semiworks) waste (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 7,560 L (2,000 gal) of sludge. This tank is considered an "assumed leaker" and is interim isolated.

2.3.2.8.14 241-C-202 Single-Shell Tank. The 241-C-202 Single-Shell Tank is northwest of the 241-C-201 Single-Shell Tank, and is the second tank in a four tank cascade comprised of 241-C-201, 241-C-202, 241-C-203, and 241-C-204. Wastes flowed first into 241-C-201, then into 241-C-202, then into 241-C-203, and then into 241-C-204. The tank is surrounded by radiation monitoring wells, however, none are currently active. The tank is also equipped with temperature sensors and a manual liquid level gage.

The tank is classified as an inactive waste management unit. It operated from 1953 until 1977. The tank received bismuth phosphate metal waste, strontium 201-C Building (Semiworks) waste, and supernatant containing bismuth phosphate metal waste from the 241-C-201 Single-Shell Tank (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 3,780 L (1,000 gal) of sludge. This tank is considered an "assumed leaker" and is interim isolated.

2.3.2.8.15 241-C-203 Single-Shell Tank. The 241-C-203 Single-Shell Tank is north of the 241-C-102 Single-Shell Tank, and is the third tank in a four tank cascade comprised of 241-C-201, 241-C-202, 241-C-203, and 241-C-204. Wastes flowed first into 241-C-201,

next into 241-C-202, then into 241-C-203, and finally into 241-C-204. The tank is surrounded by radiation monitoring wells, however, none are currently active. The tank is also equipped with temperature sensors and a manual liquid level gage.

The tank is classified as an inactive waste management unit. It operated from 1953 until 1976. The tank received PUREX high-level waste (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 18,900 L (5,000 gal) of sludge. This tank is considered an "assumed leaker" and is interim isolated.

2.3.2.8.16 241-C-204 Single-Shell Tank. The 241-C-204 Single-Shell Tank is north of the 241-C-203 Single-Shell Tank, and is the last tank in a four tank cascade comprised of 241-C-201, 241-C-202, 241-C-203, and 241-C-204. Wastes flowed first into 241-C-201, next into 241-C-202, then into 241-C-203, and finally into 241-C-204. The tank is surrounded by two active radiation monitoring wells. The tank is also equipped with temperature sensors and a manual liquid level gage.

The tank is classified as an inactive waste management unit. It operated from 1953 until 1977. The tank received PUREX high-level waste (WHC 1991a).

The *Tank Farm Surveillance and Waste Status Report for December 1991* (Hanlon 1992) indicates that the tank contains 11,340 L (3,000 gal) of sludge. This tank is considered an "assumed leaker" and is interim isolated.

2.3.2.9 241-A-302A Catch Tank. The 241-A-302A Catch Tank is located near the 241-A-151 Diversion Box, immediately south of the 202-A Building.

The 241-A-302B Catch Tank started operating in 1956 and ceased operating in 1980. It is designed to contain leaks from transfers and drainage from operation within the 241-A-151 Diversion Box. The volumes of waste received varied according to specific plant operations. It currently contains 13,645 L (3,605 gal) of waste.

2.3.2.10 241-A-302B Catch Tank. The 241-A-302B Catch Tank is located in the 241-A Tank Farm, which is approximately 487 m (1,600 ft) northeast of the 202-A Building and directly south of the 241-AX and 241-AY Tank Farms. It is located on the berm on the east side of the tank farm fence.

Constructed in 1956, the 241-A-302B Catch Tank is an inactive waste management unit. A fill pipe and a liquid level measurement station are present. The unit is associated with the 241-A Tank Farm and the 241-A-152 Diversion Box. This unit was used for the transfer of waste solutions from processing and decontamination procedures. The volumes of

waste received varied depending on the specific plant operations. It currently contains 12,306 L (3,240 gal) of waste.

2.3.2.11 241-A-350 Catch Tank. The 241-A-350 Catch Tank is located at the south end of the 241-A Tank Farm.

Constructed in 1956, the 241-A-350 Catch Tank is an active waste management unit. A fill pipe and a liquid level measurement station are present. The unit is associated with the 241-A Tank Farm and the 241-A-A and 241-A-B Diversion Boxes. This unit was used for the transfer of waste solutions from processing and decontamination procedures. The volumes of waste received varied depending on the specific plant operations.

2.3.2.12 241-A-417 Catch Tank. The 241-A-417 Catch Tank is located just west of the 241-A-401 Condenser Building and south of the 241-AX Tank Farm.

Constructed in 1956, the 241-A-417 Catch Tank is an active waste management unit. This unit was used to collect condensate from the 241-A-401 Condenser House. It currently holds 120,600 L (31,900 gal) of the 207-A Retention Basins condensate.

2.3.2.13 241-AX-152CT Catch Tank. The 241-A-152CT Catch Tank and the 241-AX-152 Diverter Station are the same waste management unit. The 241-A-152CT Catch Tank is scheduled for deletion from the WIDS system (WHC 1991a). The unit is approximately 3 m (10 ft) inside the 241-AX Tank Farm west perimeter fence.

This active unit was constructed in 1965 and consists of two diverter tanks in a common cell with a stainless steel liner on the floor that extends about 0.3 m (1 ft) up the walls. There is also a pump pit that does not have a stainless steel liner. The cell and the pump pit drain to the catch tank below.

The unit transfers waste solutions and drainage from processing operations within the 241-A-151 Diversion Box. It currently contains 10,053 L (2,656 gal) of waste.

2.3.2.14 241-C-301C Catch Tank. The 241-C-301C Catch Tank is located southwest of the 241-C-252 Diversion Box and west of the 241-C-204 Single-Shell Tank. The unit is near the southwest fence of the 241-C Tank Farm.

Constructed in 1946, the 241-C-301C Catch Tank is an inactive waste management unit. The unit was isolated at the surface in 1985 and is marked at the surface by two sets of 10 cm (4 in.) diameter, stubbed pipes, less than 1 m (2 ft) high.

The unit is associated with the 241-C-151, 241-C-152, 241-C-153, and 241-C-252 Diversion Boxes and the 241-C Tank Farm. This unit was used for the transfer of waste

solution from processing and decontamination operations. Volumes of waste varied depending on plant operations. It currently holds 120,600 L (31,900 gal) of the 207-A Retention Basins condensate.

2.3.2.15 244-A Receiving Vault. The 244-A Receiving Vault is located approximately 396 m (1,300 ft) north of the 202-A Building. The unit, also know as the 244-A Receiver Tank, began operating in 1975 and is still active. The vault is 6 m (19 ft) long and 5 m (15 ft) in diameter. The 244-A Receiving Vault, constructed of carbon steel, has a capacity 61,538 L (16,280 gal) and sits vertically inside a reinforced concrete, steel-lined vault with 0.3 m (1 ft) thick walls and a 1 m (4 ft) thick base. The bottom of the vault is 15 m (49 ft) below grade. The unit receives waste from several tank farms and currently contains 13,955 L (3,692 gal) of waste.

2.3.2.16 244-AR Vault/UPR-200-E-59 and UPR-200-E-70. The 244-AR Vault is located approximately 61 m (200 ft) west of 241-A Tank Farm. The vault began operating in 1968 and is in standby mode (WHC 1990j); however, it is considered still active. The facility comprises the following: a canyon building; wind reduction building; instrument building; closed-loop cooling equipment building; control room; crane control room; and a changehouse.

The 244-AR Vault was originally used to process radioactive waste that was being removed ("sluiced") from storage tanks. The waste was eventually transferred to B Plant for removal of cesium and strontium (WHC 1990j). The facility also was the focal point for reprocessing and routing of PUREX-generated waste between tank farms and the B Plant facilities in the late 1960's and between the tank farms and the Waste Encapsulation Storage Facility (WESF) in the late 1970's (Pines 1985). In 1984, a decision was made to upgrade the 244-AR Vault for use as a waste transfer facility. The extensive upgrading effort provided improved features for the safe and efficient transferring of PUREX-generated waste between the tanks farms and B Plant. This wastes consists of cladding removal waste enroute to B Plant and transuranic waste from B Plant/WESF to the tank farms.

Two unplanned releases are associated with the 244-AR Vault. Unplanned release UPR-200-E-59 occurred in May 1979. Contaminated mud and tumbleweeds from the 216-A-40 Trench were used by swallows to build nests at the vault. The contaminated mud contained ^{137}Cs and ^{60}Co with reading of 10,000 to 20,000 ct/min. The nests were removed from the vault. The tumbleweeds were removed from the 216-A-40 Trench, packaged, placed in the burial ground, and the sides of the trench were washed and the contaminated mud was removed.

2.3.2.17 244-CR Vault. The 244-CR Vault is located in the 241-C Tank Farm just south of the 241-C Tanks and southeast of the 241-CR-151 Diversion Box. The vault started operating in 1946 and ceased operating in 1988. The vault is a reinforced concrete building

31 m (102 ft) long by 8 m (26 ft) wide and 17 m (55 ft) deep. It is a two-level, multi-cell structure constructed below grade. The lower cell contains the process vessels and the upper cells contain the attendant piping and equipment. The facility's roof cover blocks allow access to the upper cells when removed. The lower cells contain four process vessels: TK-CR-001 and TK-CR-011 have diameters of 6 m (20 ft) and are 6 m (19 ft) tall; and TK-CR-002 and TK-CR-003 have diameters of 4 m (14 ft) and are approximately 4 m (12 ft) tall. The 244-CR Vault was used to transport waste solutions from processing and decontamination operations.

2.3.3 Cribs and Drains

The cribs and drains were all designed to inject or percolate wastewater into the ground without exposing it to the open air. The locations of cribs and drains in the aggregate area are shown on Figure 2-6. The cribs in the PUREX Plant Aggregate Area are generally excavations backfilled with permeable material; contain vertical concrete pipes or horizontal perforated pipes; have inlet pipes and a vent structure; and have a sisalkraft paper liner separating gravel from backfill. The cribs are also equipped with risers, which are open-ended pipes that allow atmospheric pressure to influence liquid movement. Water flows directly into the backfilled material or covered open space and percolates into the vadose zone soils. The cribs were designed to receive liquid until the crib's specific retention or radionuclide capacity was met. The term "specific retention" is defined as that volume of waste liquids that may be disposed to the soil and be held against the force of gravity by the molecular attraction between sand grains and the surface tension of the water, when expressed as the percent of packed soil volume (Bierschenk 1959). Radionuclide capacity refers to a specific number of curies of radioactivity the waste management units were allowed to receive until they were shut down (Fecht et al. 1977). A typical crib is illustrated in Figure 2-7. French drains and reverse wells inject wastewater into the ground at a varying depths. They are generally constructed of steel or concrete pipe and may either be open or filled with gravel. A typical french drain is illustrated in Figure 2-8. The PUREX Plant Aggregate Area contains 24 cribs and 16 french drains.

The cribs and drains typically received low-level waste for disposal. The following sections describe each crib and drain in the PUREX Plant Aggregate Area individually.

2.3.3.1 216-A-1 Crib. The 216-A-1 Crib is located inside the 200 East Area perimeter fence extension, 60 m (200 ft) east of the 241-A Tank Farm, along Canton Avenue. The bottom of the crib is 9 x 9 m (30 x 30) and 5 m (15 ft) deep. The crib has two layers of sisalkraft paper (1,134 m^2, 3,720 ft^2) separating the gravel fill from the backfill. The side slope from the surface to 2 m (7 ft) deep is 1:1.5, and from 2.1 m (7 ft) to 5 m (15 ft) deep is 1:2. The crib is composed of three 15 cm (6 in.) perforated pipes, 9 m (30 ft) long, running horizontally at 3 m (9 ft) below grade in an H pattern. There is a layer about 1.8 m

(6 ft) deep (300 m^3 11,000 ft^3) of coarse rock in the excavation bottom. Effluent entered the crib from overground piping. The distance from waste release point to the site bottom is 5 m (17 ft). The crib also has an inlet pipe entering at the cross bar of the H-pattern distribution piping; a strainer rising vertically from the center; two layers of sisalkraft paper (a natural fiber media); and, a concrete pad to support the strainer. This waste management unit is surrounded by a light chain barricade with surface contamination warning signs.

This crib was only active from November to December of 1955. During this time the site received the depleted uranium waste from the cold startup run in the 202-A Building. It received a total of 98,400 L (26,000 gal). The unit was deactivated by removing the over ground piping and backfilling when it reached specific retention capacity.

2.3.3.2 216-A-2 Crib. The 216-A-2 Crib is located 80 m (260 ft) south of the 202-A Building, 300 m (900 ft) west of Canton Avenue, and southwest of the 291-A-1 Stack. The crib dimensions are 6 x 6 m (20 x 20 ft) and 8 m (27 ft) deep. The waste management unit consists of 15 cm (6 in.) perforated lines, two 6 m (20 ft) lengths form a cross pattern horizontally 6.4 m (21 ft) below grade. It has approximately 2 m (6 ft) (140 m^3, 5,000 ft^3) of coarse rock and then backfilled to grade. The side slope from grade to 6.4 m (21 ft) deep is 1:1.5, and from 6.4 m (21 ft) to 8.2 m (27 ft) deep it is 2:1. The crib also has two 10 cm (4 in.) inlet pipes 4.6 m (15 ft) long, and a 15 cm (6 in.) strainer 4.1 m (13.5 ft) long, rising vertically from the bottom to a vent structure. There are two concrete pads to support the strainer and the vent, and a sisalkraft paper (natural fiber media) to separate the gravel fill from the backfill. The crib is marked by a light chain barrier and a stubbed green pipe.

This unit was active from January 1956 through January 1963. During this time it received 230,000 L (61,000 gal) of organic wastes, containing normal paraffin hydrocarbons and tributyl phosphate, from the 202-A Building. The unit was deactivated by removing a section of effluent piping when the specific retention capacity was reached.

2.3.3.3 216-A-3 Crib. The 216-A-3 Crib is located directly south of the 275-EA Building, approximately 365 m (1,200 ft) west of Canton Avenue and 180 m (600 ft) north of the 202-A Building. The crib dimensions are 6 m (20 ft) in length and width with a depth of 5 m (16 ft). The waste management unit has three perforated pipes 2.4 m (8 ft) below grade placed horizontally forming an H pattern. The unit has about 2.4 m (8 ft) (280 m^3, 10,000 ft^3) of gravel backfilled into the crib. The side slope from grade to 2 m (7 ft) deep is 1.5:1, and from 2 m (7 ft) to the bottom is 2:1.

The 216-A-3 Crib was in operation from January 1956 to April 1981. From the beginning of operation until November 1967, the waste management unit received wastes from the silica-gel regeneration in the 203-A Building, the uranyl nitrate hexahydrate storage pit drainage, and the liquid waste from the 203-A Pump House. From November 1967 to April 1981, the site received uranyl nitrate hexahydrate Storage Pit drainage, liquid drainage,

liquid waste from the 203-A Building enclosure sumps, and the heating coil condensate from the P1 through P4 uranyl nitrate hexahydrate tanks. Between 1967 and 1970, the unit discontinued receiving discharge from silica-gel regeneration wastes. The above wastes are reworked through the uranium cycle and any resulting waste with low radioactivity are sent to 216-A-29. This crib received over 3,000,000 L (800,000 gal) of waste (WHC 1991a).

2.3.3.4 216-A-4 Crib/UN-200-E-13. The location of the 216-A-4 Crib is 80 m (260 ft) south of the 202-A Building and 230 m (760 ft) west of Canton Avenue, and 46 m (150 ft) east of the 216-A-2 Crib. The crib dimensions are an excavation area of 6 x 6 m (20 x 20 ft) and 8 m (26 ft) deep, with a side slope from the surface to 5.5 m (18 ft) deep of 1:1.5, and from 5.5 m (18 ft) to 8 m (26 ft) deep, 1:2. The excavation has 5.5 m (18 ft, 10,000 m^3) of coarse rock fill and has been backfilled to grade. The waste management unit consists of two 6 m (20 ft) lengths of 15 cm (6 in.) perforated pipe forming a cross pattern horizontally 5.5 m (18 ft) below grade. Additional structures to the crib consist of three 10 cm (4 in.) inlet pipes 4.6 m (15 ft) long, a 15 cm (6 in.) strainer 4.1 m (13.5 ft) long, a vent structure, a vent box and concrete pad, and two layers of sisalkraft paper (a natural fiber media) separating the gravel from the backfill.

This waste management unit was active from December 1955 through December 1958. During this time the crib received 6,210,000 L (1,640,000 gal) of laboratory cell drainage from the 202-A Building and the 291-A-1 Stack drainage. In December 1958, the unit became plugged and flooded an area between the unit and the 291-A Stack, contaminating the ground surface (UN-200-E-13). The contamination was removed to a trench along the south boundary of the unit and covered with a foot of soil. The waste management unit was deactivated by blanking the effluent piping when the unit reached its specific retention capacity. The unit is surrounded by a light chain barricade in addition to the 202-A Building contamination zone barricade.

2.3.3.5 216-A-5 Crib. The 216-A-5 Crib is located 140 m (450 ft) south of the 202-A Building and 430 m (1,400 ft) west of Canton Avenue between the inner and outer 202-A Building exclusion area fences. The crib excavation dimensions are 10.6 x 10.6 m (35 x 35 ft) and 9.8 m (32 ft) deep, with a side slope from the surface to 7.3 m (24 ft) deep of 1:1.5, and from 7.3 to 9.8 m (24 to 32 ft) deep of 2:1. The excavation is backfilled with about 2.4 m (8 ft) (600 m^3, 21,000 ft^3) of coarse rock. The waste management unit consists of three 20 cm (8 in.) pipes placed horizontally 7.3 m (24 ft) below grade in an H pattern, an inlet pipe, a strainer and vent, two layers of sisalkraft paper, and a concrete pad to support the strainer.

This crib was active from December 1955 to October 1966. From December 1955 to November 1961, the waste management unit received the process condensate from the 202-A Building. From November 1961 to October 1966, the unit was active but received no waste (backup for the 216-A-10 Crib). In October 1966, the unit received the process condensate

from the 202-A Building. Over the years the crib received approximately 1,630,000,000 L (431,000,000 gal) of acidic waste. The crib was deactivated by valving out the effluent piping to the unit and then rerouting the waste to the 216-A-10 Crib.

2.3.3.6 216-A-6 Crib/UPR-200-E-21, UPR-200-E-29. The 216-A-6 Crib is located outside the 200 East Area perimeter fence, 300 m (1,000 ft) east of the 202-A Building and 76 m (250 ft) east of Canton Avenue. The bottom dimension of the crib is 30 x 30 m (100 x 100 ft) and 6 m (19 ft) deep with a side slope from the surface to 2 m (7 ft) of 1:1, and from 2 to 6 m (7 to 19 ft) of 2:1. The waste management unit contains a 38-cm (15-in.) pipe placed horizontally 4 m (12 ft) below grade the length of the unit. Five 30 m (100 foot) lengths of perforated pipe are placed perpendicularly to the first pipe at 6 m (20 ft) intervals. The unit contains 2 m (7 ft) (2,600 m^3, 91,000 ft^3) of coarse gravel fill and then backfilled to grade. This crib also has an inlet pipe, five strainers, two layers of sisalkraft paper, and five concrete pads to support the strainers at the bottom.

The crib started operating in 1955 and ceased operating in 1970. From November 1955 to January 1961, this waste management unit received the SCD, the equipment disposal tunnel floor drainage, the water-filled door drainage and the slug storage basin overflow waste from the 202-A Building. From January 1961 to March 1966, the unit was inactive. After March 1966, the waste management unit received the previously mentioned effluents again. Overall, the total volume of waste received by this crib was 3,400,000,000 L (900,000,000 gal). In August 1974, the unit was deactivated by blanking the effluent pipeline to the unit in Distributor Box No. 1. The radiation zone denoting this unit was enlarged to include the contaminated ground surface northeast of the unit.

This waste management unit has a known release, UPR-200-E-21, which occurred on March 20, 1959. It was an overflow from the crib that contaminated the soil adjacent to the crib. On January 20, 1961 unplanned release UPR-200-E-29 occurred. This release was also an overflow from the crib. After both of these incidents the ground surface was covered with 15 cm (6 in.) of sand and topped with plastic sheeting to act as a plant root barrier. The sheeting was covered with 46 cm (18 in.) of sand and 10 cm (4 in.) of gravel in July 1972. In November 1972, the five liquid level risers were cut off 1 m (2 ft) below grade and filled with concrete. Currently, the crib and valve station on the southwest side, are enclosed in a wood and box-wire fence. The valve station has a light chain barricade with surface contamination placards posted.

2.3.3.7 216-A-7 Crib. The 216-A-7 Crib is located inside of the 200 East Area perimeter fence extension, 300 m (1,000 ft) east of the 241-A Tank Farm across from Canton Avenue. The bottom of the crib is 3 x 3 m (10 x 10 ft) and 4.6 m (15 ft) deep. The side slope from the surface to 3 m (10 ft) is 1:1 and from 3 m (10 ft) to the bottom is 2:1. Two 15-cm (6-in.) perforated pipes are placed horizontally 3 m (10 ft) below grade with a 3 m (10 ft) length perpendicular to each other forming a cross pattern. The excavation is filled with

2.1 m (7 ft) (100 m^3, 3,500 ft^3) of coarse rock. The crib site is also made up of a riser supported by a concrete pad, two layers of sisalkraft paper for a barrier, and a 15 cm (6 in.) perforated inlet pipe.

From November 1955 to July 1959 the crib received the catch tank overflow waste, the sump waste, and the pump pit drainage from the 241-A-152 Diversion Box. From July 1959 to November 1966, the waste management unit received the catch tank overflow waste and the pump pit drainage from the 241-A-152 Diversion Box. In November 1966, the unit received the tributyl phosphate-soltrol organic inventory from the 202-A Building. The unit was then deactivated by blanking off the effluent pipeline from the 241-A-152 Diversion Box. Throughout the years the crib received a total of 326,000 L (86,129 gal) of low salt and neutral/basic waste.

2.3.3.8 216-A-8 Crib. The 216-A-8 Crib is located east of the 200 East Area perimeter fence, about 200 m (650 ft) northeast of the 241-A Tank Farm. The bottom of the crib is 259 m (850 ft) long, 6 m (20 ft) wide, and 4.3 m (14 ft) deep with a 1:2 side slope. The crib has a 61 cm (24-in.) perforated distribution pipe placed horizontally 2 m (7 ft) below grade. The waste management unit contains 2 m (7 ft) (6,000 m^3, 206,000 ft^3) of gravel fill and has been backfilled. The unit also contains four test risers, a vent riser, and two layers of sisalkraft paper for a barrier. A control box (ID Number 216-A-508) is used to divert effluent to either the 216-A-8 Crib or the 216-A-24 Crib.

An overflow line at the east end of the 216-A-8 Crib ran north to a 66 x 66 m (200 x 200 ft) pond. The overflow line had its own vent riser that was held up by an 8 to 10 ft high mound of soil. The overflow line and soil mound were removed in 1988 when the crib surface was stabilized with a 72 cm (24 in.) layer of clean fill to prevent the spread of contamination. The overflow pond was filled in with clean fill taken from a barrow pit between the 216-A-8 and 216-A-24 Crib. Prior to stabilization, 216-A-8 had a considerable amount of surface contamination around the vented tent risers and from deep-rooted vegetation reaching the crib.

From November 1955 to December 1957, the crib received condensate from the waste storage tanks in the 241-A and -AX Tank Farms. From December 1957 to May 1958, the crib received the above effluents and cooling water from the contact water from the contact condenser in the 241-A-431 Building. From May 1958 to January 1966, the waste management unit was inactive, it approached radionuclide capacity and was valved out. The condensate was rerouted to the 216-A-24 Crib and the cooling water rerouted to the 216-A-25 Pond. From January 1966 to April 1976, the unit was reactivated to receive the condensate from 241-A and -AX Tank Farms. From May 1976 to January 1978, the unit did not receive waste. From January 1978 to April 1978, the crib received 241-A, -AX and -AY Tank Farm condensate. From May 1978 to October 1983, the unit was inactive. In October 1983, the unit was reactivated to receive the 241-AY and -AZ Tank Farm condensate. From

October 1983 to March 1984, the unit was inactive; flow was diverted to 241-A-417 Catch Tank take due to high radiation alarms. In March 1984, the unit was reactivated the same as in October of 1983. According to the 1990 survey this crib has thus far received 1,150,000,000 L (304,000,000 gal). The crib received approximately 70% of its total effluent in its first 30 months of operation. According to Milestone Tri-Party Agreement M-17-28, all discharge to the 216-A-8 Crib was to cease September 1991. There shall be no further soil column discharge to this unit until best available technology/all known, available, and reasonable technologies (BAT/AKART) is implemented. In the interim, effluent will be routed to double-shell tanks. Following implementation of BAT/AKART and approval of the Sampling and Analysis Plan, discharge to the crib may resume if supported by the environmental impact assessment agreed to by the Washington State Department of Ecology (Ecology), DOE, and Environmental Protection Agency (EPA) (Ecology et al. 1992).

2.3.3.9 216-A-9 Crib. The 216-A-9 Crib is located 150 m (500 ft) west of the 241-A Tank Farm and 270 m (900 ft) north of 275-EA Building along 4th Street and the PUREX Plant Aggregate Area railway spur. The crib dimensions are 128 m (420 ft) in length, 6.1 m (20 ft) wide, and 4 m (13 ft) deep. The waste management unit contains a 4 cm (10 in.) perforated pipe placed horizontally 2.3 m (9 ft) below grade. The unit has 1.5 m (5 ft) of gravel backfilled into the crib. The side slope for the entire crib depth is 2:1.

The 216-A-9 Crib was in operation from March 1956 to August 1969. Between March 1956 and February 1958 the unit received the acid fractionator condensate and the condenser cooling water from the 202-A Building. From February 1958 to April 1966, the waste management unit was inactive because the condenser flow had surpassed the capacity of the crib. From April to October of 1966, the unit received N Reactor decontamination waste via a manhole at the site. From October 1966 to August 1969, the unit was inactive. In August 1969, the unit received the acid fractionator condensate from the 202-A Building. The crib was deactivated by blanking the effluent pipeline to the unit after replacing 33 m (100 ft) of the pipeline that had failed. The effluents were then rerouted to the 216-A-29 Ditch via the 202-A Building chemical sewer (CSL). The unit received 981,000,000 L (259,000,000 gal) of waste throughout the years of operation.

2.3.3.10 216-A-10 Crib. The 216-A-10 Crib is located approximately 120 m (390 ft) south of the 202-A Building. The crib excavation dimensions are 83.8 x 13.7 m (275 x 45 ft) and 13.7 m (45 ft) deep. The excavation is a wedge-shaped cross section with a side slope of 1:1.5 and has 4.6 m (15 ft) (12,000 m^3, 414,000 ft^3) of rock fill. The unit consists of an 20 cm (8 in.) pipe placed horizontally 9 m (30 ft) below grade, 8.2 m (27 ft) east of the centerline. It also has an original distribution pipe, the new distribution pipe 9.1 m (30 ft) below grade, two layers of vinyl plastic separating the gravel from the backfill, two vent structures, a vent box on a concrete pad, and three 15 cm (6 in.) risers extending from the bottom to the vent structure.

During 1956, the waste management unit was used only for testing purposes using nonradioactive water. From 1956 to November 1961, the site was inactive. From November 1961 to January 1978, the unit received process condensate from the 202-A Building. From January 1978 to October 1981, the unit was again inactive. From October 1981 to 1986, the unit received the process condensate from the 202-A Building. After the 216-A-10 Crib was closed, the waste was rerouted to the 216-A-45 Crib. The crib received a total of 3,210,000,000 L (848,000,000 gal) of waste.

2.3.3.11 216-A-21 Crib. Crib 216-A-21 is located 200 m (600 ft) south of the 202-A Building and 230 m (750 ft) west of Canton Avenue. The bottom dimensions are 18.3 x 5 m (60 x 16 ft) and 6 m (19 ft) deep. The excavation is V-shaped in cross-section with a side slope of 1:1.5. The excavation has about 1.8 m (6 ft) (100 m^3, 2,700 ft^3) of gravel fill and is backfilled to grade. The waste management unit has a new 10 cm (4 in.) distribution line running horizontally through the length of the crib 1.5 m (5 ft) above the bottom of the excavation. Branching horizontally from this distribution line are four 1.2 m (4 ft) sections of 10 cm (4 in.) tubing. Branching vertically at the same locations are four 2.4 m (8 ft) sections of 10 cm (4 in.) perforated pipe running to the bottom of the excavation. The unit also consists of a failed 15 cm (6 in.) distribution pipe placed 4 m (13 ft) below grade the length of the unit; two layers of sisalkraft paper to separate the gravel from the backfill; two 10 cm (4 in.) test risers which extend to flanges 0.9 m (3 ft) above grade; and concrete blocks at the bottom for the risers to rest on.

The unit started operation in 1957 and was taken out of service in June of 1958 when a 15 m (6 in.) clay distribution pipe failed. A new distribution system was installed, the unit was brought back to service in December 1958 and ceased operating in 1965. Until June 1958, the waste management unit received sump waste from the 293-A Building. From June 1958 to December 1958, the unit was inactive. From December 1958 to June 1965, the unit received the above effluent, laboratory cell drainage from the 202-A Building, and the 291-A-1 Stack drainage. Throughout this time the crib received a total of 77,900,000 L (20,000,000 gal) of waste. The unit was deactivated when the effluent flow rate exceeded the infiltration capacity by blanking the effluent pipeline to the unit. The effluents were rerouted to the 216-A-27 Crib.

2.3.3.12 216-A-24 Crib/UN-200-E-56. This crib is located outside the 200 East Area, about 229 m (750 ft) northeast of the 241-AX Tank Farm along Canton Avenue. The bottom of the crib is 488 x 6 m (1,600 x 20 ft) at a depth of 4.6 m (15 ft) with a 1.5:1 side slope. A 38-cm (15-in.) diameter (perforated bottom half) galvanized corrugated pipe is placed horizontally 3 m (10 ft) below grade. The excavation has 1.2 m (4 ft) (4,100 m^3, 146,000 ft^3) of gravel fill and is backfilled over. The crib is broken into 10 m (350 ft) segments by 15 m (50 ft) wide earth barriers. The segments are connected together with 38-cm (15-in) corrugated distribution pipes. The segments are arranged in a cascading fashion. The total length of the crib is approximately 488 m (1,600 ft). The waste management unit also has

eight gage wells resting on concrete pads, four corrugated risers, four filter box assemblies located on top of the risers, and a polyethylene barrier between the gravel and the backfill.

Beginning in May 1958, the waste management unit received 820,000,000 L (200,000,000 gal) of condensate from the waste storage tanks in the 241-A and 241-AX Tank Farms. The waste was low salt and neutral/basic. The crib was believed to have been deactivated by shutting the valve in January 1966. However, it was still open in 1979. The valve has since been closed. This unit was deactivated and the waste was routed to the 216-A-8 Crib. In September 1990 the surface of the unit was stabilized. It is currently about 1 m (2 ft) above grade and there are numerous concrete marking posts lying around the unit. The 216-A-24 Crib adjoins unplanned release UN-200-E-56. This unplanned release occurred in 1979 when contaminated moisture was encountered in an excavation east of the 200 East Area perimeter fence. While digging from clear fill for the 241-AN Tank Farm, beta contaminated moisture was found that had migrated laterally over the surface of a 10 cm (4 in.) crust of hard pan approximately 5 m (15 ft) below the surface (Maxfield 1979).

2.3.3.13 216-A-27 Crib. The 216-A-27 Crib is located about 213.4 m (700 ft) south of the 202-A Building and 244 m (800 ft) west of Canton Avenue, partly within the PUREX Plant Aggregate Area exclusion area. The bottom dimensions are 60 x 3 x 4.3 m (200 x 10 x 14 ft) deep with a side slope of 1:1.5. The excavation is filled with gravel to 1.8 m (6 ft) (700 m^3, 24,000 ft^3), and then backfilled over. A 15 cm (6 in.) perforated pipe is placed horizontally the length of the unit approximately 3 m (10 ft) below grade. The crib also has an 20 cm (8 in.) diameter well extending from a concrete pad, an 20 cm (8 in.) vent riser with filter, a 41 cm (16 in.) pipe for a recorder, a 3.8 cm (1.5 in.) sensing bulb well, and a polyethylene barrier.

This crib was active from June 1965 to July 1970. During this time the crib received 23,200,000 L (6,130,000 gal) of waste. The waste was the sump waste from the 293-A Building, the lab cell drainage from the 202-A Building and the 291-A-1 Stack Drainage. The waste is low salt and neutral/basic.

2.3.3.14 216-A-30 Crib. The 216-A-30 Crib is located outside the 200 East Area perimeter fence, about 500 m (1,600 ft) east of the 202-A Building. The crib dimensions of the bottom of the crib are 427 x 3 m (1,400 x 10 ft) and 37 m (12 ft) deep with a 1:1.5 side slope. The 216-A-30 Crib has one 38-cm (15-in.) corrugated perforated distribution pipe running 1.2 m (4 ft) below grade, just to the center of the crib. Another 41-cm (16-in.) steel distribution pipe parallels the first perforated pipe, 1.2 m (4 ft) below grade, just to the center of the crib, then angles 45 degrees and changes to a 38-cm (15-in.) corrugated perforated pipe running 2.1 to 2.4 m (7 to 8 ft) below grade until it reaches the end of the crib. The intent of this crib design is to maximize the distribution of liquid throughout the crib area. The crib is filled with 1.5 m (5 ft) (3,500 m^3, 123,000 ft^3) of gravel and then backfilled to grade. The crib has one 38-cm (15-in.) diameter vent riser extending from the distribution pipe 1 m

(3 ft) above grade, and two (8 in.) carbon steel gage wells extending from the bottom of the crib to 1 m (3 ft) above grade. The crib also has a polyethylene barrier and concrete pads to support the gage wells. A control box (ID Number is Diversion Box #2) on the 216-A-30 Crib is used to divert effluent to the 216-A-37-2 Crib.

The 216-A-30 Crib started operating in 1961 and ceased operating in 1991. From January 1961 to November 1965, the waste management unit received the SCD, equipment disposal tunnel floor and water-filled door drainage, and the slug storage basin overflow waste from the 202-A Building. From November 1965 to January 1970, this unit had exceeded the infiltration capacity; therefore, requiring the 216-A-6 Crib to be restored to service to receive some of the above effluents. This unit had been receiving the above effluent because the 216-A-6 Crib was deactivated in January 1970. The unit has received over 7,000,000,000 L (2,000,000,000 gal) of waste.

Currently the crib has an irregular surface, varying between 0.6 m (2 ft) above to slightly below grade in height. The northwest corner of the site is below grade and mud cracks were readily apparent suggesting that some ponding of surface water occurs. During the winter of 1971, an alkaline deposit was observed to be forming over the ground surface of the entire length of the crib. It appeared to be salt residue condensing out from vapors being emitted through the porous ground surface of the crib. According to Tri-Party Agreement M-17-27A, discharge of the PUREX Plant SCD to the 216-A-30 Crib is to cease as of June 1992.

2.3.3.15 216-A-31 Crib. The 216-A-31 Crib is located about 150 m (500 ft) south of the 202-A Building. The bottom dimensions are 21.3 x 3 m (70 x 10 ft) and 7.3 m (24 ft) deep. The excavation has 1.8 m (6 ft) (250 m^3, 9,000 ft^3) of gravel fill and has been backfilled with a side slope of 1:1.5. The waste management unit consists of a 8-cm (3-in.) perforated pipe placed horizontally 6.4 m (21 ft) below grade; a 30-cm (12-in.) vent riser extending from the bottom to 0.9 m (3 ft) above grade; a 20-cm (8-in.) gage well extending from the bottom to a cap 0.9 m (3 ft) above grade; a polyethylene barrier; and a concrete pad to support the gage well.

This unit only operated from July 1964 to November 1966. During this time the crib received over 10,000 L (3,000 gal) of neutral/basic organic waste from the 202-A Building. The unit was deactivated by blanking the 202-A Building L Cell nozzles to the 241-A-151 Diversion Box, which routed effluents to the unit.

2.3.3.16 216-A-32 Crib. The 216-A-32 Crib is located approximately 90 m (300 ft) northeast of the 202-A Building and about 200 m (700 ft) west of Canton Avenue. The bottom dimensions are 21.3 x 2.4 m (70 x 8 ft) and 3.7 m (12 ft) deep. The waste management unit contains 24 m (77.5 ft) of 15-cm (6-in.) perforated vitrified clay pipe

placed horizontally 15 m (5 ft) below grade. The excavation has 1.5 m (5 ft) (200 m^3, 6,000 ft^3) of gravel fill with a side slope of 1:1.5.

Approximately 4,000 L (1,000 gal) of waste was received by this unit between January 1959 and 1972. The crib received the 202-A Building crane maintenance facility floor, sink, and shower drainage that is expected to contain less than 1 Ci total beta activity. There was intent to dispose of 246,025 L (65,000 gal) of 50% Soltrol (a brand of kerosene) diluent in this crib. To this date, this proposed disposal has not been confirmed as having taken place. The crib is inactive and will not receive any more waste.

2.3.3.17 216-A-36A Crib. The 216-A-36A Crib is located 230 m (750 ft) south of the 202-A Building and 350 m (1,150 ft) west of Canton Avenue. The site dimensions of the bottom of the crib are 304.8 x 3.4 m (100 x 11 ft) and 6.7 m (22 ft) deep with a side slope of 1:1.5. The excavation has 1 m (2 ft) (130 m^3, 4,500 ft^3) of gravel fill, and the site has been backfilled to grade. The crib contains a 15-cm (6-in.) perforated pipe placed horizontally 6.4 m (21 ft) below grade, an 20 cm (8 in.) gage well extending from the bottom to 0.6 m (2 ft) above grade, a plastic barrier between gravel and backfill, a concrete dam separating this unit from 216-A-36B, and two 5-cm (2-in.) grout wells extending from the bottom.

This unit was only active for seven months, September 1965 to March 1966. During this time the crib received 1,070,000 L (280,000 gal) of ammonia scrubber waste from the 202-A Building. The waste is low salt and neutral/basic. The site was deactivated soon after initial operation when it became too radioactively contaminated for further use. A concrete dam was installed and the pipeline was extended to 216-A-36B.

2.3.3.18 216-A-36B Crib. The 216-A-36B Crib is located 370 m (1,200 ft) south of the 202-A Building. The site dimensions of the bottom of the crib are 152 x 3.4 m (500 x 11 ft) and 8 m (25 ft) deep with a side slope of 1:1.5. The excavation has 1 (3 ft) (620 m^3, 22,000 ft^3) of gravel fill and backfilled. The unit is a gravel structure with a 10-cm (4-in.) perforated pipe placed horizontally 7 m (23 ft) below grade. The crib is also made up of a 20-cm (8-in.) gage well, a plastic barrier between gravel and backfill, and an 20-cm (8-in.) vent with a 5-cm (2-in.) drain. The 216-A-36B Crib is an extension of the 216-A-36A Crib. A concrete dam was constructed between the cribs and a 10 cm (4 in.) perforated pipe was extended into the 216-A-36B Crib.

Beginning in March 1966, the site received the ammonia scrubber waste from the 202-A Building. Then in October 1972 the unit was retired. In November 1982, the site was reactivated to receive the above wastes when 202-A Building operation restarted and then was deactivated again on September 6, 1987. Over this period the unit received a total 317,000,000 L (84,000,000 gal) of waste. According to Tri-Party Agreement Milestone

M-17-21A all discharge to the 216-A-36B Crib was to cease as of September 1991 (Ecology 1992).

2.3.3.19 216-A-37-1 Crib. The 216-A-37-1 Crib is located outside of the 200 East Area perimeter fence, 610 m (2,000 ft) east of the 202-A Building. The bottom dimensions are 213 x 3 m (700 x 10 ft) and 3.4 m (11 ft) deep with a 1:1 side slope. The waste management unit is a gravel structure with a 25-cm (10-in.) corrugated galvanized, perforated pipe located horizontally 2 m (7 ft) below grade. The excavation contains 1.5 m (5 ft) (150 m^3, 5,300 ft^3) of gravel. The unit also has a vent riser with a concrete base, two gage wells with a concrete pad for support, and a membrane barrier between the gravel and backfill. A valve station is at the south end of the crib and a vent is located at the north end. The valve station is inside the crib perimeter fence and has surface radiation warning signs and a light chain barricade. Hanford Site diagrams indicate a connection between the 216-A-30 Crib and the 216-A-37-1 Crib. This was never used due to the fact that the 216-A-37-1 Crib use started in 1977 for evaporator discharge but the 202-A Building did not restart until 1983.

This unit became active in March 1977 and is currently inactive. It received process condensate from the 242-A Evaporator. The unit received 377,000,000 L (100,000,000 gal) of waste. In April 1989, the crib was shut down permanently after it was determined that land disposal restricted wastes (i.e., acetone, butanol) were discharged to the unit. According to Milestone M-17-29A, all discharges to the 216-A-37-1 Crib were to cease as of September 1991. No soil column disposal of 247-A process condensate is to occur until BAT/AKART is implemented as part of "242-A Evaporator/PUREX Plant Condensate Treatment Facility" (Project C-018H). When the 247-A Evaporator restarts in 1992, process condensate will be routed to the Liquid Effluent Retention Facility (LERF) basins for storage and eventual processing (Ecology et al. 1992).

2.3.3.20 216-A-37-2 Crib. The 216-A-37-2 Crib is located outside the 200 East Area perimeter fence, east of the 216-A-37-1 Crib on the same centerline, directly north of the 216-A-30 Crib. The bottom of the crib is 427 x 3 m (1,400 ft x 10 ft) and 4.6 m (15 ft) deep. There are two 20-cm (8-in.) steel drain pipes: one is perforated and runs the length of the unit, the other is not perforated and runs from west to east only to the center of the unit 3 m (10 ft) below grade. Two vents are located at the center and at the east end. Two liquid-level gage wells are located 106.7 m (350 ft) from the ends of the unit. A 15 cm (16 in.) flow meter is located in a shallow caisson on the crib. The 216-A-37-2 Crib has one 38-cm (15-in.) corrugated perforated distribution pipe running 1.2 m (4 ft) below grade, just to the center of the crib. Another 41-cm (16-in.) steel distribution pipe parallels the first perforated pipe, 1.2 m (4 ft) below grade, just to the center of the crib, then angles 45 degrees and changes to a 38-cm (15-in.) corrugated perforated pipe running 2.1 to 2.4 m (7 to 8 ft) below grade until it reaches the end of the crib. The intent of this crib design is to maximize the distribution of liquid throughout the crib area. A 1.7 m (5.5 ft) bed of gravel

on the bottom has been covered with a 20-mil polyvinyl chloride (PVC) barrier cover and then the entire area has been backfilled over with earth. The central portion of the crib's surface has subsided.

The waste management unit was activated in 1983 and, along with the 216-A-30 Crib, has been receiving steam condensate from the 202-A Building. The site received 1,090,000,000 L (290,000,000 gal) of waste. According to Tri-Party Agreement Milestone M-17-22A, discharge of the PUREX Plant SCD to the 216-A-37-2 Crib is to cease in June 1992 (Ecology 1992).

2.3.3.21 216-A-38-1 Crib. The 216-A-38-1 Crib is located approximately 180 m (600 ft) southwest of the 202-A Building and 460 m (1,500 ft) north of 1st Street. The bottom dimensions are 158 x 4.6 m (520 ft x 15 ft) and 11 m (37 ft) deep with a 1:1 side slope. There is 1.5 m (5 ft) (1,400 m^3, 50,000 ft^3) of gravel in the excavation and backfilled over. The waste management unit contains a 15-cm (6-in.) perforated steel pipe narrowing to 10 cm (4 in.) placed horizontally 10 cm (33 ft) below grade. The unit also has a 20-cm (8-in.) diameter inlet pipe, two 8-cm (3-in.) vent risers and filters, two 20-cm (8-in.) gage wells, a membrane barrier, and a 20-cm (8-in.) bypass line paralleling the distribution line in the southern half of the unit.

The crib was not activated when plans for modifying the PUREX headend process were begun. The planned addition would have been constructed immediately adjacent to the crib and it was thus never used. It was intended to receive the liquid waste discharged to the 261-A-10 Crib.

2.3.3.22 216-A-39 Crib. The 216-A-39 Crib is located directly north of 241-AX Tank Farm, and immediately south of the 241-AZ Tank Farm, along Canton Avenue. The crib is made up of a 0.9 m (3 ft) deep trench from the door of the 241-AX-801-B to the brow of the north hill, then over the hill to the flat ground below where it extended eastward approximately 27 m (90 ft). A hole was cut through the back side of the 241-AX-801-B Building, where a fire hose was inserted to wash the contamination into the trench. A second trench was also made paralleling the first one. Each trench contains a 5-cm (2-in.) diameter pipe 1.8 m (6 ft) long, a 16.7 m^2 (180 ft^2) plastic sheet, a 5-cm (2-in.) diameter line 27 m (90 ft) long and 26 m^3 (900 ft^3) of gravel fill.

This waste management unit was only active for one month, June 1966. During that time the unit received 20 L (5.3 gal) of floor drainage from the 241-AX-801-B Building. Currently, the unit is a level gravel-paved area with no markers of indications of a surface spill.

2.3.3.23 216-A-41 Crib. The 216-A-41 Crib is located about 30 m (100 ft) west of the 241-AX Tank Farm and 180 m (600 ft) south of 7th Avenue. The dimensions are 3 x 3 m

(10 x 10 ft) and 18 m (6 ft) deep. The crib contains six 20 x 20 x 41 cm (8 x 8 x 16 in.) bond beam concrete blocks placed end to end to form the dispersion structure 1.2 m (4 ft) below grade. The excavation has 0.6 m (2 ft) (8.2 m^3, 290 ft^3) of gravel fill and the crib has been backfilled with a side slope of 1:1. The crib also has an inlet pipe from the 296-A-13 Stack and a 20-mil polyethylene barrier separating the gravel from the backfill.

From January 1968 to 1974 the crib received approximately 10,000 L (2,600 gal) of drainage from the 296-A-13 Stack. The waste is slightly acidic and expected to contain less than 1 Ci total beta activity. This inactive waste management unit was deactivated by removing the stack drainage piping from the 296-A-13 Stack and then rerouting the drainage to the vessel vent seal pot system of the 244-AR Building. The exact location of this unit has not been confirmed; several temporary buildings are located in the vicinity of the crib at the present time (WHC 1991a).

2.3.3.24 216-A-45 Crib. The 216-A-45 Crib is located approximately 230 m (750 ft) southwest of the 216-A-10 Crib, which is about 120 m (390 ft) south of the 202-A Building. The bottom dimensions are 94 x 18.3 m (310 x 60 ft) and 11.4 m (37.5 ft) deep. The waste management unit has an associated drain field consisting of five 10-cm (4-in.) diameter perforated, fiberglass-reinforced pipes evenly space across the width of the site. The bottom of the crib excavation has 1.8 m (6 ft) of clean 8- to 13-cm (3- to 5-in.) diameter rock, a 15-cm (6-in.) layer of 2-cm (0.75-in.) gravel, a sheet of 10-mil polyethylene, and a 10-cm (4-in.) layer of sand.

This waste management unit was activated on March 4, 1987 and was shut down and isolated in October 1989. According to the 1990 survey this unit has received a total of 103,000,000 L (27,000,000 gal) of process condensate from the 202-A Building. This unit replaced the 216-A-10 Crib. A neutralization system was placed into operation to preclude the discharge of process condensate that is acidic (pH less than 2.0) or basic (pH greater than 12.5). According to Tri-Party Agreement Milestone M-17-20A, all discharge to the 216-A-45 Crib was to cease as of September 1991.

2.3.3.25 216-A-11 French Drain. The 216-A-11 French Drain is located at the southeast corner of the 202-A Building. The drain extends 9 m (30 ft) deep into the ground and is 0.8 m (2.5 ft) in diameter. It is constructed of two concrete pipes placed vertically end to end, placed in a 3 m (10 ft) diameter excavation, which extends 1.5 m (5 ft) below the bottom of the pipe.

The 216-A-11 French Drain was in operation from January 1956 to 1972. The waste management unit received the Trap Pit No. 1 drainage from the 202-A Building. The total volume of waste received by the unit was 100,000 L (30,000 gal) of low-salt neutral drainage. The unit is expected to contain less than 50 Ci total beta activity. An identification marker post was the only visible surface manifestation of this site.

2.3.3.26 216-A-12 French Drain. The 216-A-12 French Drain is located at the center of the south side of the 202-A Building, about 20 m (75 ft) from the building. The french drain is 10 m (33 ft) deep and 0.8 m (2.5 ft) in diameter. The unit is composed of two reinforced concrete tile pipes placed vertically end to end in a 3 m (10 ft) diameter excavation extending 1.5 m (5 ft) below the bottom. Both the drain and the excavation are filled with gravel to the top of the unit. The drain has a side slope of 1:1.

The 216-A-12 French Drain started operating in 1955 and ceased operating in 1972. This waste management unit received a total of 100,000 L (30,000 gal) of low-salt neutral drainage waste from the Steam Trap Pit No. 3 in the 202-A Building.

2.3.3.27 216-A-13 French Drain. The 216-A-13 French Drain is located at the west end of the 202-A Building. The drain is constructed of two lengths of 1 m (3 ft) diameter concrete pipe placed vertically end to end to a depth of 5.5 m (18 ft). The waste management unit is filled to a depth of 1 m (3 ft) with 5 to 8 cm (2 to 3 in.) diameter gravel. The base of the drain was over-excavated by at least 0.3 m (1 ft) in all directions and was filled with a bed of gravel.

The unit was in operation from January 1956 to December 1962. The unit received 100,000 L (30,0000 gal) of seal water (low-salt neutral waste) from the air sampler vacuum pumps in the 202-A Building. However, the base of the drain is in common with the underground radiation zone associated with the 216-A-35 French Drain. The unit was deactivated when the effluent flow rate exceeded the infiltration capacity. There is no identification post at this unit.

2.3.3.28 216-A-14 French Drain. The 216-A-14 French Drain is located on the south side of the center of the 202-A Building, about 20 m (75 ft) west of the 216-A-12 French Drain. The unit is composed of two 0.8 (2.5 ft) diameter reinforced concrete pipes placed vertically end to end in a 3-m (10-ft) diameter excavation. The pipes are placed to a depth of 8.8 m (29 ft) and the excavation extends below the bottom of the pipe 1.5 m (5 ft) Both the drain and the excavation are filled with 8 cm (3 in.) gravel to the top.

The drain was in operation from January 1956 to 1972. During this time it received 1,000 L (300 gal) low-salt neutral drainage waste from the vacuum cleaner filter and blower pit from the 202-A Building.

2.3.3.29 216-A-15 French Drain. The 216-A-15 French Drain is located approximately 80 m (270 ft) south of the center of the 202-A Building. The unit is also a registered underground injection well. The bottom dimensions are 1.2 m (4 ft) in diameter by 13 m (44 ft) deep, and assuming a 1:1 side slope for excavation. The waste management unit is composed of two lengths of bell-end, reinforced concrete sewer pipe placed vertically end to end. It is filled with 1.8 m (6 ft) of stone and has a 1.3 cm (0.5 in.) carbon steel cover.

The unit also includes a 10 cm (4 in.) diameter, 1.2 m (4 ft) long, steel inlet pipe entering at 10 m (33 ft) below grade; a 5 cm (2 in.) riser extending 1.2 m (4 ft) above grade; and a 1.6 m (5.2 ft) diameter concrete pad.

This site was in operation from December 1955 to 1972. During this time the french drain received a total of 10,000,000 L (3,000,000 gal) of drainage from the 216-A-10 Process Condensate Sampler Pit.

2.3.3.30 216-A-16 French Drain. This drain is located within the southeast corner of the 241-A Tank Farm. Both this drain and the 216-A-17 French Drain are east of the 431-A Ventilation Building. The drain is 5 m (17 ft) deep and 1.1 m (3.5 ft) in diameter, assuming a 1:1 side slope. The waste management unit is composed of a bell-end concrete pipe 1.8 m (6 ft) long, placed vertically 3.4 m (11 ft) below grade. The unit is rock-filled with a 2-cm (0.75-in.) carbon steel cover. Other parts of the drain are a steel vent riser extending from the top to 0.9 m (3 ft) above grade, and an inlet pipe 1 m (2 ft) long coming from the 216-A-17 French Drain.

This waste management was active from January 1956 to March 1969. The unit received the floor drainage and the 296-A-11 Stack drainage from the 241-A-431 Building. The unit also received the overflow from the 216-A-17 French Drain. The piping was water sealed when the 296-A-11 Stack exhaust system was deactivated. This unit received 122,000 L (32,000 gal) of low salt and neutral/basic waste. Currently there is no piping, or other surface feature, to indicate the location of this drain.

2.3.3.31 216-A-17 French Drain. The 216-A-17 French Drain is located within the southeast corner of the 241-A Tank Farm. It is constructed approximately 3.4 m (11 ft) below grade with no surface manifestations of the drain. The french drain is 5.1 m (17 ft) deep with a 1.1 m (3.5 ft) diameter and a 1:1 side slope. The waste management unit is composed of bell-end concrete pipe 1.8 m (6 ft) long, placed vertically 3.4 m (11 ft) below grade. The unit is rock-filled with a 2-cm (0.75-in.) carbon steel cover. The unit also has a 10-cm (4-in.) inlet pipe 0.6 m (2 ft) long, and an overflow pipe leading to the 216-A-16 French Drain.

The 216-A-17 French Drain was active from January 1956 to March 1969. The unit received the floor drainage and the 296-A-11 Stack drainage from the 241-A-431 Building. This unit also overflows to the 216-A-16 French Drain. The unit received 60,000 L (16,000 gal) of waste.

2.3.3.32 216-A-22 French Drain/UPR-200-E-17. The 216-A-22 French Drain is located approximately 122 m (400 ft) north of the center of the 202-A Building, near 216-A-28 French Drain. The french drain is made up of two 10-cm (4-in.) effluent pipes; one is vertical, the other enters horizontally 2.4 m (8 ft) below grade. The pipe that is vertical is

not visible from grade. The excavation is 5 m (16 ft) in diameter at grade and 6.8 m (6 ft) in diameter at the bottom with a side slope of 2:1. Approximately 3 m (10 ft) (45 m^3, 1,600 ft^3) of gravel fills the bottom of the excavation. Access to the drain was by two subsurface feeder pipes.

This french drain was in operation from March 1956 to December 1958. During its operation it received 10,000 L (3,000 gal) of drainage from the 203-A Building truck loadout apron, the sump waste from the 204-A Building enclosure, and the heating coil condensate from the P-1 through P-4 uranyl nitrate hexahydrate tanks. The waste management unit was deactivated by closing the valve to the drain. There are no surface indications of this drain.

The 216-A-14 French Drain has one unplanned release associated with it: UPR-200-E-17. The release occurred when a crib inlet failed and contaminated the soil on top of the crib. The waste type and amount deposited during the spill is unknown.

2.3.3.33 216-A-23A French Drain. The 216-A-23A French Drain is located within the southeast corner of the 241-A Tank Farm, south of the 241-A-431 Ventilation Building. The french drain is constructed to a depth of 4 m (13 ft) and a 1.1 m (3.5 ft) diameter. The waste management unit is made of a bell-end concrete pipe placed vertically 2 m (7 ft) below grade. The unit is filled with 1 m (3 ft) of rock and has a 2-cm (0.75-in.) carbon steel cover. The unit also has a carbon steel vent riser extending from the top to 1 m (3 ft) above grade, and an inlet pipe entering at 3 (9 ft) below grade. Only a single yellow gooseneck pipe was observed to mark the surface location.

The 216-A-23A French Drain was activated in September 1957 and deactivated in March 1969. The unit received 6,000 L (1,600 gal) of de-entrainer tank condensate and back flush waste from the 241-A-431 Building. The unit was deactivated by water-sealing the piping leading to it.

2.3.3.34 216-A-23B French Drain. The 216-A-23B French Drain is located within the southeast corner of the 241-A Tank Farm, south of the 241-A-431 Ventilation Building. The french drain is 2 m (7 ft) deep with 1.1 m (3.5 ft) diameter, assuming a 1:1 side slope. The waste management unit is made of a bell-end concrete pipe, placed vertically 2 m (7 ft) below grade. The unit is filled with 1 m (3 ft) of rock and has a 2-cm (0.75-in.) carbon steel cover. The unit also contains an inlet pipe entering at 3 m (9 ft) below grade.

From September 1957 to March 1969 this french drain received the de-entrainer tank condensate and the backflush waste from the 241-A-431 Building. The unit received 6,000 L (1,600 gal) of low salt and neutral/basic waste. The unit was deactivated by water-sealing the piping leading to it.

2.3.3.35 216-A-26 French Drain. The 216-A-26 French Drain, also known as the 216-A-26B French Drain, is located about 35 m (115 ft) south of the center of the 202-A Building, and about 4.5 m (15 ft) south of 216-A-26A French Drain. This drain is constructed of three 1.5 x 1.2 m (5 x 4 ft) diameter clay pipes placed end to end and filled with gravel. The drain is accessed by a subsurface feeder pipe.

The 216-A-26 French Drain began operation in July 1965 to replace the 216-A-26A French Drain and is no longer active The unit it was shut down in 1991. The waste management unit has been receiving the floor drainage a low salt neutral waste, from the 291-A Fan Control House, which is a low salt neutral waste.

2.3.3.36 216-A-26A French Drain. The 216-A-26A French Drain is approximately 30 m (100 ft) south of the center of the 291-A Building. The construction design of this waste management unit is identical to the 216-A-26 French Drain except for the diameter is only 1 m (3 ft).

This french drain was in operation from March 1959 through July 1965. During that time the drain received a total of 1,000 L (300 gal) of low-salt neutral waste. The waste was the floor drainage from the 291-A Fan control room. The unit was deactivated by removing the encasement and rerouting the effluent to the new 216-A-26B French Drain encasement. This unit cannot be distinguished from 216-A-26 French Drain from indications at the surface.

2.3.3.37 216-A-28 French Drain. The 216-A-28 French Drain is located approximately 150 m (500 ft) north of the 202-A Building and about 380 m (1,250 ft) west of Canton Avenue. The drain is constructed in a truncated cone shape; at grade the diameter is 6 m (20 ft) and at a depth of 3 m (11 ft), the diameter is 3 m (10 ft). The excavation has about 3 m (9 ft) (1,100 ft^3) of gravel fill and then backfilled to grade. The waste management unit also contains a 10-cm (4-in.) perforated pipe 5.2 m (17 ft) long extending horizontally 1.2 m (4 ft) below grade.

This drain was in operation from December 1958 to November 1967. During this time the unit received 30,000 L (8,000 gal) of low-salt neutral waste from the 203-A Building enclosure sumps and the heating coil condensate from the P1 through P4 uranyl nitrate hexahydrate tanks. The unit was deactivated by blanking the effluent pipeline to the unit when the effluent flow rate exceeded the infiltration capacity. The effluent was rerouted to the 216-A-3 Crib.

In 1981, the center of the unit was excavated and disposed of prior to installation of a PUREX Plant Aggregate Area security system. The security system is comprised of two parallel fences that surround the 202-A Building. After the security system was installed and the unit backfilled to grade, no posting or identification marker were placed at the unit.

Currently, the drain is inside a posted surface contamination area immediately north of the uranyl nitrate hexahydrate tanks and south of the security fence.

2.3.3.38 216-A-33 French Drain. The 216-A-33 French Drain is located about 90 m (300 ft) south of the 202-A Building, and 340 m (1,100 ft) west of Canton Avenue, near the southwest corner of the 291-A Building. This site is 1.8 m (6 ft) in diameter and has a depth of 3.7 m (12 ft). At 1.5 m (5 ft) below grade there is a 5-cm (2-in.) inlet pipe entering the unit.

This waste management unit was considered active from November 1955 through July 1964. It was designed to receive bearing cooling waste from the 291-A-1 Stack electrical exhaust fans; however, no coolant was ever used. Therefore, no waste was discharged to this unit. The unit was deactivated by capping the effluent pipeline to the unit on the south side of the 291-A Fan plenum.

2.3.3.39 216-A-35 French Drain. The 216-A-35 is constructed at the west end of the 202-A Building near the 216-A-8 Crib. It is 1.8 m (6 ft) in diameter to a depth of 5 m (16 ft). There is an inlet pipe located 3.2 m (10.5 ft) below grade.

From December 1963 to January 1966 this site received 10,000 L (3,000 gal) of low salt and neutral/basic waste. The waste received by this french drain was the seal cooling water from the air sampler vacuum pumps in the 202-A Building. The drain was deactivated by capping the effluent pipeline to the unit and rerouting the effluent to the 216-B-3 Pond via the 202-A Building Cooling Water liquid effluent stream. This waste management unit was a replacement for the 216-A-13 French Drain. The drain is marked by a large diameter yellow concrete pipe with a "confined space" warning posted; however, there is no identification posts. It is assumed to be in the same radiological unit as the 216-A-13 French Drain.

2.3.3.40 216-C-8 French Drain. The 216-C-8 French Drain is located about 25 m (75 ft) southeast of the 241-C Tank Farm southeast perimeter fence and 75 (250 ft) east-northeast of the 241-CR Vault. The waste management unit is composed of a 1.8 m (6 ft) diameter by 2.4 m (8 ft) long concrete culvert placed vertically 1.2 m (4 ft) below grade. The culvert is filled with gravel and rests in an 2.4 m (8 ft) diameter by 4.9 m (16 ft) deep excavation with a slope of 5.5:1. The excavation is partially filled with gravel and backfilled to grade. The drain also has a 8-cm (3-in). diameter inlet pipe 4 m (13 ft) long from the 271-C Building; a 5-cm (2-in.) plank top on the culvert, covered with two layers of tar paper; and a 5-cm (2-in.) carbon steel vent pipe extending from the bottom to 1 m (3 ft) above grade. Currently, the drain is marked by a gooseneck pipe in a 3 x 3 m (10 x 10 ft) area stabilized with sand.

This unit was active from June 1962 to June 1965. During this time the french drain received an unknown volume of ion exchange regenerant waste from the 271-CR Building.

There is a cave-in potential at the unit because of a 1.2 m (4 ft) diameter and 23 cm (9 in.) deep depression.

2.3.4 Reverse Wells

2.3.4.1 299-E24-111 Injection Well. The 299-E24-111 Injection Well is located southwest of the 202-A-Building, and west of the 216-A-38-1 Crib. The waste management unit consists of a 4.6 m x 1.2-cm (15 ft x 1-in.) diámeter pipe inside 4.6 m (15 ft) of casing, welded together at the lower end. This assembly is cemented inside a 4.6 m (15 ft) deep, 15-cm (6-in.) diameter steel well. The injection well also has 32 observation wells constructed from three 6.1 m (20 ft) sections and one 1.5 m (5 ft) section of 15-cm (6-in.) diameter steel casing, and an above ground 5,700 L (1,500 gal) mixing tank.

The injection well is located southwest of the 202-A Building outside of the fence enclosing the 202-A Building. The well was surveyed in February 1991 and found free of contamination and is currently under consideration for a change of posting to "Underground Radioactive Material."

The injection well was in operation from September 22, 1980 through February 2, 1981. The unit received eleven 4,000-L (1,000-gal) injections of uniform solutions of calcium chloride, calcium nitrate and selected tracers composed of ^{134}Cs and ^{90}Sr. The unit was part of an experimental test site constructed to obtain radionuclide migration data for model forecasting. Although it is called an injection well, this unit never received any waste.

2.3.5 Ponds, Ditches, and Trenches

The ditches and trenches in the PUREX Plant Aggregate Area were designed to percolate low-level wastewater from various sources into the ground. The locations of the ditches and trenches are shown on Figure 2-9. Trenches are commonly used for the disposal of high-salt waste or waste containing complexed radionuclides. Many of Hanford's trenches are designated "specific retention" trenches. The term "specific retention" is defined as that volume of waste liquids that may be disposed to the soil and be held against the force of gravity by the molecular attraction between sand grains and the surface tension of the water, when expressed as the percent of packed soil volume (Bierschenk 1959). Generally, for soil column disposal, a target of 10% of the specific retention capacity of the unit was utilized in an effort to be conservative and ensure that liquid did not reach groundwater. Trenches 216-A-18, 216-A-19, and 216-A-20 were specific retention trenches. Ditches were also used as a means to transport low-level waste to a waste management unit (i.e., trench, pond). The

following sections describe the ditches and trenches present in the PUREX Plant Aggregate Area.

There are no ponds located within the PUREX Plant Aggregate Area; however, the 216-A-25 Pond and the 216-B-3 Pond, located within the B Plant Aggregate Area, did receive low-level PUREX Cooling Water from the 202-A Building. These units are discussed in detail in the B Plant AAMS. The following sections describe the ditches and trenches present in the PUREX Plant Aggregate Area.

2.3.5.1 216-A-29 Ditch. The 216-A-29 Ditch is located outside the 200 East Area perimeter fence, 160 m (525 ft) southeast of the southeast corner of the 241-A Tank Farm. The ditch emptied into the 216-B-3-3 Ditch that terminates at the 216-B-3 Pond.

This waste management unit began operation in November 1955 and was shut down in 1991. The unit is a man-made, uncovered earthen trench that was approximately 1.8 m (6 ft) wide and 1,980 m (6,500 ft) long. The banks varied from about 1 m (2 to 3 ft) high at the head end to 4.6 m (15 ft) at the lower end of the trench. All discharge to the ditch occurred within the 200 East Area perimeter fencing. Discharge from the PUREX CSL is at the northeast corner of the 241-AP Tank Farm. The CSL feeds through the 216-A-42E Diversion Box in a 38-cm (15-in.) vitrified-clay pipe, into a 7.6 m (25 ft) section of 91 cm (36 in.) corrugated pipe, and into the ditch. The ditch contained two small dam structures with releases for flow control. The first 3 m (10 ft) from the point of influent is a concrete spillway designed to control erosion.

The ditch received wastes from the 202-A Building chemical sewer and cooling water liquid effluent streams that flows to 216-B-3 Pond. Until December 1957, the waste management unit received chemical sewer liquid effluent and chemical sewer liquid effluent from the 202-A Building. From December 1957 until February 1958, the unit received the chemical sewer liquid effluent from the 202-A Building (the cooling water liquid effluent was rerouted to the 216-A-25 Pond). From February 1958 until December 1962, the 216-A-29 Ditch received the chemical sewer liquid effluent from the 202-A Building, which included acid fractionator condensate from the 202-A Building. From December 1962 until December 1963, the unit received the chemical sewer liquid effluent from the 202-A Building, and acid fractionator condensate from the 202-A Building. From December 1963 until January 1966, the unit received the chemical sewer liquid effluent from the 202-A Building and acid fractionator condensate from the 202-A Building.

The 216-A-29 Ditch was stabilized in October 1991. South of the GTF perimeter fence the ditch has been filled to grade, surrounded with a light chain barricade, and posted with underground contamination placards. North of the perimeter fence the ditch has been completely backfilled and stabilized as of October 1991.

2.3.5.2 216-A-34 Ditch. The 216-A-34 Ditch is located outside the 200 East perimeter fence 90 m (300 ft) east of Canton Avenue and 270 m (900 ft) northeast of the 241-A Tank Farm on the north side of 216-A-8 Crib.

This waste management unit operated from November 1955 until December 1957 and is inactive. The ditch is 9.1 m (30 ft) wide at the east end, 3 m (10 ft) wide at the west end, and 85.3 m (280 ft) long. The side slope is 1:2. A 38-cm (15-in.) inlet pipe is placed 1 m (2 ft) below grade.

The trench received the cooling water from the contact condenser in the 241-A-431 Building enroute to the 216-A-19 and 216-A-20 Trenches. When pipeline trenches were being dug for the Liquid Effluent Retention Facility, the 216-A-34 pipeline was encountered and had contamination levels up to 6,000 ct/min. The 216-A-34 Ditch was deactivated by blanking the effluent pipeline to the unit, backfilled, and posted with underground contamination warning signs. The waste was rerouted to the 216-A-8 Crib (Lundgren 1970).

2.3.5.3 216-A-18 Trench. The 216-A-18 Ditch is located outside the 200 East Area perimeter fence, 150 m (500 ft) east of the 241-AX Tank Farm, along Canton Avenue.

This waste management unit operated from November 1955 until January 1956 and is inactive. The ditch is 24.4 m (80 ft) wide, 24.4 m (80 ft) long, and 4.6 m (15 ft) deep. The side slope is 1:2.

The trench received the depleted uranium waste from the cold start-up run at 202-A Building. The trench was deactivated by removing the aboveground piping and backfilling the excavation after the specific retention capacity was reached (Lundgren 1970).

2.3.5.4 216-A-19 Trench. The 216-A-19 Ditch is located outside the 200 East Area perimeter fence, 230 m (750 ft) east of the 241-AX Tank Farm, and 150 m (500 ft) east of Canton Avenue.

This waste management unit operated from November 1955 until January 1956 and is inactive. The ditch is 8 m (25 ft) wide, 8 m (25 ft) long, and 4.6 m (15 ft) deep.

The trench received the 241-A-431 Building contact condenser cooling water via the 216-A-34 Ditch and the depleted uranium waste from the cold start-up run at 202-A Building. The 216-A-19 Trench was deactivated by removal of surface piping and backfilling of the excavation (Lundgren 1970).

2.3.5.5 216-A-20 Trench. The 216-A-20 Ditch is located outside the 200 East Area perimeter fence, 240 m (800 ft) east of the 241-AX Tank Farm, and 180 m (600 ft) east of Canton Avenue.

This waste management unit operated from November 1955 until January 1956 and is inactive. The ditch is 8 m (25 ft) wide, 8 m (25 ft) long, and 4.6 m (15 ft) deep.

The trench received the 241-A-431 Building contact condenser cooling water via the 216-A-34 Ditch and the depleted uranium waste from the cold start-up run at the 202-A Building. The trench was deactivated by removal of surface piping and backfilling of the excavation (Lundgren 1970).

2.3.5.6 216-A-40 Trench/UPR-200-E-59. The 216-A-40 Ditch is located approximately 150 m (500 ft) west of the 241-AX Tank Farm and approximately 150 m (500 ft) south of 7th Avenue.

This waste management unit operated from January 1968 until May 1979 and is inactive. The ditch is 6 m (20 ft) wide, 122 m (400 ft) long, and 4.9 m (16 ft) deep. The side slope is 1:1.5. The unit contains three large seated bladders designed for storing effluents. A 31-cm (12-in.) SCH 40 pipe runs horizontally, 22.6 m (74 ft) through the south end of the unit 3.7 m (12 ft) below grade. A 1.5 m (5 ft) pipe section is connected perpendicularly to the 31-cm (12-in.) pipe, forming a "T."

The trench received the diverted CWL and SCD from the 244-AR Vault. Currently, the ditch is enclosed within a box-wire fence and several tumbleweeds fill the ditch bottom.

One unplanned release (UPR-200-E-59) is associated with the 216-A-40 Ditch. The exact location of the unplanned release was on the eaves of the 244-AR Vault and the walls of the 216-A-40 Ditch. Contaminated mud and tumbleweeds from the ditch were used to make bird nests at the vault. The mud had readings of ^{137}Cs at 10,000 ct/min and ^{60}Co at 20,000 ct/min. The nests and tumbleweeds were removed from the ditch, packaged, and placed in the burial ground. The sides of the 216-A-40 Ditch were washed and the contaminated mud was removed.

2.3.6 Septic Tanks and Associated Drain Fields

The location of the septic tanks and drain fields are shown on Figure 2-10. The PUREX Plant Aggregate Area contains 7 septic tanks, described as follows.

2.3.6.1 2607-EA Septic Tank and Drain Field. The 2607-EA Septic Tank is located west of the 241-A Tank Farm, approximately 150 m (500 ft) north of 4th Street, and immediately south of the 244-AR Vault. This waste management unit includes a drain field.

This unit started receiving nonhazardous and nonradioactive wastewater and sewage in 1976 and is still active. The estimated rate of waste generation is 0.06 m^3/day (2 ft^3/day).

2.3.6.2 2607-EC Septic Tank and Drain Field. The 2607-EC Septic Tank is located inside the 241-A Tank Farm. Specifically, the tank is located in the northeast corner of the 241-A Tank Farm. A drain field is associated with this waste management unit.

The tank started receiving nonhazardous and nonradioactive wastewater and sewage in 1955 and is still active. The estimated rate of waste generation is 0.45 m^3/day (16 ft^3/day).

2.3.6.3 2607-ED Septic Tank and Drain Field. The 2607-ED Septic Tank is located inside the 241-AX Tank Farm, north of the 2707-AX Building. A drain field is associated with this waste management unit.

The tank started receiving nonhazardous and nonradioactive wastewater and sewage in 1980 and is still active. The estimated rate of waste generation is 0.28 m^3/day (9 ft^3/day).

2.3.6.4 2607-EG Septic Tank and Drain Field. The 2607-EG Septic Tank and Drain Field is located on the southeast side of the 241-C Tank Farm. The tank is marked by a large diameter vertical concrete pipe.

The tank started receiving nonhazardous and nonradioactive wastewater and sewage in 1953 and is still active. The estimated rate of waste generation is 0.17 m^3/day (6 ft^3/day).

2.3.6.5 2607-EJ Septic Tank. The 2607-EJ Septic Tank is located on the east side of the 241-AW Tank Farm, near the perimeter fence. The septic tank is surrounded by a wooden barricade and marked by a concrete pipe less than 1 m (2 ft) high with a yellow steel lid.

The tank started receiving nonhazardous and nonradioactive wastewater and sewage in 1980 and is still active. The estimated rate of waste generation is 0.32 m^3/day (11 ft^3/day).

2.3.6.6 2607-EL Septic Tank and Drain Field. The WIDS database (WHC 1991a) suggests that this tank and associated drain field is located east of the 272-AW Building. However, the 241-AP Tank Farm is at that location and no septic tank could be found at those coordinates. The septic tank may have been removed when the 241-AP Tank Farm was constructed.

The tank started receiving nonhazardous and nonradioactive wastewater and sewage in 1983. The estimated rate of waste generation is 7.9 m^3/day (280 ft^3/day).

2.3.6.7 2607-E6 Septic Tank and Drain Field. The 2607-E6 Septic Tank is located north of the MO-405 Building, approximately 90 m (300 ft) west and 200 m (700 ft) north of 4th Street. The drain field is surrounded by a wooden fence and the surface is vegetated.

The tank started receiving nonhazardous and nonradioactive wastewater and sewage in 1954 and is still active. The estimated rate of waste generation is 43.5 m^3/day (1,536 ft^3/day).

2.3.7 Transfer Facilities, Diversion Boxes, and Pipelines

Transfer Facilities (also referred to as process lines) connect the major processing facilities with each other and with the various waste disposal and storage facilities. Most lines are 7.6 cm (3 in.) diameter stainless steel pipes with welded joints. Process lines are generally enclosed in steel reinforced concrete encasements and are set below grade. The major process lines in the PUREX Plant Aggregate Area, and the Transfer Facilities they connect are shown on Plate 1 and Figure 2-11. The process lines are not waste management units according to the Tri-Party Agreement and will be addressed in detail under a separate Surplus Facilities Program. However, because of the physical nature of the process lines and their installation, there is a possibility of leakage along the entire right-of-way; therefore, the process lines will be discussed further in Section 9.0.

Sewer pipelines connecting the liquid waste stream generating facilities to their soil column disposal sites are sometimes constructed of sectional vitreous clay or corrugated metal pipes and are expected to leak to some degree. The pipeline right-of-ways are, therefore, expected to be contaminated to levels equal to or higher than the soil column sites and may require extensive characterization as part of the soil column disposal facility's investigation.

Process lines, constructed for inter-facility transfers (i.e., generator-to-tank farm) of highly contaminated solutions between the 200 Areas, are generally enclosed in steel reinforced concrete encasements and are set below grade. The major process lines in the PUREX Plant Aggregate Area, and the transfer facilities that they serve are shown on Plate 1 and Figure 2-11. The process lines are not waste management units according to the Tri-Party Agreement and will be addressed in detail under a separate Surplus Facilities Program. Therefore, the process lines will be discussed further in Section 9.0.

Diversion boxes house the switching facilities where waste can be routed from one process line to another. They are concrete boxes that were designed to contain any waste that leaks from the waste transfer line connections. The diversion boxes generally drain by gravity to nearby catch tanks where any spilled waste is stored. There are 18 diversion boxes and 1 valve pit in the PUREX Plant Aggregate Area.

2.3.7.1 241-A-A Diversion Box. The 241-A-B Diversion Box is located at the south end of the 241-A Tank Farm and is associated with the 241-A-350 Catch Tank. The waste management unit began operation in 1956 and is currently active.

The 241-A-A Diversion Box is 4.3 m (14 ft) long, 3.7 m (12 ft) wide, and 2.3 m (7.5 ft) deep. The unit is an underground reinforced concrete structure with 0.3 m (1 ft) thick walls and floor. This unit routes waste solutions from processing and decontamination operations.

2.3.7.2 241-A-B Diversion Box. The 241-A-B Diversion Box is located at the south end of the 241-A Tank Farm and is associated with the 241-A-350 Catch Tank. The waste management unit began operation in 1956 and is currently active.

The 241-A-B Diversion Box is 4.3 m (14 ft) long, 3.7 m (12 ft) wide, and 2.3 m (7.5 ft) deep. The unit is an underground reinforced concrete structure with 0.3 m (1 ft) thick walls and floor. This unit routes waste solutions from processing and decontamination operations.

2.3.7.3 241-A-151 Diversion Box. The 241-A-151 Diversion Box is located approximately 15 m (50 ft) south of the east end of the 202-A Building. The diversion box is associated with the 241-A-302-A Catch Tank and the 241-A Tank Farm. The waste management unit began operation in 1956 and is currently active.

This unit routes waste solutions from processing and decontamination operations. Several unplanned releases (UN-200-E-25, UN-200-E-26, UN-200-E-31, UN-200-E-65, UN-200-E-68) are associated with the 241-A-151 Diversion Box. Leakage from the box contaminated an area southwest of the PUREX 202-A Building. More detailed information regarding unplanned releases is in Sections 2.3.10.

2.3.7.4 241-A-152 Diversion Box. The 241-A-152 Diversion Box is located 46 m (150 ft) east of tanks 241-A-103 and 241-A-106. The diversion box is associated with the 241-A-302-B Catch Tank and the 241-A Tank Farm. The waste management unit routes wastes from 241-A-151 Diversion Box to the 241-CR-151 Diversion Box.

The 241-A-152 Diversion Box is 18.6 m (61 ft) long, 7.2 m (23.5 ft) wide, and 5.6 m (18.5 ft) deep. The unit is a reinforced concrete box with 8 cm (3 in.) PUREX style nozzles.

The unit operated from 1956 until May 1980 and is currently inactive. This unit routes waste solutions from processing and decontamination operations.

2.3.7.5 241-A-153 Diversion Box. The 241-A-153 Diversion Box is located approximately 6 m (20 ft) southwest of the 241-A-104 Tank. The waste management unit routes wastes from 241-A Tank Farm to the 244-AR Vault.

The 241-A-152 Diversion Box is 5 m (17 ft) long, 4 m (9.5 ft) wide, and 4 m (13 ft) deep. The unit operated from 1956 until July 1985 and is currently inactive. This unit routes waste solutions from processing and decontamination operations.

2.3.7.6 241-AN-A Diversion Box. The 241-AN-A Diversion Box is located in the 241-AN Tank Farm just south and between double-shell tanks 241-AN-105 and 241-AN-106. The diversion box, also known as the 241-AN-A Valve Pit, began operating in 1981 and is still active. The concrete diversion box is 4 m (14 ft) long by 4 m (14 ft) wide by 2 m (7 ft) deep. The cover block is approximately 51 cm (20 in.) thick. The waste management unit has a floor drain that leads to the 241-AN-101 Double-Shell Tank.

The diversion box has two functions (1) routes slurry from the 242-A Evaporator to the designated 241-AN tanks, and (2) routes supernatant from other tank farms to the 241-AN Tanks, between tanks within the -AN Tank Farm and to forward material to other tank farms from the 241-AN Tanks. The 241-AN-A Diversion Box is connected by slurry lines and supernatant lines to the 241-AN-104, -AN-105, -AN-106, -AN-107 Double-Shell Tanks, and the 241-AN-B Diversion Box.

2.3.7.7 241-AN-B Diversion Box. The 241-AN-B Diversion Box is located in the 241-AN Tank Farm just north and between double-shell tanks 241-AN-102 and 241-AN-103. The diversion box, also known as the 241-AN-B Valve Pit, began operating in 1981 and is still active. The concrete diversion box is 4 m (14 ft) long by 4 m (14 ft) wide by 2 m (7 ft) deep. The cover block is approximately 51 cm (20 in.) thick. The waste management unit has a floor drain which leads to the 241-AN-101 Double-Shell Tank.

The diversion box has two functions (1) routes slurry from the 242-A Evaporator to the designated 241-AN tanks, and (2) routes supernatant from other tank farms to the 241-AN Tanks, between tanks within the -AN Tank Farm and to forward material to other tank farms from the 241-AN Tanks. Waste material is routed through the 241-AN-B Diversion Box and then to the designated double-shell tanks. The 241-AN-B Diversion Box is connected by slurry lines and supernatant lines to the 241-AN-101, -AN-102, -AN-103 Double-Shell Tanks, and the 241-AN-A Diversion Box.

2.3.7.8 241-AP Valve Pit. The 241-AP Valve Pit is located in the 241-AP Tank Farm just south of double-shell tank 241-AP-103. The waste management unit began operating in 1986 and is still active. The concrete valve pit is 19 m (61 ft) long by 5 m (16 ft) wide by 2 m (8 ft) deep. The cover block is approximately 66 cm (26 in.) thick. On the east end of the pit is a jumper storage area that is 5 m (18 ft) long separated from the process side by a 63 cm (25 in.) wall. The jumper storage area has a 10-gage stainless steel liner on the floor and walls. A floor drain is in both the process and storage side of the valve pit.

The 241-AP Valve Pit routes waste solutions from processing and decontamination operations. Process lines from the 241-AW Valve Pits and from the 241-AW-102 Central Pump Pit terminate at the 241-AP Valve Pit as do other slurry lines and supernatant lines from all 241-AP Central Pump Pits located atop the 241-AP Double-Shell tanks.

2.3.7.9 241-AR-151 Diversion Box. The 241-AR-151 Diversion Box is located east of the 244-AR Vault and is associated with the 241-AY and 241-AZ Tank Farms. The waste management unit began operation in 1983 and is currently active. This unit routes waste solutions from processing and decontamination operations.

2.3.7.10 241-AW-A Diversion Box. The 241-AW-A Diversion Box is located in the 241-AW Tank Farm just east and between double-shell tanks 241-AW-101 and 241-AW-103. The diversion box, also known as the 241-AW-A Valve Pit, began opagerating in 1980 and is still active. The concrete diversion box is 4 m (14 ft) long by 4 m (12 ft) wide by 2 m (7 ft) deep. The cover block is approximately 51 cm (20 in.) thick. The waste management unit has a floor drain which leads to the 241-AW-102 Double-Shell Tank.

The diversion box has three functions (1) to routes slurry from the 242-A Evaporator to the designated 241-AW tanks, (2) to route supernatant between tanks within the 241-AW Tank Farm or among other tank farms and the 241-AW Tank Farm, and (3) to route waste from the PUREX Plant to waste storage tanks. The 241-AW-A Diversion Box has a slurry line and supernatant line connecting double-shell tanks 241-AW-101, -AW-103, -AW-105, and the 241-AW-B Diversion Box.

2.3.7.11 241-AW-B Diversion Box. The 241-AW-B Diversion Box is located in the 241-AW Tank Farm just west and between double-shell tanks 241-AW-102 and 241-AW-104. The diversion box, also known as the 241-AW-B Valve Pit, began operating in 1980 and is still active. The concrete diversion box is 4 m (14 ft) long by 4 m (12 ft) wide by 2 m (7 ft) deep. The cover block is approximately 51 cm (20 in.) thick. The waste management unit has a floor drain which leads to the 241-AW-A Diversion Box and eventually to the 241-AW-102 Double-Shell Tank.

The diversion box has three functions (1) to route slurry from the 242-A Evaporator to the designated 241-AW tanks, (2) to route supernatant between tanks within the 241-AW Tank Farm or among other tank farms and the 241-AW Tank Farm, and 3) to route waste from the PUREX Plant to waste storage tanks. The 241-AW-B Diversion Box has a slurry line and supernatant line connecting double-shell tanks 241-AW-102, -AW-104, -AW-106, and the 241-AW-A Diversion Box.

2.3.7.12 241-AX-A Diversion Box. The 241-AX-A Diversion Box is active and is associated with the 241-AY and 241-AX Tank Farms. The diversion box is interconnected with 241-AX-B Valve Pit, the 241-A-A Pit, the 241-A-B Pit, and the 242-A Evaporator.

The 241-AX-A Diversion Box is 4.3 m (14 ft) long, 3.7 m (12 ft) wide, and 2.3 m (7.5 ft) deep. The waste management unit is an underground reinforced concrete box with 0.3 m (1 ft) thick walls and floor.

The unit began operation in 1965 and is currently active. This unit routes waste solutions from processing and decontamination operations.

2.3.7.13 241-AX-B Diversion Box. The 241-AX-B Diversion Box is active and is associated with the 241-AY and 241-AX Tank Farms. The diversion box is interconnected with 241-AX-B Valve Pit, the 241-A-A Pit, the 241-A-B Pit, and the 242-A Evaporator.

The 241-AX-B Diversion Box is 4.3 m (14 ft) long, 3.7 m (12 ft) wide, and 2.3 m (7.5 ft) deep. The waste management unit is an underground reinforced concrete box with 0.3 m (1 ft) thick walls and floor.

The unit began operation in 1965 and is currently active. This unit routes waste solutions from processing and decontamination operations.

2.3.7.14 241-AX-151 Diversion Box. The 241-AX-151 Diversion Box is located southwest of the 241-A Tank Farm. The waste management unit routes waste from the 202-A Plant to the 244-AR Vault and to the 241-AY and 241-AZ Tank Farms.

The 241-AX-151 Diversion Box is 13.4 m (44 ft) long, 3 m (10 ft) wide, and 7.6 m (25 ft) deep. The unit is an underground reinforced concrete box. There are four diverter tanks in individual cells and a pump pit. Each cell has a stainless steel liner on the floor that extends approximately 0.3 m (1 ft) up the walls. The cells and pump pit are above and drain into the catch tank below.

It is unknown when the unit started operating. This active unit routes wastes from the 202-A Building.

2.3.7.15 241-AX-152DS Diversion Box. The 241-AX-152DS Diversion Box is located approximately 3 m (10 ft) inside the 241-AX Tank Farm west perimeter fence. The waste management unit is associated with the 241-AZ and 241-AY Tank Farms.

The 241-AX-152DS Diversion Box is 8 m (25 ft) long, 3 m (9 ft) wide, and 8.8 m (29 ft) deep. The unit is an underground reinforced concrete box. There are two diverter tanks in a common cell with a stainless steel liner on the floor that extends approximately 0.3 m (1 ft) up the walls. There is also a pump pit that does not have a stainless steel liner. The cells and pump pit drain into the catch tank below.

The unit began operation in 1965 and is currently active. It routes waste solutions from processing and decontamination operations.

2.3.7.16 241-AX-155 Diversion Box. The 241-AX-155 Diversion Box is located near the 241-AX and 241-AY Tank Farm dividing fence. The waste management unit is associated with the 241-AX-152 Diversion Box.

The unit began operation in 1983 and is currently active. The 241-AX-155 Diversion Box routes waste solutions from processing and decontamination operations.

2.3.7.17 241-AX- 501 Valve Pit. The 241-AX-155 Valve Pit is located south of the 241-AX Tank Farm, just northwest of 241-A-417. The waste management unit interconnects the 241-AX Tank Farm to the 241-A-417 pump pit and tank.

It is unknown when the unit started operating. This active unit routes waste solutions from processing and decontamination operations.

2.3.7.18 241-AY-151 Diversion Box. The 241-AY-151 Diversion Box is located west 241-A Tank Farm. The waste management unit, also known as the 241-AY-151 Pumpout Pit, is still considered active. It is unclear when the unit started operating. The concrete diversion box is 3 m (9 ft) long by 2 m (7 ft) wide by 3 m (10 ft) deep. The diversion box transfers aging waste from the PUREX Plant to the 241-AY and 241-AZ Tank Farms.

2.3.7.19 241-AY-152 Diversion Box. The 241-AY-152 Diversion Box is located between the 241-AY and the 241-AZ Tank Farms. The waste management unit, also known as the 241-AY-152 Sluice Transfer Box, began operating in 1971 and stopped operating in 1985 and is considered inactive. A transfer box is different from a diversion box in that a transfer box connects a common transfer line to each of several other lines one at a time. The reinforced concrete diversion box is 5 m (17 ft) long by 5 m (15 ft) wide by 3 m (10 ft) deep. The diversion box transfers aging waste form the PUREX Plant to the 241-AY and 241-AZ Tank Farms.

2.3.7.20 241-AZ-151DS Diversion Box. The 241-AZ-151DS Diversion Box is located in the 241-AZ Tank Farm, approximately 33 m (100 ft) southwest of the 241-AZ-102 Double-Shell Tank. The waste management unit, also known as the 241-AZ-151 Diverter Station, started operating in 1976 and is still active. The unit is an underground reinforced concrete structure with two diverter tanks in a common cell and a pump pit. The diversion box has a stainless steel liner on the floor that extends approximately 0.3 m (1 ft) up the walls. The diverter cell and pump pit are above and drain into the catch tank below which is lined with 16 GA stainless steel.

The diversion box is used to transfer waste solutions from processing and decontamination operations. The catch tank contains 10,017 L (2,650 gal) of waste.

2.3.7.21 241-AZ-152 Diversion Box. The 241-AZ-152 Diversion Box is located in the 241-AZ Tank Farm just south of the 241-AZ-102 Double-Shell Tank. The waste management unit, also known as the 241-AZ-152 Sluice Transfer Box, began operating in 1977 and is still active. A transfer box is different from a diversion box in that a transfer box connects a common transfer line to each of several other lines one at a time. The 241-AZ-152 Diversion Box (Sluice Transfer Box) is the only active transfer box in the Double-Shell Tank Farm System. The inside dimensions of the concrete diversion box are 6 m (18 ft) long by 3 m (11 ft) wide by 2 m (6 ft) deep. All the walls are 46 cm (18 in.) thick and taper to 30 cm (12 in.) at the top where the 30 cm (12 in.) thick cover block sits.

The diversion box is used to transfer waste solutions from processing and decontamination operations. The unit interconnects the 241-AZ Tank Farm, 241-AY Tank Farm, 241-AZ-151 Diversion Box and the 241-AY-152 Diversion Box.

2.3.7.22 241-C-151 Diversion Box. The 241-C-151 Diversion Box is located approximately 900 m (3,000 ft) north of the 202-A Building and approximately 60 m (200 ft) southwest of the 241-C Tank Farm. The waste management unit is associated with the 241-C Tank Farm and interconnects the 241-C-153, 241-C-152, and 241-CR-151 Diversion Boxes. This unit is 6 m (20 ft) long, 3 m (9 ft) wide, and 3.5 m (11.5 ft) deep.

The 241-C-151 Diversion Box started operating in 1946 and ceased operating in July 1985. This unit routes waste solutions from processing and decontamination operations. One contamination release incident occurred in January 1985. The diversion box site was stabilized with weatherproofing foam. More detailed information regarding unplanned releases can be found in Sections 2.3.10 and 4.1.8.

On January 11, 1985 Rockwell Radiation Protection Technologists reported that a release of fission products had been detected in the eastern section of the 200 East Area. The source of the release was the deactivated 241-C-151 Diversion Box. The release, estimated at less than 500 millicuries of ^{90}Sr, spread detectable contamination over approximately a 2 mi^2 area, primarily within the 200 East Area fence. There was no evidence that any significant contamination had migrated from the Hanford Site.

The cause of the release could not be positively determined but evidence pointed strongly towards a scenario involving a transfer jet in the 244-AR Vault facility connected to a line terminating in an open nozzle in the 241-C-151 Diversion Box. An air blow of this transfer jet most likely blew contaminated particulates into the diversion box and the resulting pressurization was sufficient to force contaminated air out through gaps in the diversion box cover blocks.

2.3.7.23 241-C-152 Diversion Box. The 241-C-152 Diversion Box is located approximately 45 m (150 ft) southwest of the 241-C Tank Farm, just north of the 241-C-151 Diversion Box. The waste management unit is associated with the 241-C-301 Catch Tank and interconnects the 241-B-154, 241-B-153, and 241-C Tank Farm. This unit is 8.5 m (28 ft) long, 3 m (9 ft) wide, and 3.5 m (11.5 ft) deep.

The 241-C-152 Diversion Box started operating in 1946 and ceased operating in July 1985. This currently inactive unit transferred waste solutions from processing and decontamination operations. One unplanned release (UN-200-E-82) is associated with this unit. A leak was discovered near the 241-C-152 Diversion Box, the source was determined to be the feed line that runs from the 241-C-105 Tank to the 221-B Building. More detailed information regarding unplanned releases is in Sections 2.3.10 and 4.1.8.

2.3.7.24 241-C-153 Diversion Box. The 241-C-153 Diversion Box is located west of the 241-C-107 and 241-C-110 Single-Shell Tanks. The waste management unit is associated with the 241-C-301 Catch Tank and the 241-C Tank Farm. It interconnects the 241-C-151 and 241-C-152 Diversion Boxes. This unit is 10.4 m (34 ft) long, 3 m (9 ft) wide, and 3.2 m (10.5 ft) deep.

The 241-C-153 Diversion Box started operating in 1946 and ceased operating in July 1985. This currently inactive waste management unit transferred waste solutions from processing and decontamination operations.

2.3.7.25 241-C-252 Diversion Box. The 241-C-252 Diversion Box is located northwest of the 241-C-204 Single-Shell Tanks. The waste management unit is associated with the 241-C-301 Catch Tank and the 241-C Tank Farm. It interconnects the 241-C-151 Diversion Boxes and the 241-C Tank Farm. This unit is 11 m (36 ft) long, 3 m (9 ft) wide, and 4.6 m (15 ft) deep.

The 241-C-252 Diversion Box started operating in 1946 and ceased operating in July 1985. This currently inactive unit transferred waste solutions from processing and decontamination operations.

2.3.7.26 241-CR-151 Diversion Box. The 241-CR-151 Diversion Box is located directly south of the 241-C Tank Farm, between 241-CR-152 and 241-CR-153 Diversion Boxes and the 244-CR Vault.

It is uncertain when the 241-CR-151 Diversion Box started operating; however, it is no longer active. This waste management unit transferred waste solutions from processing and decontamination operations. One unplanned release (UN-200-E-81) is associated with this unit. A puddle of contaminated liquid was discovered near the 241-CR-151 Diversion Box in

October 1969. More detailed information regarding unplanned releases is in Sections 2.3.10 and 4.1.8.

2.3.7.27 241-CR-152 Diversion Box. The 241-CR-152 Diversion Box is located south of the 241-C Tank Farm. It interconnects the 241-C-151 Diversion Box and the tanks in the 241-C Tank Farm.

The 241-CR-152 Diversion Box started operating in 1946 and ceased operating in July 1985. This currently inactive waste management unit transferred waste solutions from processing and decontamination operations.

2.3.7.28 241-CR-153 Diversion Box. The 241-CR-153 Diversion Box interconnects the 241-CR-152 Diversion Box just northwest of the 241-CR-151 Diversion Box.

The 241-CR-153 Diversion Box started operating in 1946 and ceased operating in July 1985. This currently inactive waste management unit transferred waste solutions from processing and decontamination operations to the 241-C Tank Farm.

2.3.7.29 241-ER-153 Diversion Box. The 241-ER-153 Diversion Box is located approximately 122 m (400 ft) south of 7th Street. The unit is associated with the 244-A Lift Station.

The diversion box started operating in 1945 and is an active waste management unit. The unit transfers waste solutions from processing and decontamination operations. The quantities of waste transferred vary according to the specific plant operations.

2.3.7.30 216-A-524 Control Structure. The control structure is located within the 216-A-524 Crib area. The WIDS database coordinates place this structure north of the 216-A-24 Crib. Environmental protection records contain a work order mandating the disassembly of the 216-A-524 Control Structure, located at the southwest side of the crib. Currently, there is no sign of this structure on or near the crib. The unit was a reinforced concrete box, extending 15 cm (6 in.) above grade to 3 m (10 ft) below grade. The opening into the unit was covered by a 15 cm (6 in.) thick, 1 m (4 ft) by 4 m (12 ft) concrete cover fitted with lifting eyes.

The unit started operating in 1957 and ceased operating in 1966. The unit received condensate from the waste storage tanks in the 241-A and 241-AX Tank Farms. The waste was low salt and neutral/basic.

2.3.8 Basins

Basins are rubber-lined, open, settling ponds where wastewater was held before overflowing into a ditch. The locations of the basins are shown on Figure 2-12.

2.3.8.1 207-A Retention Basins. The 207-A Retention Basins lie directly east of the 242-A Evaporator.

The 207-A Retention Basins consist of 6 rubber-lined holding basins, each with an operating capacity of 205,790 L (54,370 gal). The waste management unit is 16.8 m (55 ft) long, 3 m (10 ft) wide at the bottom, and 2 m (7 ft) deep. A 10-cm (4-in.) fill line enter each basin and a 7.6-cm (3-in.) drain line exits the basin. During operations the basins are alternately filled, sampled, and emptied when meeting specifications.

The 207-A Retention Basins began operation in March 1977 and are still active. They have been receiving two liquid waste streams from the 242-A Evaporator: (1) SCD is sent to the three north basins and then to the 216-B-3 Pond System; (2) process condensate is sent to the three south basins and then to the double-shell tanks.

2.3.8.2 216-A-42 Retention Basin/UPR-200-E-66. The 216-A-42 Retention Basin lies east of the 202-A Building, directly east of the 216-A-6 Crib.

The 216-A-42 Retention Basin consists of three covered concrete-lined sections. The capacity of the three basins is in excess of 6,056,000 L (1,600,000 gal). The waste management unit is 104.2 m (342 ft) long, 9.1 m (30 ft) wide, and 7 m (23 ft) deep. The south end of each section of the basin has a 20.3 cm (8 in.) steam condensate pipe, and the north end of each section has a 91.4 cm (36 in.) cooling water pipe. Both lines enter at 3 m (10 ft) below grade.

The basin receives effluent from the Steam Condensate Line, Cooling Water Line, and Chemical Sewer Line. Waste from these lines is directed to the basin when on-line beta, gamma, or alpha monitors detect contamination in the line. The Chemical Sewer Line is equipped with a pH monitor that when triggered diverts waste to the basin. After the diverted effluent is sampled and cleared for disposal, it is released to the normal soil column disposal sites. In the past, the effluent was discharged to the 216-B-3 Pond, 216-A-30 Crib, and 216-A-37-2 Crib. Currently, the effluent is discharged only to the 216-B-3 Pond.

One unplanned release (UPR-200-E-66) is associated with the retention basin. In November 1984, wind spread contamination was discovered in the basin consisting of unknown beta/gamma contamination with readings inside the area to 40,000 ct/min and outside to 3,000 ct/min. The ground was wet down and the basin was flushed.

2.3.9 Burial Sites

There are five burial grounds and one burning pit in the PUREX Plant Aggregate Area. The locations of the burial sites and the burning pit are shown on Figure 2-13.

2.3.9.1 200-E Burning Pit/UPR-200-E-62 and UPR-200-E-106. The burning pit is located in the large excavation east of site 218-E-8 burial ground. The site is has a surface area of 119.4 x 61.3 m (392 x 201 ft) with a depth of 4.6 m (15 ft). There are no specific markers for this site.

This waste management unit was active from 1950 to 1970. It received 1,500 m^3 (53,000 ft^3) of construction and office waste, paint wastes, and chemical solvents. The burning pit was used to burn nonradioactive material.

Three enclosures are located within the basin. South of site 218-E-8, a 12.2 x 12.2 m (40 x 40 ft) light chain and nylon rope barrier with surface contamination placards surrounds several drums, pallets, and sections of steel pipe. This may be a tank farm storage area. A nylon cord extends from the 218-E-8 eastern perimeter out about 6 m (20 ft) to a fallen steel T-post. The triangular enclosure is empty. In the middle of the basin is a 4.6 x 4.6 m (15 x 15 ft) light chain barricade with asbestos warning signs. Several small excavations are visible inside the enclosure. Northeast of the asbestos enclosure is a 4.6 x 4.6 m (15 x 15 ft) empty rope enclosure with a sign labeled "RCRA Waste Site." This enclosure marks the location of a single detonation event in 1984, used to dispose of a quantity of unstable liquids.

This unit has two unplanned releases associated with it: UN-200-E-62 and UPR-200-E-100. Unplanned release UPR-200-E-106 consisted of contaminated paper towels from the control laboratory.

2.3.9.2 218-E-1/UPR-200-E-53 Burial Ground. Burial Ground 218-E-1 is a 3-acre dry waste burial ground located about 100 m (350 ft) west of the 202-A Building. The unit consists of fifteen 60 m (200 ft) long trenches running north and south, ranging from 4.9 x 6.1 m (16 to 20 ft) wide. All sunken trenches in the waste management unit were filled in 1974 to ground level with cinders from the 200 East Power Plant and then covered with coarse gravel and backfilled in an attempt to stabilize the unit. The overall unit dimensions are 148 x 88.4 x 3 m (486 x 290 x 9 ft) deep. In October 1981 the entire surface of the unit was covered with a minimum of 46 cm (18 in.) of clean overburden and re-vegetated. This unit was active from 1945 to 1953 and during that time it received about 3,030 m^3 (107,000 ft^3) of both mixed fission products and TRU dry waste.

This unit has an unplanned release associated with it: UPR-200-E-53. The release occurred during a burial operation when contamination was spread by uncovering previously

buried waste at the south end of a waste trench in the 218-E-1 Burial Ground. Currently, there are no signs indicative of an unplanned release.

2.3.9.3 218-E-8 Burial Ground. The 218-E-8 Burial Ground is located 1,500 m (5,000 ft) north of the 202-A Building on the hillside between the Old Burning Pit and the 218-E-12B Burial Ground. The burial ground is 122 x 35 m (400 x 115 ft) to a depth of 4.6 m (15 ft). The waste management unit consists of an unknown number of backfilled trenches. This unit adjoins the 218-E-12B Burial Ground on the east. Its surface slopes down to the basin floor and the burning area. The east side is approximately 9.1 m (30 ft) lower than the west, where it adjoins the 218-E-12B Burial Ground.

The burial ground was used from 1958 to 1959. It received mixed fission products and transuranic waste, including repair and construction wastes from the 293-A Stack and the PUREX new crane addition. The burial ground received 2,265 m^3 (80,000 ft^3) of waste.

2.3.9.4 218-E-12A Burial Ground/UPR-200-E-24, UPR-200-E-30. The 218-E-12A Burial Ground is located 50 m (150 ft) northwest of the 241-C Tank Farm. The burial ground is 362 x 12.2 m (1,188 x 40 ft) to a depth of 5 m (16 ft). The waste management unit contains 28 dry waste burial trenches. Operational experience indicates that the trenches were often 12.2 m (40 ft) wide rather than 9.1 m (30 ft) wide. Also, the backfill was substantially less than the present requirement of 1.2 m (4 ft). Visual observations confirmed that some waste was visible at the surface prior to stabilization efforts. Several old wooden signs identifying trenches and the types of grasses sown to stabilize them, are visible on the south side of the unit. A small light chain barrier with underground contamination placards surrounding an area stabilized with sand was found on the south side of the burial ground. A ditch from B Plant cuts along the north perimeter, which has surface contamination signs posted. The ditch empties into a pipe on the northeast corner of the burial ground.

This burial ground was used from 1953 to 1967. Trenches 1-3, 12-14, and 17-25 contain predominantly dry waste packaged in cardboard boxes and plastic bags. Trenches 4-11, 15-16, and 26-28 contain predominantly acid-soaked material. Specific contents of trench 28 are unlisted. The total volume of waste received by the burial ground is 15,249 m^3 (538,511 ft^3).

During the past years, many of the trenches settled and created voids in the waste buried below, subsequently requiring the holes to be filled to ground level. The acid-soaked radioactive waste is buried in a shallow excavation. Earlier practices required the process operator to make the initial cover by hand shovel.

This burial ground has two unplanned releases associated with it: UPR-200-E-24 and UPR-200-E-30. Unplanned release UPR-200-E-24 occurred on June 17, 1960. A burial box collapsed during burial operations, causing spotty ground contamination from the burial

ground to the east area perimeter fence, a distance of about 3 km (2 mi). Unplanned release UPR-200-E-30 occurred on April 20, 1961. Another burial box collapsed during burial operations spreading contamination throughout the burial ground.

2.3.9.5 218-E-12B Burial Ground. The 218-E-12B Burial Ground is active and located about 304 m (1,000 ft) north of the 241-C Tank Farm, and about 1,327 m (4,500 ft) north of PUREX. The unit consists of 138 trenches running north to south. As of September 1982, 27 of the trenches were completely full, 2 were partially filled, and the remaining 109 trenches were empty. The trenches are filled with miscellaneous wastes. A special study showed mixed fission products in part of Trench 28 and TRU in parts of Trenches 17 and 27 (Maxfield 1979).

The burial grounds can be divided into two general sections, north and south, which are separated by a road. The southern section contains an eastern portion that is stabilized with soil and posted with underground contamination signs and concrete identification posts. The western half of the southern section is not stabilized and contains less vegetation than the eastern section. It has two open trenches that contain an abundant quantity of tumbleweed.

The northern portion of the burial grounds consists of Trench 94 in the east, which contains Navy reactor compartments, and several borrow pits and spoil piles in the west. A barrier with surface contamination warning signs extends along the road separating the northern and southern portions of the burial grounds. The Navy reactor compartments contain lead shielding, with an anticipated minimum life expectancy for containment of 300 yr. The unit is partially stabilized.

2.3.9.6 218-E-13 Burial Ground. Burial Ground 218-E-13 is located approximately 100 (350 ft) west of the PUREX Plant Aggregate Area exclusion area patrol gate house on 4th Street. This unit has an area of 170 m^2 (1,830 ft^2) and a depth of 2.4 m (8 ft).

This waste management unit has an unplanned release site. In August 1966, broken pieces of contaminated concrete from a pipe trench were left in the excavation hole and buried following repair to the piping at that location. This resulted in the 218-E-13 Burial Ground. The contaminated soil volume is estimated at 184 m^3 (6,800 ft^3) with an overburden soil volume of 175 m^3 (6,180 ft^3) (WHC 1991a).

2.3.10 Unplanned Releases

Sixty-three unplanned releases are included in the PUREX Plant Aggregate Area. Their locations are shown on Figure 2-14. Many of the releases are not included as independent sites in the Tri-Party Agreement; however, because they are closely associated with existing waste management units. These unplanned releases and their associated waste

management units will be addressed together in this study. Table 2-5 summarizes the known information for each unplanned release and, where applicable, lists the waste management unit to which it is related. Most of the information available for the unplanned releases is derived from the WIDS sheets (WHC 1991a).

One additional, potentially significant, release site is known to exist in the PUREX Plant Aggregate Area but has not been officially documented as an unplanned release. More information will be compiled on this site in the future to assess the potential impacts to the environment. A formal evaluation of the regulatory status of this site will be made. It is described in the following paragraph.

In 1985 a release of fission products to the environment was detected in the eastern section of the 200 East Area. The source of the release was a deactivated diversion box, 241-C-151, in the 241-C Tank Farm. The release, estimated at less than 500 mCi ^{90}Sr, spread detectable contamination over about a 5 km^2 (2 mi^2) area, primarily within the 200 East Area fence. There was no evidence that any significant contamination had migrated from the Hanford Site.

2.4 WASTE GENERATING PROCESSES

The primary waste generating processes in the PUREX Plant Aggregate Area are associated with the operation of the 202-A Building and its ancillary support facilities. Operations in the 202-A Building complex have included the recovery of uranium and plutonium from spent reactor fuels, treatment and/or storage of liquid and solid wastes, and discharge of gaseous and liquid effluents that meet environmental release criteria. This section describes the primary waste generating processes and the associated building locations in the PUREX Plant Aggregate Area including:

- 202-A Building and 293-A Building (PUREX Process)
- 242-A Evaporator (Waste Volume Reduction Process)
- 241-A-431 Condenser Building in the 241-A Tank Farm (Tank Farm Condensate).

In addition, some waste management units within the aggregate area received wastes from outside facilities. Some of the B Plant waste was sent to the 241-A, 241-AX, and 241-C Tank Farms. The 201-C Building (Semiworks) waste was also sent to the 241-C Tank Farm.

Table 2-6 summarizes the available information about the waste streams produced within the aggregate area. The chemicals or radionuclides that are known or suspected to be in the PUREX Plant Aggregate Area waste streams are listed in Table 2-7; Table 2-8 lists the chemicals used in the 202-A Building Analytical Laboratory; and Table 2-9 lists radionuclides, organic and inorganic chemicals disposed of at the PUREX Plant Aggregate Area waste management facilities. These lists have been compiled from inventory data, sampling data and process descriptions. Section 2.4.1 through 2.4.5 describe the PUREX Plant Aggregate Area waste generating processes that were previously mentioned.

2.4.1 PUREX Process

The 202-A Building was the primary location of the PUREX process. The PUREX chemical separation processes are based on dissolving jacketed fuel rods in nitric acid and conducting multiple purification operations on the resulting aqueous nitrate solution. The goal is to extract, purify and concentrate the uranium, plutonium and neptunium produced from the declad fuel elements. The driving forces for the separations consist of concentration changes, temperature changes, and chemical additions. The process steps include fuel-element decladding, uranium metal dissolution, solvent extraction, ion exchange, and product load-out.

The PUREX process begins with zirconium cladding on fuel elements being removed in an AFAN solution. Ammonium nitrate is required to react with the ammonia and hydrogen that evolve during decladding due to the potential combustion hazard. Nitric acid is used to dissolve declad fuel elements for the solvent extraction process. The solvent extraction process used a light phase solvent, tributyl phosphate in a normal paraffin hydrocarbon (kerosene) diluent, to extract the uranium, plutonium and neptunium from the fission products. The organic phase is sent to the partitioning cycle where the plutonium is partitioned from the uranium and neptunium. The plutonium stream is routed through two additional solvent-extraction cycles for further purification. After purification, the plutonium stream is concentrated. The other stream from the partition cycle, which bears the neptunium and uranium, is routed to the final uranium cycle where neptunium is separated. The aqueous neptunium stream is sent to the backcycle waste system for concentration and recycling to the solvent-extraction column. The uranium stream is routed to a column that strips the uranium from the organic stream with an aqueous nitric acid solution. The uranium product, uranyl nitrate hexahydrate, is then stored in tanks until it is shipped to the UO_3 Plant in the 200 West Area.

The 202-A Building is the source of five liquid effluent streams. These liquid effluent streams are the process condensate (PDD), cooling water, PUREX steam condensate, chemical sewer, and ammonia scrubber distillate (ASD). The PDD stream comes from the concentration stages of the PUREX process. The concentration changes are provided by

dilution with water and by removal of water by boiling. Most, but not all, of the water removed by boiling is recycled back into the dilution stages of the process. The fraction of water not recycled is disposed of through the PDD stream. The PDD stream is currently rerouted to TK G-7. Steam condensate and warm water constitute the liquid effluents from the PUREX process in the cooling water, PUREX steam condensate, and most of the chemical sewer streams. The steam condensate and warm water effluents are the condensed steam used for boiling process solutions and the warmed cooling water used for condensing the resulting process vapors. The rest of the chemical sewer stream comes from ventilation, heating, water services, and room drainage (mostly shower rooms, water coolers, housekeeping water, and steam and water leaks, together with occasional chemical leaks). The ASD stream is the result of the first step in fuel dissolution, which produces large quantities of gaseous ammonia. The ammonia is scrubbed from the offgas with water to prevent releasing the ammonia to the air. Then the resulting ammonia solution is boiled to concentrate the ammonia and radionuclides for disposal to underground storage tanks. The condensed vapor becomes the ASD stream. The ASD stream is currently inactive.

One of the secondary facilities within the PUREX process is the 293-A Building. This building houses the back-up facility, which removes nitrogen oxides from the dissolver offgas stream then converts them to nitric acid. Offgases are treated with hydrogen peroxide to remove the nitrogen oxides. The nitric acid is then recycled into the PUREX process via the 206-A Building.

Process wastes from the 202-A Building were discharged to various waste management units including, but not limited to, the following:

- 216-A-1 and 216-A-2 Cribs
- 216-A-21 and 216-A-27 Cribs
- 216-A-11 and 216-A-12 French Drains
- 216-A-18 and 216-A-19 Trenches
- 216-A-29 Ditch
- 241-A, 241-AX and 241-C Tank Farms
- 216-A-42 Retention Basin.

2.4.2 Waste Volume Reduction Process

The 242-A Evaporator started operation in 1977. The purpose of this facility is to reduce the volume of radioactive liquid waste by evaporating water from the feed solution to produce a concentrated salt solution. The solution separates upon cooling to form salt cake and residual liquor. This process reduces the number of double-shell tanks required to store this type of waste by 35 to 60%.

The 242-A Building contains the evaporator vessel, supporting process equipment, and the principal process components of the evaporator-crystallizer (EC) system. The building comprises two adjoining, structurally independent structures, designated A and B. Structure A houses the processing and service areas while structure B houses operating and personnel support areas.

Process condensate from the 242-A Evaporator flows into one of the three cells at the 207-A Retention Basins until it reaches operational capacity. At this time the steam condensate flow is diverted to one of the two remaining cells. The cell that has reached capacity is then sampled and analyzed at the 222-S Laboratory for radionuclides as an indication of process control. The steam condensate from the full diversion basin is then discharged to the 216-B-3 Pond and the cooling water line via the 216-B-3-3 Ditch if the analytical results are within set radionuclide limits.

Process wastes were discharged to various waste management units including the following:

- 216-A37-1 Crib
- 207-A Retention Basins.

2.4.3 Tank Farm Condensate

Condensate waste from the 241-A Tank Farm was condensed in the 241-A-431 Building. The waste was then directed to eight waste management units. The condensate was primarily water and included entrained radionuclides and chemicals from the waste in the tanks. The following waste management units received condensate waste:

- 216-A-8 Crib
- 216-A-16 and 216-A-17 French Drains
- 216-A-23A and 216-A-23B French Drains

- 216-A-19 and 216-A-20 Trenches

- 216-A-34 Trench.

2.5 INTERACTIONS WITH OTHER AGGREGATE AREAS OR OPERABLE UNITS

The PUREX Plant Aggregate Area is bordered by the B Plant Aggregate Area on all sides with the exception of a small portion of the western border where the Semiworks Aggregate Area is present. During operation of the 202-A Building, several other processing and support facilities on the Hanford Site are utilized. The purpose of this section is to summarize facilities that interact directly with 202-A Building operations. These facilities include the Plutonium Finishing Plant, UO_3 Plant, 241-AW Tank Farm, and the double-shell storage tanks within the 241-AY and -AZ Tank Farms.

- The Plutonium Finishing Plant (PFP) received product material, plutonium oxide (PuO_2) and plutonium nitrate ($PuNO_3)_4$), from the PUREX Plant.

- Uranium was recovered as uranyl nitrate and transported to the UO_3 Plant for conversion to UO_3.

- Decladding wastes and other miscellaneous PUREX process liquid wastes are stored in the double-shell waste tanks and concentrated to double-shell slurry in the 242-A Evaporator for long-term storage in double-shell tanks in AN, AW, and/or AP Tank Farms.

- PUREX process high-level wastes are adjusted at the 202-A Building to meet the storage tank specifications and transferred to double-shell tanks in 241-AY and -AZ Tank Farms.

Several PUREX Plant waste management units have received wastes from the surrounding aggregate areas. The 216-A-8 Crib received condensate from the 241-AY and -AZ Tank Farms. The 216-A-9 Crib received N Reactor decontamination waste. The 241-A Tank Farm received various wastes including B Plant high-level waste, complexed and non-complexed waste from the 241-BX, -SX tanks, double-shell slurry feed from 241-AY, -AZ, -BX, -BY, and -SX tanks. The 241-AX Tank Farm received B Plant high-level waste, and sludge supernatant from the 241-AZ Tank Farm. The 241-C Tank Farm received B Plant high-level waste, B Plant waste fractionization low-level waste, REDOX high-level waste, N Reactor waste, PNL waste, Hanford Laboratory operations waste, Semiworks waste, evaporator bottoms from 241-B, -BX Tank Farms, tributyl phosphate waste from 241-BY, -TY, and -U tanks, and metal wastes from 241-AY, and -TX tanks.

Some wastes that were generated in the PUREX Plant Aggregate Area were sent outside of the area for disposal. These include cooling water from the 241-A-431 Building that was routed to the 216-A-25 Pond. Wastes were sent via the 216-A-29 Ditch to the 216-B-3 Pond in the B Plant Aggregate Area. The 216-B-3 Pond is addressed in the B Plant Aggregate Area Management Study.

2.6 INTERACTION WITH RESOURCE CONSERVATION AND RECOVERY ACT PROGRAM

Appendixes B and C of the Tri-Party Agreement (Ecology et al. 1990) list RCRA TSD facilities on the Hanford Site which have entered interim status and, thus, will require final permitting or closure. Within the geographical extent of the PUREX Plant Aggregate Area there are 29 facilities which fall into this category. Table 2-10 lists the RCRA-regulated facilities, the operable unit where they are located, and the planned action (closure or operating permit).

2.7 INTERACTIONS WITH OTHER HANFORD PROGRAMS

In addition to RCRA, there are several other ongoing programs that affect buildings and waste management units in the PUREX Plant Aggregate Area. These programs include: the Hanford Surplus Facilities Program, the Radiation Area Remedial Action (RARA) Program, the Hanford Site Single-Shell Tank Program, and the Defense Waste Management Program.

At the Hanford Site, the programmatic responsibility within the Westinghouse Hanford Environmental Restoration Program for the surveillance maintenance and decommissioning of surplus facilities belongs to the Surplus Facilities and RCRA Closures Program. The program is also responsible for managing the RCRA closure and RARA activities. The program establishes the cost, schedule, and technical baselines for individual projects and provides the program management for completing the work. The work activities relative to projects are completed by various functional organizations through a matrix management system. Performing organizations are assigned work by the program office using cost account authorizations and cost account plans. Project status is reported to the program office using an earned-value system. The majority of decommissioning, RCRA, and RARA field work at the Hanford Site is performed by Hanford Restoration Operations (Winship and Hughes 1991).

The RARA Program is conducted as part of the Surplus Facilities Program. The RARA is responsible for the surveillance, maintenance, decontamination, and/or interim stabilization of inactive burial grounds, cribs, ponds, trenches and unplanned releases at the

Hanford Site. A major concern associated with these requirements is the management and control of surface soil contamination. All of the controlled access surface radiation zones in the PUREX Plant Aggregate Area are covered by this program. Table 2-11 lists the waste management units in the PUREX Plant Aggregate Area that are monitored by this program.

The Hanford Site Single-Shell Tank Program covers near-term waste management activities to ensure safe interim storage of waste in the tanks. It also addresses the environmental restoration activities to close the single-shell tank operable units, including the 241-A, 241-AX, and 241-C Tank Farms. The primary regulatory drivers of this program are the Tri-Party Agreement and RCRA.

The Defense Waste Management Program is responsible for all actively operating waste management units in the PUREX Plant Aggregate Area, all high-level waste process lines and their associated diversion boxes and double-shell tanks. Table 2-12 summarizes the units monitored by this program.

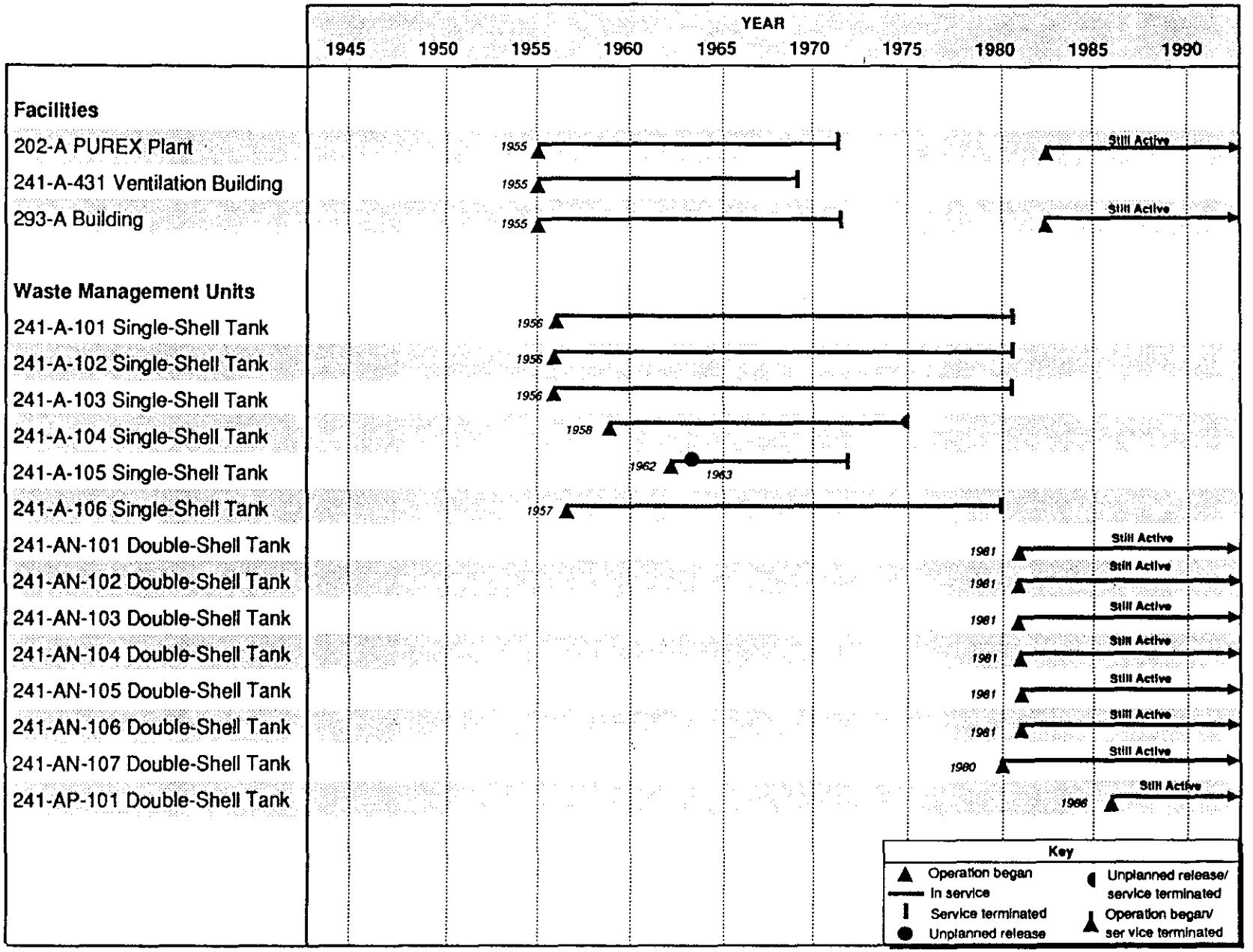


Figure 2-1. Operational and Waste-Related History.

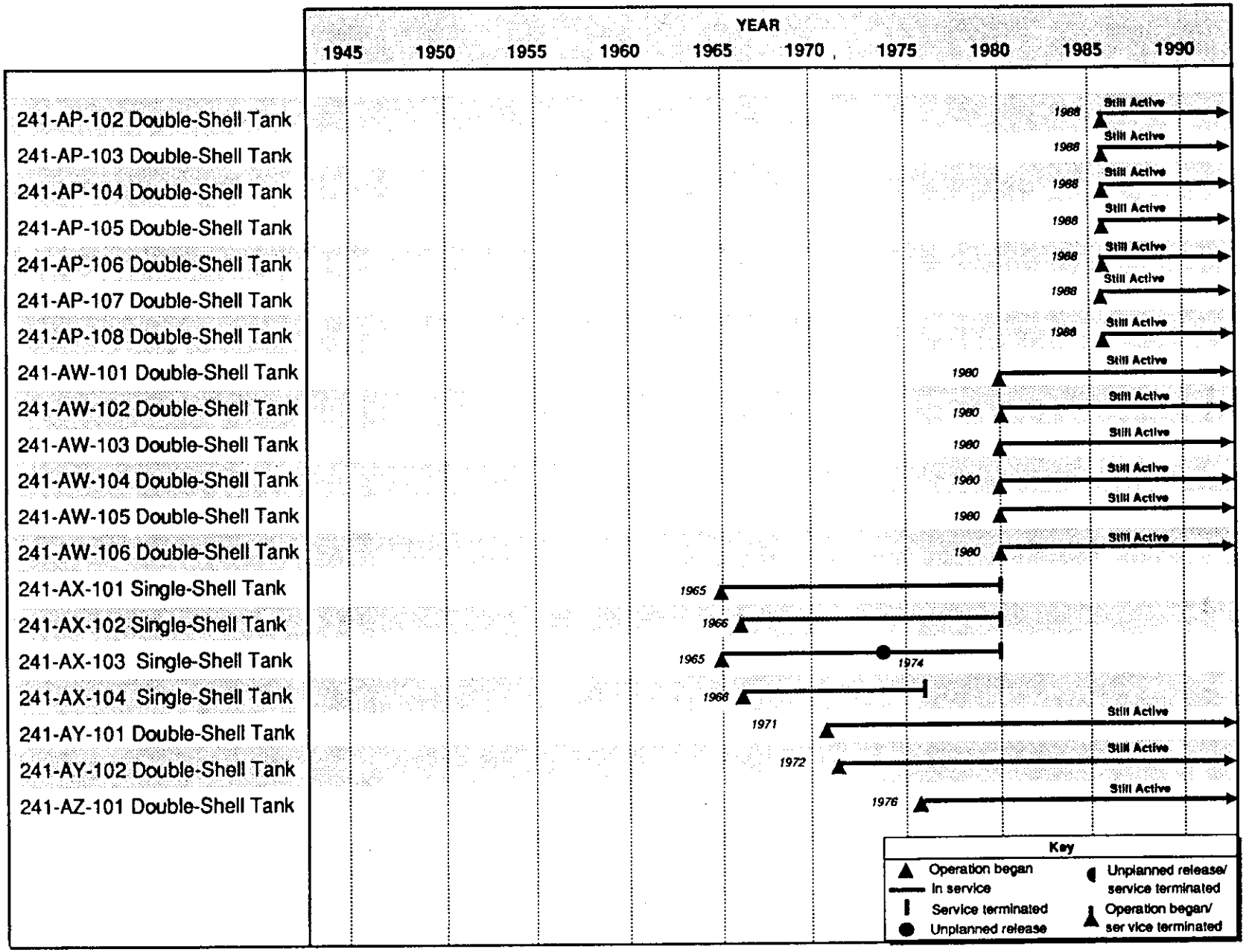


Figure 2-1. Operational and Waste-Related History (continued).

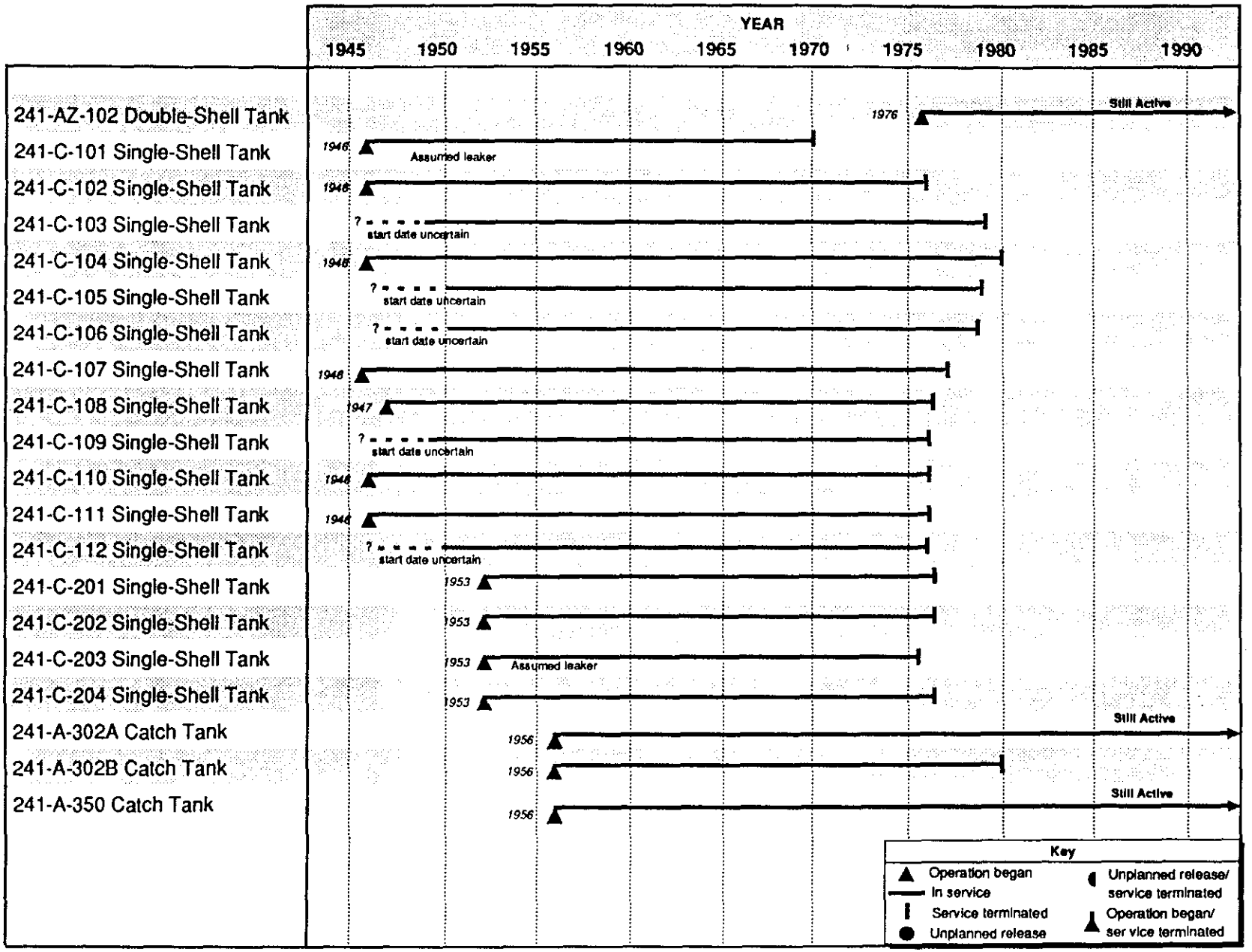


Figure 2-1. Operational and Waste-Related History (continued).

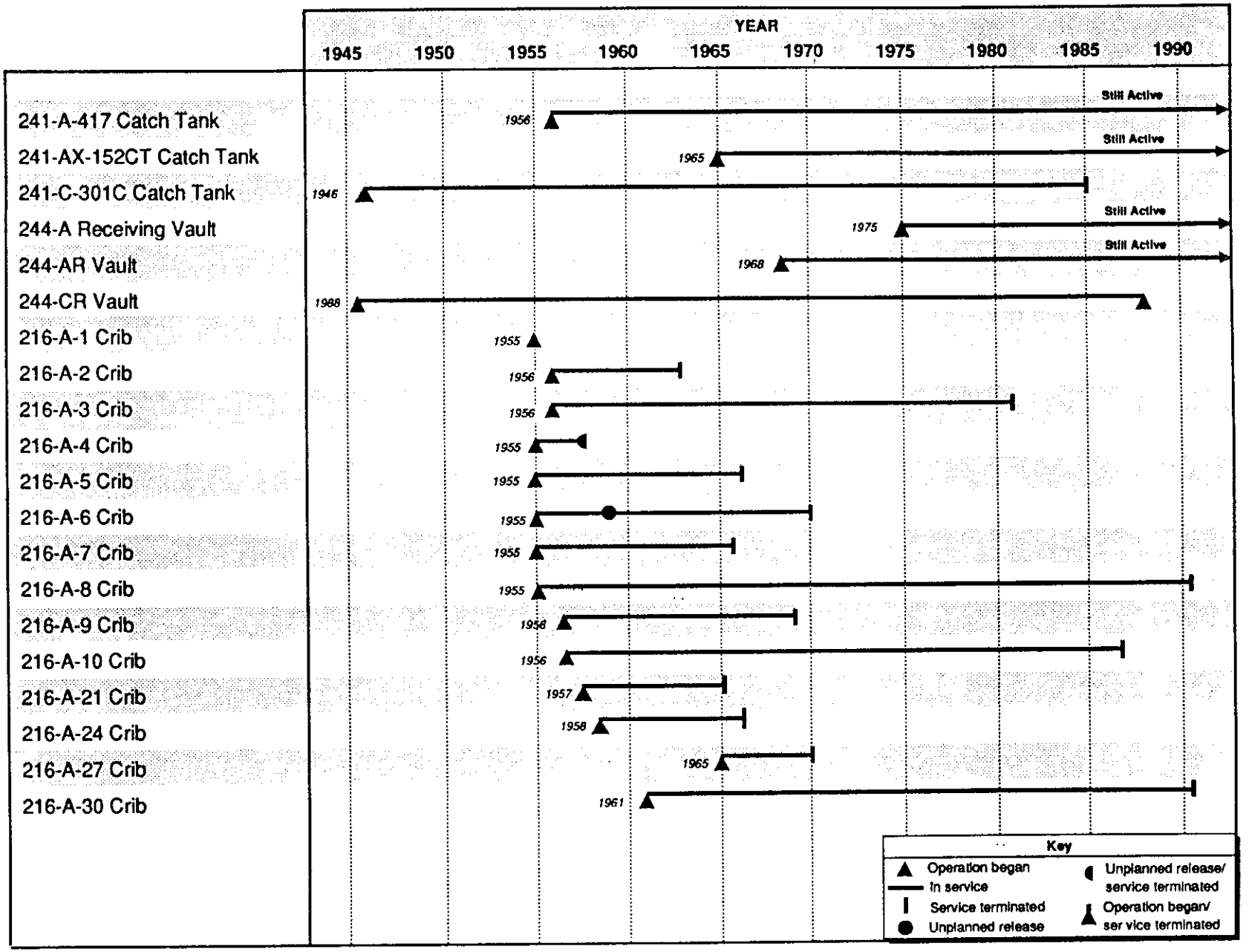


Figure 2-1. Operational and Waste-Related History (continued).

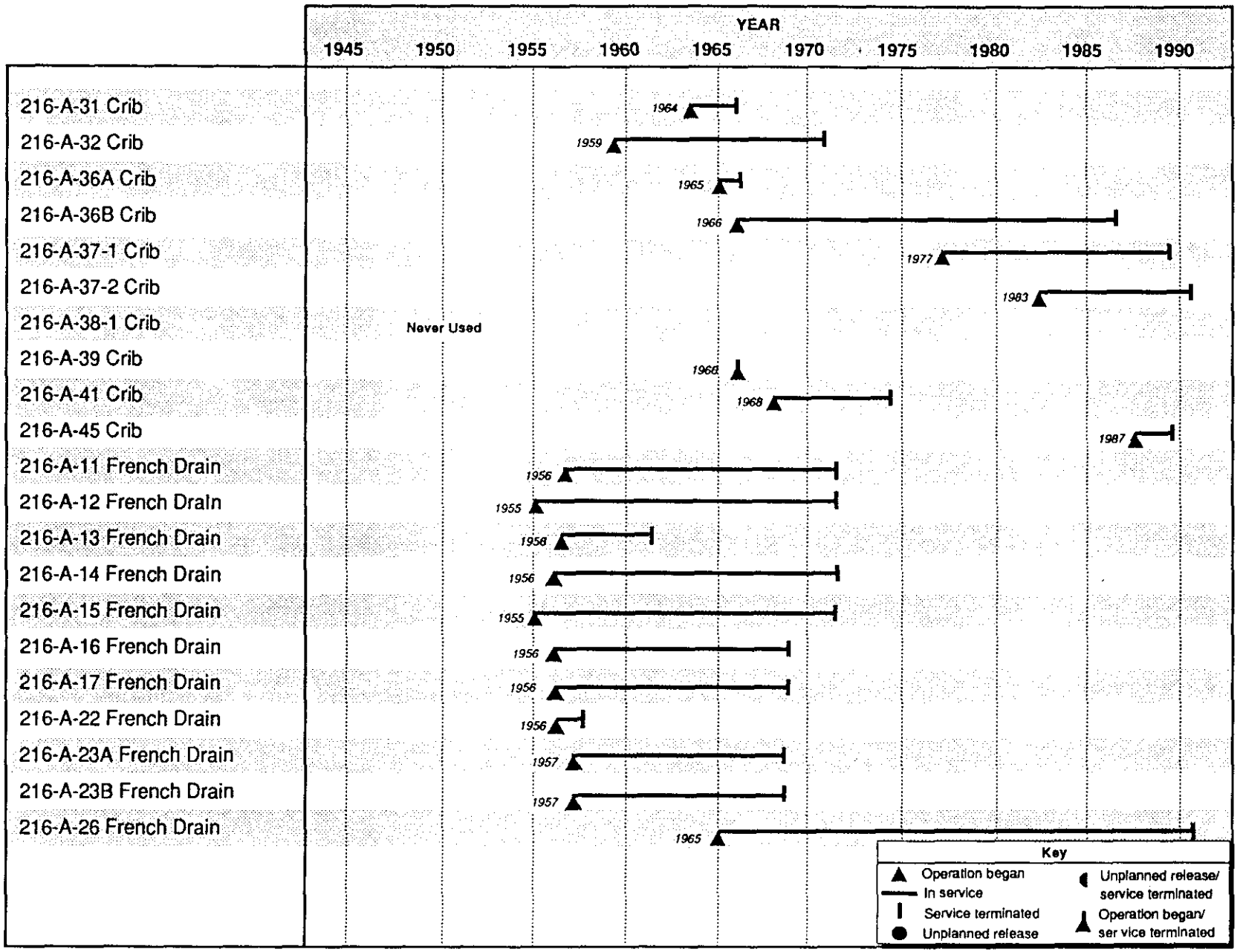


Figure 2-1. Operational and Waste-Related History (continued).

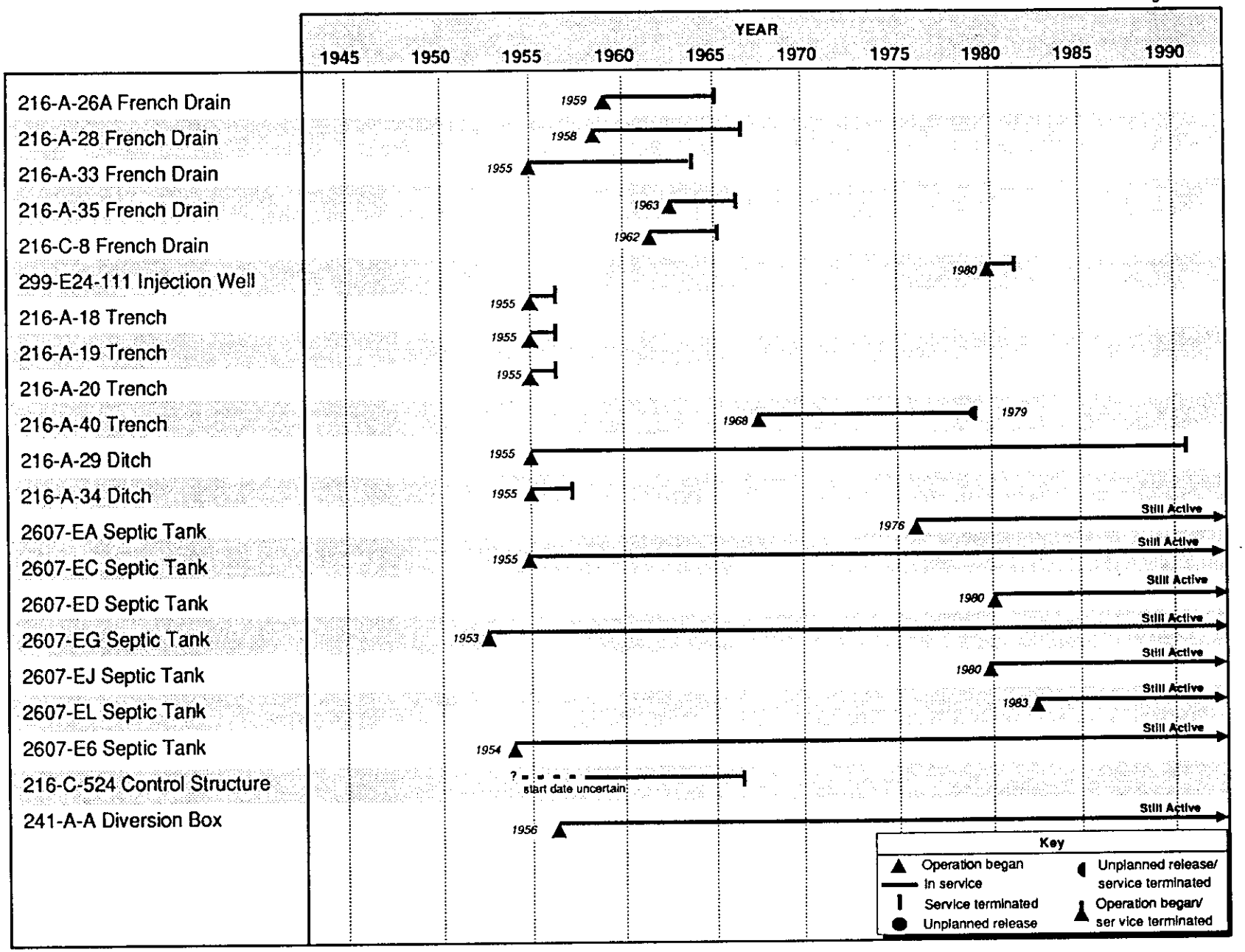


Figure 2-1. Operational and Waste-Related History (continued).

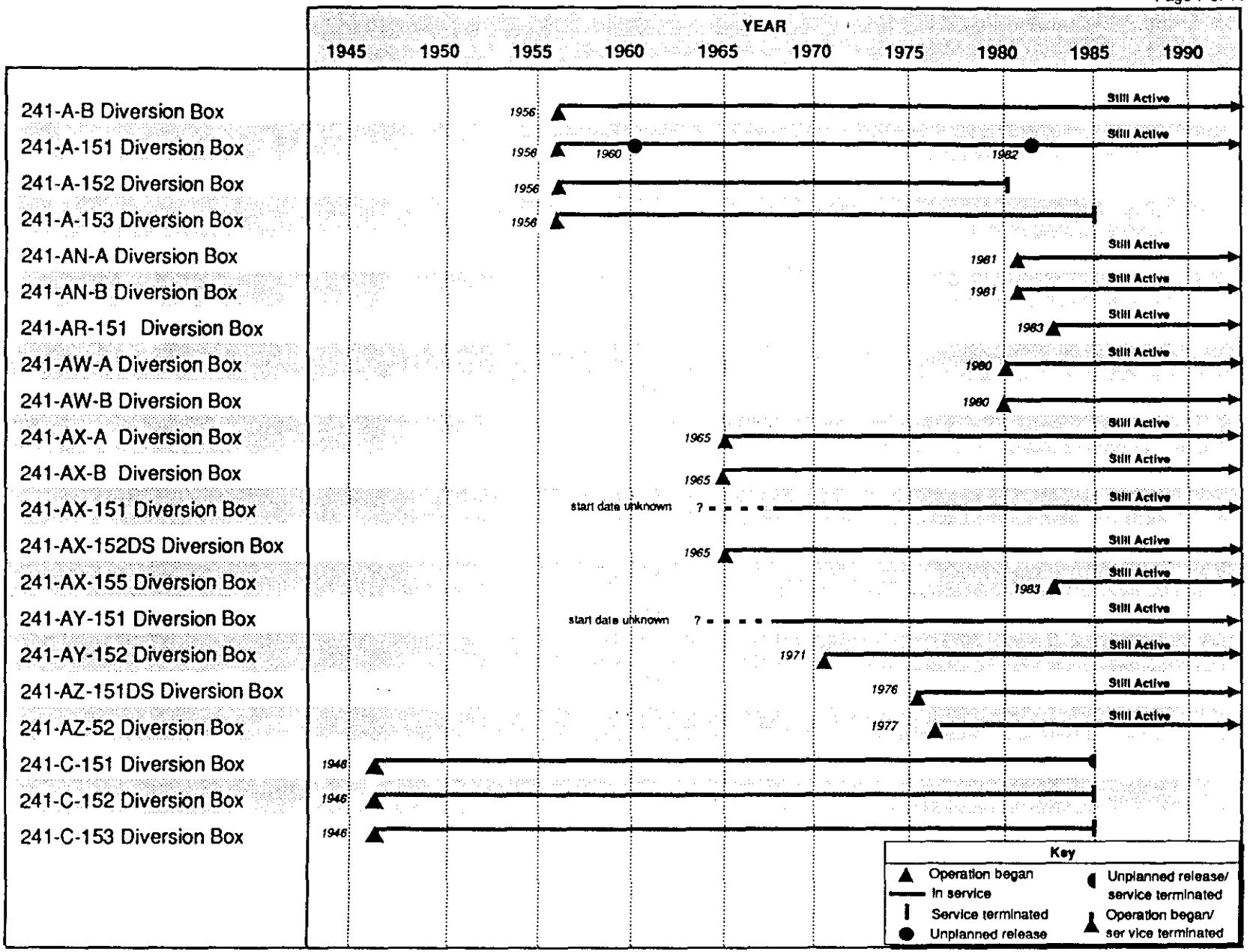


Table 2. Operational and Waste-Related History (continued).

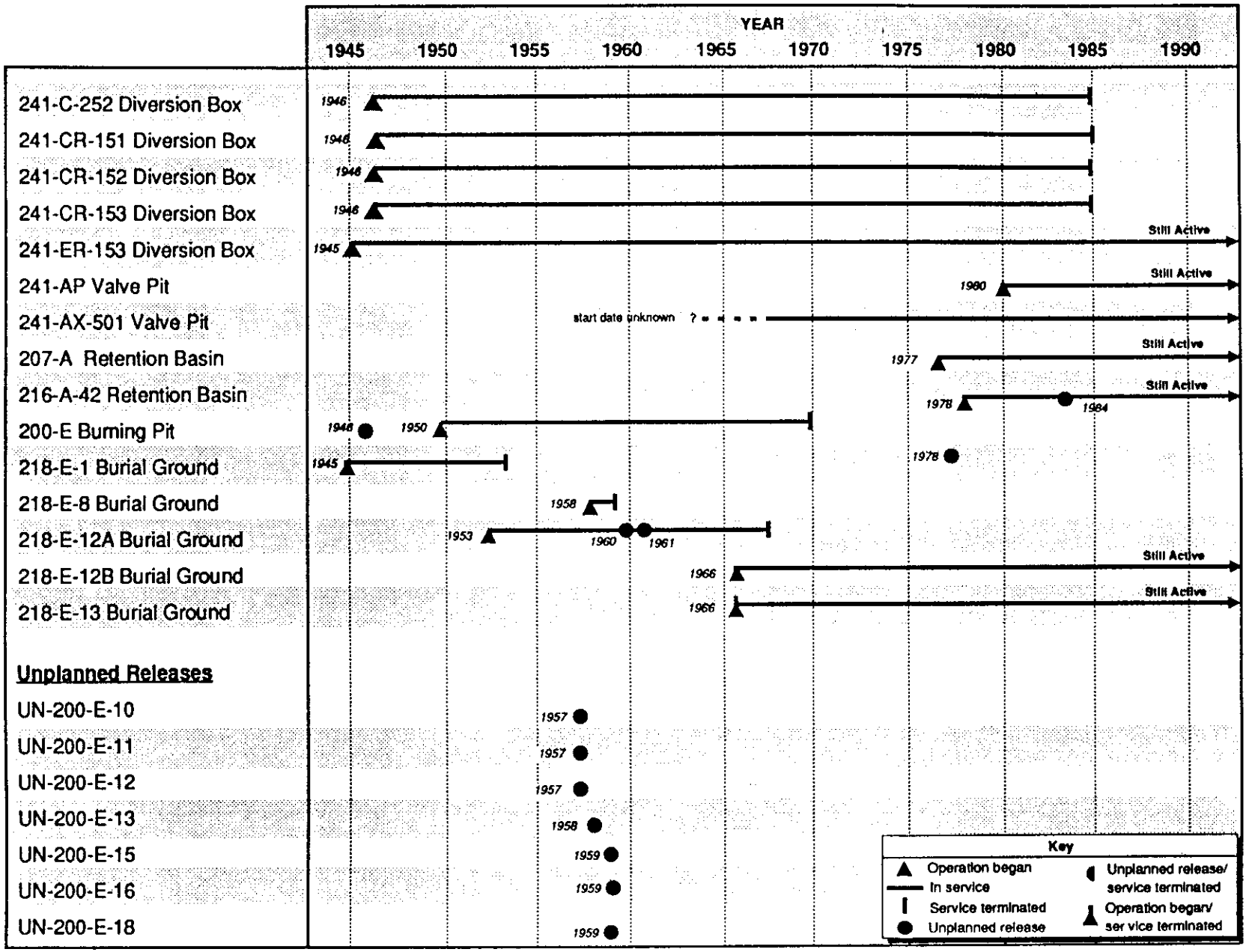


Figure 2-1. Operational and Waste-Related History (continued).

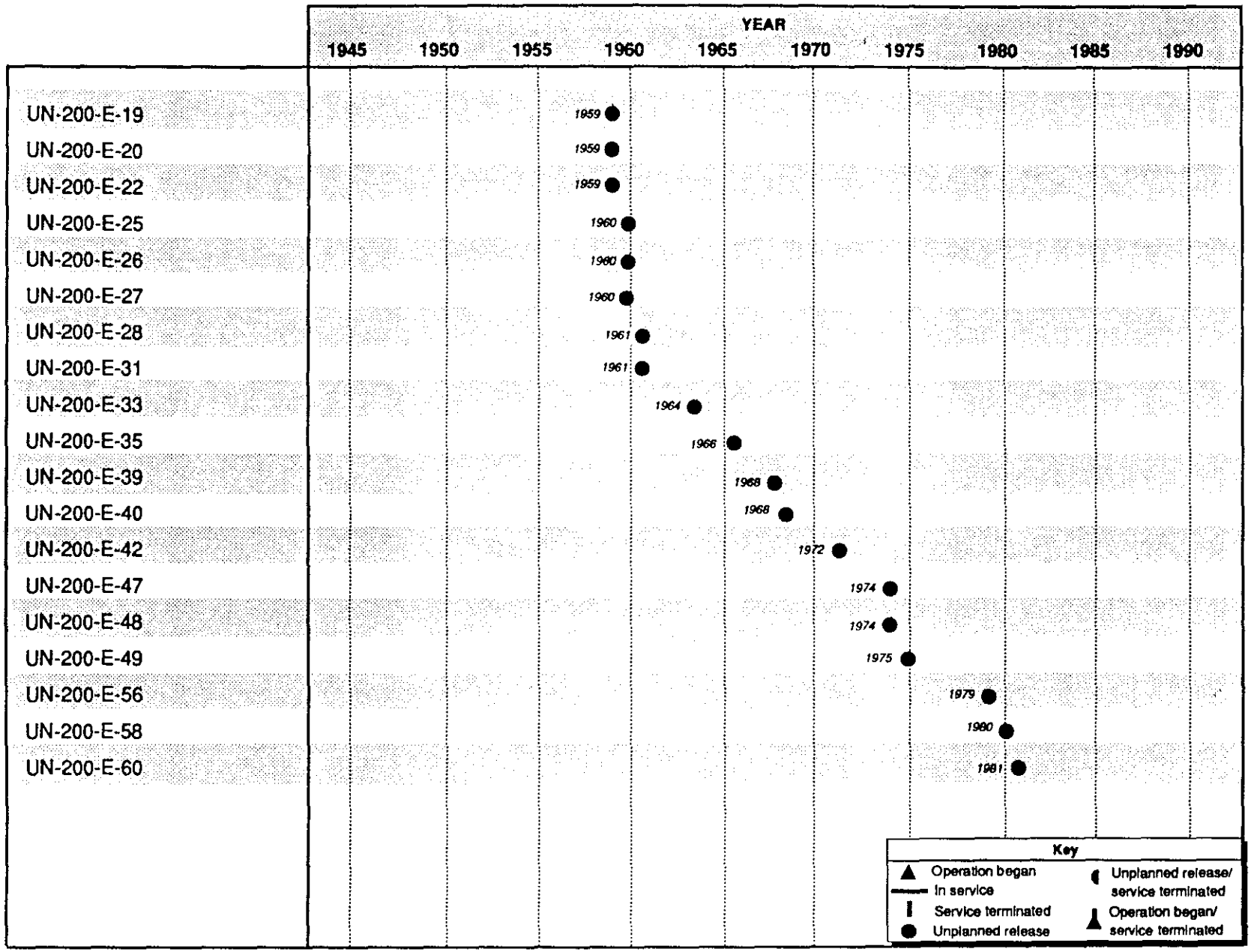


Figure 2-1. Operational and Waste-Related History (continued).

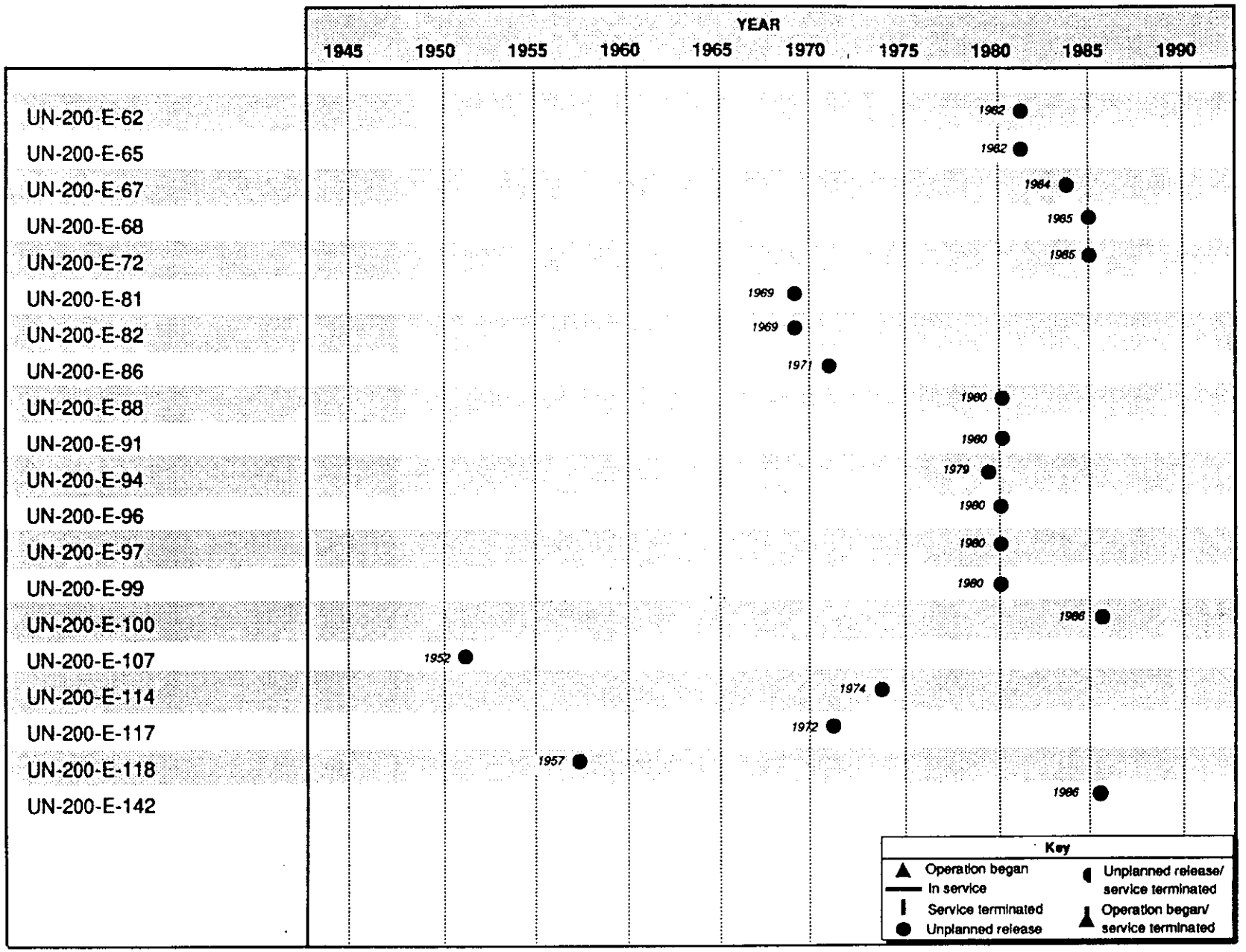


Figure 2-1. Operational and Waste-Related History (continued).

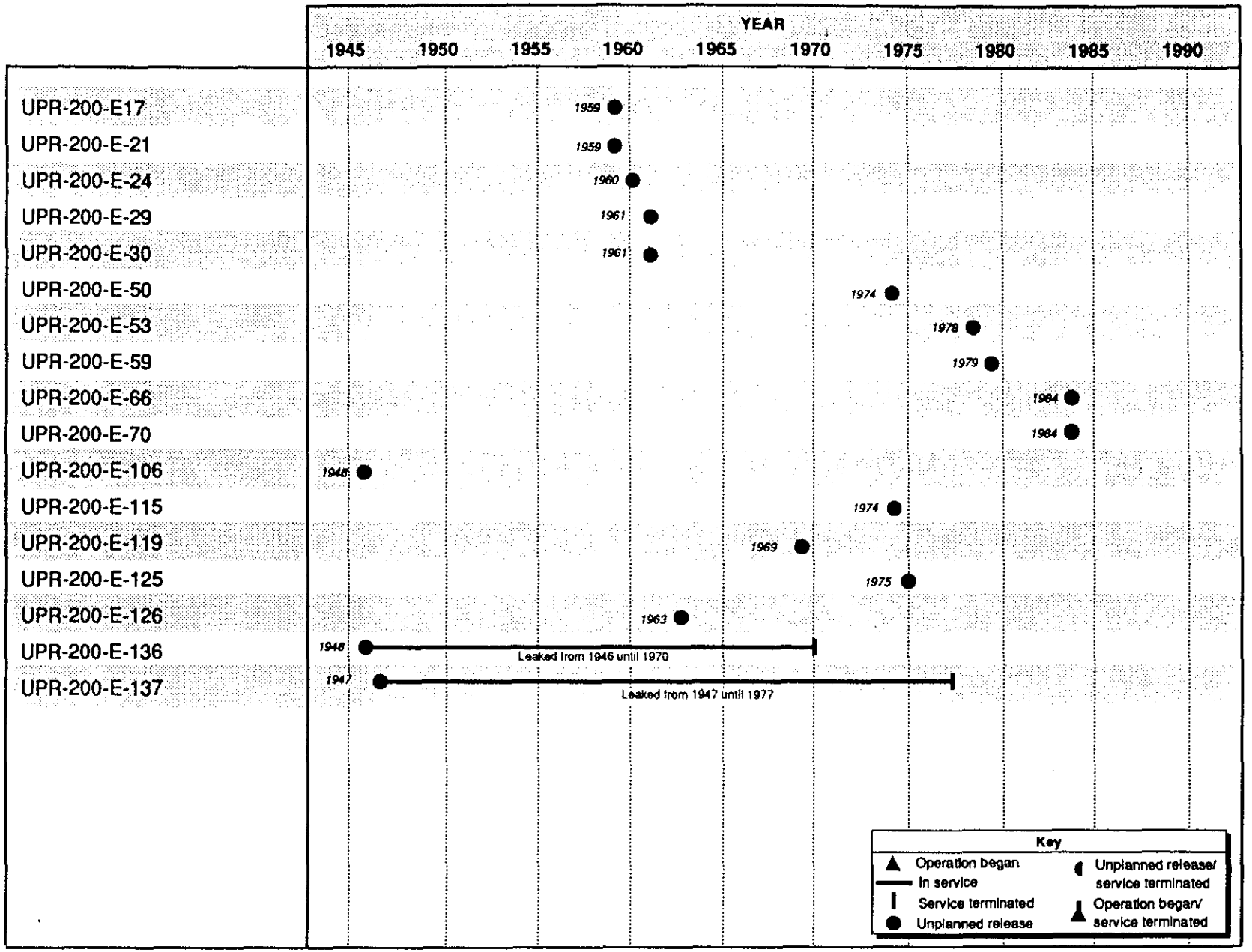
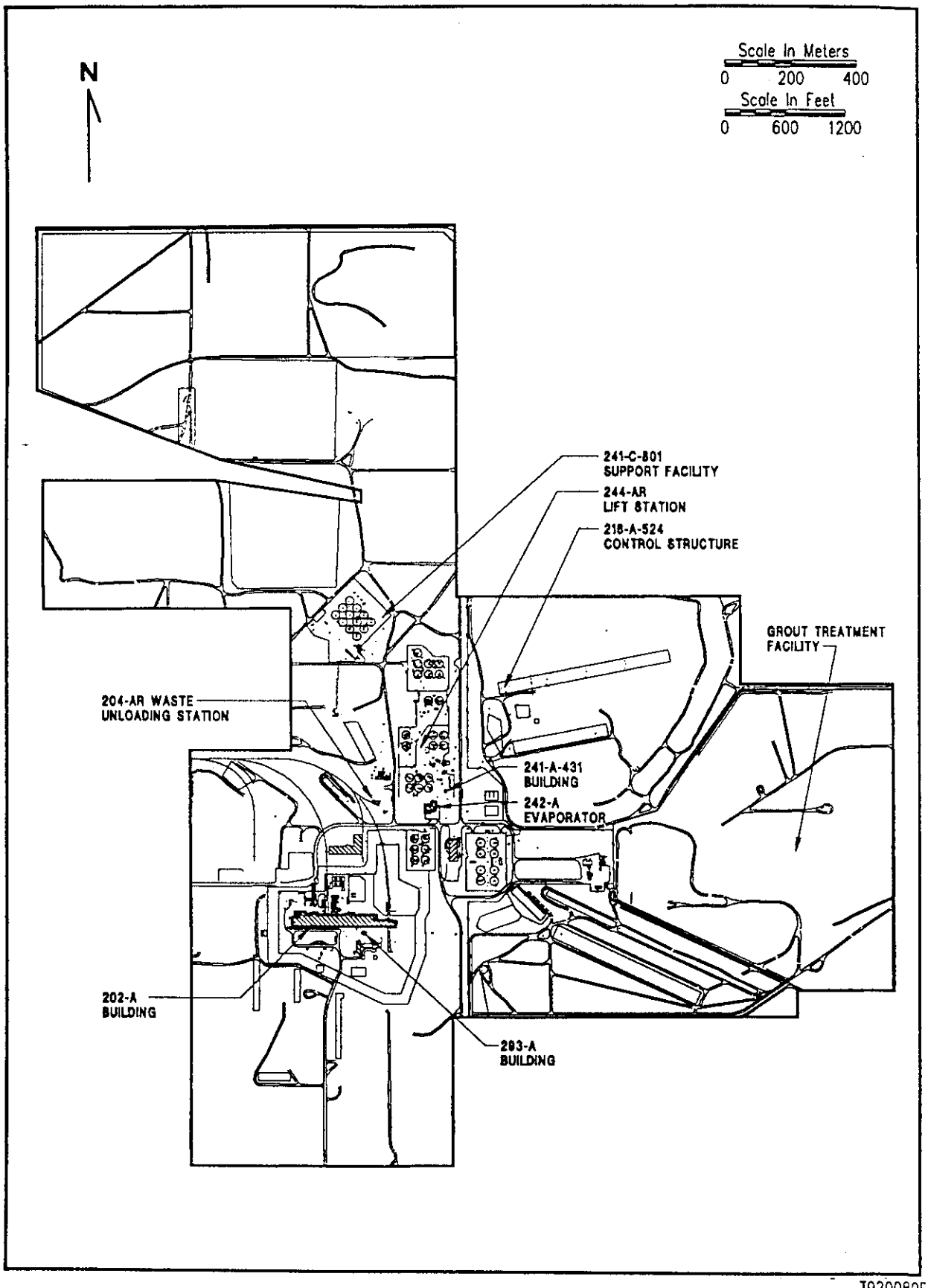


Figure 2-1. Operational and Waste-Related History (continued).



T920080E

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

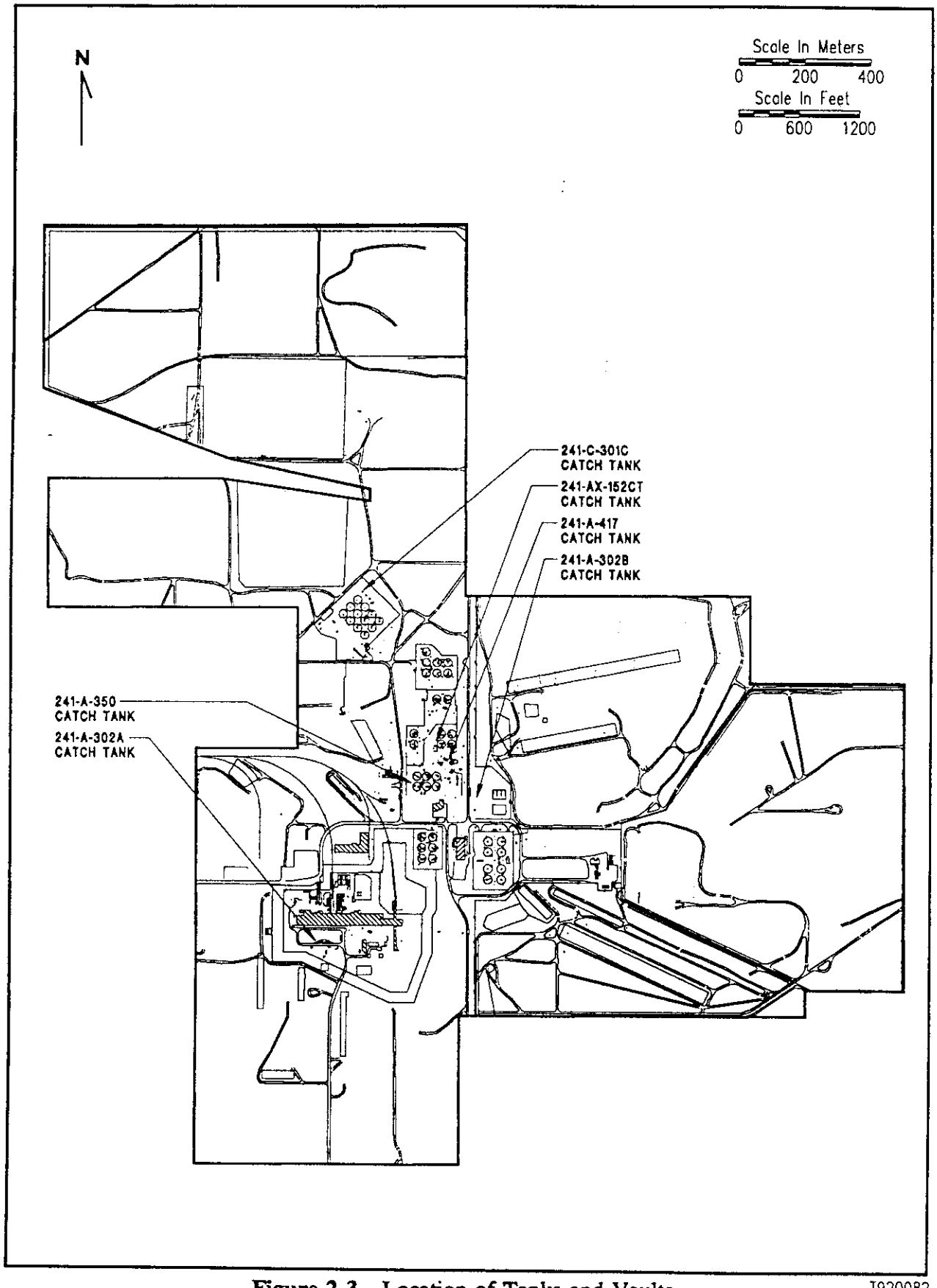


Figure 2-3. Location of Tanks and Vaults.

T920082

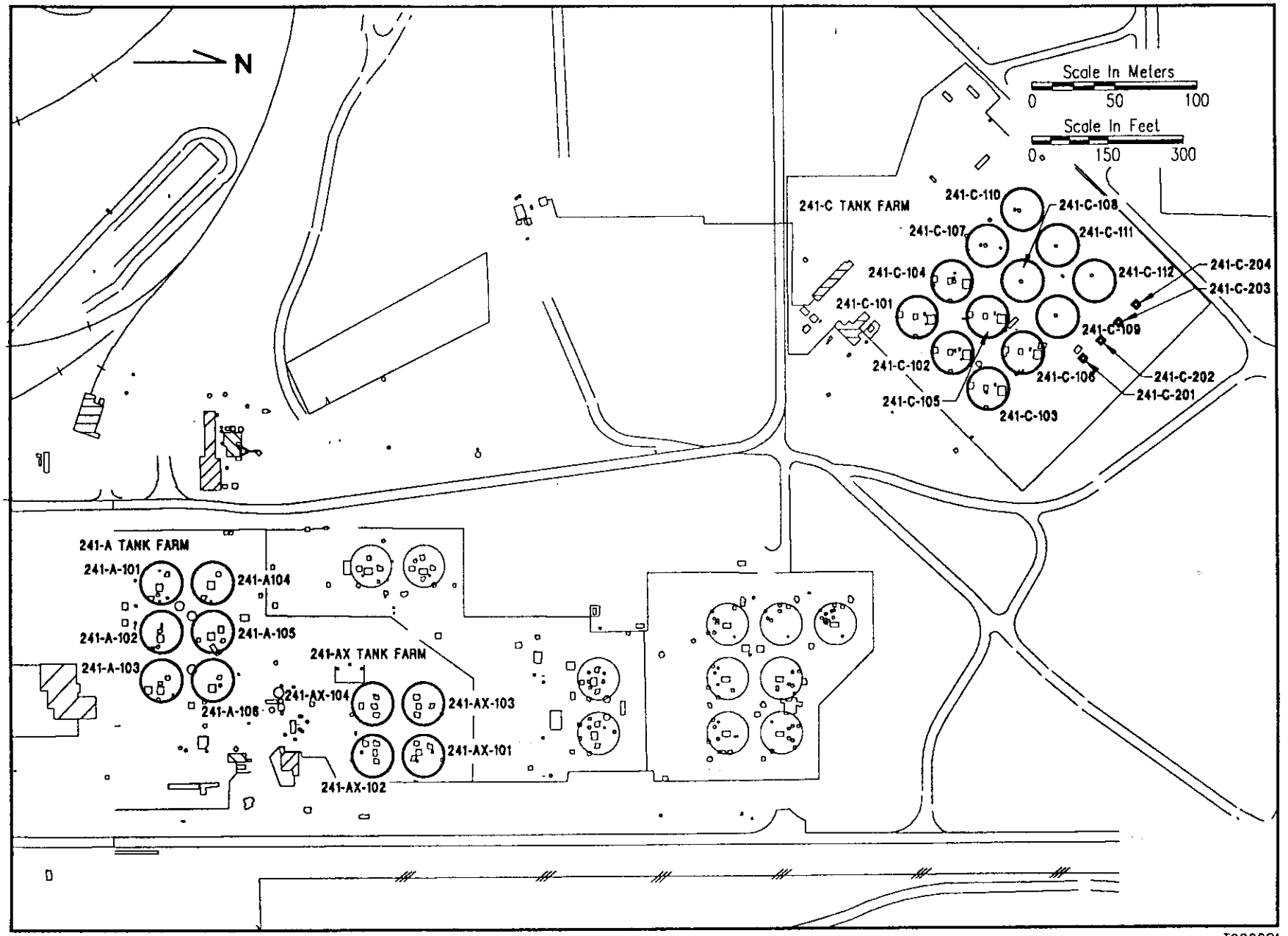


Figure 2-4. Location of Tanks and Vaults.

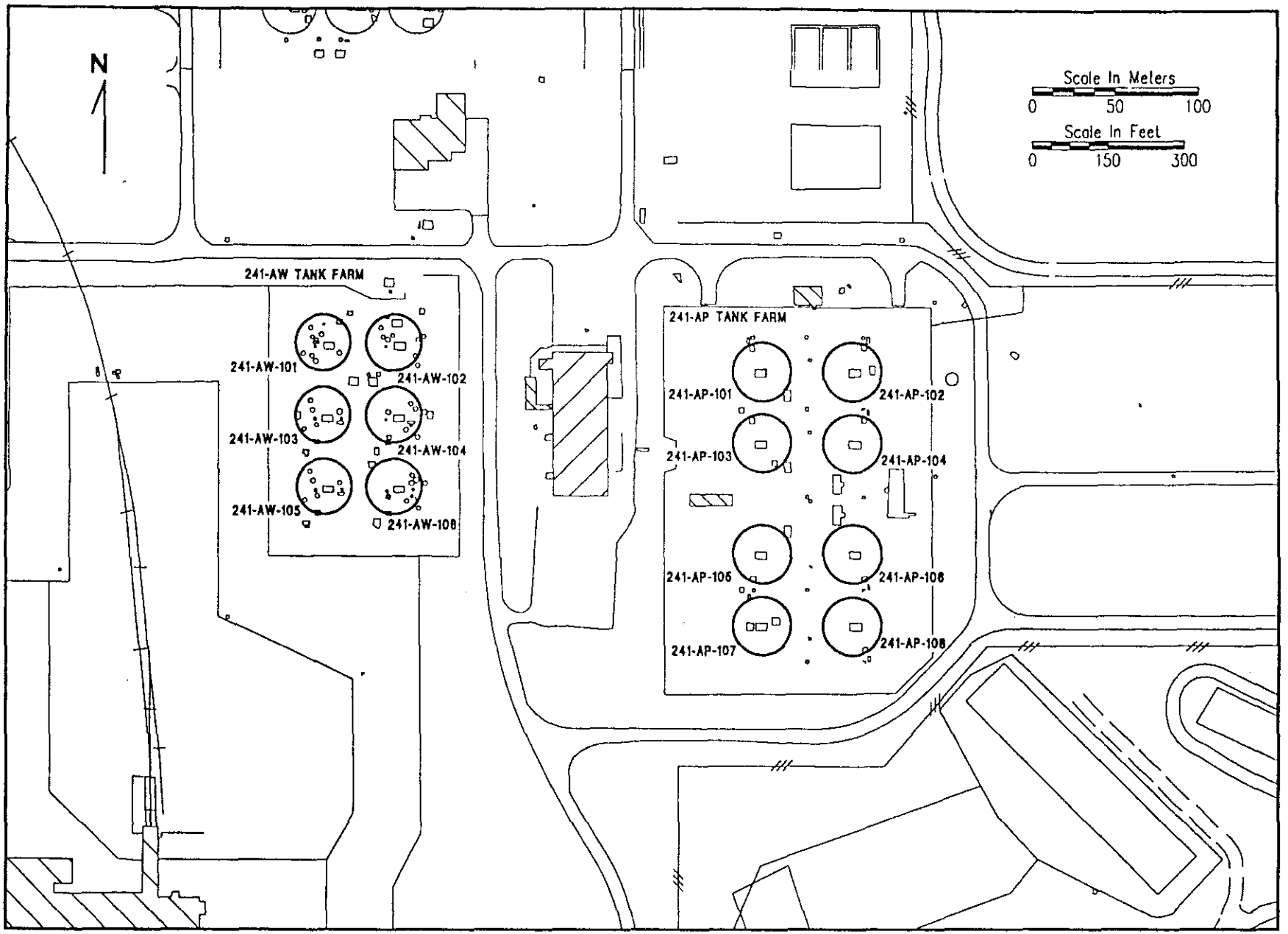


Figure 2-5. Location of 241-AP and 241-AW Tank Farms.

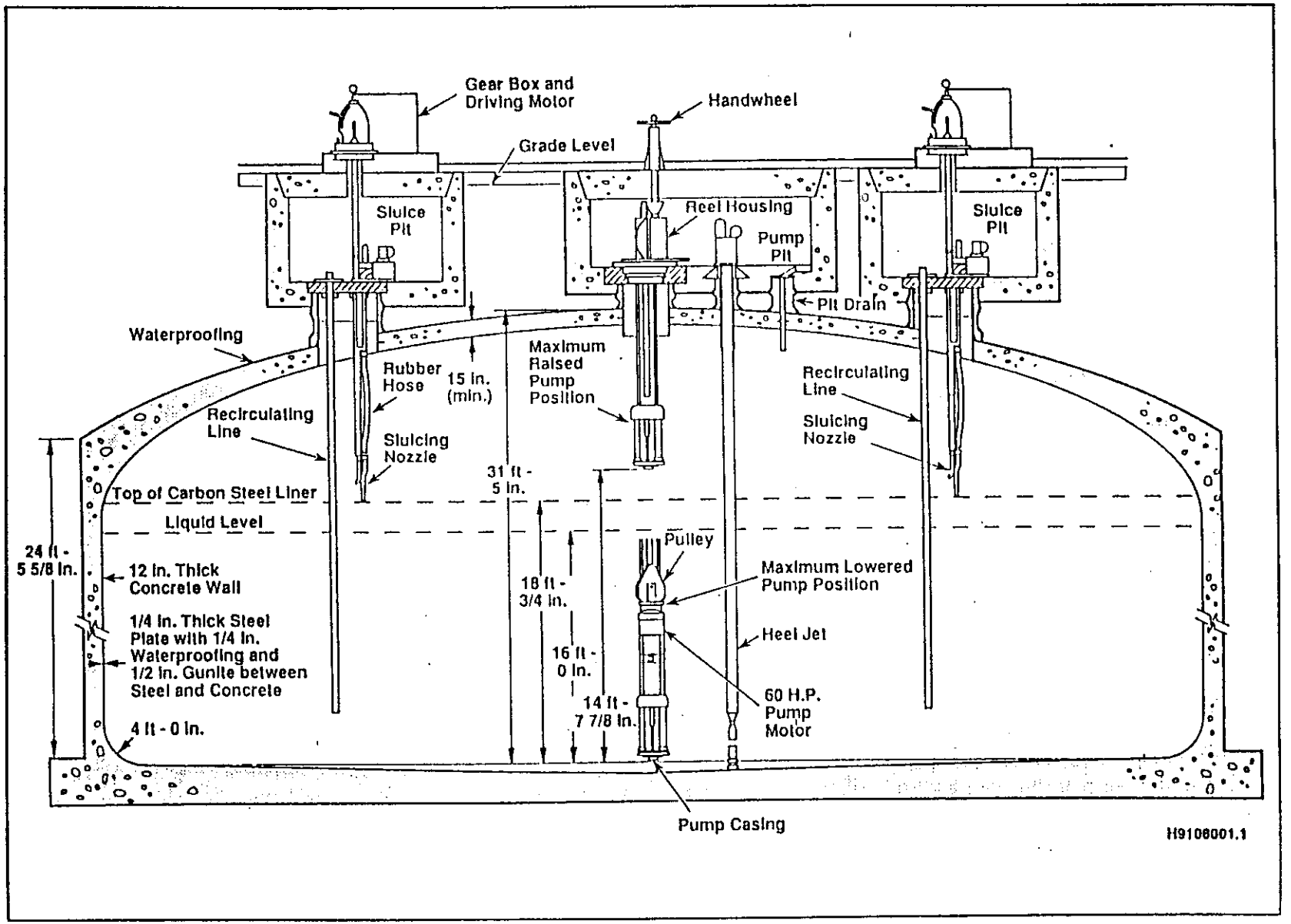


Figure 2-6. Typical Tank.

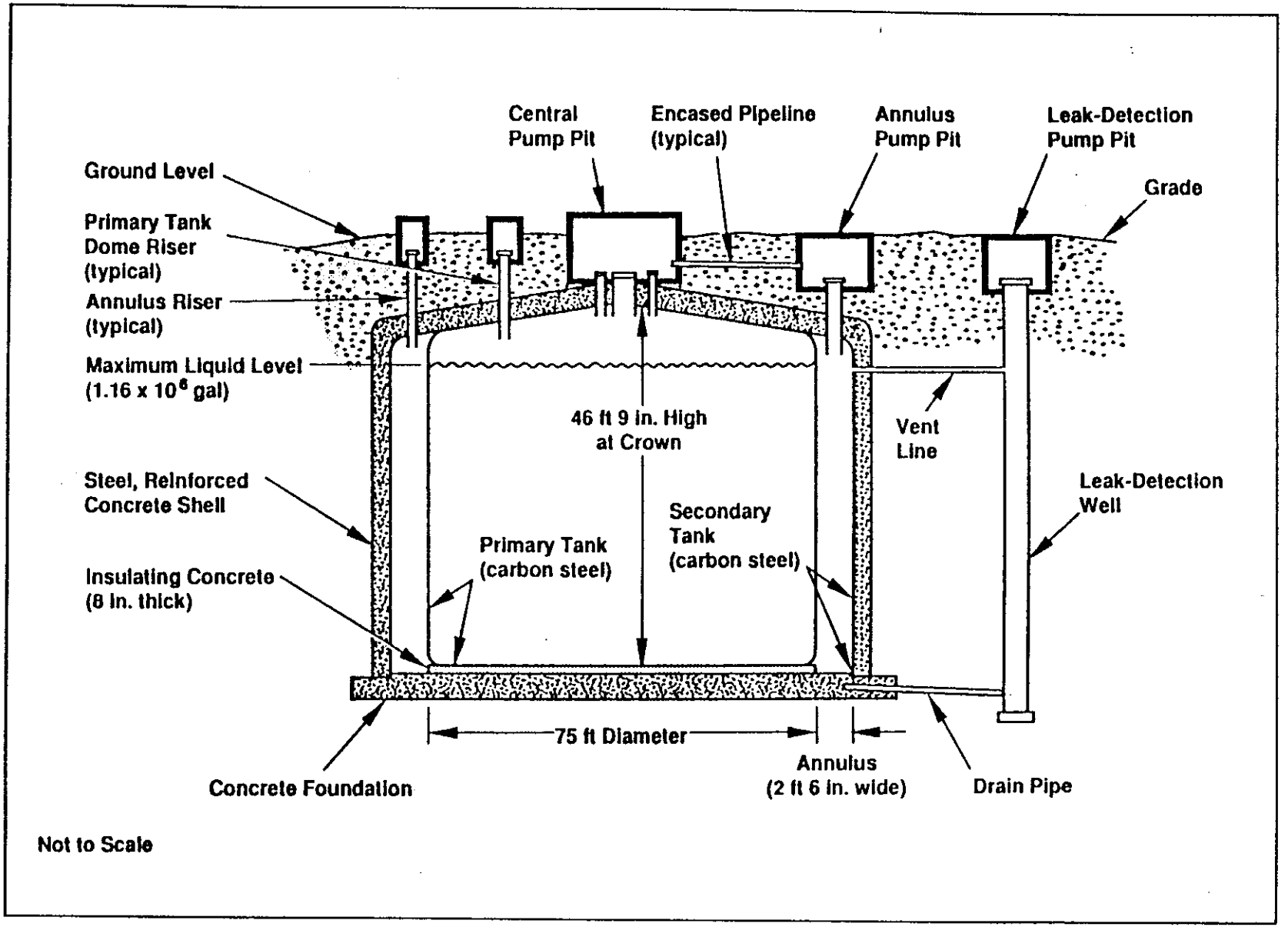


Figure 2-7. Typical Double-Shell Tank.

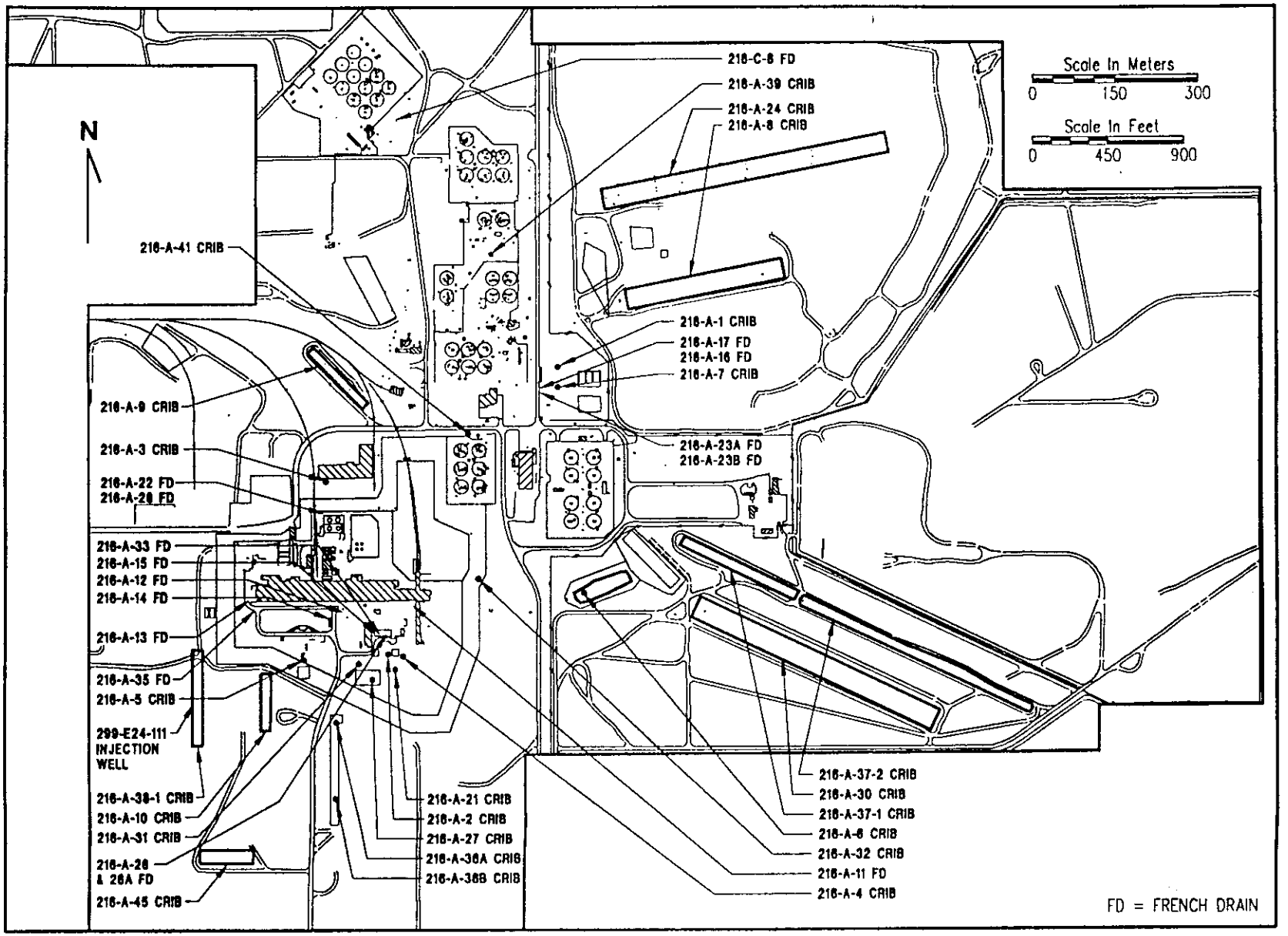


Figure 2-8. Location of Cribs and Drains.

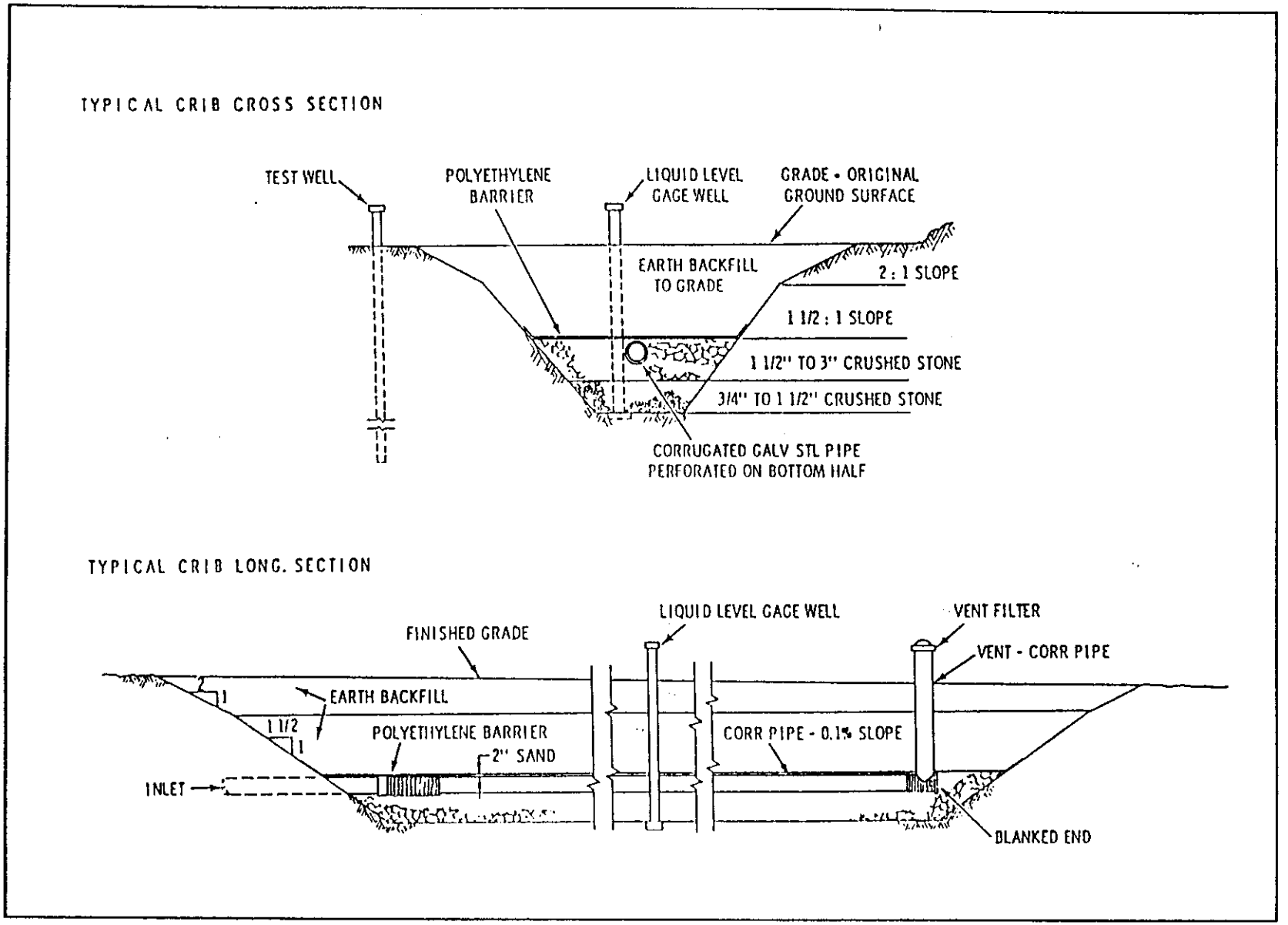


Figure 2-9. Typical Crib.

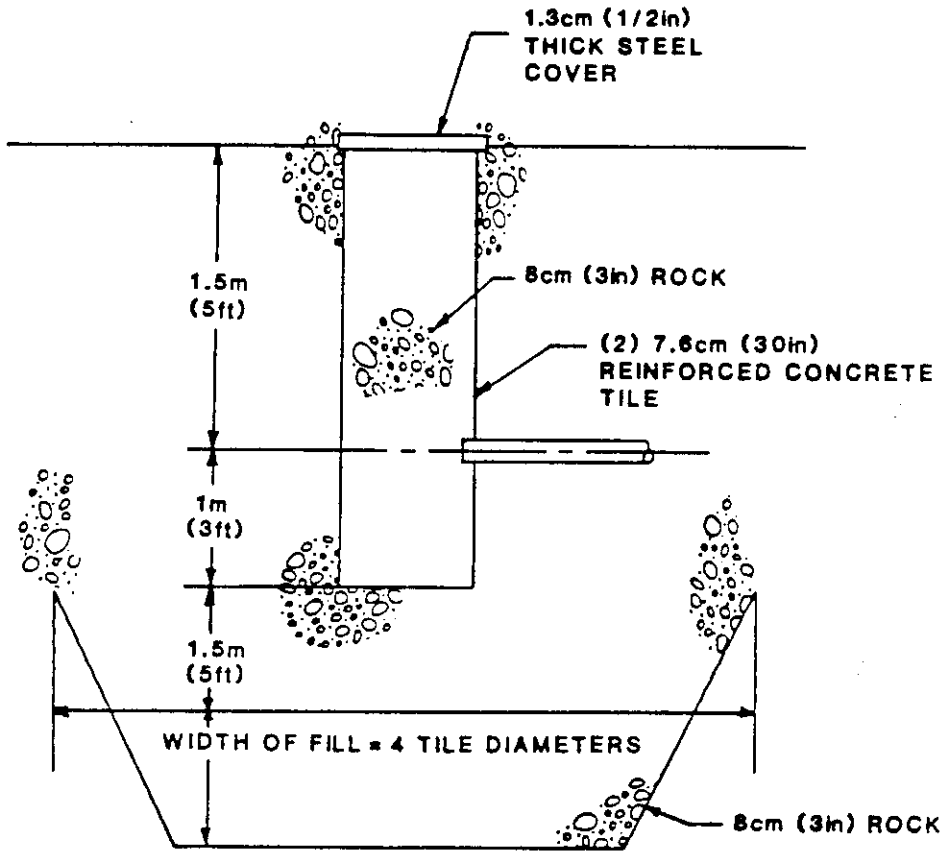


Figure 2-10. Typical French Drain.

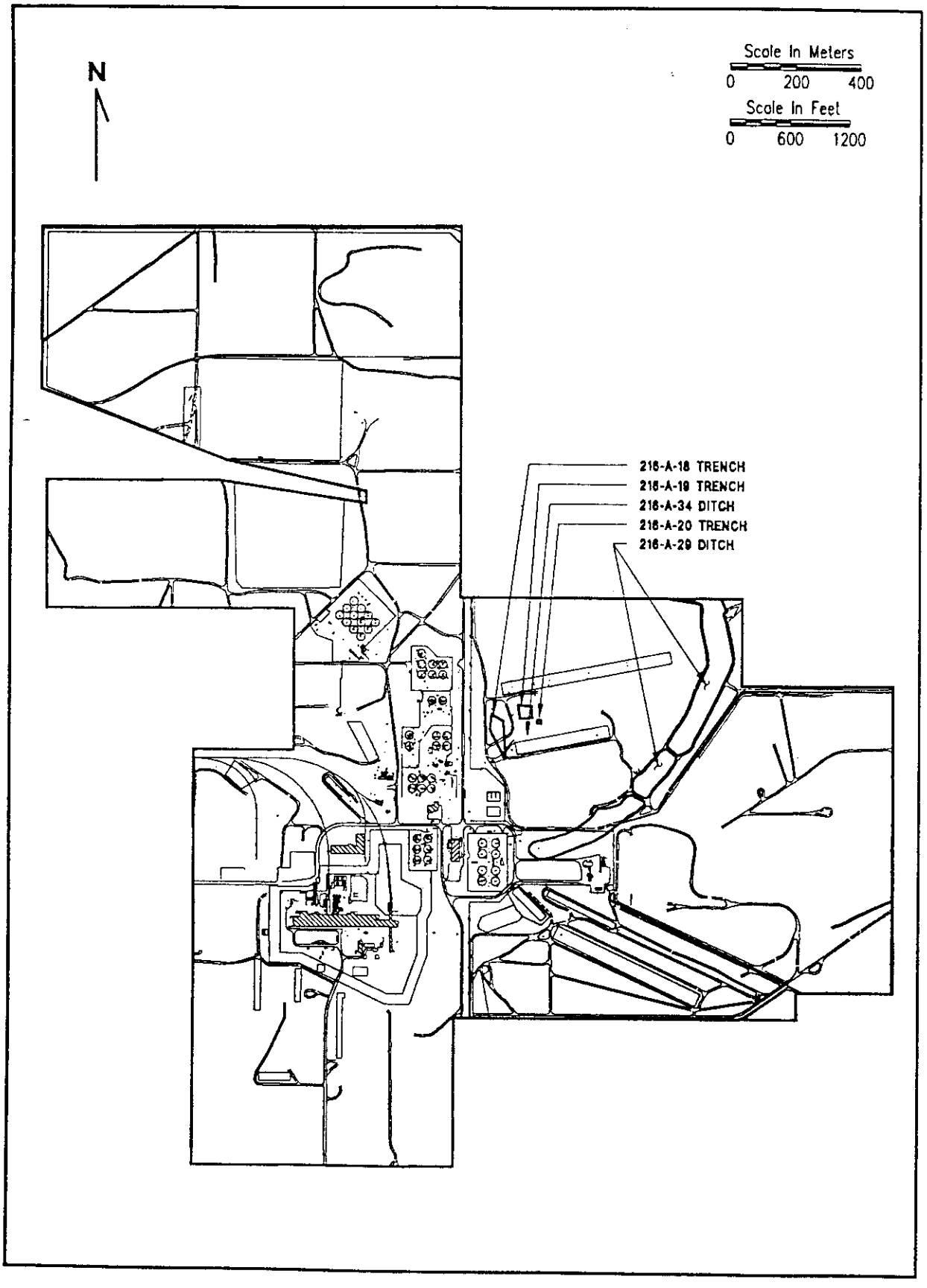
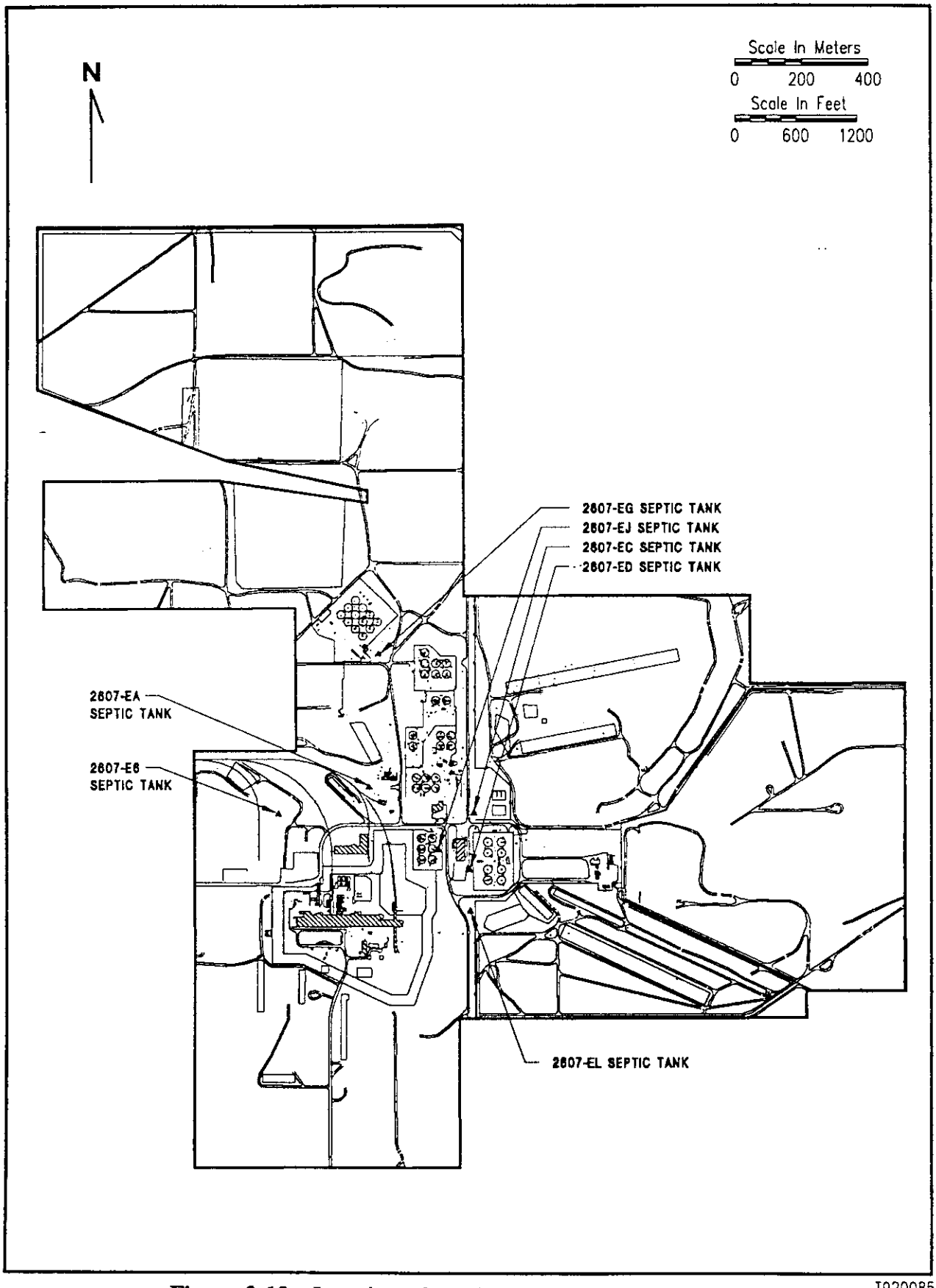


Figure 2-11. Location of Ditches and Trenches.



T920085

Figure 2-12. Location of Septic Tanks and Drain Fields.

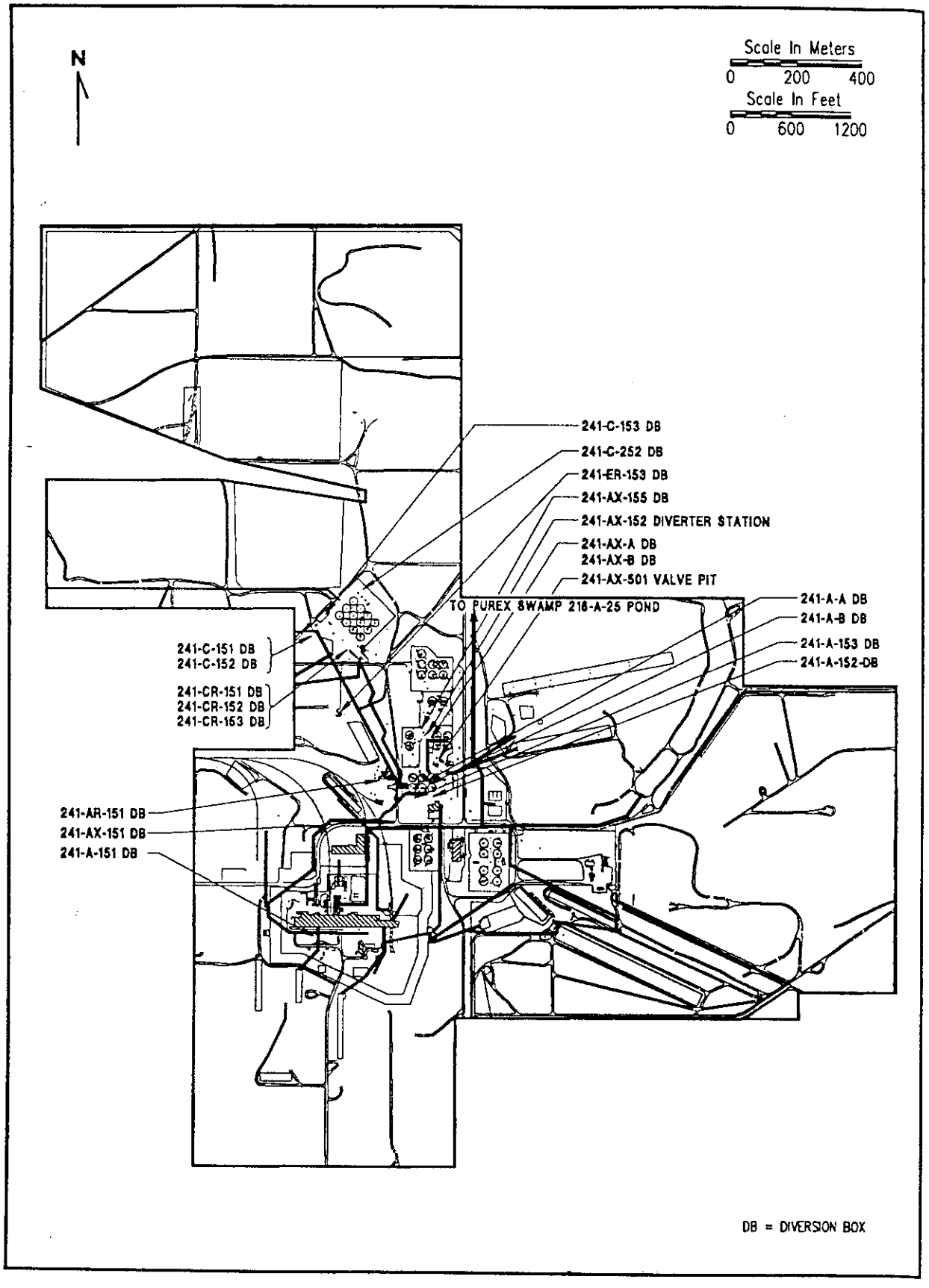
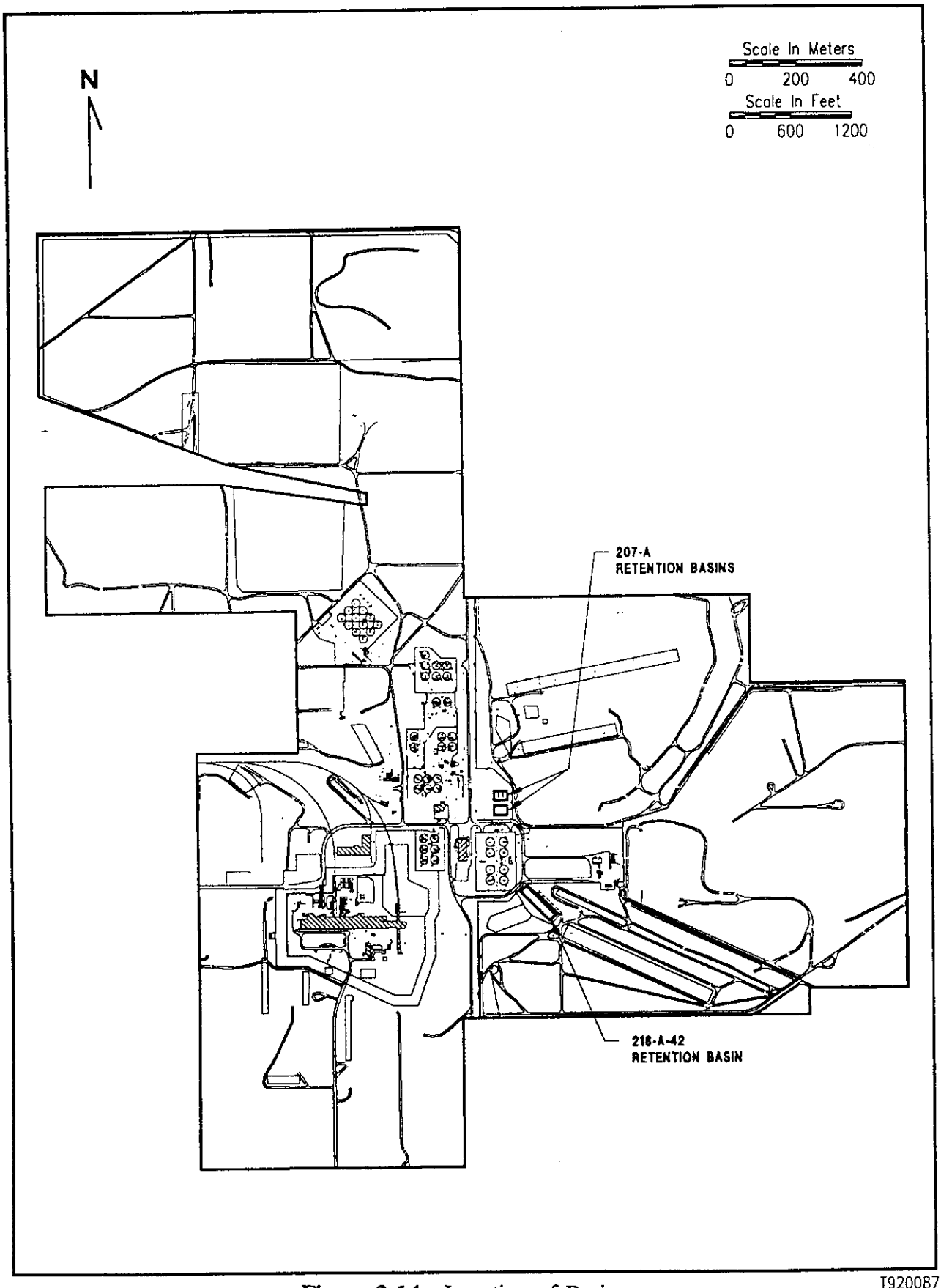


Figure 2-13. Location of Process Lines and Transfer Facilities.



T920087

Figure 2-14. Location of Basins.

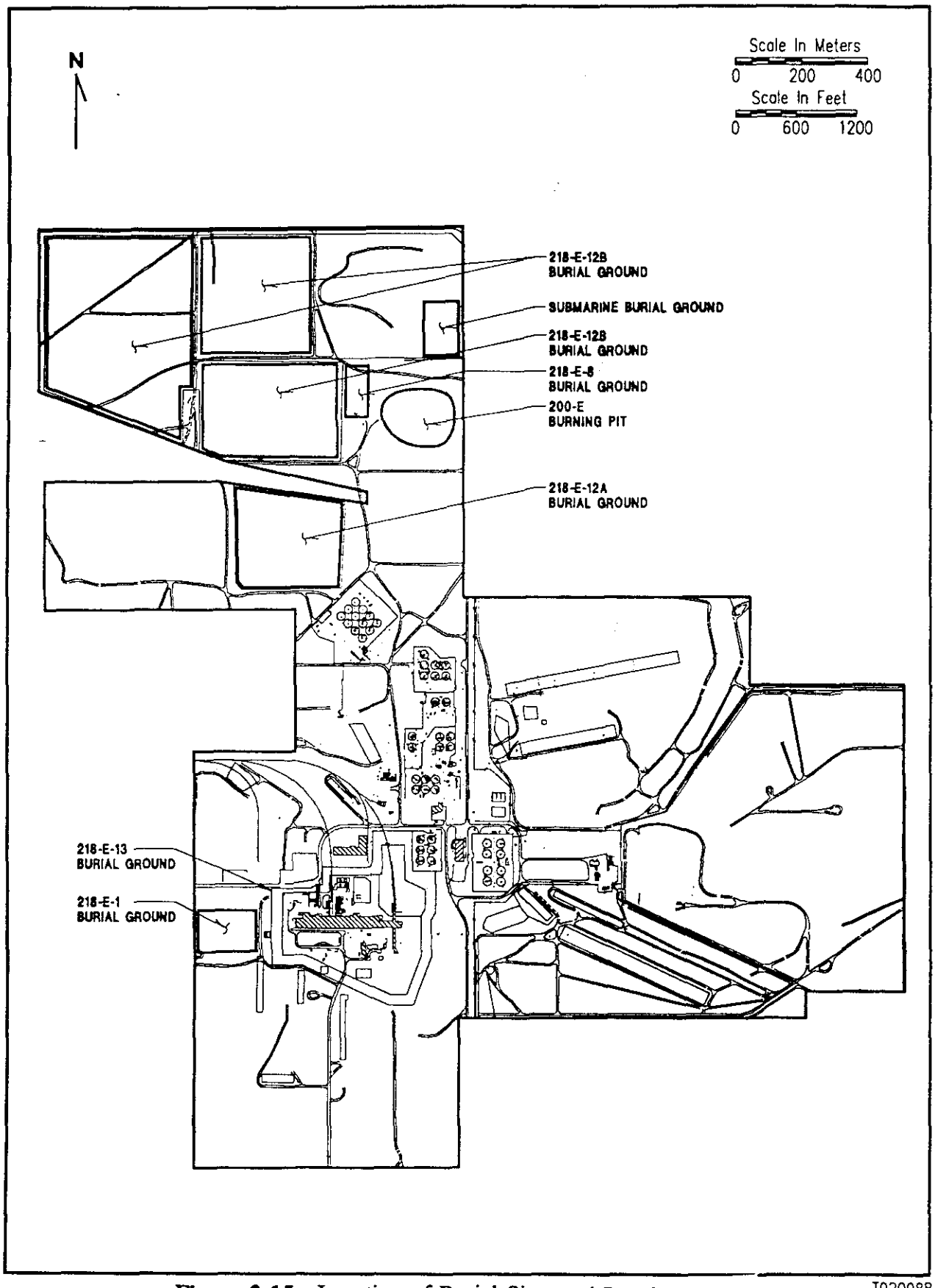


Figure 2-15. Location of Burial Sites and Burning Pits.

T920088

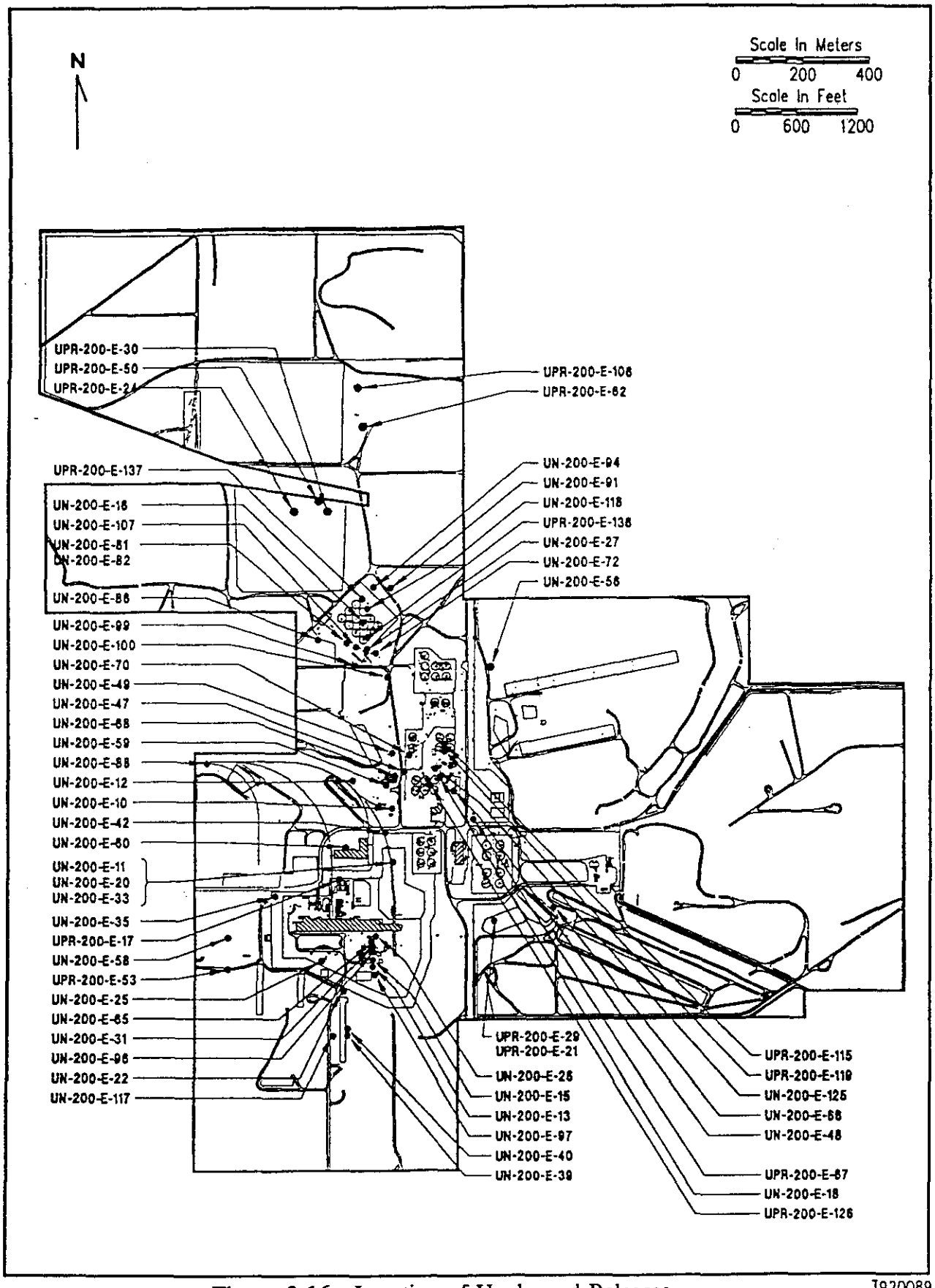


Figure 2-16. Location of Unplanned Releases.

T920089

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

Waste Management Unit	Years in Service / *Status*	Source Description	Waste Volume Received (L)	Operable Unit
Plants, Buildings, and Storage Areas				
204-AR Waste Unloading Station	1982 - Present *Active*	Receives wastes generated from decontamination and regeneration operations in 100 Area; from recovery, fuels fabrication, and laboratory operations in 300 Area; from decontamination operations in 400 Area; Waste is chemically adjusted prior to pumpout to double-shell tanks	Contains 1,966 (catch tank only)	200-PO-3
241-A-431 Ventilation Building	1955 - 1969 *Inactive*	Contains radioactively contaminated equipment and concrete	ni	200-PO-3
241-C-801 Support Facility	1962 - 1976 *Inactive*	This unit is a radioactively contaminated structure	ni	200-PO-3
242-A Evaporator	1977 - Present *Active*	Dilute noncomplexed radioactive waste; PUREX Dilute misc. waste; PUREX cladding removal waste; complexed radioactive waste; NaNO3 is used to regenerate ion exchange column, Turco 4518 or NaOH is used for decontamination applications, a Dow-Corning antifoam agent is used in the evaporator vessel	ni	200-PO-3
Grout Treatment Facility	1986 - Present	The unit treats waste by mixing it with grout, forming solid in an in-lime mixer. Wastes are usually corrosive (pH 12.5), EP Toxic (cadmium, chromium, lead silver) and extremely hazardous. Slurry is disposed of in a vault.	ni	200-PO-3
244-AR Lift Station	1975 - Present *Active*	Transports waste from processing and decontamination operations	ni	200-PO-3
Tanks and Vaults				
241-A-101 Single-Shell Tank	1956 - 1980 *Inactive*	PUREX carbonate wash waste, organic wash waste, high-level waste; B Plant high-level waste (waste fractionization); supernatant with B Plant high-level waste, PUREX high-level waste, double-shell slurry feed, and complexed and non complexed wastes from 241-A, -AX, -BX, -SX Tanks	Contains 3,602,340	200-PO-3
241-A-102 Single-Shell Tank	1956 - 1980 *Inactive*	PUREX carbonate wash waste; PUREX high-level waste; B Plant high-level waste (waste fractionization); supernatant with PUREX high-level waste, B Plant high-level waste, PUREX sludge supernatant, evaporator waste, noncomplexed and complexed waste, and double-shell slurry feed from 241-A, -AX, -AY, -AZ, -BX, -C, and -SX Tank Farms and 244-AR Vault	Contains 154,980	200-PO-3

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

Waste Management Unit	Years in Service / *Status*	Source Description	Waste Volume Received (L)	Operable Unit
241-A-103 Single-Shell Tank	1956 - 1980 *Inactive*	PUREX carbonate wash waste, organic wash waste, high-level waste; B Plant high-level waste (waste fractionization); Waste Fractionization ion exchange waste; and supernatant with B Plant high-level waste, Waste Fractionization ion exchange waste, PUREX high-level waste, PUREX sludge supernatant, and double-shell slurry feed from 241-A, -AX, -BY, and -C Tank Farms and 244-AR, -CR Vaults	Contains 1,398,600	200-PO-3
241-A-104 Single-Shell Tank	1958 - 1975 *Inactive*	PUREX carbonate wash waste, organic wash waste, high-level waste; waste fractionization (B Plant) ion exchange waste; and supernatant with PUREX sludge supernatant from the 241-A Tank Farm and 244-AR Vault	Contains 105,840	200-PO-3
241-A-105 Single-Shell Tank	1962 - 1971 *Inactive*	PUREX inorganic wash waste and supernatant with PUREX high-level waste from the 241-A Tank Farm	Contains 71,820	200-PO-3
241-A-106 Single-Shell Tank	1957 - 1980 *Inactive*	PUREX organic and inorganic wash waste; PUREX carbonate wash waste; PUREX high-level waste; B Plant high-level waste; supernatant with PUREX high-level waste, B Plant high-level waste, and complexed concentrate from the 241-A Tank Farm, 244-AR Vault, and the B-302 Tanks	Contains 472,500	200-PO-3
241-AN-101 Double-Shell Tank	1981 - Present *Active*	100/300 Area customer waste; salt well liquor; dilute noncomplexed waste	Contains 2,074,406	200-PO-3
241-AN-102 Double-Shell Tank	1981 - Present *Active*	Dilute and concentrated complexant waste	Contains 4,145,026	200-PO-3
241-AN-103 Double-Shell Tank	1981 - Present *Active*	Salt well liquor and dilute noncomplexed waste	Contains 3,599,927	200-PO-3
241-AN-104 Double-Shell Tank	1981 - Present *Active*	Dilute noncomplexed waste and double-shell slurry feed	Contains 4,023,893	200-PO-3
241-AN-105 Double-Shell Tank	1981 - Present *Active*	Dilute noncomplexed waste and double-shell slurry feed	Contains 4,288,872	200-PO-3
241-AN-106 Double-Shell Tank	1981 - Present *Active*	Dilute and concentrated phosphate waste from 100-N Area	Contains 3,853,549	200-PO-3
241-AN-107 Double-Shell Tank	1981 - Present *Active*	Dilute and concentrated complexant wastes	Contains 4,076,888	200-PO-3
241-AP-101 Double-Shell Tank	1986 - Present *Active*	PUREX ammonia scrubber feed waste	Contains 4,023,893	200-PO-3
241-AP-102 Double-Shell Tank	1986 - Present *Active*	Dilute noncomplexed customer waste; unit will be the Grout Treatment Facility feed tank	Contains 503,460	200-PO-3

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

Waste Management Unit	Years in Service / *Status*	Source Description	Waste Volume Received (L)	Operable Unit
241-AP-103 Double-Shell Tank	1986 - Present *Active*	PUREX ammonia scrubber feed	Contains 4,296,442	200-PO-3
241-AP-104 Double-Shell Tank	1986 - Present *Active*	Dilute noncomplexed waste; unit is designated as a receiver tank	Contains 75,708	200-PO-3
241-AP-105 Double-Shell Tank	1986 - Present *Active*	Double-shell slurry feed	Contains 3,126,750	200-PO-3
241-AP-106 Double-Shell Tank	1986 - Present *Active*	Neutralized cladding removal waste	Contains 4,288,872	200-PO-3
241-AP-107 Double-Shell Tank	1986 - Present *Active*	Dilute noncomplexed waste	Contains 4,266,159	200-PO-3
241-AP-108 Double-Shell Tank	1986 - Present *Active*	Dilute noncomplexed waste	Contains 700,301	200-PO-3
241-AW-101 Double-Shell Tank	1980 - Present *Active*	Double-shell slurry feed and dilute noncomplexed waste	Contains 4,258,588	200-PO-3
241-AW-102 Double-Shell Tank	1980 - Present *Active*	Unit is designated as the 242-A Evaporator feed tank	Contains 3,910,330	200-PO-3
241-AW-103 Double-Shell Tank	1980 - Present *Active*	PUREX decladding supernate and TRU sludge	Contains 2,449,161	200-PO-3
241-AW-104 Double-Shell Tank	1980 - Present *Active*	Double-shell slurry feed and dilute noncomplexed waste	Contains 4,262,374	200-PO-3
241-AW-105 Double-Shell Tank	1980 - Present *Active*	Supernate and TRU PUREX decladding sludge	Contains 3,418,227	200-PO-3
241-AW-106 Double-Shell Tank	1980 - Present *Active*	Unit is designated as the 242-A Evaporator receiver tank; waste may be complexed or noncomplexed waste	Contains 2,002,483	200-PO-3
241-AX-101 Single-Shell Tank	1965 - 1980 *Inactive*	Fission product waste; PUREX organic wash waste; PUREX high & low-level waste; B Plant high-level waste (waste fractionization); and supernatant with fission product waste, PUREX sludge supernatant, organic wash waste, and double-shell slurry feed from 241-A and 241-AX Single-Shell Tanks.	Contains 2,827,440	200-PO-3
241-AX-102 Single-Shell Tank	1966 - 1980 *Inactive*	PUREX high & low-level wastes; PUREX organic wash waste; B Plant high-level waste (waste fractionization); and supernatant with PUREX high-level waste, complexant concentrate, B Plant high-level waste, and complexed waste from 241-A, -AX, and -C Tanks, 244-AR Vault, and TK-417	Contains 147,420	200-PO-3

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

Waste Management Unit	Years in Service / *Status*	Source Description	Waste Volume Received (L)	Operable Unit
241-AX-103 Single-Shell Tank	1965 - 1980 *Inactive*	PUREX high & low-level wastes; PUREX organic and inorganic wash waste; B Plant low-level & high-level waste (waste fractionization); supernatant with PUREX high-level and sludge supernatant from 241-A, -AX, -AZ, and -C Tanks, 244-AR Vault, and AX-152 Tank	Contains 423,360	200-PO-3
241-AX-104 Single-Shell Tank	1966 - 1976 *Inactive*	PUREX high & low-level wastes; PUREX organic and inorganic wash waste; B Plant high-level waste (waste fractionization); and supernatant with PUREX high-level and sludge supernatant waste from 241-A and -AX Tanks and 244-AR-002 Tank	Contains 26,460	200-PO-3
241-AY-101 Double-Shell Tank	1971 - Present *Active*	Sr and Cs depleted, neutralized, high-level waste from B Plant; dilute noncomplexed waste from single-shell tanks; dilute complexed waste; PUREX and B Plant high-level waste and supernatant with complexed waste from -A and -AX Tank Farms	Contains 3,384,158	200-PO-3
241-AY-102 Double-Shell Tank	1972 - Present *Active*	Neutralized high-level waste and double-shell slurry feed; dilute noncomplexed waste; supernatant with double-shell slurry feed and noncomplexed waste from -A and -BX Tank Farms	Contains 3,724,845	200-PO-3
241-AZ-101 Double-Shell Tank	1976 - Present *Active*	Dilute B Plant high-Sr waste; complexed waste; double-shell slurry feed, and noncomplexed waste; aging waste (NCAW) from PUREX; supernatant with complexed waste, double-shell slurry feed, and noncomplexed waste from the -A, -AX, -BX, and -C Tank Farms	Contains 3,675,635	200-PO-3
241-AZ-102 Double-Shell Tank	1976 - Present *Active*	Dilute B Plant high-Sr waste and complexed waste; aging waste (NCAW) from PUREX; supernatant with complexed waste from -AX Tank Farm	Contains 3,599,927	200-PO-3
241-C-101 Single-Shell Tank	1946 - 1970 *Inactive*	Bismuth phosphate metal waste; tributyl phosphate waste and PUREX coating waste	Contains 332,640	200-PO-3
241-C-102 Single-Shell Tank	1946 - 1976 *Inactive*	Bismuth phosphate metal waste; tributyl phosphate waste; PUREX coating waste; thorium high-level waste; PUREX organic wash waste; and supernatant with organic wash wastes and coating wastes from 241-A, -AX, and -C Single-Shell Tanks	Contains 1,614,060	200-PO-3

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

Waste Management Unit	Years in Service / *Status*	Source Description	Waste Volume Received (L)	Operable Unit
241-C-103 Single-Shell Tank	??? - 1979 *Inactive*	PUREX coating waste; tributyl phosphate; supernatant with tributyl phosphate waste, coating waste, PUREX high-level waste, B Plant high-level waste, B Plant waste fractionization low-level waste, PUREX sludge supernatant, PUREX low-level waste, waste fractionization, PUREX sludge, PUREX organic wash waste, laboratory waste, decontamination waste, REDOX ion exchange waste, REDOX high-level waste, noncomplexed waste, waste fractionization ion exchange waste, N Reactor waste, PNL waste, and evaporator bottoms from 241-A, -B, -BX, and -C Tank Farms. This unit was used as the receiver for operating P-10 saltwater systems within the 241-C Farm	Contains 737,100	200-PO-3
241-C-104 Single-Shell Tank	1946 - 1980 *Inactive*	PUREX coating waste; bismuth phosphate metal waste; PUREX low-level & high-level waste; thorium low-level & high-level waste; PUREX organic was waste; supernatant containing metal waste, PUREX organic wash waste, PUREX low-level & high-level waste, coating waste, complexed waste, PNL waste, N Reactor complexed waste, waste fractionizationion exchange waste, decontamination waste, B Plant low-level & high-level waste, evaporator bottoms; REDOX high-level waste, and tributyl phosphate waste from 241-A, -AX, -C, -BY,-TY, and -U Tanks	Contains 1,115,100	200-PO-3
241-C-105 Single-Shell Tank	??? - 1979 *Inactive*	PUREX coating waste; tributyl phosphate waste; PUREX sludge supernatant; REDOX supernatant; and supernatant with tributyl phosphate waste, coating waste, PUREX sludge supernatant, REDOX supernatant, PUREX high-level waste, REDOX high-level waste, noncomplexed waste, B Plant waste fractionization low-level and metal wastes from 241-A, -AX, -AY, -B, -C, and -TX Tanks; and solids with PUREX sludge supernatant, coating waste, and cesium feet from 241-AX and -A Single-Shell Tanks	Contains 567,000	200-PO-3
241-C-106 Single-Shell Tank	??? - 1979 *Inactive*	PUREX coating waste; B plant low-level waste (waste fractionization); supernatant with PUREX high-level waste, and tributyl phosphate waste from 241-A and -C Tank Farms; solids with PUREX sludge supernatant from 241-A Single-Shell Tank Farm	Contains 865,620	200-PO-3

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

Waste Management Unit	Years in Service / *Status*	Source Description	Waste Volume Received (L)	Operable Unit
241-C-107 Single-Shell Tank	1946 - 1978 *Inactive*	Bismuth phosphate first-cycle waste; Hot Semiworks waste; tributyl phosphate; PUREX coating waste; Hanford Laboratory Operations waste; supernatant with PUREX coating waste, PNL waste, N Reactor waste, laboratory waste, decontamination waste, waste fractionization ion exchange waste, and evaporator bottoms waste from 241-C and -BX Tanks	Contains 1,273,860	200-PO-3
241-C-108 Single-Shell Tank	1947 - 1976 *Inactive*	Bismuth phosphate first-cycle waste; hot Semiworks waste; tributyl phosphate; PUREX coating waste; supernatant with tributyl phosphate waste, coating waste, PUREX organic wash waste, fractionization ion exchange waste, PNL waste; N Reactor waste, laboratory waste, decontamination waste, and REDOX high-level waste from 241-C Single-Shell Tank Farm	Contains 249,480	200-PO-3
241-C-109 Single-Shell Tank	??? - 1976 *Inactive*	Bismuth phosphate first-cycle waste; Hot Semiworks waste; tributyl phosphate; PUREX coating waste; supernatant with PUREX coating waste, Hot Semiworks waste, evaporator bottoms, and ion exchange waste from 241-C Single-Shell Tank Farm	Contains 249,480	200-PO-3
241-C-110 Single-Shell Tank	1946 - 1976 *Inactive*	Bismuth phosphate first-cycle waste; tributyl phosphate; supernatant with PUREX organic wash waste, ion exchange waste, coating waste, evaporator bottoms, and REDOX ion exchange waste	Contains 759,780	200-PO-3
241-C-111 Single-Shell Tank	1946 - 1976 *Inactive*	Bismuth phosphate first-cycle waste; PUREX organic wash waste, tributyl phosphate waste, PUREX coating waste; evaporator bottoms; Hot Semiworks waste; and supernatant with evaporator bottoms, coating waste, and tributyl phosphate waste from 241-B and -C Tanks	Contains 215,460	200-PO-3
241-C-112 Single-Shell Tank	??? - 1976 *Inactive*	Tributyl phosphate waste; PUREX coating waste; Hot Semiworks waste; supernatant with coating waste, tributyl phosphate waste, and ion exchange waste from 241-C Single-Shell Tank Farm	Contains 393,120	200-PO-3
241-C-201 Single-Shell Tank	1953 - 1977 *Inactive*	Bismuth phosphate metal waste and strontium Semiworks waste	Contains 7,560	200-PO-3
241-C-202 Single-Shell Tank	1953 - 1977 *Inactive*	Bismuth phosphate metal waste; strontium Semiworks waste; supernatant with bismuth phosphate metal waste from 241-C-201 Single-Shell Tank	Contains 3,780	200-PO-3
241-C-203 Single-Shell Tank	1953 - 1976 *Inactive*	PUREX high-level waste	Contains 18,900	200-PO-3
241-C-204 Single-Shell Tank	1953 - 1977 *Inactive*	PUREX high-level waste	Contains 11,340	200-PO-3

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

Waste Management Unit	Years in Service / *Status*	Source Description	Waste Volume Received (L)	Operable Unit
241-A-302A Catch Tank	1956 - Present *Active*	Transports wastes from processing and decontamination operations	Contains 13,627	200-PO-1
241-A-302B Catch Tank	1956 - 1980 *Inactive*	Transports wastes from processing and decontamination operations	Contains 12,247	200-PO-5
241-A-350 Catch Tank	1956 - Present *Active*	Transports wastes from processing and decontamination operations	Variable	200-PO-3
241-A-417 Catch Tank	1956 - Present *Active*	Collects condensate from the 241-A-401 Condenser House	Contains 120,431	200-PO-3
241-AX-152CT Catch Tank	#NAME? *Active*	Transports wastes from processing and decontamination operations	Contains 10,040	200-PO-3
241-C-301C Catch Tank	1946 - 1985 *Inactive*	Transports wastes from processing and decontamination operations	Variable	200-PO-3
244-A Receiving Vault	1975 - Present *Active*	This unit receives waste from several tank farms	Contains 13,956	200-PO-3
244-AR Vault	1968 - Present *Active*	Transports wastes from processing and decontamination operations	Variable	200-PO-3
244-CR Vault	1946 - 1988 *Inactive*	Transports wastes from processing and decontamination operations	Variable	200-PO-3
Cribs and Drains				
216-A-1 Crib	1955 - 1955 *Inactive*	Depleted uranium waste from cold startup run in the 202-A Building	98,400	200-PO-5
216-A-2 Crib	1956 - 1963 *Inactive*	Organic wastes from 202-A Building.	230,000	200-PO-2
216-A-3 Crib	1956 - 1981 *Inactive*	Received waste from 203-A Building, uranyl nitrate hexahydrate storage pit drainage liquid from 203-A Pump House	3,050,000	200-PO-1
216-A-4 Crib	1955 - 1958 *Inactive*	Laboratory cell drainage from 202-A Building and 291-A-1 Stack drainage	6,210,000	200-PO-2
216-A-5 Crib	1955 - 1966 *Inactive*	Process condensate from 202-A Building	1,630,000,000	200-PO-2
216-A-6 Crib	1955 - 1970 *Inactive*	Steam condensate, equipment disposal tunnel floor drainage, water-filled door drainage, and waste from 202-A Building	3,400,000,000	200-PO-4

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

Waste Management Unit	Years in Service / *Status*	Source Description	Waste Volume Received (L)	Operable Unit
216-A-7 Crib	1955 - 1966 *Inactive*	Catch tank overflow, sump waste, pump pit drainage from the 241-A-152 Diversion Box, TBP-Soltrol organic inventory from 202-A Building	326,000	200-PO-5
216-A-8 Crib	1955 - 1991 *Inactive*	Condensate from 241-A, -AX , -AY, -AZ Tank Farms, cooling water from the contact condenser in the 241-A-431 Building	1,150,000,000	200-PO-5
216-A-9 Crib	1956 - 1969 *Inactive*	Acid fractionator condensate and cooling water from 202-A Building; N Reactor decontamination waste, acid fractionator condensate from 202-A Building	981,000,000	200-PO-1
216-A-10 Crib	1956 - 1987 *Inactive*	Nonradioactive water, process condensate from 202-A Building	3,210,000,000	200-PO-2
216-A-21 Crib	1957 - 1965 *Inactive*	Sump waste from 293-A Building, laboratory cell drainage from the 202-A Building, 291-A-1 Stack drainage	77,900,000	200-PO-2
216-A-24 Crib	1958 - 1966 *Inactive*	Condensate from 241-A and -AX Single-Shell Tank Farms	820,000,000	200-PO-5
216-A-27 Crib	1965 - 1970 *Inactive*	Sump waste from 293-A Building, lab cell drainage from 202-A Building, 291-A-1 Stack drainage	23,200,000	200-PO-2
216-A-30 Crib	1961 - 1991 *Inactive*	Steam condensate, equipment disposal tunnel floor and water-filled door drainage, and slug storage basin overflow waste from the 202-A Building	7,110,000,000	200-PO-4
216-A-31 Crib	1964 - 1966 *Inactive*	Organic waste from 202-A Building	10,000	200-PO-2
216-A-32 Crib	1959 - 1972 *Inactive*	202-A crane maintenance facility floor, sink and shower drainage	4,000	200-PO-1
216-A-36A Crib	1965 - 1966 *Inactive*	Ammonia scrubber waste from 202-A Building	1,070,000	200-PO-2
216-A-36B Crib	1966 - 1987 *Inactive*	Ammonia scrubber waste from 202-A Building	317,000,000	200-PO-2
216-A-37-1 Crib	1977 - 1991 *Inactive*	Process condensate from 242-A Evaporator	377,000,000	200-PO-4
216-A-37-2 Crib	1983 - Present *Active*	Steam condensate from PUREX Plant	1,090,000,000	200-PO-4
216-A-38-1 Crib	N/A	The site was never used	N/A	200-PO-2
216-A-39 Crib	1966 *Inactive*	Floor drainage from 241-AX-801-B Building	20	200-PO-3

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

Waste Management Unit	Years in Service / *Status*	Source Description	Waste Volume Received (L)	Operable Unit
216-A-41 Crib	1968 - 1974 *Inactive*	296-A-13 Stack drainage	10,000	200-PO-1
216-A-45 Crib	1987 - 1989 *Inactive*	Process condensate from 202-A Building	103,000,000	200-PO-2
216-A-11 French Drain	1956 - 1972 *Inactive*	Trap Pit No. 1 drainage from 202-A Building	100,000	200-PO-1
216-A-12 French Drain	1955 - 1972 *Inactive*	Steam trap Pit No. 3 drainage from 202-A Building	100,000	200-PO-1
216-A-13 French Drain	1956 - 1962 *Inactive*	Seal water from air sampler vacuum pumps in 202-A Building	100,000	200-PO-1
216-A-14 French Drain	1956 - 1972 *Inactive*	Vacuum cleaner filter and blower pit drainage from 202-A Building	1,000	200-PO-1
216-A-15 French Drain	1955 - 1972 *Inactive*	Drainage from 216-A-10 Process Condenser Sampler Pit	10,000,000	200-PO-2
216-A-16 French Drain	1956 - 1969 *Inactive*	Floor drainage and 296-A-11 Stack drainage form 241-A-431 Building	122,000	200-PO-5
216-A-17 French Drain	1956 - 1969 *Inactive*	Floor drainage and 296-A-11 Stack drainage form 241-A-431 Building drainage from 241-A-431 Building	60,000	200-PO-5
216-A-22 French Drain	1956 - 1958 *Inactive*	Drainage from 203-A Building truck layout apron, sump waste from 203-A Building enclosure	10,000	200-PO-1
216-A-23A French Drain	1957 - 1969 *Inactive*	Deentrainer tank condensate, backflush waste from 241-A-431 Building	6,000	200-PO-5
216-A-23B French Drain	1957 - 1969 *Inactive*	Deentrainer tank condensate, backflush waste from 241-A-431 Building	6,000	200-PO-5
216-A-26 French Drain	1965 - 1991 *Inactive*	Floor drainage from the 291-A Fan Control House	ni	200-PO-1
216-A-26A French Drain	1959 - 1965 *Inactive*	Floor drainage from the 291-A Fan Control House	1,000	200-PO-1
216-A-28 French Drain	1958 - 1967 *Inactive*	203-A Building enclosure sumps, heating coil condensate from uranyl nitrate hexahydrate tanks	30,000	200-PO-1
216-A-33 French Drain	1955 - 1964 *Inactive*	Bearing coolant waste from 291-A-1 Stack electrical exhaust fans	ni	200-PO-1

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

Waste Management Unit	Years in Service / *Status*	Source Description	Waste Volume Received (L)	Operable Unit
216-A-35 French Drain	1963 - 1966 *Inactive*	Seal cooling water from air sampler vacuum pumps in 202-A Building	10,000	200-PO-1
216-C-8 French Drain	1962 - 1965 *Inactive*	Ion exchange waste from 271-CR Building	10,000	200-PO-3
Reverse Wells				
299-E24-111 Injection Well	1980 - 1981 *Inactive*	Experimental well, 11 injections of calcium, chloride, solutions	ni	200-PO-2
Ponds, Ditches, and Trenches				
216-A-18 Trench	1955 - 1956 *Inactive*	Depleted uranium from the cold startup run at 202-A Building	488,000	200-PO-5
216-A-19 Trench	1955 - 1956 *Inactive*	241-A-431 Building contact condenser cooling water, depleted uranium waste from cold startup run at 202-A Building	1,100,000	200-PO-5
216-A-20 Trench	1955 - 1956 *Inactive*	241-A-431 Building contact condenser cooling water, depleted uranium waste from cold startup run at 202-A Building	961,000	200-PO-5
216-A-40 Trench	1968 - 1979 *Inactive*	Diverted cooling water and steam condensate from 244-AR Vault	946,000	200-PO-1
216-A-29 Ditch	1955 - 1991 *Inactive*	202-A chemical sewer, acid fractionator condensate, condenser cooling water, process cooling water, seal cooling water from air sampler vacuum pumps in 202-A Building	ni	200-PO-5
216-A-34 Ditch	1955 - 1957 *Inactive*	Cooling water from contact condenser in 241-A-431 Building	ni	200-PO-5
Septic Tanks and Associated Drain Fields				
2607-EA Septic Tank & Field	1976 - Present *Active*	Sanitary wastewater and sewer	ni	200-PO-1
2607-EC Septic Tank & Field	1955 - Present *Active*	Sanitary wastewater and sewer	ni	200-PO-5
2607-ED Septic Tank & Field	1980 - Present *Active*	Sanitary wastewater and sewer	ni	200-PO-3
2607-EG Septic Tank & Field	1953 - Present *Active*	Sanitary wastewater and sewer	ni	200-PO-3

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

Waste Management Unit	Years in Service / *Status*	Source Description	Waste Volume Received (L)	Operable Unit
2607-EJ Septic Tank & Field	1980 - Present *Active*	Sanitary wastewater and sewer	ni	200-PO-3
2607-EL Septic Tank & Field	1983 - Present *Active*	Sanitary wastewater and sewer	ni	200-PO-4
2607-E6 Septic Tank & Field	1954 - Present *Active*	Sanitary wastewater and sewer	ni	200-PO-1
Transfer Facilities, Diversion Boxes, and Pipelines				
241-A-A Diversion Box	1956 - Present *Active*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-A-B Diversion Box	1956 - Present *Active*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-A-151 Diversion Box	1956 - Present *Active*	Transports waste from processing and decontamination operations	Variable	200-PO-1
241-A-152 Diversion Box	1956 - 1980 *Inactive*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-A-153 Diversion Box	1956 - 1985 *Inactive*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-AN-A Diversion Box	1981 - Present *Active*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-AN-B Diversion Box	1981 - Present *Active*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-AR-151 Diversion Box	1983 - Present *Active*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-AW-A Diversion Box	1980 - Present *Active*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-AW-B Diversion Box	1980 - Present *Active*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-AX-A Diversion Box	1965 - Present *Active*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-AX-B Diversion Box	1965 - Present *Active*	Transports waste from processing and decontamination operations	Variable	200-PO-3

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

Waste Management Unit	Years in Service / *Status*	Source Description	Waste Volume Received (L)	Operable Unit
241-AX-151 Diversion Box	??? - Present *Active*	Receives wastes from 202-A PUREX plant	Variable	200-PO-3
241-AX-152DS Diversion Box	1965 - Present *Active*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-AX-155 Diversion Box	1983 - Present *Active*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-AY-151 Diversion Box	??? - Present *Active*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-AY-152 Diversion Box	1971 - 1985 *Active*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-AZ-151DS Diversion Box	1976 - Present *Active*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-AZ-152 Diversion Box	1977 - Present *Active*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-C-151 Diversion Box	1946 - 1985 *Inactive*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-C-152 Diversion Box	1946 - 1985 *Inactive*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-C-153 Diversion Box	1946 - 1985 *Inactive*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-C-252 Diversion Box	1946 - 1985 *Inactive*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-CR-151 Diversion Box	1946 - 1985 *Inactive*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-CR-152 Diversion Box	1946 - 1985 *Inactive*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-CR-153 Diversion Box	1946 - 1985 *Inactive*	Transports waste from processing and decontamination operations	Variable	200-PO-3
241-ER-153 Diversion Box	1945 - Present *Active*	Transports waste from processing and decontamination operations	Variable	200-PO-3
216-A-524 Control Structure	1957 - 1966 *Inactive*	Unit contains radioactive piping and cement	ni	200-PO-5

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

Waste Management Unit	Years in Service / *Status*	Source Description	Waste Volume Received (L)	Operable Unit
241-AP Valve Pit	1986 - Present *Active*	Transports waste from processing and decontamination operations	ni	200-PO-3
241-AX-501 Valve Pit	??? - Present *Active*	Receives and routes tank farm condensate	ni	200-PO-3
Basins				
207-A Retention Basins	1976 - Present *Active*	Waste streams from the 242-A Evaporator	ni	200-PO-5
216-A-42 Retention Basin	1978 - Present *Active*	Chemically or radioactively contaminated diversions from the PUREX chemical sewer line, cooling water line, and steam condensate discharge		200-PO-4
Burial Sites and Burning Pits				
218-E-1 Burial Ground	1945 - 1954 *Inactive*	Mixed fission products and transuranic dry waste	3,030,000	200-PO-1
218-E-8 Burial Ground	1958 - 1959 *Inactive*	Mixed fission products and transuranic waste, repair and construction wastes from 293-A and PUREX new crane addition	2,265,000	200-PO-6
218-E-12A Burial Ground	1953 - 1968 *Inactive*	Dry waste and acid-soaked material	15,249,000	200-PO-6
218-E-12B Burial Ground	1966 - Present *Active*	Navy reactor subcomponents	ni	200-PO-6
218-E-13 Burial Ground	1966 *Inactive*	Pieces of concrete from pipe trench	ni	200-PO-1
200-E Burning Pit	1950 - 1970 *Inactive*	Radioactive waste	ni	200-PO-6
Unplanned Releases				
UN-200-E-10	1957	PUREX tube bundles	ni	200-PO-1
UN-200-E-11	1957	ni	ni	200-PO-1
UN-200-E-12	1957	Contaminated liquid from a burial box	ni	200-PO-1
UN-200-E-13	1958	216-A-4 Crib became plugged and flooded ground	ni	200-PO-2
UN-200-E-15	1959	216-A-4 Crib became plugged causing ground contamination	ni	200-PO-1
UN-200-E-16	1959	241-C-105 to 241-C-108 overground transfer line broke	ni	200-PO-3
UN-200-E-18	1959	Moisture from vent pipe bonnet at the A-8 Proportional Sample Pit	ni	200-PO-3

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

Waste Management Unit	Years in Service / *Status*	Source Description	Waste Volume Received (L)	Operable Unit
UN-200-E-19	1959	Moisture from vent pipe bonnet at the A-6 Proportional Sample Pit	ni	200-PO-1
UN-200-E-20	1959	PUREX tube bundles	ni	200-PO-1
UN-200-E-22	1959	General contamination around 291-A Stack	ni	200-PO-2
UN-200-E-25	1960	Leakage from 241-A-151 Diversion Box	ni	200-PO-2
UN-200-E-26	1960	Leakage from 241-A-151 Diversion Box	ni	200-PO-1
UN-200-E-27	1960	Near the 244-CR Vault	ni	200-PO-3
UN-200-E-28	1961	Fission products from a process vessel steam coil	ni	200-PO-1
UN-200-E-31	1961	Leakage from 241-A-151 Diversion Box	ni	200-PO-1
UN-200-E-33	1964	Leaking tube bundle burial box	ni	200-PO-1
UN-200-E-35	1966	Contaminated concrete	ni	200-PO-1
UN-200-E-39	1968	Pressurized ammonia scrubber waste containing fission products	ni	200-PO-2
UN-200-E-40	1968	Vent line valve at the 216-A-36B Crib	ni	200-PO-2
UN-200-E-42	1972	Thought to be from 244-AR Diverter Tank	ni	200-PO-1
UN-200-E-47	1974	Contaminated soil of unknown origon in 241-A Tank Farm	ni	200-PO-3
UN-200-E-48	1974	241-A-106 pump pit contaminated parking lot	ni	200-PO-3
UN-200-E-49	1975	Thermocouple well contaminated road	ni	200-PO-1
UN-200-E-56	1979	ni	ni	200-PO-5
UN-200-E-58	1980	Contaminated tumbleweeds near 218-E-1 Burial Ground	ni	200-PO-1
UN-200-E-60	1981	Contaminated dirt from an overfilled dump truck	ni	200-PO-1
UN-200-E-62	1982	Liquid from pressure test assembly	ni	200-PO-6
UN-200-E-65	1982	Wind spread contamination from 241-A-151 Diversion Box	ni	200-PO-1
UN-200-E-67	1984	An old, contaminated pipe encasement	ni	200-PO-5
UN-200-E-68	1985	Wind spread contamination from 241-C-151 Diversion Box	ni	200-PO-3
UN-200-E-72	1985	Previously buried contaminated waste of unspecified origon	ni	200-PO-3
UN-200-E-81	1969	PUREX coating waste via the transfer line from the 202-A Building to the 102-C waste storage tank via 241-CR-151 Diversion Box	136,274	200-PO-3
UN-200-E-82	1969	Feed line from 241-C-105 Tank to the 221-B Building	9,842	200-PO-3
UN-200-E-86	1971	Line no. 812, used to transfer process waste from AR Vault to C Farm	ni	200-PO-3
UN-200-E-88	1980	Unknown, associated with TC-4 railroad spur	ni	200-PO-1
UN-200-E-91	1980	Migration of low-level radioactivity from 241-C Tank Farm	ni	200-PO-3
UN-200-E-94	1979	Possible moisture from 216-A-24 Crib	ni	200-PO-3
UN-200-E-96	1980	Residue contamination from PUREX 291-A Stack and Diversion Box	ni	200-PO-1
UN-200-E-97	1980	Unknown source south of PUREX near railroad tunnel	ni	200-PO-2

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

Waste Management Unit	Years in Service / *Status*	Source Description	Waste Volume Received (L)	Operable Unit
UN-200-E-99	1980	Near the 244-CR Vault	ni	200-PO-3
UN-200-E-100	1986	Spill to ground	ni	200-PO-3
UN-200-E-107	1952	Tributyl phosphate from 221-U Building	19	200-PO-3
UN-200-E-114	1974	ni	ni	200-PO-1
UN-200-E-117	1972	Liquid spurting out of ground near PUREX area	ni	200-PO-2
UN-200-E-118	1957	107-C effluet tank released airborne contamination	ni	200-PO-3
UN-200-E-142	1986	Diesel fuel	76	200-PO-1
UPR-200-E-17	1959	Uranium from 216-A-22 Crib	ni	200-PO-1
UPR-200-E-21	1959	216-A-6 Crib overflowed contaminating ground	ni	200-PO-4
UPR-200-E-24	1960	Collapse of burial box at 218-E-12A	ni	200-PO-6
UPR-200-E-29	1961	216-A-6 Crib overlowed	ni	200-PO-4
UPR-200-E-30	1961	Collapse of burial box at 218-E-12A	ni	200-PO-6
UPR-200-E-50	1974	Wind spread contamination from 241-C Tank Farm	ni	200-PO-6
UPR-200-E-53	1978	Contamination spread by uncovering previously buried waste at the 218-E-1 Burial Ground	ni	200-PO-2
UPR-200-E-59	1979	Contaminated mud and tumbleweeds from 216-A-40 Trench used by swallows to build nests at 244-AR Vault	ni	200-PO-3
UPR-200-E-66	1984	Wind spread contamination from 216-A-42 Retention Basin	ni	200-PO-4
UPR-200-E-70	1984	Contamination during a jumper removal at 244-A Lift Station	ni	200-PO-3
UPR-200-E-106	1946	Contaminated paper towels	ni	200-PO-6
UPR-200-E-115	1974	Liquid form AX-103 Pump Pit	ni	200-PO-3
UPR-200-E-119	1969	High-level waste	ni	200-PO-3
UPR-200-E-125	1975	Waste from the 241-A-104 Single-Shell Tank	9,450	200-PO-3
UPR-200-E-126	1963	241-A-105 Single-Shell Tank	18,900	200-PO-3
UPR-200-E-136	1946 - 1970	241-C-101 Single-Shell Tank	64, 260 to 90,720	200-PO-3
UPR-200-E-137	1947 - 1978	241-C-203 Single-Shell Tank	1,512	200-PO-3

ni = no information available

Table 2-2. Radionuclide Waste Inventory Summary.

Waste Management Unit No.	QUANTITY OF REPORTED RADIONUCLIDES (Ci)[a/]																		Reported Waste
	Co-60	Sr-90	Cs-137	Pu-147	Pu-Total[c/]	Pu-238	Pu-239	Pu-240[b/]	Pu-241	Ru-106	Sn-113	Uranium Gross	U-238[b/]	I-129	Am-241	H-3	Alpha	Beta[b/]	Volume Rec'd (L)
216-A-01	1.790E-03	4.220E-02	4.440E-02	[illegible]	1.000E-01		5.710E-03[b/]	1.540E-03		2.750E-12		5.140E-02	5.160E-02				6.140E-03	1.700E-01	98,400
216-A-02	2.970E-02	9.210E-01	1.45E-00	[illegible]	1.100E+02		7.420E+00[b/]	2.000E+00		7.830E-08		2.600E-02	2.620E-02				7.980E+00	4.710E+00	230,000
216-A-03		4.310E-02	4.550E-02		2.000E-01					1.520E-07		5.590E-01					1.230E-02	1.820E-01	3,050,000
216-A-04	2.260E-02	4.390E+00	6.930E+00		1.400E+02		7.990E+00[b/]	2.160E+00		4.380E-08		1.330E-01	1.340E-01				8.600E+00	2.210E+00	6,210,000
216-A-05	3.320E+00	4.160E+01	1.210E+01		6.500E+01		3.710E+00[b/]	1.000E+00		1.080E-07		8.770E-02	8.810E-02				3.990E+00	1.090E+02	1,630,000,000
216-A-06	1.800E-01	4.410E+01	1.050E+02		3.560E+01		2.090E+00[b/]	5.480E-01		5.500E-06		5.500E-02	5.530E-02				2.190E+00	2.910E+02	3,400,000,000
216-A-07	2.040E-03	4.310E-01	2.310E+00		1.000E+00		5.710E-02[b/]	1.540E-02		1.100E-07		2.270E-03	2.280E-03				6.140E-02	5.290E+00	326,000
216-A-08		5.150E+01	5.220E+02		5.000E+01					4.690E-05		1.230E-01				3.460E-01	3.070E+00	1.110E+03	1,150,000,000
216-A-09	5.830E-03	1.100E+01	4.650E+00		5.000E-01		2.851E-02[b/]	7.700E-03		3.630E-08		7.570E-05	8.000E-05			4.000E+03[b/]	3.070E-02	3.100E+01	981,000,000
216-A-10		8.250E+01	8.050E+01	3.120E-01	3.500E+02	3.290E-01	3.490E+00		4.230E+01	3.090E-01		8.100E-02		1.070E-01	7.73E-01	1.850E+04	2.810E+01	3.600E+02	3,210,000,000
216-A-11																			100,000
216-A-12																			100,000
216-A-13																			100,000
216-A-14																			1,000
216-A-15																			10,000,000
216-A-16																			122,000
216-A-17																			60,000
216-A-18	1.790E-03	4.200E-02	4.440E-02		1.000E-01		5.710E-03[b/]	1.540E-03		2.750E-12		4.690E-01	4.720E-01				6.140E-03	1.720E-01	488,000
216-A-19	1.790E-03	4.200E-02	4.440E-02		1.000E-01		5.710E-03[b/]	1.540E-03		2.750E-12		1.300E+01	1.310E+01				6.140E-03	1.700E-01	1,100,000
216-A-20	1.790E-03	4.200E-02	4.400E-02		1.000E-01		5.710E-03[b/]	1.540E-03		2.750E-12		1.350E-01	1.350E-01				6.140E-03	1.700E-01	96,000
216-A-21	4.710E-01	7.510E+00	7.850E+01		1.500E+02		8.560E+00[b/]	2.310E+00		1.450E-06		6.500E-02	6.530E-02				9.210E+00	1.660E+02	77,900,000
216-A-22																			10,000
216-A-23A																			6,000
216-A-23B																			6,000
216-A-24	2.190E-02	1.830E-01	2.680E+02		5.06E+00		2.890E-01[b/]	7.790E-02		1.320E-06		1.670E-02	1.680E-02			1.400E+03[b/]	3.110E-01	5.520E+02	820,000,000
216-A-26A																			1,000
216-A-27	3.000E-01	2.450E-01	3.240E+01		9.650E+01		5.510E+00[b/]	1.490E+00		1.380E-05		2.270E-02	2.280E-02				5.920E+00	1.120E+02	23,200,000
216-A-28												2.110E-01	2.120E-01					7.470E-03	30,000
216-A-30		1.020E+02	1.170E+02	4.290E-01	7.310E+01		7.510E-02			8.140E-02	3.150E-03	1.000E-01			1.980E-01	1.640E+01	4.640E+00	4.320E+02	7,110,000,000
216-A-31	5.880E-03	1.050E+00	8.200E+01		9.000E+00		5.140E-01[b/]	1.390E-01		1.300E-03		6.830E-03	6.860E-03				5.530E-01	1.620E+02	10,000
216-A-35																			10,000
216-A-36A	7.100E-01	9.780E+02	8.470E+02		8.000E+01		4.570+00[b/]	1.230E+00		1.160E-04		4.840E-02	4.860E-02				4.910E+00	3.630E+03	1,070,000
216-A-36B		3.310E+02	3.500E+02	1.990E+00	1.780E+02		5.690E-02		5.580E-01	3.170E+00	5.790E-04	3.980E-02		8.420E-03	2.170E-01	5.070E+02	1.100E+01	1.360E+03	317,000,000
216-A-37-1		5.420E-02	9.470E-02	9.190E-02	2.830E-02		2.010E-04			4.150E-02	2.520E-03	1.090E-02		4.260E-03	3.690E-04	1.600E+03	8.450E-03	5.080E-01	377,000,000
216-A-37-2		3.070E-01	2.040E-01	1.960E-01			3.730E+02			4.070E-02	1.570E-03	1.720E-02			9.820E-02	6.13E+00	1.050E-01	1.850E+00	1,090,000,000
216-A-39			1.430E+01															2.750E+01	20
216-A-40																			946,000
216-A-41																			10,000
216-A-45		8.340E-03	9.700E-03	4.210E-02		6.130E-03	5.560E-02		6.580E-01	1.330E-02	6.560E-05	2.250E-03		1.110E-02	1.100E-01	3.850E+03	5.510E-02	1.120E-01	103,000,000
216-C-08																			10,000
218-E-01		7.165E-01	8.166E-01		9.000E+02		5.140E+01[b/]	1.390E+01		7.690E-12		4.000E+05	1.340E-01						3,030,000
218-E-08		9.058E-02	1.017E-01		2.000E+01		1.140E+00[b/]	3.080E-01		1.177E-10		2.000E+03	6.700E-04						2,265,000
218-E-12A		9.056E+00	1.099E+01		8.930E+03		5.100E+02[b/]	1.380E+02		1.222E-06		9.900E+05	3.320E-01						15,249,000

a/ Values decayed through December 31, 1989 unless otherwise noted.
b/ Values are decayed through April 1, 1986.
c/ Values are reported in grams.

THIS PAGE INTENTIONALLY
LEFT BLANK

Table 2-3. Chemical Waste Inventory Summary.

Waste Management Unit No.	QUANTITY OF REPORTED CHEMICALS (kg)[a/]									
	Nitrate	Nitric Acid	NPH	Sodium	Sodium Dichromate	Sulfate	TBP	BP	Ammonium Carbonate	Ammonium Nitrate
216-A-01	80									
216-A-02			120,000				70,000			
216-A-03										
216-A-04	300			4,000	110	5,000				
216-A-05	1,000,000									
216-A-06	10,000									
216-A-07			180,000				100,000			
216-A-08			46,000					130,000	320,000	
216-A-09	300,000									
216-A-10										
216-A-11	100									
216-A-12	100									
216-A-13	1									
216-A-14	1									
216-A-15		1								
216-A-16	1									
216-A-17	1									
216-A-18	730									
216-A-19	20,000									
216-A-20	210									
216-A-21	9,000			11,000	300	15,000				400,000
216-A-22	1									
216-A-23A	1									
216-A-23B	1									
216-A-24			30,000					90,000	200,000	
216-A-26A	1									
216-A-27	5,000			6,000	200	9,000				300,000
216-A-28	300									
216-A-30	16,000									
216-A-31			5,200				2,900			
216-A-35	1									
216-A-36A										
216-A-36B										
216-A-37-1	600									
216-A-37-2										
216-A-39	6									
216-A-40	1									
216-A-41	1									
216-A-45										
216-C-08	3									
218-E-01										
218-E-08										
218-E-12A										

a/ Not all sites have reported inventories. These inventories do not necessarily list all of the contaminants disposed of at a site.

Table 2-4. Description of PUREX Plant Aggregate Area Tank Farms.

Waste Management Unit	Tank Integrity	Interim Stabilized	Isolation	Total Waste Volume (L)	Drainable Waste Volume (L)	Flammable Gas Generation ?
241-A Tank Farm						
241-A-101 Single-Shell Tank	Sound	no	Part. Interim Isolated	3,602,340	1,561,140	yes
241-A-102 Single-Shell Tank	Sound	yes	Part. Interim Isolated	154,980	22,680	no
241-A-103 Single-Shell Tank	Assumed Leaker	yes	Interim Isolated	1,398,600	45,360	no
241-A-104 Single-Shell Tank	Assumed Leaker	yes	Interim Isolated	105,840	0	no
241-A-105 Single-Shell Tank	Assumed Leaker	yes	Interim Isolated	71,820	15,120	no
241-A-106 Single-Shell Tank	Sound	yes	Interim Isolated	472,500	26,460	no
241-AN Tank Farm						
241-AN-101 Double-Shell Tank	Sound	no	no	2,275,032	2,275,032	no
241-AN-102 Double-Shell Tank	Sound	no	no	4,141,240	3,815,695	no
241-AN-103 Double-Shell Tank	Sound	no	no	3,599,927	52,996	yes
241-AN-104 Double-Shell Tank	Sound	no	no	4,027,678	3,122,965	yes
241-AN-105 Double-Shell Tank	Sound	no	no	4,269,944	4,269,944	yes
241-AN-106 Double-Shell Tank	Sound	no	no	3,849,764	3,785,412	no
241-AN-107 Double-Shell Tank	Sound	no	no	4,069,318	3,596,141	no

Table 2-4. Description of PUREX Plant Aggregate Area Tank Farms.

Waste Management Unit	Tank Integrity	Interim Stabilized	Isolation	Total Waste Volume (L)	Drainable Waste Volume (L)	Flammable Gas Generation ?
241-AP Tank Farm						
241-AP-101 Double-Shell Tank	Sound	no	no	4,020,107	4,020,107	no
241-AP-102 Double-Shell Tank	Sound	no	no	503,460	503,460	no
241-AP-103 Double-Shell Tank	Sound	no	no	4,296,442	4,296,442	no
241-AP-104 Double-Shell Tank	Sound	no	no	75,708	75,708	no
241-AP-105 Double-Shell Tank	Sound	no	no	3,122,965	3,122,965	no
241-AP-106 Double-Shell Tank	Sound	no	no	4,288,872	4,288,872	no
241-AP-107 Double-Shell Tank	Sound	no	no	4,258,588	4,258,588	no
241-AP-108 Double-Shell Tank	Sound	no	no	3,346,304	3,346,304	no
241-AW Tank Farm						
241-AW-101 Double-Shell Tank	Sound	no	no	4,254,803	3,944,399	no
241-AW-102 Double-Shell Tank	Sound	no	no	3,917,901	3,914,116	no
241-AW-103 Double-Shell Tank	Sound	no	no	2,460,518	1,226,473	no
241-AW-104 Double-Shell Tank	Sound	no	no	4,262,374	3,350,089	no
241-AW-105 Double-Shell Tank	Sound	no	no	3,418,227	2,403,736	no
241-AW-106 Double-Shell Tank	Sound	no	no	1,994,912	1,075,057	no

Table 2-4. Description of PUREX Plant Aggregate Area Tank Farms.

Waste Management Unit	Tank Integrity	Interim Stabilized	Isolation	Total Waste Volume (L)	Drainable Waste Volume (L)	Flammable Gas Generation ?
241-AX Tank Farm						
241-AX-101 Single-Shell Tank	Sound	no	Part. Interim Isolated	2,827,440	1,209,600	yes
241-AX-102 Single-Shell Tank	Assumed Leaker	yes	Interim Isolated	147,420	64,260	no
241-AX-103 Single-Shell Tank	Sound	yes	Interim Isolated	423,360	136,080	yes
241-AX-104 Single-Shell Tank	Assumed Leaker	yes	Interim Isolated	26,460	0	no
241-AY Tank Farm						
241-AY-101 Single-Shell Tank	Sound	no	no	3,478,793	3,175,960	no
241-AY-102 Single-Shell Tank	Sound	no	no	1,309,752	1,188,619	no
241-AZ Tank Farm						
241-AZ-101 Single-Shell Tank	Sound	no	no	3,656,708	3,524,218	no
241-AZ-102 Single-Shell Tank	Sound	no	no	3,694,562	3,361,446	no
241-C Tank Farm						
241-C-101 Single-Shell Tank	Assumed Leaker	yes	Interim Isolated	332,640	11,340	no
241-C-102 Single-Shell Tank	Sound	no	Part. Interim Isolated	1,602,720	166,320	no
241-C-103 Single-Shell Tank	Sound	no	Part. Interim Isolated	737,100	502,740	no
241-C-104 Single-Shell Tank	Sound	yes	Interim Isolated	1,115,100	41,580	no
241-C-105 Single-Shell Tank	Sound	no	Part. Interim Isolated	567,000	41,580	no

Table 2-4. Description of PUREX Plant Aggregate Area Tank Farms.

Waste Management Unit	Tank Integrity	Interim Stabilized	Isolation	Total Waste Volume (L)	Drainable Waste Volume (L)	Flammable Gas Generation ?
241-C-106 Single-Shell Tank	Sound	no	Part. Interim Isolated	865,620	181,440	no
241-C-107 Single-Shell Tank	Sound	no	Part. Interim Isolated	1,273,860	128,520	no
241-C-108 Single-Shell Tank	Sound	yes	Interim Isolated	249,480	0	no
241-C-109 Single-Shell Tank	Sound	yes	Interim Isolated	249,480	15,120	no
241-C-110 Single-Shell Tank	Assumed Leaker	no	Part. Interim Isolated	740,880	79,380	no
241-C-111 Single-Shell Tank	Assumed Leaker	yes	Interim Isolated	215,460	0	no
241-C-112 Single-Shell Tank	Sound	yes	Part. Interim Isolated	393,120	120,960	no
241-C-201 Single-Shell Tank	Assumed Leaker	yes	Interim Isolated	7,560	0	no
241-C-202 Single-Shell Tank	Assumed Leaker	yes	Interim Isolated	3,780	0	no
241-C-203 Single-Shell Tank	Assumed Leaker	yes	Interim Isolated	18,900	0	no
241-C-204 Single-Shell Tank	Assumed Leaker	yes	Interim Isolated	11,340	0	no

Table 2-5. Description of Unplanned Releases.

Unplanned Release	Location	Date	Associated Waste Management Unit	Reported Waste-Related History
UN-200-E-10	PUREX railroad right-of-way	October 23, 1957	N/A	• PUREX tube bundles in transit for burial provided some spotty ground contamination. • Extensive decontamination was required.
UN-200-E-11	Railroad tracks from PUREX tunnel entrance to west end of exclusion fence to the spur into 218-E-5 Burial Ground and to the "TC" spur	1957	N/A	• Contamination spots were found along the railroad track. Specific release details are unknown. • Waste is fission products. • Most of the contamination was removed. The tracks were marked with stakes and radiation zone signs.
UN-200-E-12	PUREX railroad bed and right-of-way	December 23, 1957	N/A	• Unknown beta/gamma with readings from 40 to 1,700 mR/h • Contaminated liquid dripped from a burial box in transit to the burial ground.
UN-200-E-13	Between the 216-A-4 Crib and the 291-A Stack	December 1958	216-A-4 Crib	• The 216-A-4 Crib became plugged and flooded an area between the crib and the 291-A Stack. • The contaminated soil was removed to a trench along the south boundary of the 216-A-4 Crib and covered with a foot of soil. • Type of soil was not identified in reference.
UN-200-E-15	The blacktop area outside of the 291-A Turbine House	January 21, 1959	216-A-4 & 216-A-2	• Unknown beta/gamma with readings up to 8 R/h. • The 216-A-4 Crib became plugged during the jetting of the 216-A-2 Catch Tank, causing ground contamination.

Table 2-5. Description of Unplanned Releases.

Unplanned Release	Location	Date	Associated Waste Management Unit	Reported Waste-Related History
UN-200-E-16	18 m (60 ft) northeast of the 105-C Tank Pit	1959	241-C-105	• Waste type was PUREX coating waste. • The 241-C-105 to 241-C-108 overground transfer line broke and contaminated the soil northeast of the 241-C-105 Single-Shell Tank pit. • The contaminated pipe was buried in a trench near the 241-C fence. The original site was marked with chain and underground radiation zone signs.
UN-200-E-18	30 m (100 ft) east of the 241-A-271 Building	1959	N/A	• Moisture dripping from a vent pipe bonnet at the 216-A-8 Proportional Sample Pit contaminated the ground near the 241-A-271 Building. • Waste type was low-level fission products. • The area is marked with stakes, chains, and radiation zone signs.
UN-200-E-19	183 m (600 ft) east of the 202-A Building	1959	N/A	• A drip in the vent pipe bonnet at the 216-A-6 Proportional Sample Pit contaminated the ground near the 202-A Building. • Waste type was low-level fission products. • The area is marked with stake, chain, and radiation zone signs.
UN-200-E-20	The PUREX railroad right-of-way	November 20, 1959	N/A	• Readings were to 3 R/h at 46 cm (18 in.). • PUREX tube bundles in transit for burial provided some spotty ground contamination.
UN-200-E-22	Ground around the 291-A Stack	1959	N/A	• General contamination has built up around the 291-A Stack. The heaviest concentrations are northwest and southeast of the stack within approximately 91 m (300 ft). • Waste type is mixed fission products. • The area was staked and chained off with radiation zone signs.

Table 2-5. Description of Unplanned Releases.

Unplanned Release	Location	Date	Associated Waste Management Unit	Reported Waste-Related History
UN-200-E-25	Southwest of PUREX to 61 m (200 ft) beyond the limited area fence	September 5, 1960	241-A-151	• Unknown beta/gamma with readings to 100,000 ct/min • Leakage from the 241-A-151 Diversion Box contaminated an area southwest of PUREX.
UN-200-E-26	South of the 241-A-151 Diversion Box outside the 200 East Area perimeter fence. The contamination also crossed Route 4S	September 30, 1960	241-A-151	• Unknown beta/gamma with readings from 1 to 3 mR/h near the diversion box and just outside the exclusion fence. General contamination was up to 3,000 ct/min. • Leakage from the 241-A-151 Diversion Box caused an operator to stop transfer, but the process tank emptied and steam blew out of the jumper connection.
UN-200-E-27	Generally east from 244-CR up to several hundred feet beyond the limited area fence	November 1, 1960	244-CR Vault	• Unknown beta/gamma with readings near the vault on the order of 50 to 100 mR/h. Readings outside the fence area were up to 40,000 ct/min. • Near the 244-CR Vault winds provided some spotty ground contamination beyond the area fence.
UN-200-E-28	Eastern half of the PUREX exclusion area	December 21, 1961	N/A	• A process vessel steam coil failed, causing ground contamination. • Waste type was fission products.
UN-200-E-31	Contamination spread over PUREX exclusion area and east of PUREX to the west bank of the Columbia River	October 7, 1961	241-A-151 Diversion Box	• Unknown beta/gamma with readings from 40,000 to 100,000 ct/min in the vicinity of PUREX. Readings outside of the limited area fence were an order of magnitude lower and decreased to 1,000 ct/min. • Leakage from the 241-A-151 Diversion Box.
UN-200-E-33	The railroad right-of-way from PUREX to the 200 East Burial Ground	March 20, 1964	216-A-24 Crib	• A leaking tube bundle burial box in transit to the burial ground contaminated a portion of the railroad right-of-way and area adjacent to the 216-A-24 Crib. • The site was surface stabilized in 1981.

Table 2-5. Description of Unplanned Releases.

Unplanned Release	Location	Date	Associated Waste Management Unit	Reported Waste-Related History
UN-200-E-35	218-E-13 excavation	October 1966	N/A	• Contaminated concrete from an underground encasement was left in the pit excavated to repair the broken pipe. This site is also known as 218-E-13 and UN-218-E-1. • This site is scheduled for deletion. It is duplicate of 218-E-13. • An area about 107 m (350 ft) west of the PUREX Exclusion Area Patrol Gatehouse on Fourth Street was contaminated.
UN-200-E-39	Ground and blacktop outside the 216-A-36B Crib Sampler Shack	February 6, 1968	216-A-36B	• Pressurized ammonia scrubber waste containing fission products. The readings were 20 to 450 mR/h. • Pressured ammonia scrubber waste was inadvertently released through the vent at the 216-A-36B Crib sampling shack.
UN-200-E-40	Blacktop outside the 216-A-36B Crib Sampler Shack	August 5, 1968	216-A-36B	• Unknown beta/gamma with readings to a maximum of 150 mR/h. • The vent line valve at the 216-A-36B Crib Sampler Shack was inadvertently left open and contaminated the blacktop outside the shack.
UN-200-E-42	The dirt bank east of the 151-AX Diversion Station and weeds east of the established parking lot	November 6, 1972	N/A	• Unknown beta/gamma with readings of 300 to 3,000 ct/min. • Surveys revealed contamination thought to be a result of pressurization of a 244-AR Diverter Tank, which was inadvertently left on. • The area was cleaned.

Table 2-5. Description of Unplanned Releases.

Unplanned Release	Location	Date	Associated Waste Management Unit	Reported Waste-Related History
UN-200-E-47	The parking lot east of the 702-A Building	October 15, 1974	241-A Tank Farm	• Unknown beta/gamma with readings of 500 to 20,000 ct/min from the 241-A Tank Farm. • Contaminated soil was detected in the 241-A Tank Farm. • The contaminated soil was removed and the area released for normal service.
UN-200-E-48	The 241-A Tank Farm parking lot	November 22, 1974	N/A	• Unknown beta/gamma with readings of 1,000 to 2,000 ct/min • The 241-A-106 pump pit contaminated the 241-A Tank Farm parking lot. • The parking area was cleaned and returned to normal operation by 6:45 p.m. the same day.
UN-200-E-49	The roadway between the 241-AY Tank Farm and 218-E-12B Burial Ground.	February 7, 1975	N/A	• Unknown beta/gamma with readings of 100,000 ct/min. • A thermocouple well being transferred to the burial ground from the 241-AY Tank Farm contaminated a section of the road. Contamination was confined to the snow cover and did not reach the ground surface. • The contaminated sections of road immediately northwest of the 241-AY Tank Farm and northeast of the 241-C Tank Farm, were barricaded and cleaned up.
UN-200-E-56	An excavation east of the 200 Areas perimeter fence	June 13, 1979	N/A	• Unknown beta/gamma with readings up to 8,000 ct/min. • Contaminated soil was found during an excavation for clean soil to be used around the 241-AN tanks. • The area was zoned off and posted.

Table 2-5. Description of Unplanned Releases.

Unplanned Release	Location	Date	Associated Waste Management Unit	Reported Waste-Related History
UN-200-E-58	A dirt roadway leading to the 218-E-1 Dry Waste Burial Ground	March 4, 1980	N/A	• Unknown beta/gamma with readings to 100,000 ct/min. • Contaminated tumbleweeds were detected along the roadway near the 218-E-1 Dry Waste Burial Ground. • The roadway was cleaned up.
UN-200-E-60	An area about 0.3 to 1 m (1 to 2 ft) wide and 12 m (40 ft) long on the roadway near 275-EA	June 3, 1981	N/A	• Radioactive contamination with unknown beta/gamma readings from 200 to 500 ct/min. • Contaminated dirt was spilled from an overfilled dump truck en route to the burial grounds. • There is no potential for further release from this spill site; only background levels of radiation remain. • The roadway was decontaminated to background radiation levels.
UN-200-E-62	An area about 5 cm (2 in.) wide and 30 m (100 ft) long on a hill near the 200 East Overground Storage Area	March 19, 1982	N/A	• Contamination consisted of unknown beta/gamma readings to 350 mR/h. • Radioactive liquid was spilled from a pressure test assembly while in transit. • There is no potential for further release from this spill site; only background levels of radiation remain. • The ground contamination was picked up, placed in barrels, and removed to the burial ground. The area was released from area posting on March 22, 1982.

Table 2-5. Description of Unplanned Releases.

Unplanned Release	Location	Date	Associated Waste Management Unit	Reported Waste-Related History
UN-200-E-65	The immediate ground area around the 241-A-151 Diversion Box and 21 m (70 ft) to the west	September 1, 1982	241-A-151 Diversion Box	• The contamination consists of unknown beta/gamma, with spot readings from 600 to 5,000 ct/min. • The wind spread contamination from the 241-A-151 Diversion Box. • The potential for release is very low; contamination is physically fixed in place. • The contaminated ground was kept wet until it could be decontaminated to background radiation levels and stabilized. The diversion box cover blocks were sprayed with Turco Fabri-film, which is used to physically fix contamination to a solid surface.
UN-200-E-67	Excavation site north of the parking lot at 272-AW	May 7, 1984	N/A	• The contamination consists of unknown beta/gamma, with readings from 1,000 to 1,500 mR/h. • An old, contaminated pipe encasement was encountered during the excavation. • No potential for release from this spill site exists; only background levels of radiation remain. • The area was decontaminated to background radiation levels and stabilized.
UN-200-E-68	The general vicinity of the 244-AR Vault and the 241-C Tank Farm	January 11, 1985	241-C-151	• The contamination consisted of unknown beta/gamma, with readings of 2,000 ct/min and dose rates of 5 R/h on the diversion box. • Wind-borne contamination spread from the 241-C-151 Diversion Box. • The affected areas were either decontaminated to background radiation levels or covered for later decontamination. The 241-C-151 Diversion Box was opened, contamination to a solid surface.

Table 2-5. Description of Unplanned Releases.

Unplanned Release	Location	Date	Associated Waste Management Unit	Reported Waste-Related History
UN-200-E-72	South of the 241-C Tank Farm	April 20, 1985	N/A	• The contamination consists of unknown beta/gamma with readings to 7 R/h. • Buried contaminated waste was excavated. • Low release potential; the contamination is physically fixed in place. • The source of the contamination was stabilized with Turco Fabri-Film, a product used to physically fix contamination to a solid surface, and the area was chained off and posted as a surface contamination area.
UN-200-E-81	A few feet west of the 241-CR-151 Diversion Box	October 1969	241-CR-151 Diversion Box	• PUREX coating waste was lost to the soil, including 360 Ci of ^{90}Sr, 720 Ci of ^{137}Cs, 360 Ci of ^{144}Ce, 1,080 Ci of $^{95}Zr/Nb$, and 1,080 Ci ^{103}Ru. This is a Transuranic-Fission product disposal site containing high salt and neutral/basic wastes. • A puddle of contaminated liquid was discovered near the 241-CR-151 Diversion Box, the source determined as the underground transfer line from the 202-A Building to the 102-C waste storage tank via the diversion box. • A radiological survey on 10/75 showed surface contamination of 10,000 to 100,000 ct/min. • The contamination was covered with earth backfill and clean gravel.

Table 2-5. Description of Unplanned Releases.

Unplanned Release	Location	Date	Associated Waste Management Unit	Reported Waste-Related History
UN-200-E-82	Across from the 241-C-152 Diversion Box, outside the 241-C Tank Farm fence line	December 19, 1969	241-C-152 Diversion Box, 241-C-105 Tank	• The leak consisted of waste containing 100 Ci of ^{134}Cs, 11,300 Ci of ^{137}Cs, 260 Ci of ^{144}Ce, 260 Ci of ^{95}Zr, and 130 Ci of ^{106}Ru. This is a Transuranic-Fission product disposal site containing high salt and neutral/basic wastes. • A leak was discovered near the 241-C-152 Diversion Box, the source determined as the feed line that runs from 241-C-105 Tank to the 221-B Building. The leak waste stream flowed through a surface area of about 1 ft^2 northeastward, downgrade, until it pooled into an estimated 5 ft^2 area outside the tank farm fence line. • The contaminated soil was covered with clean gravel. The site was cleaned up during a decontamination outage of the 241-C Tank Farm following the 241-C-151 release in 1985.
UN-200-E-86	Outside the southwest corner of the 241-C Tank Farm	March 1971	N/A	• Waste from the process transfer line containing 25,000 Ci of ^{137}Cs. This is a Transuranic Fission Product waste site containing high salt and neutral/basic waste. • During a routine line monitoring near the southwest corner of 241-C Tank Farm, a radiation zone was detected in the vicinity of Line No. 812, which is used to transfer process waste from 244-AR Vault to the 241-C Tank Farm. At this location, the No. 812 line is 2.4 m (8 ft) deep. • Test wells driven into the ground indicated the contamination did not extend below a depth of 6 m (20 ft). The contaminated soil zone was estimated at 1,300 ft^3.

Table 2-5. Description of Unplanned Releases.

Unplanned Release	Location	Date	Associated Waste Management Unit	Reported Waste-Related History
UN-200-E-88	About 274 m (900 ft) northwest of the 202-A Building at the TC-4 railroad spur	September 11, 1980	N/A	• The large radiation zone was incorrectly designated as an unplanned release site. This site in question was properly known as a Regulated Equipment Storage Area. • Gamma dose rates from radioactive equipment parked on the railroad spur would be less than 1 mR/h. • The site was stabilized, but recontamination has occurred.
UN-200-E-91	Along the northeast corner of 241-C Tank Farm	September 1980	N/A	• This condition resulted from the migration of low-level radioactivity from the neighboring 241-C Tank Farm. The occurrence date is unknown. • The contaminated soil was removed from the area and placed in the excavation adjacent to the north side of the 216-A-24 Crib. It has been released from the status of an "Unplanned Release" site.
UN-200-E-94	Outside the perimeter fence directly north of 216-B-3-1 and 1,600 feet northeast of 241-C Tank Farm	June 1979	N/A	• Residue contamination to 300 ct/min activity was on the ground in the bottom of the gravel pit. • Radiation monitoring surveys on the soil in the area detected 8,000 ct/min in the moisture on the earthmoving equipment and in the soil.

Table 2-5. Description of Unplanned Releases.

Unplanned Release	Location	Date	Associated Waste Management Unit	Reported Waste-Related History
UN-200-E-96	From the south side of the 202-A Building to the southern fence	September 1980	N/A	• This site originated from the residue contamination from the 291-A Stack and diversion box work during the operational years of the 202-A Building. • Surface contamination, debris, and vegetation were removed from the south side of the 202-A Building to the southern fence during September 1980. The area was covered with 10 to 15 cm (4 to 6 in.) of 5/8-inch crushed gravel. The surface contamination posting has been removed, but the area has been recontaminated following the restarting of the 202-A Building.
UN-200-E-97	South of the 202-A Building near the railroad tunnel	September 1980	N/A	• Ground contamination from an unknown source was detected south of PUREX near the railroad tunnel. • On a field survey 9/22/81, the site could not be located. The actual occurrence date is unknown. • Apparently, the surface contamination was removed and the zone eliminated when the double-exclusion fence was built around the 202-A Building. The area was released from zone posting and established as an unplanned release site in 9/80.
UN-200-E-99	Approximately 122 m (400 ft) south of the 241-C Tank	September 1980	244-CR Vault	• A portion of the ground surface surrounding the 244-CR Vault became contaminated during the numerous piping changes associated with that facility. • The actual occurrence date is unknown. It was established as a site in September 1980. • The site was decontaminated during the summer of 1981 and released from zone posting.

Table 2-5. Description of Unplanned Releases.

Unplanned Release	Location	Date	Associated Waste Management Unit	Reported Waste-Related History
UN-200-E-100	South and east of 241-C Tank Farm surrounding the 244-A Lift Station	1986	244-A Lift Station	• Radioactive contamination, amount unknown. • Known release was a spill to the ground.
UN-200-E-107	Inside the 241-CR Tank Farm at the 100-CR Tank	November 26, 1952	100-CR Tank	• Known waste was tributyl phosphate waste from the 221-U Building. Contaminated liquid was discharged before the pump could be shut off. A maximum dose of 4.2 rep/h at the surface and 200 mR/h at a depth of 5 cm (2 in.) was observed for the ground contamination. • Contamination spread to ground and equipment during a transfer pump installation in the 100-CR Tank in the 241-CR Tank Farm.
UN-200-E-114	Valve pit outside the 202-A Building	March 12, 1974	N/A	• Readings of 8,000 ct/min beta and 1,000 ct/min alpha were detected on an employee. An employee had been working in an area where contamination was found.
UN-200-E-117	Within a few inches of the top of the waste encasement on the west side of PUREX railroad tunnel	April 20, 1972	N/A	• Up to 2,000 mR/h of Cs and Sr including 500 mR/h at 1 foot from the liquid. • An excavation exposed liquid spurting up out of ground in the 200 East/PUREX Area.
UN-200-E-118	241-C Tank Farm; inside the fence: 100 to 300 yards north of the badgehouse; outside the fence: to the south bank of the parking lot	April 20, 1957	N/A	• Readings to 3,000 ct/min were measured. The highest dose rate at the surface was estimated at 50 mR/h, with one particle deposited per square foot. • The 107-C effluent tank released airborne contamination in the 200 East Area.
UN-200-E-142	North of the 202-A Building at the 202-A Building diesel fuel tank	November 17, 1986	N/A	• The release consisted of diesel fuel. • The tank of a diesel-fueled compressor overflowed during filling. • The diesel fuel was absorbed, cleaned up and drummed for disposal.

Table 2-5. Description of Unplanned Releases.

Unplanned Release	Location	Date	Associated Waste Management Unit	Reported Waste-Related History
UPR-200-E-17	The ground on top of the 216-A-22 Crib	1959	216-A-22 Crib	• Uranium was the waste type. • The 216-A-22 Crib inlet failed and contaminated the soil.
UPR-200-E-21	Adjacent to the 216-A-6 Crib	March 20, 1959	216-A-6 Crib	• Unknown beta/gamma with readings to 500 mR/h. • The 216-A-6 Crib overflowed and caused some soil contamination adjacent to the crib.
UPR-200-E-24	From the 200 East Burial Ground to the 200 East Area perimeter fence, a distance of about 3 km (2 mi.)	June 17, 1960	218-E-12A Burial Ground	• Unknown beta/gamma with readings up to 2,000 mR/h at the trench. Average radiation level inside the burial ground fence was 30 mR/h at 10 cm (4 in.). • A burial box collapsed during burial operations, causing spotty ground contamination.
UPR-200-E-29	In the area of the 216-A-6 Crib	January 20, 1961	216-A-6 Crib	• Unknown beta/gamma with readings to 30 R/h at 1.2 m (4 ft). • The 216-A-6 Crib overflowed outside the area of the crib.
UPR-200-E-30	The majority was confined to the 200 East Area Burial Ground chained area	April 20, 1961	218-E-12A Burial Ground	• Unknown beta/gamma with readings up to 500 R/h. • A burial box collapsed during routine operation, spreading contamination within the burial ground. • Contamination stabilization started immediately after the burial trench involved was backfilled.
UPR-200-E-50	Southeast of the Overground Radioactive Equipment Storage Yard, north of 241-C Tank Farm	September 27, 1974		• Unknown beta/gamma with readings of 3,000 to 100,000 ct/min. • Wind spread contamination from an adjacent radiation zone to the 241-C Tank Farm.

Table 2-5. Description of Unplanned Releases.

Unplanned Release	Location	Date	Associated Waste Management Unit	Reported Waste-Related History
UPR-200-E-53	At the south end of a waste trench in the 200 East Dry Waste Burial Ground 218-E-1	October 17, 1978	218-E-1 Burial Ground	• Beta/gamma with readings to 150 mR/h. • During a burial operation, contamination was spread by uncovering previously buried waste.
UPR-200-E-59	The eaves of the 244-AR Vault and the walls of the 216-A-40 Trench	May 23, 1979	244-AR Vault 216-A-40 Trench	• Contaminated mud containing ^{137}Cs and ^{60}Co with readings of 10,000 to 20,000 ct/min. • Contaminated mud and tumbleweeds from the 216-A-40 Trench were used by swallows to build nests at the 244-AR Vault. • The nests were removed from the 244-AR Vault. The tumbleweeds were removed from 216-A-40, packaged, and placed in the burial ground. The sides of the 216-A-40 were washed and the contaminated mud removed.
UPR-200-E-66	The 216-A-42 Retention Basin and immediate vicinity	November 7, 1984	216-A-42 Retention Basin	• The contamination consists of unknown beta/gamma, with readings inside the area to 40,000 ct/min and outside to 3,000 ct/min. • The wind spread contamination from the 216-A-42 Retention Basin. • The ground was wet down and the basin flushed.
UPR-200-E-70	Around the 244-A Lift Station	October 15, 1984	244-A Lift Station	• The contamination consisted of unknown beta/gamma with readings of 1,000 to 50,000 ct/min and an isolated area at 100,000 ct/min. • The contamination spread during a jumper removal at the lift station. • There is no release potential; radiation contamination was removed to background levels. • The area was decontaminated to background radiation levels and stabilized.

Table 2-5. Description of Unplanned Releases.

Unplanned Release	Location	Date	Associated Waste Management Unit	Reported Waste-Related History
UPR-200-E-106	200-E Burning Pit	September 5, 1946	200-E Burning Pit	• Contaminated paper towels. The radiation level was measured to be as high as 2.5 rep/h. • Considerable contamination has been found at the burning ground.
UPR-200-E-115	The ground adjacent to the AX-103 Pump Pit in the 241-AX Tank Farm	February 12, 1974	241-AX-103 Pump Pit	• Beta/gamma with readings to 2,000 mR/h. • During bleeding of air from a line, air flowed up (instead of down), causing contaminated liquid to spray on 2 employees and the ground in an area within the 241-AX Tank Farm.
UPR-200-E-119	Next to 241-AX-104 Tank	December 22, 1969	241-AX-104 Tank	• High-level waste. • An employee mistakenly pulled 4.6 m (15 ft) of a contaminated electrode cable out of tank 241-AX-104 and set it on the ground. He then removed his contaminated gloves and set them on the ground. Contamination was limited to a small area near the AX-104 Tank, the employee, and the change house.
UPR-200-E-125	The 241-A-104 Single-Shell Tank and soil beneath	May 1975	241-A-104 Tank	• 9,463 L (2,500 gal) of waste from the 241-A-104 containing 18,000 Ci of ^{137}Cs with readings to 6,450 ct/min. • Tank 104-A was classified a "Confirmed Leaker" on April 16, 1975. The basis for declaration of status were leak detection lateral indications of increasing radiation at several locations beneath the tank. • The tank was pumped down to a sludge heel.

Table 2-5. Description of Unplanned Releases.

Unplanned Release	Location	Date	Associated Waste Management Unit	Reported Waste-Related History
UPR-200-E-126	The 241-A-105 Single-Shell Tank and soil beneath	1963	241-A-105 Tank	• 18,925 L (5,000 gal) of waste from the 241-A-105 Tank. • The 241-A-105 Tank was suspected of leaking and was taken out of service in December 1963 but was immediately put back into service. Soon after when the tank was filled there was a sudden steam release of severe intensity. It was determined that the liner had bulged to maximum elevation of 2.6 m (8.5 ft) creating a void space of 302,800 L (80,000 gal). • The tank was pumped to a residual liquid heel. 3,785 L (1,000 gal) of water were applied weekly to prevent sludge from overheating.
UPR-200-E-136	The 241-C-101 Single-Shell Tank and soil beneath	1946-1970	241-C-101 Tank	• 64,345 to 90,840 L (17,000 to 24,000 gal) of waste from the 241-C-101 Tank containing 2,000 Ci. • Because of a liquid level decrease, tank 101-C was categorized "Questionable Integrity" in 1970. • The tank was pumped to a minimum heel (112 cm, 44 in.) in December 1969, and a salt well system was installed.
UPR-200-E-137	The 241-C-203 Single-Shell Tank and soil beneath	1947-1977	241-C-203 Tank	• 1,514 L (400 gal) of PUREX high-level waste from the 241-C-203 Tank. • Over a period of 2 to 3 years, natural water apparently entered the tank, migrated through the salt cake, and either became entrained in the salt cake or leaked out. • The tank was stabilized and isolated in 1982.

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

Process	Waste Generated	Major Chemical Constituents	Ionic Strength	pH	Organic Concentration	Radioactivity
Plutonium Uranium Extraction (PUREX 202-A Building)	Process Waste	Nitric acid Tributyl phosphate Bismuth phosphate Parrafin hydrocarbon	High	Acidic (neutralized before disposal)	Low	High
	Wastewater	Nitrates	Low	Acidic to neutral/basic	Low	Low
Waste Reduction (242 Evaporator)	Cooling water	Beta Activity Cadmium Copper Potassium Sodium Nitrate	Unknown	Basic	Low	Low
Tank Farm Condensate (241-A-431 Building)	Wastewater	Unknown	Low	Neutral/basic	Low	Low

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

RADIONUCLIDES

Actinium-225
Actinium-227
Americium-241
Americium-242
Americium-242m
Americium-243
Antimony-126
Antimony-126m
Astitine-217
Barium-135m
Barium-137m
Beryllium-7
Bismuth-210
Bismuth-211
Bismuth-213
Bismuth-214
Carbon-14
Cerium-141
Cerium-144
Cesium-134
Cesium-135
Cesium-137
Cobalt-58
Cobalt-60
Curium-242
Curium-244
Curium-245
Europium-152
Europium-154
Europium-155
Francium-221
Francium-223
Iodine-129
Lead 211
Lead 210
Lead-209
Lead-212
Lead-214
Manganese-54
Neptunium-237
Neptunium-239
Nickel 63
Nickel-59
Niobium-93m
Palladium-107
Plutonium-238
Plutonium-239/240
Plutonium-241
Polonium-210
Polonium-213
Polonium-214
Polonium-215
Polonium-218
Potassium-40
Promethium-147
Protactinium-231
Protactinium-233
Protactinium-234m
Radium
Radium-223
Radium-225
Radium-226
Ruthenium-103
Ruthenium-106
Samarium-151
Selenium-79
Strontium-90
Technetium-99
Thallium-207
Thallium-208
Thorium-227
Thorium-229
Thorium-230
Thorium-231
Thorium-233
Thorium-234
Tin-113
Tin-126
Tritium
Uranium-233
Uranium-234
Uranium-235
Uranium-238
Yttrium-90
Zinc-65
Zirconium-93
Zirconium-95

INORGANIC CHEMICALS

Aluminum
Aluminum nitrate nonahydrate
Aluminum nitrate (mono basic)
Ammonium fluoride
Ammonium nitrate
Beryllium
Cadmium nitrate
Ferric nitrate
Ferrous sulfamate
Hydrazine
Hydroxylamine nitrate
Iron
Lead nitrate
Mercuric nitrate
Nickel nitrate
Nitric acid
Phosphoric acid
Potassium fluoride
Potassium hydroxide
Potassium permanganate
Silicon
Silver nitrate
Sodium carbonate
Sodium ferrocyanide
Sodium fluoride
Sodium hydroxide
Sodium nitrate
Sodium nitrite
Sodium sulfate
Sodium thiosulfate
Sulfamic acid
Sulfuric acid
Zirconium

ORGANIC CHEMICALS

Acetic acid
Dibutyl butyl phosphonate
Formaldehyde (solution)
Hydroxyacetic acid
Normal paraffin hydrocarbon
Oxalic acid
Sugar
Tararic acid
Tributyl phosphate
Trichloroethane
Tri-n-dodecylamine

Table 2-8. Chemicals Used in the 202-A Building Analytical Laboratory (1955-1972).

Compound Name	Formula
Acetone	$CH_3C_2OH_3$
Carbon Tetrachloride	CCl_4
Ceric Fluoride	CeF_4
Ceric Sulfate	$Ce(SO_4)_2$
Ferrous Sulfate	$FeSO_4$
Hydrobromic Acid	HBr
Hydrochloric Acid	HCl
Hydrogen Peroxide	H_2O_2
Hydroxylamine Hydrochloride	NH_2OH HCl
Isopropyl Alcohol	C_3H_7OH
Lanthanum Fluoride	LAF_3
Lanthanum Hydroxide	$LA(OH_3)$
Lanthanum Nitrate	LA $(NO_3)_3$
Magnesium	Mg
Nitric Acid	HNO_3
Periodic Acid	HIO_4
Phosphorous Pentoxide	P_2O_5
Potassium Oxalate	$K_2C_2O_4$
Potassium Permanganate	$KMnO_4$
Silver Nitrate	$AgNO_3$
Sodium Bisulfate	$NaHSO_4$ H_2O
Sodium Bromate	$NaBrO_3$
Sodium Carbonate	Na_2CO_3
Sodium Fluoride	NaF
Sodium Hydroxide	NaOH
Sodium Nitrate	$NaNO_3$
Sulfuric Acid	H_2SO_4
Thenoyltrifluoroacetone	$(CH)_3SCOCH_2COCF_3$
Zirconyl Phosphate	$ZrOPO_4$

Table 2-9. Radionuclides and Chemicals Disposed of to PUREX Plant Aggregate Area Waste Management Units.

RADIONUCLIDES

Actinium-225
Actinium-227
Americium-241
Americium-242
Americium-242m
Americium-243
Antimony-126
Antimony-126m
Astitine-217
Barium-135m
Barium-137m
Beryllium-7
Bismuth-210
Bismuth-211
Bismuth-213
Bismuth-214
Carbon-14
Cerium-141
Cerium-144
Cesium-134
Cesium-135
Cesium-137
Cobalt-58
Cobalt-60
Curium-242
Curium-244
Curium-245
Europium-152
Europium-154
Europium-155
Francium-221
Francium-223
Iodine-129
Lead-211
Lead-210
Lead-209
Lead-212
Lead-214
Manganese-54
Neptunium-237
Neptunium-239
Nickel 63
Nickel-59
Niobium-93m
Palladium-107
Plutonium-238
Plutonium-239/240
Plutonium-241
Polonium-210
Polonium-213
Polonium-214
Polonium-215
Polonium-218
Potassium-40
Promethium-147
Protactinium-231
Protactinium-233
Protactinium-234m
Radium
Radium-223
Radium-225
Radium-226
Ruthenium-103
Ruthenium-106
Samarium-151
Selenium-79
Strontium-90
Technetium-99
Thallium-207
Thallium-208
Thorium-227
Thorium-229
Thorium-230
Thorium-231
Thorium-233
Thorium-234
Tin-113
Tin-126
Tritium
Uranium-233
Uranium-234
Uranium-235
Uranium-238
Yttrium-90
Zinc-65
Zirconium-93
Zirconium-95

INORGANIC CHEMICALS

Aluminum
Aluminum nitrate
Ammonium carbonate
Ammonium fluoride
Ammonium nitrate
Arsenic
Barium
Beryllium
Bismuth
Bismuth phosphate
Boron
Cadmium
Cadmium nitrate
Calcium
Carbonate
Cerium
Chloride
Chromium
Copper
Cyanide
Ferric cyanide
Ferric nitrate
Ferrous sulfamate
Fluoride
Gold
Hydrazine
Hydrogen peroxide
Hydroxide
Hydroxylamine nitrate
Iron
Lanthanum
Lead
Magnesium
Manganese
Mercury
Nickel
Nitrate
Nitric acid
Nitrite
Phosphate
Potassium
Potassium fluoride
Potassium hydroxide
Potassium permanganate
Selenium
Selenium tetroxide (SeO_4)
Silicon trioxide (SiO_3)
Silver
Silver nitrate
Sodium
Sodium carbonate
Sodium dichromate
Sodium nitrate
Sodium nitrite
Sodium thiosulfate
Strontium
Sulfamic acid
Sulfate

Table 2-9. Radionuclides and Chemicals Disposed of to PUREX Plant Aggregate Area Waste Management Units.

INORGANIC CHEMICALS
(Cont.)

Sulfuric acid
Tin
Tungsten tetroxide (WO_4)
Uranium
Vanadium
Zinc
Zirconium oxide

ORGANIC CHEMICALS

Acetone
Chloroform
Citrate
Ethylene diamine tetraacetate (EDTA)
Gylcolate
Methylene chloride
N-(2-hydroxyethyl) ethylenediaminetriacetate (HEDTA)
Oxalate
Oxalic acid
Paraffin hydrocarbons
Sugar (sucrose)
Tartaric acid
Toluene
Tributyl phosphate
Other degradation products

Table 2-10. Listing of Treatment, Storage, and Disposal Groups/Units Within the PUREX Plant Aggregate Area.

Treatment, Storage, and Disposal		Operable Unit	Planned Action	
Group No.	Group/Units		Closure*	Operating Permit
D-2-2	216-A-10 Crib	200-PO-2	X	
D-2-3	216-A-29 Ditch	200-PO-5	X	
D-2-4	216-A-36B Crib	200-PO-2	X	
S-2-3	Double-Shell Tanks			
	241-AN Farm (7 tanks)			Storage
	241-AP Farm (8 tanks)			Storage
	241-AW Farm (6 tanks)			Storage
	241-AY Farm (2 tanks)			Storage
	241-AZ Farm (2 tanks)			Storage
	244-AR Vault			Storage
	244-CR Vault			Storage
	244-A Receiver Tank			Storage
D-2-9	Low-Level Burial Grounds			
	218-E-12B	200-PO-6		Landfill
S-2-1	PUREX Tunnels 1 and 2			
	218-E-14			Storage
	218-E-15			Storage
S-2-4	Single-Shell Tanks			
	241-A Farm (6 tanks)	200-PO-3	X	
	241-AX Farm (4 tanks)	200-PO-3	X	
	241-C Farm (16 tanks)	200-PO-3	X	
T-2-6	242-A Evaporator			Treatment
TS-2-6	PUREX			
	Neutralization Tank E-5			Treatment
	E-F11 Concentrator			Treatment
	Neutralization Tank G-7			Treatment
	Ammonia Distillate Treatment System (Future Tank)			Treatment

9 2 1 2 6 . 6 0 2 0 5

Table 2-10. Listing of Treatment, Storage, and Disposal Groups/Units Within the PUREX Plant Aggregate Area.

Treatment, Storage, and Disposal		Operable Unit	Planned Action	
Group No.	Group/Units		Closure*	Operating Permit
TS-2-6 (Cont.)	PUREX			
	Neutralization Tank F-18			Treatment
	Neutralization Tank F-15			Treatment
	Neutralization Tank F-16			Treatment
	Neutralization Tank U3			Treatment
	Neutralization Tank U4			Treatment
	Purex Waste Piles			Storage

* Post-Closure Permit required if closed as a land disposal unit in accordance with Section 6.3.3.

Table 2-11. Radiation Area Remedial Action Units in the PUREX Aggregate Area.

Waste Management Unit	Type	Operable Unit
200-E Burning Pit	Burning Pit	200-PO-6
216-A-1	Crib	200-PO-5
216-A-2	Crib	200-PO-2
216-A-3	Crib	200-PO-1
216-A-4	Crib	200-PO-2
216-A-5	Crib	200-PO-2
216-A-6	Crib	200-PO-4
216-A-7	Crib	200-PO-5
216-A-9	Crib	200-PO-1
216-A-10	Crib	200-PO-2
216-A-11	French Drain	200-PO-1
216-A-12	French Drain	200-PO-1
216-A-13	French Drain	200-PO-1
216-A-14	French Drain	200-PO-1
216-A-15	French Drain	200-PO-2
216-A-16	French Drain	200-PO-5
216-A-17	French Drain	200-PO-5
216-A-18	Trench	200-PO-5
216-A-19	Trench	200-PO-5
216-A-20	Trench	200-PO-5
216-A-21	Crib	200-PO-2
216-A-22	French Drain	200-PO-1
216-A-23A	French Drain	200-PO-5
216-A-23B	French Drain	200-PO-5
216-A-24	Crib	200-PO-5
216-A-26A	French Drain	200-PO-1
216-A-27	Crib	200-PO-2
216-A-28	French Drain	200-PO-1
216-A-31	Crib	200-PO-2
216-A-32	Crib	200-PO-1
216-A-33	French Drain	200-PO-1
216-A-34	Ditch	200-PO-5
216-A-35	French Drain	200-PO-1
216-A-36A	Crib	200-PO-2
216-A-38-1	Crib	200-PO-2
216-A-39	Crib	200-PO-3
216-A-40	Trench	200-PO-1
216-A-41	Crib	200-PO-1
216-C-8	French Drain	200-PO-3
218-E-1	Burial Ground	200-PO-1
218-E-8	Burial Ground	200-PO-6
218-E-12A	Burial Ground	200-PO-6
218-E-13	Burial Ground	200-PO-1

Table 2-12. Defense Waste Management Program Units in the PUREX Plant Aggregate Area.

Waste Management Unit	Type	Operable Unit
241-A-302A	Catch Tank	200-PO-1
241-A-350	Catch Tank	200-PO-3
241-A-417	Catch Tank	200-PO-3
241-AX-152CT	Catch Tank	200-PO-3
216-A-8	Crib	200-PO-5
216-A-30	Crib	200-PO-4
216-A-37-1	Crib	200-PO-4
216-A-37-2	Crib	200-PO-4
216-A-45	Crib	200-PO-2
216-A-26	French Drain	200-PO-1
216-A-29	Ditch	200-PO-5
241-A-A	Diversion Box	200-PO-3
241-A-B	Diversion Box	200-PO-3
241-A-151	Diversion Box	200-PO-1
241-AR-151	Diversion Box	200-PO-3
241-AX-A	Diversion Box	200-PO-3
241-AX-B	Diversion Box	200-PO-3
241-AX-151	Diversion Box	200-PO-3
241-AX-152DS	Diversion Box	200-PO-3
241-AX-155	Diversion Box	200-PO-3
241-ER-153	Diversion Box	200-PO-3
241-AX-501	Valve Pit	200-PO-3
207-A	Retention Basins	200-PO-5
216-A-42	Retention Basin	200-PO-4

3.0 SITE CONDITIONS

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

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

Sections describing topography, geology, and hydrogeology have been taken from standardized texts provided by Westinghouse Hanford (Delaney et al. 1991 and Lindsey et al. 1992) for that purpose.

3.1 PHYSIOGRAPHY AND TOPOGRAPHY

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

The physiography of the Hanford Site is dominated by the low-relief plains of the Central Plains physiographic region and anticlinal ridges of the Yakima Folds physiographic region (Figure 3-3). Surface topography seen at the Hanford Site is the result of (1) uplift of

anticlinal ridges, (2) Pleistocene cataclysmic flooding, and (3) Holocene eolian activity (DOE 1988b). Uplift of the ridges began in the Miocene epoch and continues to the present. Cataclysmic flooding occurred when ice dams in western Montana and northern Idaho were breached, allowing large volumes of water to spill across eastern and central Washington. The last major flood occurred about 13,000 years ago, during the late Pleistocene Epoch. Anastomosing flood channels, giant current ripples, bergmounds, and giant flood bars are among the landforms created by the floods. Since the end of the Pleistocene Epoch, winds have locally reworked the flood sediments, depositing dune sands in the lower elevations and loess (windblown silt) around the margins of the Pasco Basin. Generally, sand dunes have been stabilized by anchoring vegetation except where they have been reactivated where vegetation is disturbed (Figure 3-4).

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

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

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

3.2 METEOROLOGY

The following sections provide information on Hanford Site meteorology including precipitation (Section 3.2.1), wind conditions (Section 3.2.2), and temperature variability (Section 3.2.3).

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

3.2.1 Precipitation

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

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

3.2.2 Winds

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

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

3.2.3 Temperature

Based on data from 1914 to 1980, minimum winter temperatures vary from -33 to -6° C (-27 to +22 °F), and maximum summer temperatures vary from 38 to 46 °C (100 to 115 °F). Between 1914 and 1980, a total of 16 days with temperatures -29 °C (-20 °F) or

below are recorded. There are 10 days of record when the maximum temperature failed to go above -18 °C (0 °F). Prior to 1980, there were three summers on record when the temperatures were 38 °C (100 °F) or above for 11 consecutive days (Stone et al. 1983).

3.3 SURFACE HYDROLOGY

3.3.1 Regional Surface Hydrology

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

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

3.3.2 Surface Hydrology of the Hanford Site

Primary surface water features associated with the Hanford Site, located near the center of the Pasco Basin, are the Columbia and Yakima Rivers and their major tributaries, the Snake and Walla Walla Rivers. West Lake, about 4 hectares (10 acres) in size and less than 0.9 m (3 ft) deep, is the only natural lake within the Hanford Site (DOE 1988b). Wastewater ponds, cribs, and ditches associated with nuclear fuel reprocessing and waste disposal activities are also present on the Hanford Site.

The Columbia River flows through the northern part and along the eastern border of the Hanford Site. This section of the river, the Hanford Reach, extends from Priest Rapids Dam to the headwaters of Lake Wallula (the reservoir behind McNary Dam). Flow along the Hanford Reach is controlled by Priest Rapids Dam. Several drains and intakes are also present along this reach, including irrigation outfalls from the Columbia Basin Irrigation

Project, the Washington Public Power Supply System (WPPSS) Nuclear Project 2, and Hanford Site intakes for onsite water use. Much of the northern and eastern parts of the Hanford Site are drained by the Columbia River.

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

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

3.3.3 PUREX Plant Aggregate Area Surface Hydrology

No natural surface water bodies exist in the PUREX Plant Aggregate Area. The only existing manmade surface water bodies are the 207-U Retention Basins and the open stretches of the 216-A-29 Ditch. The 216-A-29 Ditch is located outside the perimeter fence, southeast of the southeast corner of the 241-A Tank Farm. The ditch empties into the 216-B-3-3 Ditch that terminates at the 216-B-3 Pond. During the fall of 1991, the 216-A-29 Ditch was dramatically changed. The southern portion of the ditch, located within the Grout Treatment Facility (GTF), has been stabilized, filled to grade with gravel, surrounded with a light chain barricade, and posted with underground contamination placards. The section of the ditch north of the GTF has been cleared of vegetation and graded to a gentle side slope. Several gravel covered ridges cross the ditch. These discontinuous open portions of the ditch represent minor, if any, ponding and infiltration potential due to the nature of the soil that allows the entry of surface water into the ground. The 207-A Retention Basins present no threat of flooding because the north basins discharge into the Gable Mountain Pond pipeline and the south basins are discharged to the 216-A-37 Crib.

The 200 East Area, and specifically the PUREX Plant Aggregate Area, is not in a designated floodplain. Calculations of probable maximum floods for the Columbia River and the Cold Creek Watershed indicate that the 200 East Area is not expected to be inundated under maximum flood conditions (DOE/RL 1991b).

3.4 GEOLOGY

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

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

3.4.1 Regional Tectonic Framework

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

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

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

The principal characteristics of the Yakima Fold Belt (Figure 3-10) are a series of segmented, narrow, asymmetric anticlines that have wavelengths between 5 and 32 km (3 and 19 mi) and amplitudes commonly less than 1 km (0.6 mi) (Reidel 1984; Reidel et al. 1989a). The northern limbs of the anticlines generally dip steeply to the north, are vertical, or even overturned. The southern limbs generally dip at relatively shallow angles to the south. Thrust or high-angle reverse faults with fault planes that strike parallel or subparallel to the axial trends are principally found on the north sides of these anticlines. The amount of vertical stratigraphic offset associated with these faults varies but commonly exceeds hundreds of meters. These anticlinal ridges are separated by broad synclines or basins that, in many cases, contain thick accumulations of Neogene- to Quaternary-age sediments. The Pasco Basin is one of the larger structural basins in the Yakima Fold Belt Subprovince.

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

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

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

3.4.1.3 Regional and Hanford Site Seismology. Eastern Washington, especially the Columbia Plateau region, is a seismically inactive area when compared to the rest of the

western United States (DOE 1988b). The historic seismic record for eastern Washington began in approximately 1850, and no earthquakes large enough to be felt had epicenters on the Hanford Site. The closest regions of historic moderate-to-large earthquake generation are in western Washington and Oregon and western Montana and eastern Idaho. The most significant event relative to the Hanford Site is the 1936 Milton-Freewater, Oregon, earthquake that had a magnitude of 5.75 and that occurred more than 90 km (54 mi) away. The largest Modified Mercalli Intensity for this event was felt about 105 km (63 mi) from the Hanford site at Walla Walla, Washington, and was VII.

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

3.4.2 Regional Stratigraphy

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

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

The suprabasalt sediment sequence is up to approximately 230 m (750 ft) thick and dominated by laterally extensive deposits assigned to the late Miocene- to Pliocene-age Ringold Formation and the Pleistocene-age Hanford formation (Figure 3-13). Locally occurring strata informally referred to as the pre-Missoula gravels, Plio-Pleistocene unit, and early "Palouse" soil comprise the remainder of the sedimentary sequence. The pre-Missoula gravels underlie the Hanford formation in the east-central Cold Creek syncline and at the east end of Gable Mountain anticline east and south of 200 East Area. The pre-Missoula gravels have not been identified in the 200 East Area. The nature of the contact between the pre-

Missoula gravels and the overlying Hanford formation has not been completely delineated. In addition, it is unclear whether the pre-Missoula gravels overlie or interfinger with the early "Palouse" soil and Plio-Pleistocene unit. Magnetic polarity data indicate the unit is no younger than early Pleistocene in age (>1 Ma) as discussed in Baker et al. (1991).

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

3.4.2.1 Columbia River Basalt Group. The Columbia River Basalt Group (Figure 3-12) comprises an assemblage of tholeiitic, continental flood basalts of Miocene age. These flows cover an area of more 163,700 km^2 (63,000 mi^2) in Washington, Oregon, and Idaho and have an estimated volume of about 174,356 km^3 (40,800 mi^3) (Tolan et al. 1989). Isotopic age determinations indicate that basalt flows were erupted approximately 17 to 6 Ma (million years before present), with more than 98% by volume being erupted in a 2.5 million year period (17 to 14.5 Ma) (Reidel et al. 1989b).

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

3.4.2.2 Ellensburg Formation. The Ellensburg Formation consists of all sedimentary units that occur between the basalt flows of the Columbia River Basalt Group in the central Columbia Basin. The Ellensburg Formation generally displays two main lithologies: volcaniclastics (Reidel and Fecht 1981; Smith et al. 1989), and siliciclastics (DOE 1988b). The volcaniclastics consist mainly of primary pyroclastic air fall deposits and reworked epiclastics derived from volcanic terrains west of the Columbia Plateau. Siliciclastic strata in the Ellensburg Formation consists of reworked clastic, plutonic, and metamorphic detritus derived from the Rocky Mountain terrain. These two lithologies occur as both distinct and mixed in the Pasco Basin. A detailed discussion of the Ellensburg Formation in the Hanford Site is given by Reidel and Fecht (1981). Smith et al. (1989) provide a discussion of age equivalent units adjacent to the Columbia Plateau.

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

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

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

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

3.4.2.3 Ringold Formation. The Ringold Formation at the Hanford Site is up to 185 m (607 ft) thick in the deepest part of the Cold Creek syncline south of the 200 West Area and 170 m (558 ft) thick in the western Wahluke syncline near the 100-B Area. The Ringold Formation pinches out against the Gable Mountain, Yakima Ridge, Saddle Mountains, and Rattlesnake Mountain anticlines. It is largely absent in the northern and northeastern parts of the 200 East Area and adjacent areas to the north in the vicinity of Gable Gap. The Ringold Formation is assigned a late Miocene to Pliocene age (Fecht 1978; DOE 1988b) and was deposited in alluvial and lacustrine environments (Bjornstad 1985; Fecht et al. 1987; Lindsey 1991a).

Recent studies of the Ringold Formation (Lindsey and Gaylord 1989; Lindsey et al. 1992) indicate that it is best described and divided on the basis of sediment facies associations and their distribution. Facies associations in the Ringold Formation (defined on the basis of lithology, petrology, stratification, and pedogenic alteration) include fluvial

gravel, fluvial sand, overbank deposits, lacustrine deposits, and alluvial fan. The facies associations are summarized as follows:

- Fluvial gravel--Clast-supported granule to cobble gravel with a sandy matrix dominates the association. Intercalated sands and muds also are found. Clast composition is variable, with common types being basalt, quartzite, porphyritic volcanics, and greenstones. Silicic plutonic rocks, gneisses, and volcanic breccias also are found. Sands in this association are generally quartzo-feldspathic, with basalt contents generally in the range of 5 to 25%. Low angle to planar stratification, massive bedding, wide, shallow channels, and large-scale cross-bedding are found in outcrops. The association was deposited in a gravelly fluvial system characterized by wide, shallow, shifting channels.

- Fluvial sand--Quartzo-feldspathic sands displaying cross-bedding and cross-lamination in outcrop dominate this association. These sands usually contain less than 15% basalt lithic fragments, although basalt contents as high as 50% may be encountered. Intercalated strata consist of lenticular silty sands and clays up to 3 m (10 ft) thick and thin (<0.5 m) gravels. Fining upwards sequences less than 1 m (3.3 ft) to several meters thick are common in the association. Strata comprising the association were deposited in wide, shallow channels.

- Overbank deposits--This association dominantly consists of laminated to massive silt, silty fine-gained sand, and paleosols containing variable amounts of pedogenic calcium carbonate. Overbank deposits occur as thin lenticular interbeds (<0.5 m to 2 m, <1.6 ft to 6 ft) in the fluvial gravel and fluvial sand associations and as thick (up to 10 m, 3 ft) laterally continuous sequences. These sediments record deposition in a floodplain under proximal levee to more distal floodplain conditions.

- Lacustrine deposits--Plane laminated to massive clay with thin silt and silty sand interbeds displaying some soft-sediment deformation characterize this association. Coarsening upwards packages less than 1 m (3.3 ft) to 10 m (33 ft) thick are common in the association. Strata comprising the association were deposited in a lake under standing water to deltaic conditions.

- Alluvial fan--Massive to crudely stratified, weathered to unweathered basaltic detritus dominates this association. These basaltic deposits generally are found around the periphery of the basin. This association was deposited largely by debris flows in alluvial fan settings.

The lower half of the Ringold Formation contains five separate stratigraphic intervals dominated by fluvial gravels. These gravels, designated units, A, B, C, D, and E

(Figure 3-13), are separated by intervals containing deposits typical of the overbank and lacustrine facies associations. The lowermost of the fine-grained sequences, overlying unit A, is designated the lower mud sequence. The uppermost gravel unit, unit E, grades upwards into interbedded fluvial sand and overbank deposits. These sands and overbank deposits are overlain by lacustrine-dominated strata.

Fluvial gravel units A and E correspond to the lower basal and middle Ringold units respectively as defined by DOE (1988b). Gravel units B, C, and D do not correlate to any previously defined units (Lindsey 1991a). The lower mud sequence corresponds to the upper basal and lower units as defined by DOE (1988b). The upper basal and lower units are not differentiated. The sequence of fluvial sands, overbank deposits, and lacustrine sediments overlying unit E corresponds to the upper unit as seen along the White Bluffs in the eastern Pasco Basin. This essentially is the same usage as originally proposed by Newcomb (1958) and Myers et al. (1979).

3.4.2.4 Plio-Pleistocene Unit. Unconformably overlying the Ringold Formation in the western Cold Creek syncline in the vicinity of 200 West Area (Figures 3-11, 3-12, and 3-13) is the laterally discontinuous Plio-Pleistocene unit (DOE 1988b). The unit is up to 25 m (82 ft) thick and divided into two facies: (1) sidestream alluvium and (2) calcic paleosol (Stage III and Stage IV) (Bjornstad 1984; DOE 1988b). The calcic paleosol facies consist of massive calcium carbonate-cemented silt, sand, and gravel (caliche) to interbedded caliche-rich and caliche-poor silts and sands. The basaltic detritus facies consists of weathered and unweathered basaltic gravels deposited as locally derived slope wash, colluvium, and sidestream alluvium. Where the unit occurs, it unconformably overlies the Ringold Formation. The Plio-Pleistocene unit appears to be correlative to other sidestream alluvial and pedogenic deposits found near the base of the ridges bounding the Pasco Basin on the north, west, and south. These sidestream alluvial and pedogenic deposits are inferred to have a late Pliocene to early Pleistocene age on the basis of stratigraphic position and magnetic polarity of interfingering loess units.

3.4.2.5 Pre-Missoula Gravels. Quartzose to gneissic clast-supported pebble to cobble gravel with a quartzo-feldspathic sand matrix underlies the Hanford formation in the east-central Cold Creek syncline and at the east end of Gable Mountain anticline east and south of the 200 East Area (Figures 3-11, 3-12, and 3-13). These gravels, called the pre-Missoula gravels (PSPL 1982), are up to 25 m (82 ft) thick, contain less basalt than underlying Ringold gravels and overlying Hanford deposits, have a distinctive white or bleached color, and sharply truncate underlying strata. The nature of the contact between the pre-Missoula gravels and the overlying Hanford formation is not clear. In addition, it is unclear whether the pre-Missoula gravels overlie or interfinger with the early "Palouse" soil and Plio-Pleistocene unit. Magnetic polarity data indicates the unit is no younger than early Pleistocene in age (>1 Ma) (Baker et al. 1991).

3.4.2.6 Early "Palouse" Soil. The early "Palouse" soil consists of up to 20 m (66 ft) of massive, brown yellow, and compact, loess-like silt and minor fine-grained sand (Tallman et al. 1979, 1981; DOE 1988b). These deposits overlie the Plio-Pleistocene unit in the western Cold Creek syncline around the 200 West Area (Figures 3-11, 3-12, and 3-13). The unit is differentiated from overlying graded rhythmites (Hanford formation) by greater calcium carbonate content, massive structure in core, and high natural gamma response in geophysical logs (DOE 1988b). The upper contact of the unit is poorly defined, and it may grade up-section into the lower part of the Hanford formation. Based on a predominantly reversed polarity the unit is inferred to be early Pleistocene in age (Baker et al. 1991).

3.4.2.7 Hanford Formation. The Hanford formation consists of pebble to boulder gravel, fine- to coarse-grained sand, and silt (Baker et al. 1991). These deposits are divided into three facies: (1) gravel-dominated, (2) sand-dominated, and (3) silt-dominated facies. These facies are referred to as coarse-grained deposits, plane-laminated sand facies, and rhythmite facies, respectively, in Baker et al. (1991). The silt-dominated facies also is referred to as slackwater deposits or Touchet Beds, while the gravelly facies are generally referred to as the Pasco Gravels. The Hanford formation is thickest in the Cold Creek bar in the vicinity of 200 West and 200 East Areas where it is up to 107 m (350 ft) thick (Figures 3-11, 3-12, and 3-13). The Hanford formation was deposited by cataclysmic flood waters that drained out of glacial Lake Missoula (Fecht et al. 1987; DOE 1988b; and Baker et al. 1991. Hanford deposits are absent on ridges above approximately 385 m (1,263 ft) above sea level. The following sections describe the three Hanford formation facies.

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

3.4.2.7.2 Sand-Dominated Facies. The sand-dominated facies consists of fine-grained to coarse-grained sand and granule gravel displaying plane lamination and bedding

and less commonly plane cross-bedding in outcrop. These sands may contain small pebbles and rip-up clasts in addition to pebble-gravel interbeds and silty interbeds less than 1 m (3.3 ft) thick. The silt content of these sands is variable, but where it is low, an open framework texture is common. These sands are typically very basaltic, commonly being referred to as black, gray, or salt and pepper sands. This facies is most common in the central Cold Creek syncline, in the central to southern parts of the 200 East and 200 West Areas, and in the vicinity of the WPPSS facilities. The sand-dominated facies was deposited in channelways as flow power waned and adjacent to main flood channelways as water in the channelways spilled out of them, losing their competence. The facies is transitional between gravel-dominated facies and silt-dominated facies.

3.4.2.7.3 Silt-dominated Facies. The silt-dominated (slackwater) facies consists of thinly bedded, plane-laminated and ripple cross-laminated silt and fine- to coarse-grained sand that commonly display normally graded rhythmites similar to Bouma sequences, a few centimeters to several tens of centimeters thick in outcrop (Myers et al. 1979; DOE 1988b; Baker et al. 1991). The facies dominates the Hanford formation throughout the central, southern, and western Cold Creek syncline within and south of 200 East and West Areas. These sediments were deposited under slackwater conditions and in backflooded areas (DOE 1988b).

In addition to the three Hanford formation facies discussed previously, clastic dikes (Black 1980) also are commonly found in the Hanford formation. These dikes, while common in the Hanford formation, also are found locally in other sedimentary units in the Pasco Basin. Clastic dikes, whether in the Hanford formation or other sedimentary units, are structures that generally cross-cut bedding, although they do locally parallel bedding. The dikes generally consist of alternating vertical to subvertical layers (millimeters to centimeters thick) of silt, sand, and granules. Where the dikes intersect the ground surface, a feature known as patterned ground can be observed (Lindsey et al. 1992).

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

3.4.3 200 East Area and PUREX Plant Aggregate Area Geology

The following sections describe the occurrence and variation of suprabasalt sediments in the 200 East Area. The sections discuss notable stratigraphic characteristics, sediment thickness variations, dip trends, and other features such as areas where formations are known or suspected to be absent. Also, stratigraphic variations pertinent to the PUREX Plant Aggregate Area are identified where applicable, and are presented in the overall context of

stratigraphic trends throughout the 200 East Area. The following sections are based on Lindsey et al. (1992) and a review of boring logs from wells in the PUREX Plant Aggregate Area (Chamness et al. 1992).

Geologic cross-sections depicting the stratigraphy and the relative thickness of basalt and sedimentary units within and near the PUREX Plant Aggregate Area are presented on Figures 3-14 through 3-18. Figure 3-14 illustrates the cross-sections locations. A legend for symbols used on the cross-sections is provided on Figure 3-15. The cross-sections are based on geologic information from wells shown on the figures, as interpreted in Lindsey et al. (1992). To develop these stratigraphic interpretations, logs for all the wells in the PUREX Plant Aggregate Area were reviewed and a selection was made of the most relevant to the PUREX Plant AAMS. The cross sections depict subsurface geology in the PUREX Plant Aggregate Area. For each cross-section, locations of PUREX Plant Aggregate Area waste management units are identified for reference. Figures 3-19 through 3-31 present structure maps of the top of the sedimentary units, and isopach maps illustrating the thickness of each unit in the 200 East Area and PUREX Plant Aggregate Area. The structure and isopach maps are included from Lindsey et al. (1992). Plate 1 should be consulted to identify locations of PUREX Plant Aggregate Area buildings and waste management units referenced in the text.

3.4.3.1 Elephant Mountain Basalt. The uppermost basalt unit beneath most of the 200 East Aggregate Area is the Elephant Mountain Member of the Saddle Mountains Basalt. At one location north of the 200 East Area, the Elephant Mountain Member is absent due to erosion by cataclysmic flooding, and the uppermost basalt encountered is the Pomona Member. Where the Elephant Mountain Member is absent the Rattlesnake Ridge Interbed, the sedimentary unit that commonly separates the Elephant Mountain and Pomona Members, is in direct contact with overlying suprabasalt sediments.

3.4.3.2 Ellensburg Formation. The Rattlesnake Ridge Interbed of the Ellensburg Formation is found beneath the entire 200 East Area (Reidel and Fecht 1981). Mapping on Gable Mountain indicates it is absent at many localities on this structural high (Fecht 1978). Three units comprise the Rattlesnake Ridge interbed; (1) a lower clay or tuffaceous sandstone, (2) a middle, micaceous-arkosic and/or tuffaceous sandstone, and (3) an upper, tuffaceous siltstone or sandstone. In the 200 Area East, the unit thickens from 6 m (20 ft) in the north to approximately 24 m (79 ft) in the south. The upper contact of the interbed with the overlying Elephant Mountain Member generally is baked from contact with the Elephant Mountain Basalt (Fecht 1978).

3.4.3.3 Ringold Formation. Within the 200 East Area, the Ringold Formation includes the fluvial gravels of unit A, the paleosol and lacustrine muds of the lower mud sequence, the fluvial gravels of unit E, and the sand and minor muds of the upper unit. These strata are

found throughout the southern two-thirds of the 200 East Area where it disconformably overlies basalt. The Ringold Formation is absent from the north-central part of the area where sediment of the overlying Hanford formation directly overlie basalt or sedimentary interbeds in the basalt. Ringold units B, C, and D are not found in the immediate vicinity of the 200 East Area.

The lowest Ringold unit in the 200 East Area, the fluvial gravels of unit A, thicken and dip to the south and southwest towards the axis of the Cold Creek syncline. Unit A generally pinches out in the central part of the area against structural highs in the underlying basalt. Thin, lenticular occurrences of unit A are found locally in the area between the northeast 200 East Area and Gable Mountain. Most of the Ringold gravels encountered in the central part of the 200 East Area probably belong to unit A (Lindsey et al. 1992). The top of the unit is a relatively flat surface that dips to the south into the Cold Creek syncline. Intercalated lenticular sand and silt of the fluvial sand overbank facies associations are found locally in the middle part of the unit in the southeastern part of the area. In the PUREX Plant Aggregate Area, the Ringold unit A is present throughout the area except in the northern portion near the 218-E-12B Burial Ground (Figures 3-19 and 3-20).

The overbank and lacustrine deposits of the lower mud sequence thicken and dip to the south and southwest in a manner similar to the Ringold unit A gravels. However, unlike unit A, the line along which the lower mud sequences pinches out is very irregular. In the area between the 200 East Area and Gable Mountain the lower mud sequence can be found directly overlying the Elephant Mountain basalt at a number of locations where unit A is absent. Within the central part of the 200 East Area the lower mud sequence is largely absent. The nature of the pinchout of the lower mud sequence varies from location to location. At some locations it pinches out against uplifted basalt while at other locations the sequence is truncated by overlying deposits (either Ringold gravel unit E or Hanford gravels). In the area between Gable Mountain and the 200 East Area and in the vicinity of the B Pond complex, the lower mud sequence forms the uppermost part of the Ringold Formation and is overlain by the Hanford formation. Throughout the rest of the 200 East Area the lower mud sequence is overlain by the gravels of Ringold unit E. In regard to the PUREX Plant Aggregate Area, the lower mud sequence is thickest in the GTF near the 216-A-30 Crib where the sequence reaches a thickness of approximately 15.2 m (50 ft). The lower mud sequence is absent just north of the southern corner of the 241-C Tank Farm (Figures 3-21 and 3-22).

Ringold unit E thickens to the south and southwest in the 200 East Area. Like the lower mud sequence, the line along which unit E pinches out is very irregular. In the 200 East Area, unit E is largely restricted to the southwest corner of the area and the GTF. It is absent in the B Pond area, the central and northern part of the area, and from the area between 200 East and Gable Mountain. Based on the stratigraphic relationships shown in

Figure 3-12, most of the Ringold gravels encountered beneath the central part of the 200 East Area are part of gravel unit A and not gravel unit E. Ringold unit E dominantly consists of fluvial gravels. Strata typical of the fluvial sand and overbank facies associations may be encountered locally. However, predicting where intercalated lithologies will occur is very difficult. In the PUREX Plant Aggregate Area, the Ringold unit E is not present north of the 241-AX Tank Farm. The Ringold Unit E is found throughout the southern part of the PUREX Plant Aggregate Area and is thickest (34 m, 105 ft) near the 216-A-36B Crib (Figures 3-23, 3-24, and 3-25).

3.4.3.4 Plio-Pleistocene Unit and Early "Palouse" Soil. The Plio-Pleistocene unit and early "Palouse" soil are not found within or near the 200 East Area or the PUREX Plant Aggregate Area. They are encountered only near the eastern boundary of the 200 West Area approximately 5 km (3 mi) from the 200 East Area.

3.4.3.5 Hanford Formation. As discussed in the regional geology section, the cataclysmic flood deposits of the Hanford formation are divided into three facies: 1) gravel-dominated, 2) sand-dominated, and 3) the silt-dominated facies. Typical lithologic successions consist of fining upwards packages, major fine-grained intervals, and laterally persistent coarse-grained sequences. Mineralogic and geochemical data were not used in differentiating units because of the lack of a comprehensive mineralogic and geochemical data set. Studying the distribution of these facies types and identifying similarities in lithologic succession from borehole to borehole across the 200 East Area indicates the Hanford formation can be divided into three stratigraphic sequences. These sequences are designated the: (1) lower gravel, (2) sand, and (3) upper gravel. However, because of the variability of Hanford deposits, contacts between the sequences can be difficult to identify.

The sequences are composed mostly of the gravel-dominated and sand-dominated facies. The silt-dominated facies is relatively rare except in the southern part of the 200 East Area. Two of the sequences are dominated by deposits typical of the gravel-dominated facies and they are designated the upper and lower gravel sequences. The third sequence consists of deposits of the sand-dominated facies with lesser intercalated occurrences from both the gravel-dominated and silt-dominated facies. This sequence, designated the sandy sequence, generally is situated between the upper and lower gravel sequences.

The lower gravel sequence is dominated by deposits typical of the gravel-dominated facies. Local intercalated intervals of the sand-dominated facies are also found. The lower gravel sequence ranges form 0 to 41 m (0 to 133 ft) thick and is found throughout most of the 200 East Area. In the northern portion of the PUREX Plant Aggregate Area the lower gravel sequence is not differentiated from the upper gravel sequence due to the absence of the sandy sequence which is used to distinguish the two gravel sequences from one another. The contact between the lower coarse sequence and the overlying sandy sequence is placed at

the top of the first thick (> 6 m, >20 ft) gravel interval encountered below the sand-dominated strata of the sandy sequence. In the PUREX Plant Aggregate Area the lower gravel sequence is thickest near the northeastern border near the 218-E-12B Burial Ground. In the center of the PUREX Plant Aggregate Area, near the 202-A Building and the 241-C Tank Farm, the lower gravel sequence is absent (Figures 3-26 and 3-27).

The sandy sequence consists of a heterogenous mix of sands typical of the sand-dominated facies. Deposits of the silt-dominated facies are present, but less abundant. The sandy sequence ranges from 0 to 84 m (0 to 275 ft) thick. This sequence is dominated by the sand-dominated facies in the north, and the silt-dominated facies becomes more common towards the south. Gravels, occurring as single clasts and as interbeds are common in the sandy sequence, especially towards the north. The sandy sequence probably contains the greatest concentration of clastic dikes and it is laterally equivalent with lower fine sequence in the 200 West Area (Lindsey et al. 1991). Where the sandy sequence pinches out it commonly interfingers with gravels of the overlying and underlying gravel sequences. Where this occurs the contact separating the sandy sequence from the other intervals is difficult to place. The sandy sequence is differentiated from the gravelly strata of the upper and lower gravel sequences on the basis of sand content. The base of the sandy sequence is placed at the top of the highest gravelly interval and underlies sand-dominated strata. The top of the sequence is placed at the top of the highest thick, sand-dominated interval. In the PUREX Plant Aggregate Area, the thickness of the sequence ranges from 14 m (44 ft) near the northeast corner to 87 m (265 ft) near the 202-A Building (Figures 3-28 and 3-29).

The third Hanford formation stratigraphic sequence consists of gravel-dominated strata referred to as the upper gravel sequence. This sequence is dominated by deposits typical of the gravel-dominated facies. Lesser occurrences of the sand-dominated facies are encountered locally. The sequence thins from as much as 55 m (180 ft) in the north to zero near the southern border of the 200 East Area. In addition, at one location, northwest of the 200 East Area, the sequence thins more than surrounding localities and at another location, in the central part of the 200 East Area, the unit is completely absent. Where the upper gravel sequence is thickest, in the north, it is found to form an elongated northwest to southeast oriented body. The upper gravel and lower gravel sequences are not differentiated in this area where the intervening sandy sequence is absent. In the PUREX Plant Aggregate Area the thickness of the upper gravel sequence ranges from approximately 8 m (25 ft) near the 216-A-45 Crib to 32 m (98 ft) in the northeast corner near the 218-E-12B Burial Ground (Figures 3-30 and 3-31).

3.4.3.6 Holocene Surficial Deposits. Holocene-age surficial deposits in the 200 East Area are dominated by very fine- to medium-grained to occasionally silty eolian sheet sands. These deposits have been removed from much of the area by construction activities. Where the eolian sands are found they tend to consist of thin sheets (<3 m, 10 ft) that cover the

ground. Longitudinal (southwest to northeast trending) dunes are well developed in the southern part of the 200 East Area. The Holocene surficial deposits are not differentiated on cross-sections and maps because they are relatively thin and because of the lack of definition on so many of the borehole geologic logs available for the 200 East Area and the PUREX Plant Aggregate Area.

3.5 HYDROGEOLOGY

Regional hydrogeology and hydrogeology of the 200 East Area are summarized in the following sections. Where sufficient data exists, interpretations of the hydrogeology beneath the PUREX Plant Aggregate Area are presented. The information presented in these sections is principally taken from the standardized text (Delaney et al. 1991) provided by Westinghouse Hanford for this purpose.

3.5.1 Regional Hydrogeology

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

Local recharge to the shallow basalt aquifers results from infiltration of precipitation and runoff along the margins of the Pasco Basin, and in areas of artificial recharge where a downward gradient from the unconfined aquifer systems to the uppermost confined basalt aquifer may occur. Regional recharge of the deep basalt aquifers is inferred to result from interbasin groundwater movement originating northeast and northwest of the Pasco Basin in areas where the Wanapum and Grande Ronde Basalts crop out extensively (DOE 1988).

Groundwater discharge from shallow basalt aquifers is probably to the overlying aquifers and to the Columbia River. The discharge area(s) for the deeper groundwater system is uncertain, but flow is inferred to be generally southeastward with discharge thought to be south of the Hanford Site (DOE 1988b).

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

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

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

3.5.2 Hanford Site Hydrogeology

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

3.5.2.1 Hydrostratigraphy. The hydrostratigraphic units of concern in the 200 Areas are 1) the Rattlesnake Ridge interbed (confined water-bearing zone), 2) the Elephant Mountain Basalt Member (confining horizon), 3) the Ringold Formation (unconfined and confined water-bearing zones and lower part of the vadose zone), 4) the Plio-Pleistocene unit and

early "Palouse" soil (primary vadose zone perching horizons and/or perched groundwater zones) and 5) the Hanford formation (vadose zone) (Figure 3-32). The Plio-Pleistocene unit and early "Palouse" soil are only encountered in the 200 West Area. Strata below the Rattlesnake Ridge interbed are not discussed because the more significant water-bearing intervals, relating to environmental issues, are primarily closer to ground surface. The hydrogeologic designations for the 200 Areas were determined by examination of borehole logs and integration of these data with stratigraphic correlations from existing reports.

3.5.2.1.1 Vadose Zone. The vadose zone beneath the 200 Areas ranges from approximately 55 m (180 ft) beneath the former U Pond to approximately 104 m (318 ft) in the southern portion of the 200 East Area (Last et al. 1989). Sediments in the vadose zone consist of the 1) fluvial gravel of Ringold unit E, 2) the upper unit of the Ringold Formation, 3) Plio-Pleistocene unit, 4) early "Palouse" soil, and 5) Hanford formation. Only the Hanford formation is continuous throughout the vadose zone in the 200 Areas. The upper unit of the Ringold Formation, the Plio-Pleistocene unit, and the early "Palouse" soil only occur in the 200 West Area. In the 200 East Area the Plio-Pleistocene and early "Palouse" soil are absent. The unconfined aquifer water table (discussed in Section 3.5.2.1.3) lies within the Ringold unit E and the Hanford formation.

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

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

where

- $K(\theta)$ is the water-content-dependent unsaturated hydraulic conductivity in cm/s
- $\partial\varphi/\partial\theta$ is the slope of the soil-moisture retention curve $\varphi(\theta)$ at a particular volumetric moisture content θ (a soil-moisture retention curve plots volumetric moisture content observed in the field or laboratory against suction values for a particular soil, see Figure 3-33 from Gee and Heller (1985) for an example)
- $\partial\theta/\partial x$ is the water content gradient in the x direction.

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

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

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

An alternative to direct measurement of unsaturated hydraulic conductivity is to use theoretical methods that predict the conductivity from measured soil moisture retention data (Van Genuchten et al. 1991).

Thirty-five soil samples from the 200 West Area have had moisture retention data measured. These samples were collected from Wells 299-W18-21, 299-W15-16, 299-W15-2, 299-W10-13, 299-W7-9, and 299-W7-2. Eleven of these samples were reported by Bjornstad (1990). The remaining 24 were analyzed as part of an ongoing performance assessment of the low-level burial grounds (Connelly et al. 1992). For each of these samples saturated hydraulic conductivity was measured in the laboratory. Van Genuchten's computer program RETC was then used to develop wetting and drying curves for the Hanford, early "Palouse," Plio-Pleistocene, upper Ringold, and Ringold Gravel lithologic units. An example of the wetting and drying curves, and corresponding grain size distributions, is provided on Figure 3-33.

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

Once the relationship between unsaturated hydraulic conductivity and moisture content is known for a particular lithologic unit, travel time can also be estimated for a steady-state flux passing through each layer by assuming a unit hydraulic gradient. Under the unit

gradient condition, only the force of gravity is acting on water and all other forces are considered negligible. These assumptions may be met for flows due to natural recharge since moisture differences become smoothed out after sufficient time. Travel time for each lithologic unit of a set thickness and calculated for any given recharge rate and the total travel time is equivalent to the sum of the travel times for each individual lithologic unit. To calculate the travel time for any particular waste management unit the detailed layering of the lithologic units should be considered. For waste management units with artificial recharge (e.g., cribs and trenches) more complicated analyses would be required to account for the effects of saturation.

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

An example of the potential use of this vadose zone hydraulic parameter information is presented by Smoot et al. (1989) in which precipitation infiltration and subsequent contaminant plume movement near a prototype single-shell tank was evaluated using a numerical computer code. Smoot et al. (1989) used the UNSAT-H one-dimensional finite-difference unsaturated zone water flow computer code to predict the precipitation infiltration for several different soil horizon combinations and characteristics. The researchers used statistically generated precipitation values that were based on actual daily precipitation values recorded at the Hanford Site between 1947 and 1989 to simulate precipitation infiltration from January 1947 to December 2020. The same authors also used the PORFLO-3 computer code to simulate ^{106}Ru and ^{137}Cs movement through the unsaturated zone.

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

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

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

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

The lateral extent and composition of the Plio-Pleistocene and early "Palouse" soil units may provide conditions amenable to the formation of perched water zones in the vadose zone above the unconfined aquifer. The calcrete facies of the Plio-Pleistocene unit, consisting of calcium-carbonate-cemented silt, sand, and gravel, is a potential perching horizon due to its likely low hydraulic conductivity. However, the Plio-Pleistocene unit is typically fractured and may have erosional scours in some areas, potentially allowing deeper infiltration of groundwater, a factor which may limit the lateral extent of accumulated perched groundwater. The early "Palouse" soil horizon, consisting of compact, loess-like silt and

minor fine-grained sand, is also a likely candidate for accumulating moisture percolating downward through the sand and gravel-dominated Hanford formation. As discussed earlier, the Plio-Pleistocene unit and the early "Palouse" soil do not occur in the 200 East Area. Therefore, the potential for perched water occurring in the PUREX Plant Aggregate Area is low.

3.5.2.1.3 Unconfined Aquifer. The uppermost aquifer system in the 200 Areas occurs primarily within the sediments of the Ringold Formation and Hanford formation. In the 200 West Area the upper aquifer is contained within the Ringold Formation and displays unconfined to locally confined or semiconfined conditions. In the 200 East Area the upper aquifer occurs in the Ringold Formation and Hanford formation. The depth to groundwater in the upper aquifer underlying the 200 Areas ranges from approximately 60 m (197 ft) beneath the former U Pond in the 200 West Area to approximately 105 m (340 ft) west of the 200 East Area to approximately 103 m (313 ft) near the 202-A Building in the 200 East Area. The saturated thickness of the unconfined aquifer ranges from approximately 67 to 112 m (220 to 368 ft) in the 200 West Area and approximately 61 m (200 ft) in the southern 200 East Area to nearly absent in the northeastern 200 East Area where the aquifer thins out and terminates against the basalt located above the water table in that area.

The upper part of the uppermost aquifer in the 200 East Area consists of generally unconfined groundwater within the Ringold unit E. In the northern part of the PUREX Plant Aggregate Area the Ringold Formation has been eroded and the groundwater is found within the Hanford formation. The lower part of the uppermost aquifer consists of confined to semi-confined groundwater within the gravelly sediments of Ringold unit A. The Ringold unit A is generally confined by fine-grained sediments of the lower mud sequence.

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

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

Details regarding this aquifer system can be found in the 200 East Groundwater Aggregate Area Management Study Report (AAMSR).

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

Natural precipitation infiltration at or near waste management units or unplanned releases may provide a driving force for the mobilization of contaminants previously introduced to surface or subsurface soils. For this reason, determination of precipitation recharge rates at the Hanford Site has been the focus of many previous investigations. Previous field programs have been designed 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 various studies.

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

Examples of precipitation recharge studies include:

- A study by Gee and Heller (1985) described various models used to estimate natural recharge rates. Many of the models use a water retention relationship for the soil. This relates the suction required to remove (or move) water to its dryness (saturation or volumetric moisture content). Two of these have been developed by Gee and Heller (1985) for soils in lysimeters on the Hanford Site. As an example of available data, the particle size distribution and the water retention curves of these two soils are shown in Figure 3-34. Additional data and information about possible models for unsaturated flow may be found in Brownell et al. (1975), and Rockhold et al. (1990).

- Moisture contents have been obtained from a number of core-barrel samples in the 200 Areas (East and West) and varied from 1 to 18%, with most in the range

of 2 to 6% (Last et al. 1989). The data appear to indicate zones of increased moisture content that could be interpreted as signs of moisture transport.

- A lysimeter study reported by Routson and Johnson (1990) was conducted at a location 1.6 km south of the 200 East Area. During much of the lysimeters' 13-year study period between 1972 and 1985, the surface of the lysimeters were maintained unvegetated with herbicides. No information regarding the soil types in the lysimeters was found. To a precision of $\pm$ 0.2 cm, no downward moisture movement was observed in the instruments during periodic neutron-moisture measurements or as a conclusion of a final soil sample collection and moisture content analysis episode.

- An assessment of precipitation recharge involving the redistribution of ^{137}Cs in vadose zone soil also reported by Routson and Johnson (1990). In this study, split-spoon soil samples were collected beneath a solid waste burial trench in the T Plant Aggregate Area. The trench, located just south and west of the 218-W-3AE Burial Ground, approximately 6 km (3.7 mi) west of the 200 East Area, received soil containing ^{137}Cs from an unspecified spill. Cesium-137 was not detected below the bottom of the burial trench. However, increased ^{137}Cs activity was observed above the top of the waste fill which Routson and Johnson concluded indicated that net negative recharge (loss of soil moisture to evapotranspiration) had occurred during the 10-year burial period.

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

- A weighing lysimeter study reported by Rockhold et al. (1990) was conducted at a grassy plot approximately 5 km (3 mi) northwest of the 300 Area. The grass test site was located in a broad, shallow topographic depression approximately 900 m (2,953 ft) wide, several hundred meters long, trending southwest. The area is covered with annual grasses (cheatgrass and bluegrass). The upper 3.5 m (11.5 ft) of the soil profile consists of slightly silty to silty sand (sandy loam) with an estimated saturated hydraulic conductivity of 9×10^{-3} cm/s. Rockhold et al. (1990) estimated that approximately 0.8 cm (0.3 in.) of downward moisture movement occurred between July 1987 and June 1988. This represents approximately 7% of the total precipitation recorded in that area during that time period.

- A gravel-covered lysimeter study discussed by Rockhold et al. (1990) was conducted at the 200 East Area lysimeter site, approximately 1 km (1.6 mi) south of the 200 East Area. Water contents below the 4.88 m (16 ft) depth in the closed-bottom lysimeter have not changed reasonably between 1972 and 1988, implying that significant recharge has not occurred. Data are insufficient to conclude whether the presence of a plant community on the lysimeter is the reason for the lack of water increase.

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

3.5.2.3 Groundwater Flow. Groundwater flow north of Gable Mountain currently trends in a northeasterly direction as a result of mounding near reactors and flow through Gable Gap. South of Gable Mountain, flow is interrupted locally by the groundwater mounds in the 200 Areas. There is also a component of groundwater flow to the north between Gable Mountain and Gable Butte from the 200 Areas. In the 200 East Area, groundwater elevations in June 1990 for the unconfined aquifer showed little variation and were generally around 133 m (405 ft) (Kasza et al. 1990).

Temporary reversal of groundwater flow entering the Columbia River may occur during transient, high-river stages. This occurrence is known as bank storage. Correlations were made between groundwater level and river-stage fluctuations along a 81 km (50 mi) reach of the Columbia River adjacent to the Hanford Site by Newcomb and Brown (1961). They concluded that a 260 km^2 (100 mi^2) area within the Hanford Site was affected by bank storage. During a 45 day rise in river stage, it was estimated that water infiltrated at an average rate of 4,600,000 m^3/day (3,700 acre-ft/day) versus 1,200,000 m^3/day (1,000 acre-ft/day) during the 165 day recession period. Since this study was conducted, dam control on the Columbia River has reduced the magnitude of bank storage on the groundwater system.

Natural groundwater inflow to the unconfined aquifer primarily occurs along the western boundary of the Hanford Site. Currently, man-made recharge occurs in several active waste management units (e.g., the 216-A-8 Crib, 216-A-26 French Drain, 216-A-29 Ditch). Historically, much greater recharge occurred from a number of waste management units in the 200 Areas. Manmade recharge probably substantially exceeds natural precipitation recharge in these areas. The unconfined aquifer ultimately discharges to the Columbia River, either near the 100 Areas, north of the 200 Areas through Gable Gap, or between the 100 Areas and the 300 Area, east of the 200 Areas. The precise path is strongly dependent on the hydrologic conditions in the 200 East Area (Delaney et al. 1991). Generally, groundwater flow is from the west towards the east-southeast. Artificial recharge from the 216-B-3 Pond System in the neighboring B Plant Aggregate Area has produced a groundwater mound which has altered the hydraulic gradients and groundwater flow direction

throughout the 200 East Area. The result of this flow convergence in the development of a large groundwater "saddle" beneath the 200 East Area. The overall effect of the "saddle" is that groundwater flow is partitioned in two primary directions: north through the Gable Gap area and southeast towards Richland. Locally, within the 200 East Area groundwater, flow direction is difficult to determine and can be variable due to extremely low hydraulic gradient and effects of variable discharges to the 216-B-3 Pond System.

3.5.2.4 Historical Effects of Operations. Historical effluent disposal at the Hanford Site altered previously prevailing groundwater hydraulic gradients and flow directions. Before operations at the Hanford Site began in 1944, groundwater flow was generally toward the east, and the groundwater hydraulic gradient in the 200 East Area was on the order of 0.0003 (Delaney et al. 1991). Prior to disposing liquid waste to the soil column in the 200 (Separations) Areas, groundwater elevations in the 200 East Area may have been as much as 18 m (55 ft) lower in 1944 than at present. As seen in Figure 3-35, a distinct groundwater mound is still apparent east of the 200 East Area near the B Pond. The B Pond has caused the groundwater flow direction to change to a northwest-southeast flow pattern.

3.5.3 PUREX Plant Aggregate Area Hydrogeology

This section presents additional hydrogeologic information identified with specific application to the PUREX Plant Aggregate Area.

3.5.3.1 Hydrostratigraphy. As shown on Figure 3-36, the hydrostratigraphic units of concern beneath the PUREX Plant Aggregate Area are 1) the Rattlesnake Ridge interbed, 2) the Elephant Mountain Basalt Member, 3) the Ringold Formation units A and E, and 4) the Hanford formation. The hydrogeologic designations for the PUREX Plant Aggregate Area were determined by examination of borehole logs from Lindsey et al. (1992) and Chamness et al. (1992) and integration of these data with stratigraphic correlations from existing reports. For the purposes of the PUREX Plant AAMSR, this discussion will be limited to the vadose zone and possible perching horizons with the vadose zone underlying the aggregate area. Additional information on the aquifer systems can be found in the 200 East Groundwater AAMSR.

3.5.3.1.1 Vadose Zone. The vadose zone beneath the PUREX Plant Aggregate Area ranges in thickness from about 104 m (317 ft) along the southern part of the eastern aggregate area boundary to 58 m (193 ft) in the vicinity of the 218-E-12B Burial Ground based on June 1990 groundwater elevation data (Kasza et al. 1990). The observed variation in vadose zone thickness is the result of variable surface topography and the variable elevation of the water table in the underlying unconfined aquifer.

During the 1985 Grout Treatment Facility (GTF) baseline and site characterization study, several groundwater monitor wells were drilled (Swanson et al. 1988). The data collected from the drilling of these wells (299-E25-25, 299-E25-26, 299-E25-27 and 299-E25-28) provided information pertaining to the vadose zone east of the PUREX Plant Aggregate Area. Similar data were collected, to the west from groundwater monitor wells adjacent to the 216-U-12 Crib and at the southwest boarder of the U Plant Aggregate Area (Goodwin 1990). Because of the nearly identical stratigraphy, it is probable the PUREX Plant Aggregate Area vadose zone is similar and it can be assumed that the collected data are correct for this study area. Analysis of the borehole samples collected from the GTF and U Plant indicate that soil moisture is normally between <1% to 27% by weight. Of 105 samples analyzed for moisture content from the U Plant Aggregate Area, 86% were between 1% and 10% by weight. At the GTF, 126 samples were collected for soil moisture and 89% were between 1% and 10% by weight. It should be noted however, that both investigations are in the vicinity of previously active cribs and/or ditches, and that it is likely there is some impact by the disposal of liquid waste on these moisture contents.

3.5.3.1.2 Perched Water Zones. Unlike the 200 West Area, the likelihood of perched water occurring in the 200 East Area is low. In the 200 West Area perched water is found predominantly in the Plio-Pleistocene and the early "Palouse" soil. Those stratigraphic units are not present in the 200 East Area. However, because of the large quantity of liquid waste disposed of and dependent on the grain size/stratigraphy and occurrence of intercalated lenses, the water is possible.

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

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

3.5.3.3 Groundwater Flow Beneath the PUREX Plant Aggregate Area. Within the PUREX Plant Aggregate Area, groundwater flow is generally toward the west, based on December 1990 Hanford wells groundwater elevation data (Kasza et al. 1990) (Figure 3-35). Flow is generally away from the groundwater mound located below the B Pond just east of the PUREX Plant Aggregate Area. A review of groundwater maps of the unconfined aquifer

(Kasza et al. 1990) indicates relatively steep decreases in groundwater elevations directly west of the mound and a very gradual elevation decrease to the west across the PUREX Plant Aggregate Area.

3.5.3.4 Historical Effects of Operations. Artificial recharge from waste management facilities within the 200 East Area has caused significant changes to the water levels of the unconfined aquifer since operations began in 1943. Historically, the majority (greater than 90%) of wastewater discharged from the 200 East Area has been routed to the B or Gable Mountain Ponds (Zimmerman et al. 1986). Between 1943 and 1980 approximately 3.433 x 10^{11} L of wastewater had been discharged to these ponds. The B Pond received greater than 90% of the wastewater discharged from the 200 East Area between 1945 and 1955. In 1957 the Gable Mountain Pond began receiving wastewater. From 1956 to 1980 these ponds received over 90% of the wastewater generated from the 200 East Area. This discharging has created elevated groundwater levels, or mounding of the groundwater, in the vicinity of the B and Gable Mountain Ponds.

Between 1950 and 1955 small groundwater elevation increases occurred south of Gable Mountain in response to wastewater discharges from the B Plant. Groundwater mounding in the vicinity of the B Pond continued in response to the startup of the PUREX Plant in 1956 and new discharges to the Gable Mountain Pond. During this time the artificial recharge caused elevations to reach approximately 10 m (32 ft) above the natural groundwater elevations.

During the 1960's the groundwater mound grew at a much slower rate and reached near equilibrium conditions during the 1970's. During the 1980's three expansion ponds were created near the B Pond to receive wastewater redirected from the Gable Mountain Pond and the PUREX Plant which resumed production in 1983. This increased discharge amount has elevated groundwater levels in the vicinity of the B Pond approximately 1.5 m (5 ft) between December 1979 and December 1989. Groundwater elevations in the vicinity of the Gable Mountain Pond have decreased approximately 1 m (3 ft) during this same time.

3.6 ENVIRONMENTAL RESOURCES

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

3.6.1 Flora and Fauna

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

3.6.1.1 Vegetation of the 200 Areas Plateau. The 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. The native stands are classified as an *Artemisia tridentata/Poa sandbergii - Bromus tectorum* community (Rogers and Rickard 1977) meaning that the dominant shrub is Big Sagebrush (*Artemisia tridentata*) and the understory is dominated by the native Sandberg's Bluegrass (*Poa sandbergii*) and the introduced annual Cheatgrass (*Bromus tectorum*). Other shrubs that are typically present include Gray Rabbitbrush (*Chrysothamnus nauseosus*), Green Rabbitbrush (*C. viscidiflorus*), Spiny Hopsage (*Grayia spinosa*), and occasionally Antelope Bitterbrush (*Pursia tridentata*). Other native bunchgrasses that are typically present include Bottlebrush Squirreltail (*Sitanion hystrix*), Indian Ricegrass (*Oryzopsis hymenoides*), Needle-and-Thread (*Stipa comata*), and Prairie Junegrass (*Koleria cristata*). Common and important herbaceous species include Turpentine cymopteris (*Cymopteris terebinthinus*), Globemallow (*Spheracea munroana*), balsamroot (*Basamorhiza careyana*), several Milkvetch species (*Astragalus caricinus*, *A. sclerocarpus*, *A. succumbens*), Long-leaf Phlox (*Phlox longifolia*), the common Yarrow (*Achillea millifolium*), Pale Evening-primrose (*Oenothera pallida*), Thread-leaf phacelia (*Phacelia linearis*), and several Daisy/Fleabane Species (*Erigeron poliospermus*, *E. Filifolius*, and *E. pumilus*). In all, well over 100 plant species have been documented to occur in native stands on the 200 Areas Plateau.

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

Range fires also have dramatic effects on the overall ecosystem, the most obvious being the complete removal of Sagebrush from the community, and the rapid increase in cheatgrass coverage. Unlike the native grasses, the other important shrubs, and many of the perennial herbaceous species, Sagebrush is unable to resprout from rootstocks after being burned. Therefore, there is no dominant shrub component in burned areas until Sagebrush is able to become re-established from seed. Burning also opens the community to the invasion by

cheatgrass, which is capable of quickly utilizing the nutrients that are released through burning. The extensive cover of cheatgrass may then prevent the re-establishment of many of the native species, including Sagebrush. The species richness in formerly burned areas is usually much lower than in native stands, often consisting of only Cheatgrass, Sandberg's Bluegrass, Russian thistle, and Jim Hill Mustard, with very few other species.

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

3.6.1.2 Plant Species of Concern. The Washington State Department of Natural Resources, Natural Heritage Program classifies rare plants in the State of Washington in three different categories, depending on the overall distribution of the taxon and the state of its natural habitat. These categories are: *Endangered*, which is a "vascular plant taxon in danger of becoming extinct or extirpated in Washington within the near future if factors contributing to its decline continue. Populations of these taxa are at critically low levels or their habitats have been degraded or depleted to a significant degree"; *Threatened*, which is a "vascular plant taxon likely to become endangered within the near future in Washington if factors contributing to its population decline or habitat degradation or loss continue"; and *Sensitive*, which is a taxon that is "vulnerable or declining, and could become endangered or threatened in the state without active management or removal of threats" (definitions taken from the Natural Heritage Program [1990]). Of concern to the Hanford Site, there are two Endangered taxa, two Threatened taxa, and at least eleven Sensitive taxa; these are listed in Table 3-3. All four of the Threatened and Endangered taxa are presently candidates for the Federal Endangered Species List.

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

Of the Sensitive species, five are inhabitants of aquatic or moist habitats and the other six are inhabitants of dry upland habitats. Dense Sedge, Shining Flatsedge, Southern Mudwort, and False Pimpernel are all known to occur in the 100 Areas, especially near the B-C Area, in or near the Columbia River. Some of these species could be present in or near ponds and ditches in the 200 Areas. The few-flowered collinsia may also occur in these habitats. The Gray Cryptantha occurs on open dunes throughout the Hanford Site. Piper's Daisy is fairly common on Umptanum Ridge and Rattlesnake Ridge, but has also been documented in the vicinity of B Pond, the 216-A-24 Crib, and 100-H Area. Bristly Cryptantha, Dwarf Evening-primrose have been found at the south end of the White Bluffs, approximately 3.2 km (2 mi) upstream from the 300 Area. The "Palouse" Milk-vetch and Coyote tobacco are not as well documented but are known to inhabit dry sandy areas such as the 200 Areas Plateau.

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

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

3.6.1.3.1 Mammals. The largest mammal occurring on the 200 Area Plateau is the mule deer (*Odocoileus hemionus*). Although mule deer are much more common to riparian sites along the Columbia River they are frequently observed foraging throughout the 200 Areas. Elk (*Cervus elaphus*) also occur at Hanford but they have only been observed at the Arid Lands Ecology Reserve. Other mammal species common to the 200 Areas include badgers (*Taxidea taxus*), coyotes (*Canis latrans*), blacktail jackrabbits (*Lepus californicus*), Townsend ground squirrels (*Spermophilus townsendii*), Great Basin pocket mice (*Perognathus parvus*), pocket gophers (*Thomomys talpoides*), and deer mice (*Peromyscus maniculatus*). Badgers are known for their digging capability and have been implicated several times for encroaching into inactive burial grounds throughout the 200 Areas. The majority of the badger excavations in the 200 Areas are a result of badgers searching for prey (mice and ground squirrels). Coyotes are the principal predators, consuming such prey

as rodents, insects, rabbits, birds, snakes and lizards. The Great Basin pocket mouse is the most abundant small mammal, which thrives in sandy soils and lives entirely on seeds from native and revegetated plant species. Townsend ground squirrels are not abundant in the 200 Areas but they have been seen at several different sites. Other small mammals that occur in low numbers include the Western harvest mouse (*Reithrodontomys megalotis*) and the Grasshopper mouse (*Onychomys leucogaster*). Mammals associated more closely with buildings and facilities include Nuttall's cottontails (*Sylvilagus nuttallii*), house mice (*Mus musculus*), Norway rats (*Rattus norvegicus*), and some bat species. Bats probably play a minor role in the 200 Areas' ecosystem but no documentation is available on bat populations at Hanford. Mammals such as skunks (*Mephitis mephitis*), raccoons (*Procyon lotor*), weasels (*Mustela* spp.), porcupines (*Erethizon dorsatum*), and bobcats (*Lynx rufus*) have only been observed on very few occasions.

3.6.1.3.2 Birds. Over 235 species of birds have been documented to occur at the Hanford Site (Landeen et al. 1991). At least 100 of these species have been observed in the 200 Areas. The most common passerine birds include starlings (*Sturnus vulgaris*), horned larks (*Ermophila alpestris*), meadowlarks (*Sturnella neglecta*), Western kingbirds (*Tyranus virticalis*), rock doves (*Columba livia*), barn swallows (*Hirundo rustica*), cliff swallows (*Hirundo pyrrhonota*), black-billed magpies (*Pica pica*) and ravens (*Corvus corax*). Common raptors include the Northern harrier (*Circus cyaneus*), American kestrel (*Falco sparvarius*), and Red tailed hawk (*Buteo jamaicensis*). Swainson's hawks (*Buteo swainsoni*) sometimes nest in the trees located at some of the army bunker sites that were used in the 1940's. Golden eagles (*Aquila chrysaetos*) are observed infrequently. Burrowing owls (*Athene cunicularia*) nest at several locations throughout the 200 Areas. The most common upland game birds found in the 200 Areas are California Quail (*Callipepla californica*) and Chukar partridge (*Alectoris chukar*), however, Ring-necked pheasants (*Phasianus colchicus*) and Gray partridge (*Pertx perdix*) may be found in limited numbers. The only native game bird common to the 200 Areas Plateau is the Mourning dove (*Zenaida macrora*) which migrates south each fall. Other species of note which nest in undisturbed sagebrush habitats in the 200 Areas include Sage sparrows (*Amphispiza belli*), and Loggerhead shrikes (*Lanius ludovicianus*). Long-billed Curlews (*Numenius americanus*) also use the sagebrush areas and revegetated burial grounds for nesting and foraging.

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

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

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

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

3.6.2 Land Use

The PUREX Plant Aggregate Area is the location of the 202-A Building and its attendant facilities and structures (242-A Evaporator, 244-AR Vault, etc.). Past activities at the 202-A Building and related facilities were mainly the extraction of uranium and plutonium from fuel rods. Other buildings within the aggregate area served mainly as storage or office space. Currently, the 202-A Building is on standby. Waste management units that remain active are noted on Figure 2-1, Operational and Waste-Related History.

3.6.3 Water Use

There is no consumptive use of groundwater within the PUREX Plant Aggregate Area. Water for drinking and emergency use, and facilities process water is drawn from the Columbia River, treated, and imported to the 200 East Area. The nearest wells used to supply drinking water are located at the Yakima Barricade (Well 699-40-100-C) about 7 km (4 mi) west of the 200 East Area; at the Hanford Safety Patrol Training Academy (Well 699-528-E0) about 40 km (24 mi) to the southeast; at the PNL Observatory (Well 6652-C); and near the Fast Flux Test Facility in the 400 Area (Well 699-S1-8J) about 32 km (19 mi) to the southeast. There is one well, 299-E26-6, used by the 241-A Tank Farm as an emergency water supply for the Tank Farm vent cooling system. This well is located approximately 240 m (800 ft) north of the 241-A-701 Building. The nearest water supply wells located offsite are about 15 km (9.4 mi) to the northwest (upgradient). These wells obtain their water from the basalt and the basalt interbeds (the Berkshire Well and Chateau Ste. Michelle No. 1 and No. 2). The latter wells are reportedly used for irrigation although they may also be used to supply drinking water.

3.7 HUMAN RESOURCES

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

3.7.1 Demography

There are no residences on the Hanford Site. The nearest inhabited residences are farm homes on land located 21 km (13 mi) north of the PUREX Plant Aggregate Area. According to the 1980 census, there are approximately 258,000 people living within a 80 km (50 mi) radius of the 200 Areas Plateau. The primary population centers are the cities of Richland, Kennewick, and Pasco, located southeast of the Hanford Site, Prosser to the south, Sunnyside to the southwest, and Benton City to the southeast.

3.7.2 Archaeology

An archaeologic survey has been conducted of undeveloped portions of the 200 East Area by the Hanford Cultural Resources Laboratory. Isolated artifacts and sites of interest

were identified in the 200 West Area but not within the PUREX Plant Aggregate Area. The closest site of interest is the remains of the White Bluffs Road, located approximately 15 km (9 mi) northwest of the aggregate area, which was previously an Indian trail.

3.7.3 Historical Resources

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

3.7.4 Community Involvement

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

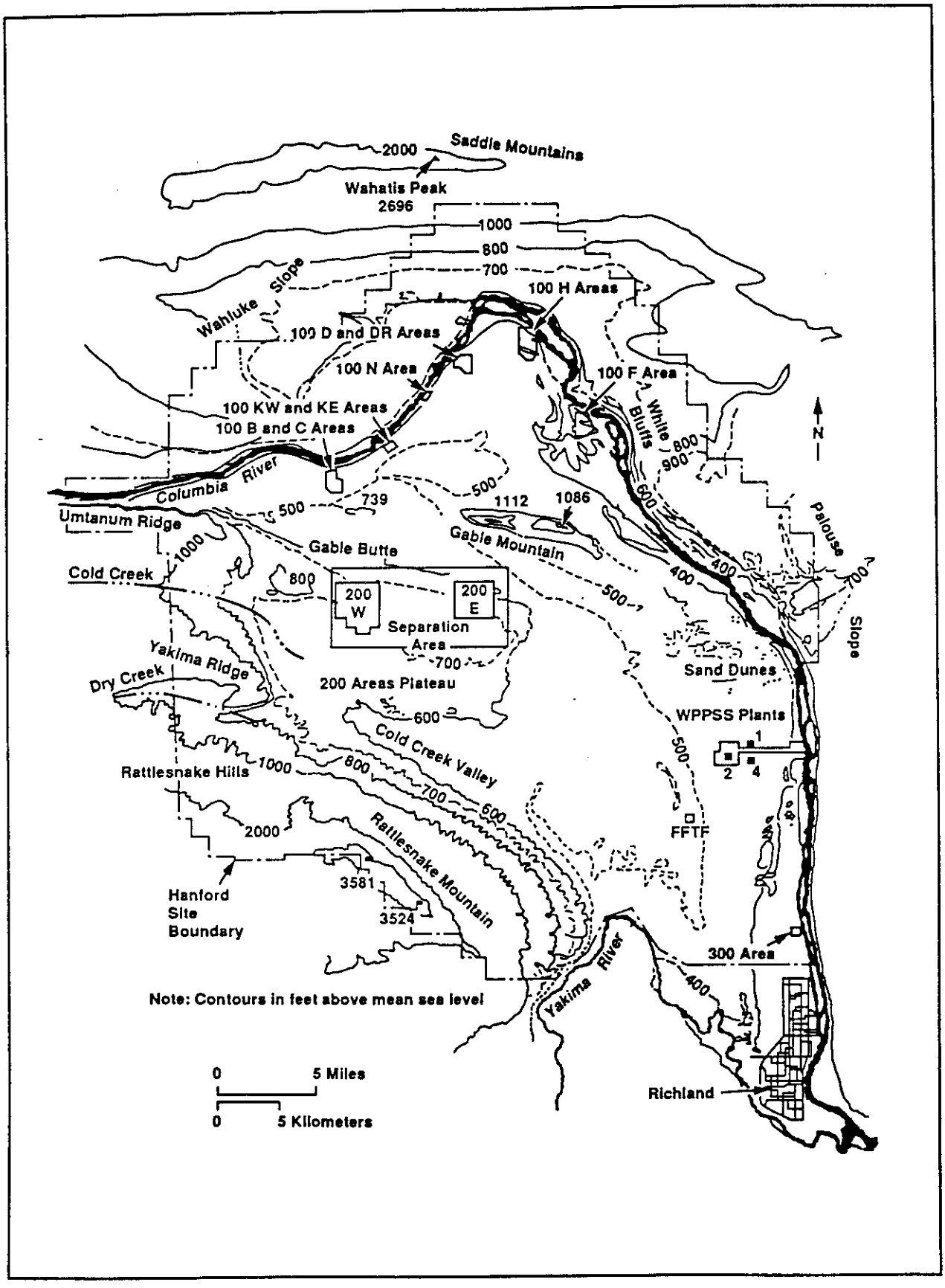


Figure 3-1. Topography and Location Map for the Hanford Site.

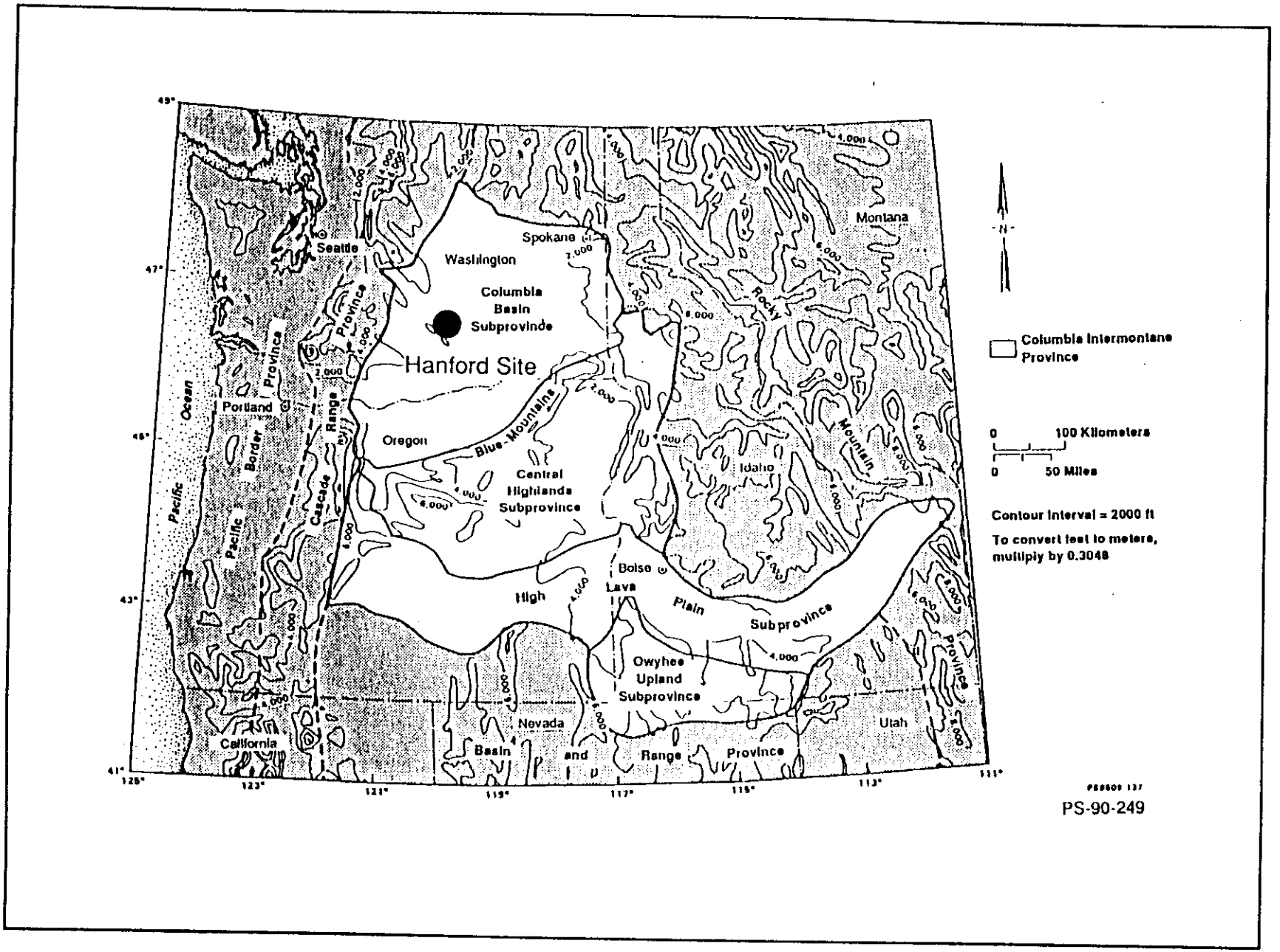


Figure 3-2. Divisions of the Columbia Intermontane Province and Adjacent Snake River Plains Province.

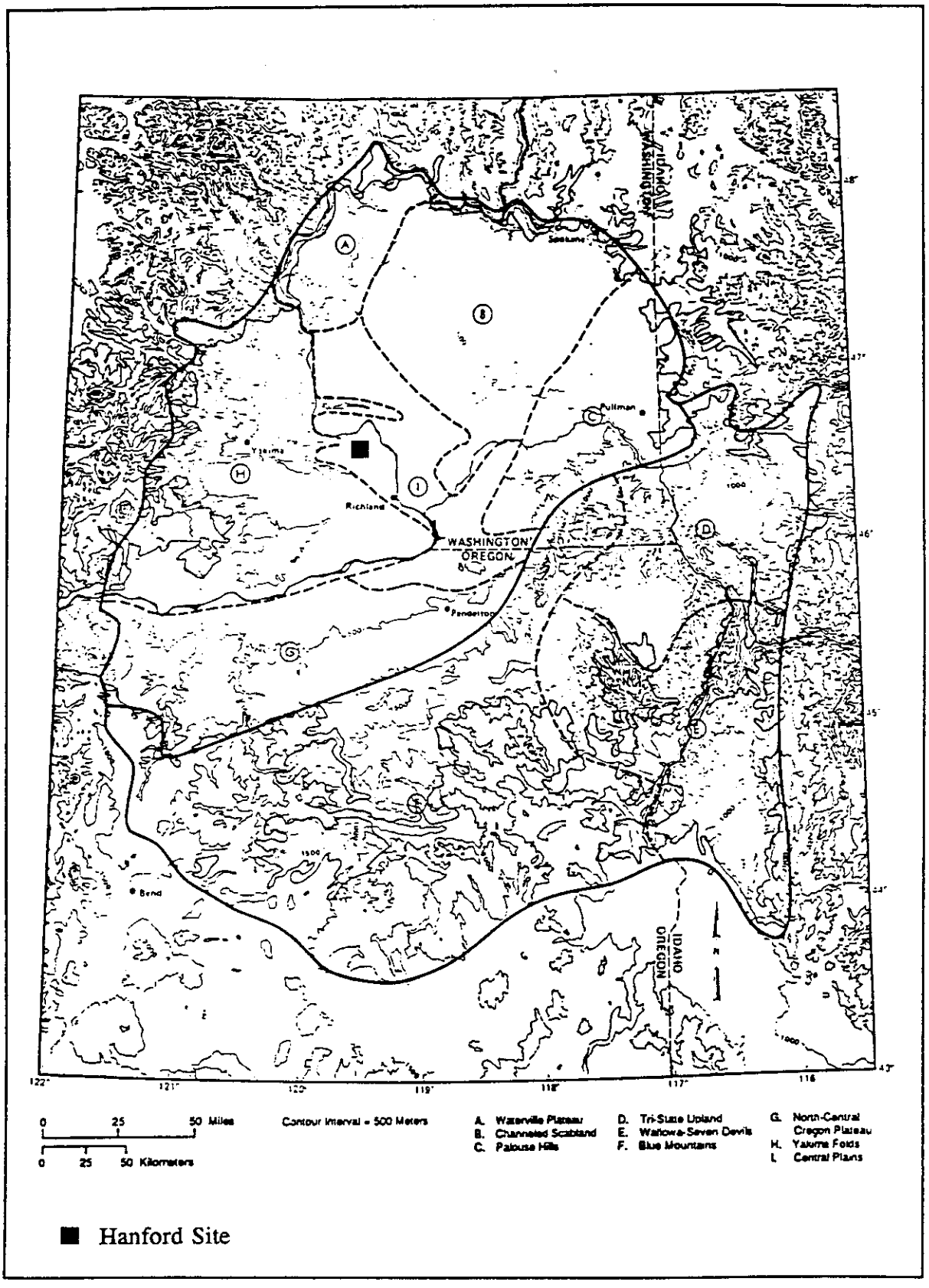


Figure 3-3. Geomorphic Units Within the Central Highlands and Columbia Basin Subprovinces that Contain the Columbia River Basalt Group (after Thornbury 1965) (Last et al. 1989).

9 2 1 2 5 6 0 2 6 9

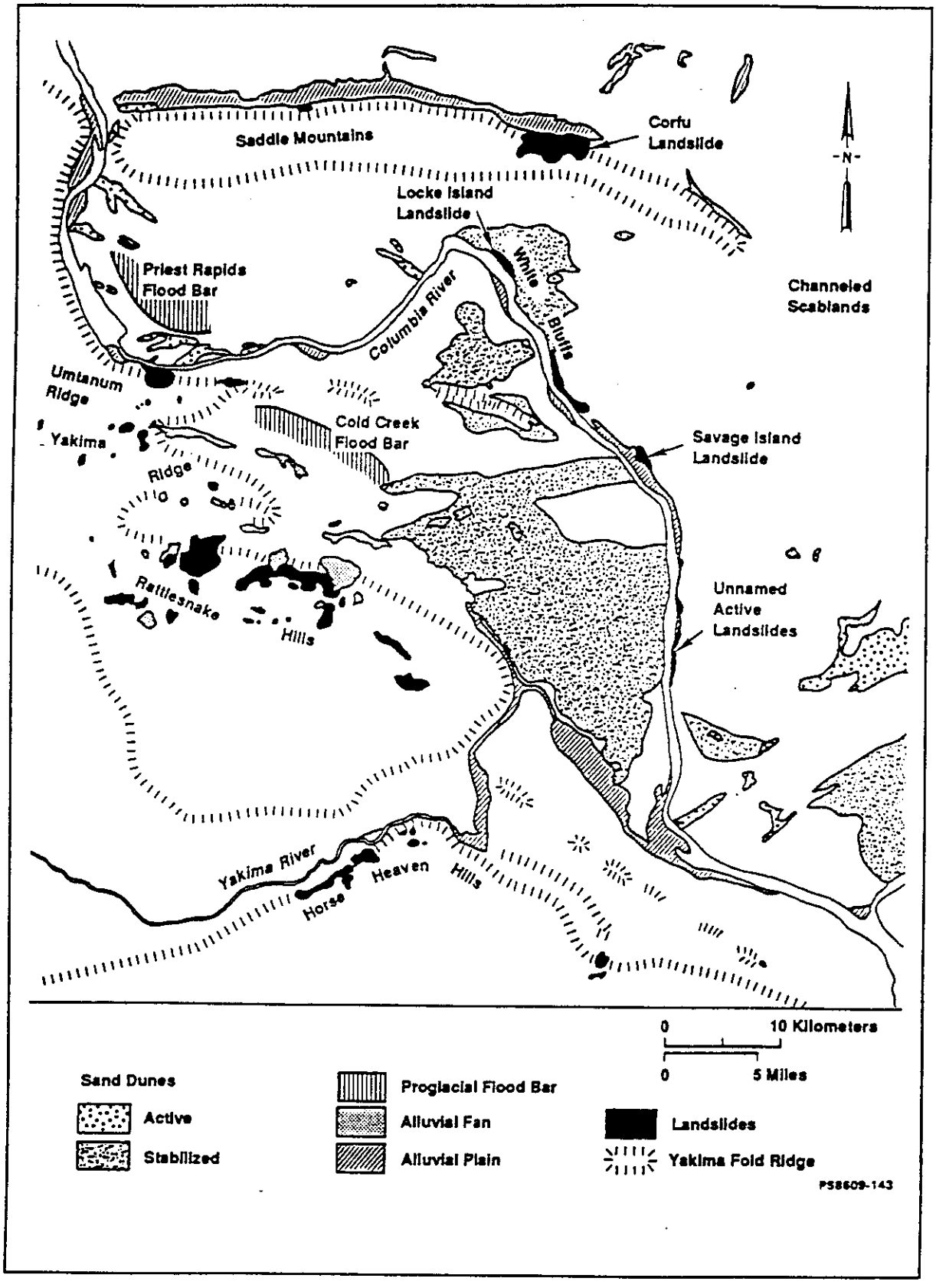


Figure 3-4. Landforms of the Pasco Basin and the Hanford Site.

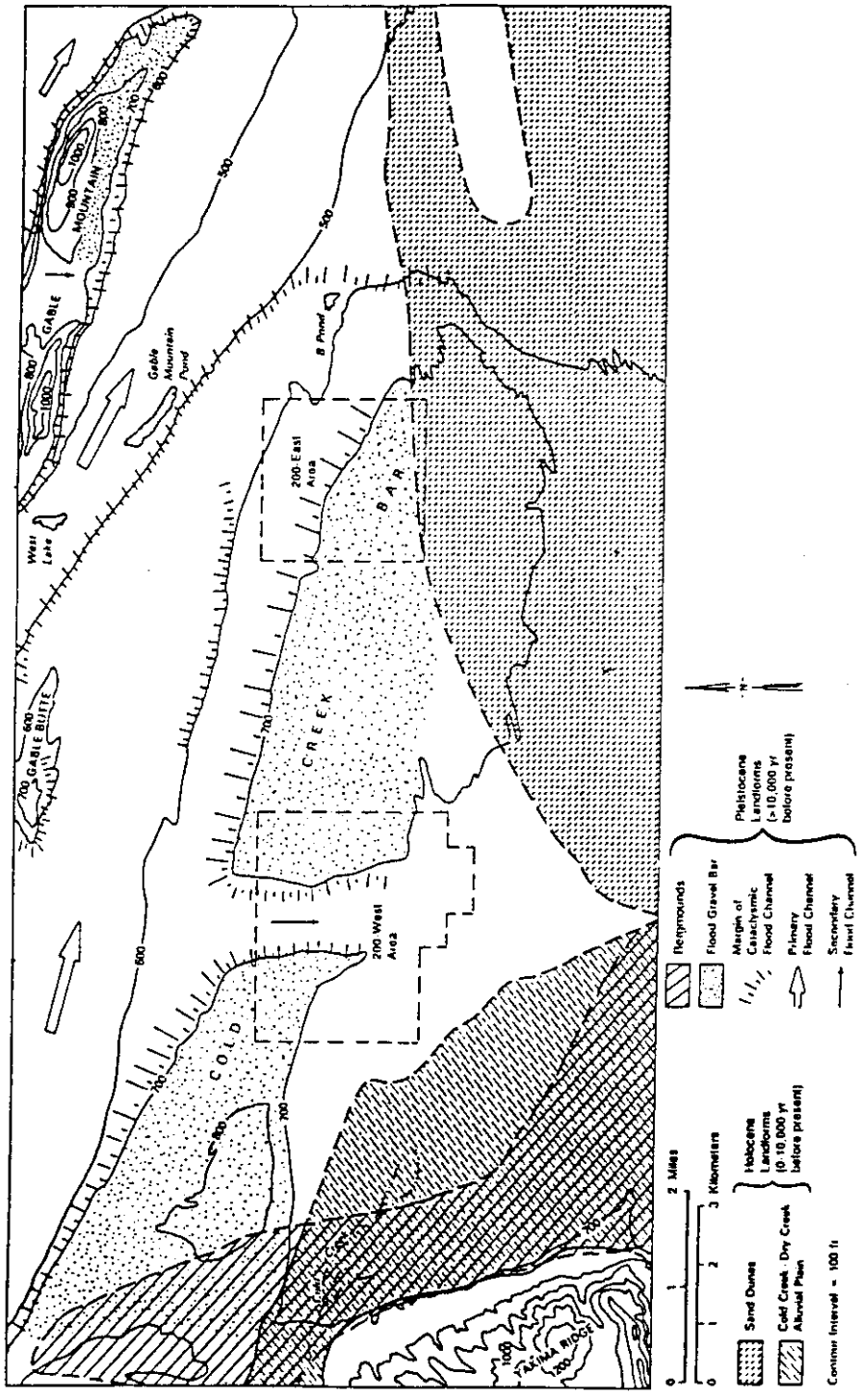


Figure 3-5. Geomorphic Features Surrounding the 200 Areas (Last et al. 1989).

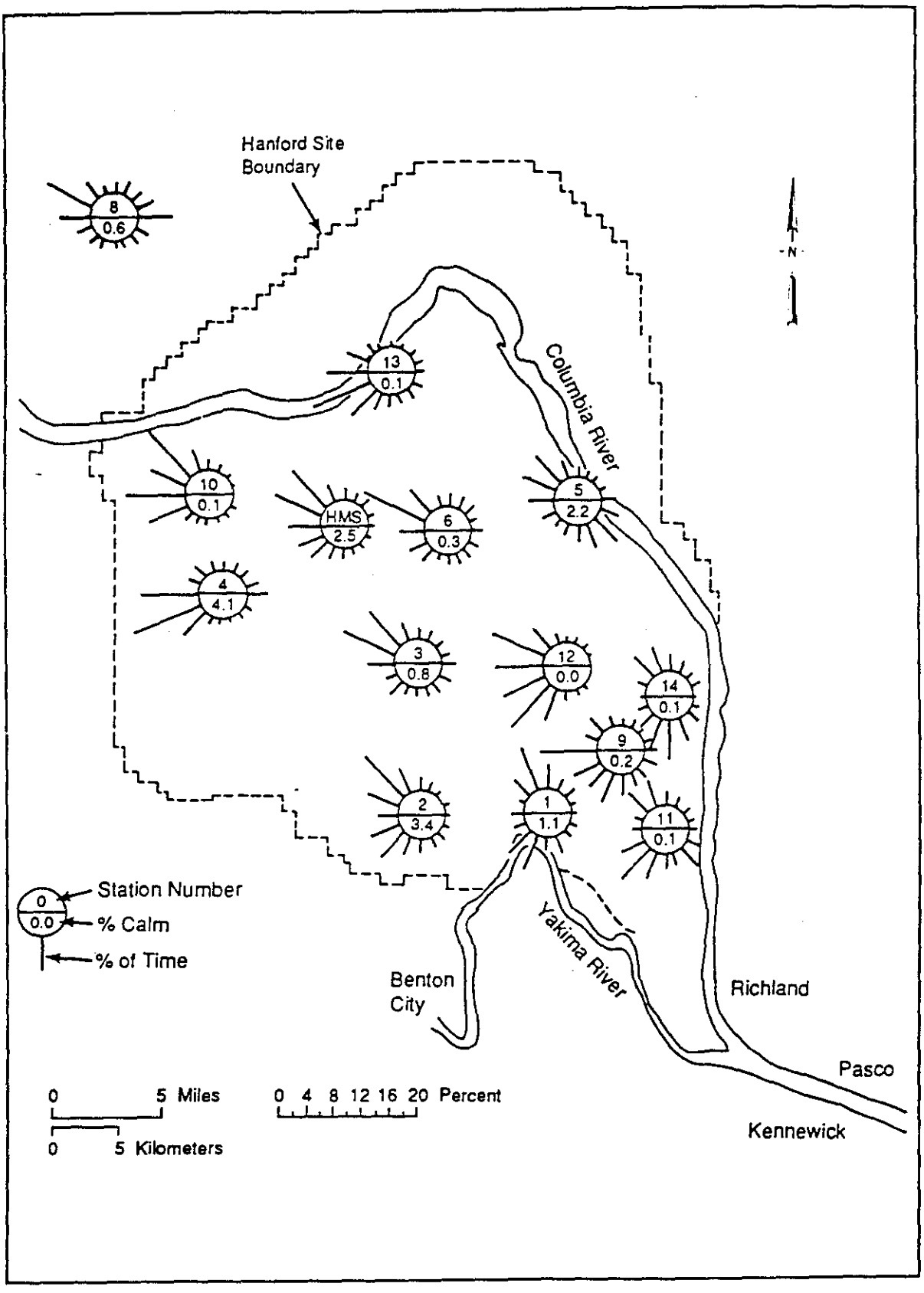


Figure 3-6. Hanford Site Wind Roses, 1979 through 1982 (Stone et al. 1983).

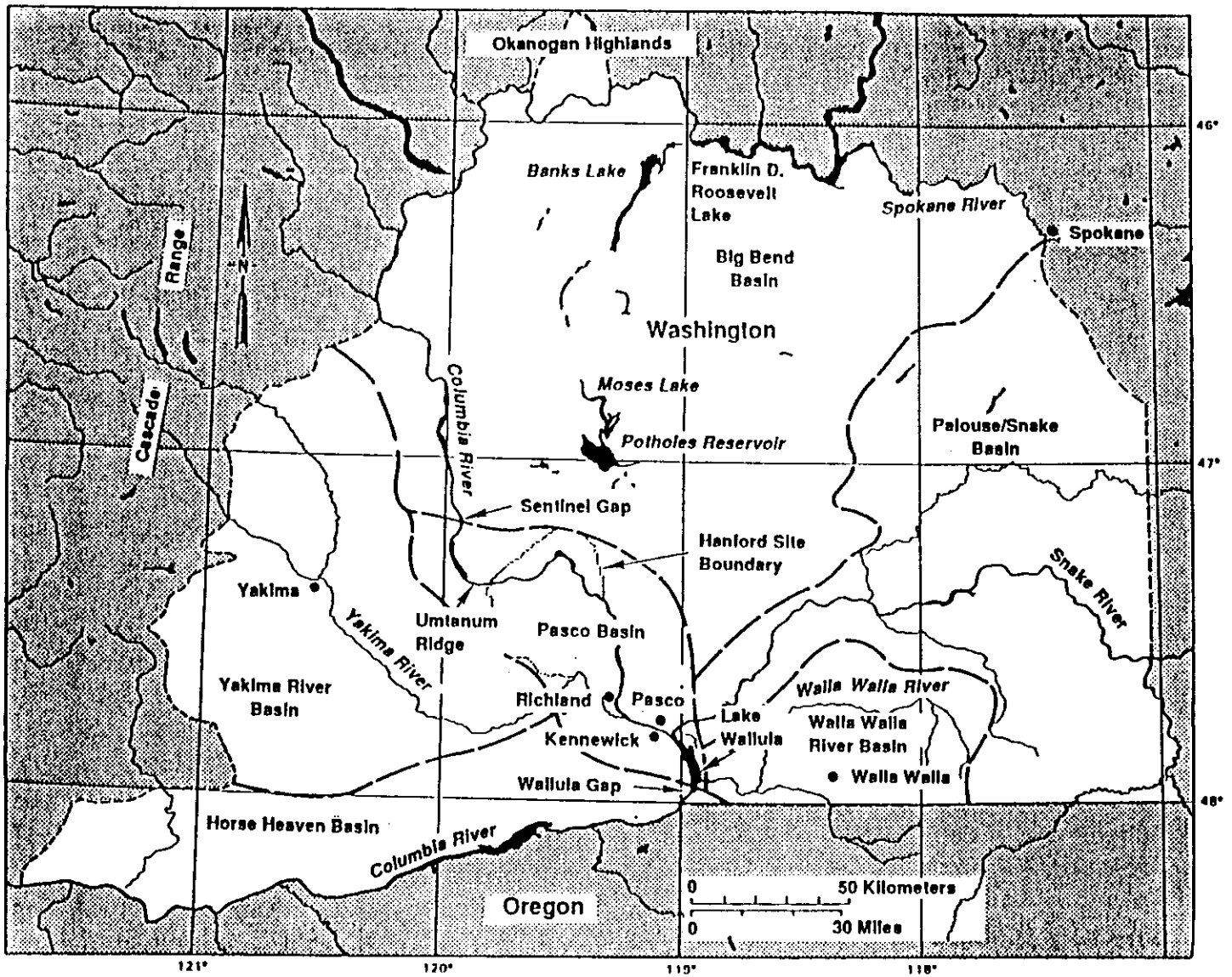
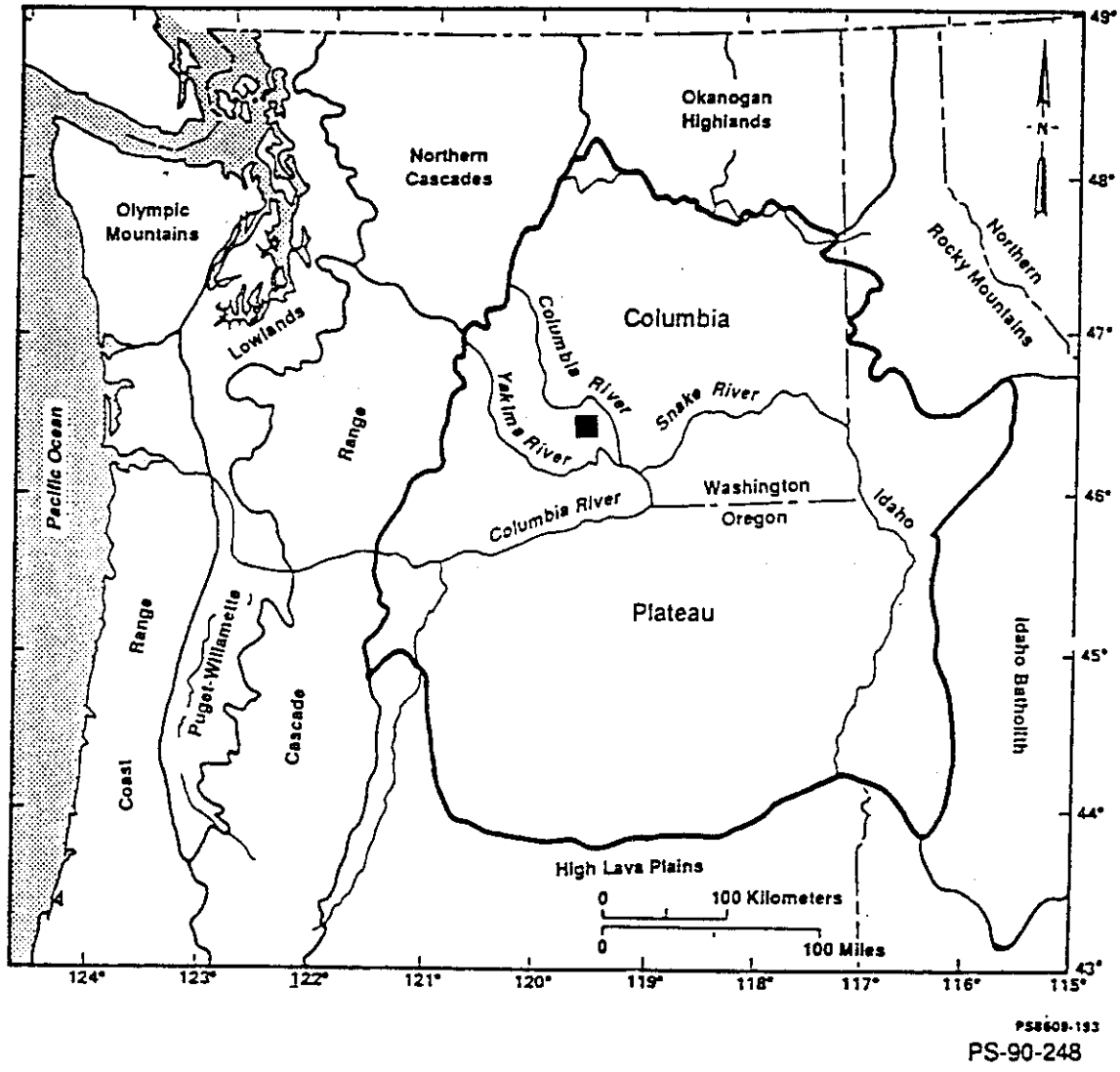


Figure 3-7. Hydrologic Basins Designated for the Washington State Portion of the Columbia Plateau (DOE 1988).



■ Hanford Site

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

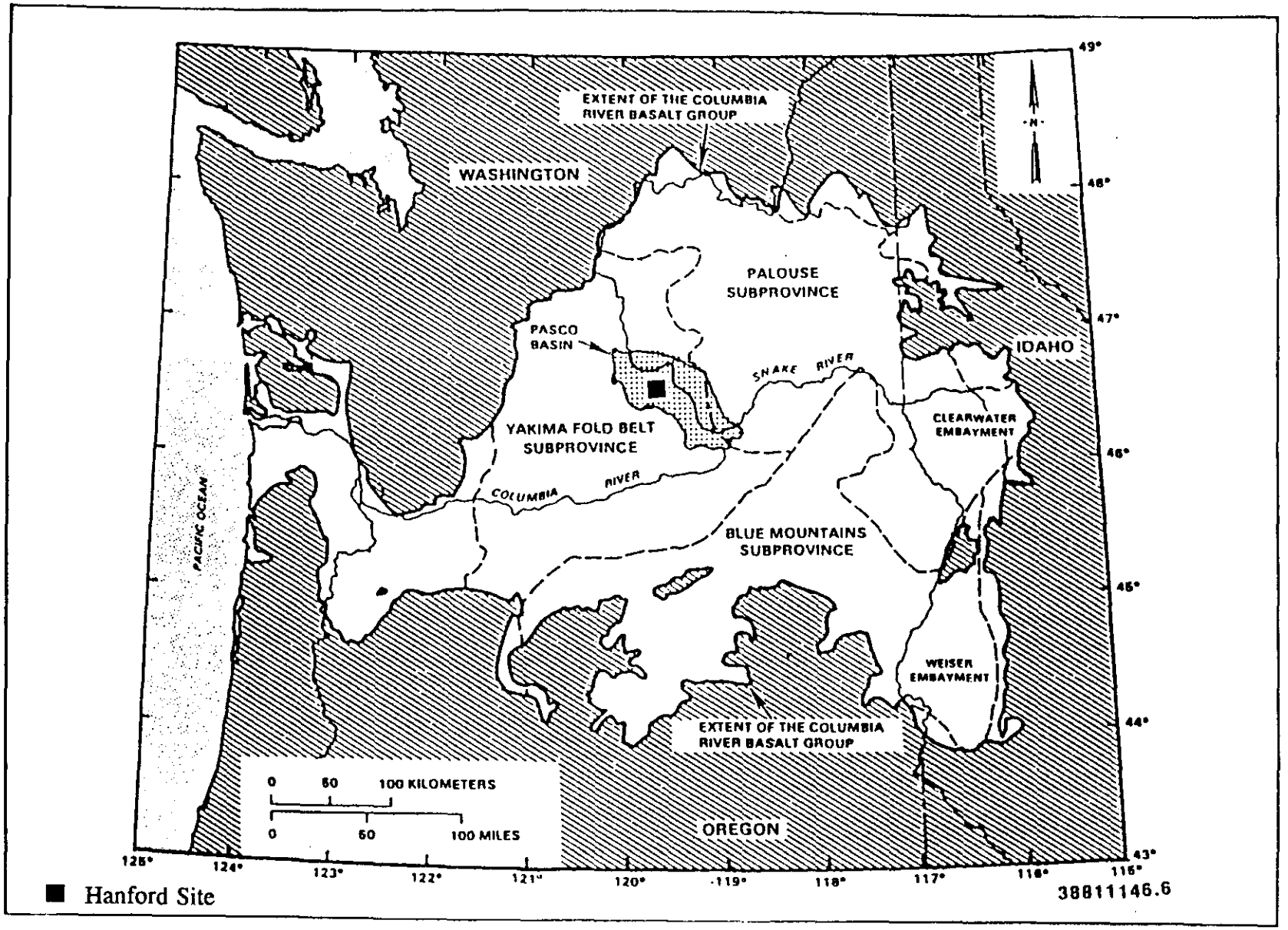


Figure 3-9. Structural Subprovinces of the Columbia Plateau (Last et al. 1989).

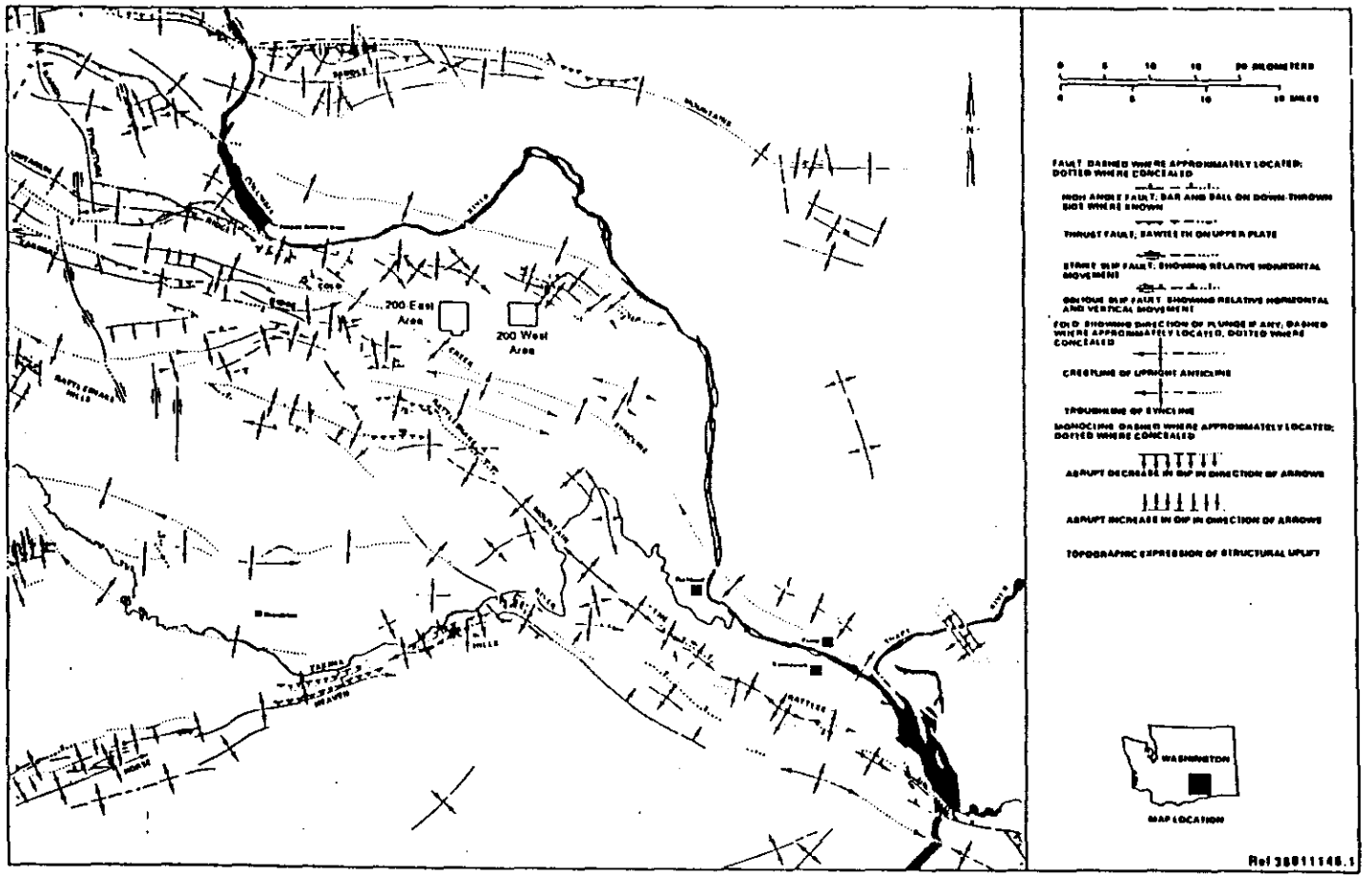


Figure 3-10. Structural Elements of the Yakima Fold Belt Subprovince (Last et al. 1989).

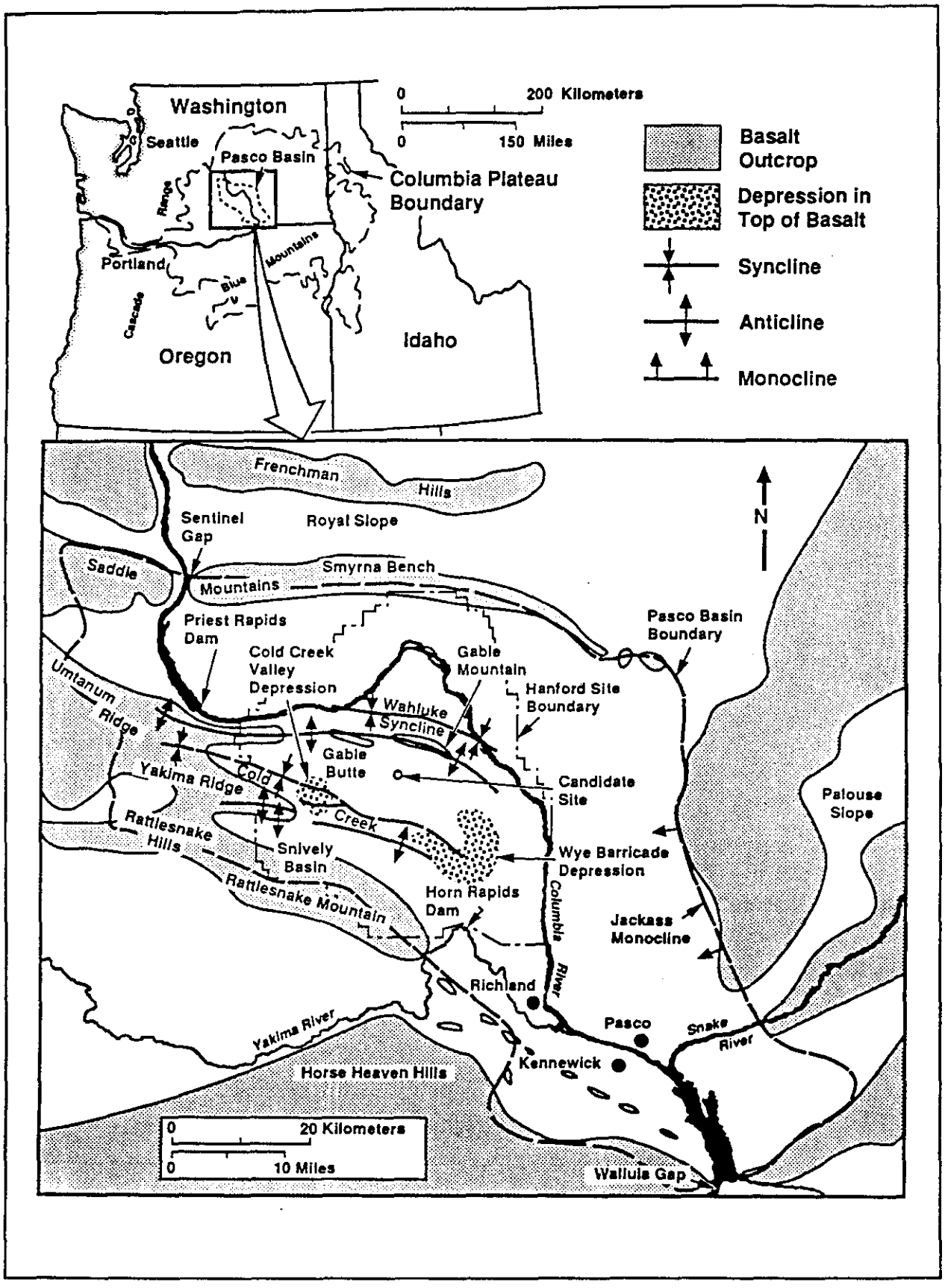
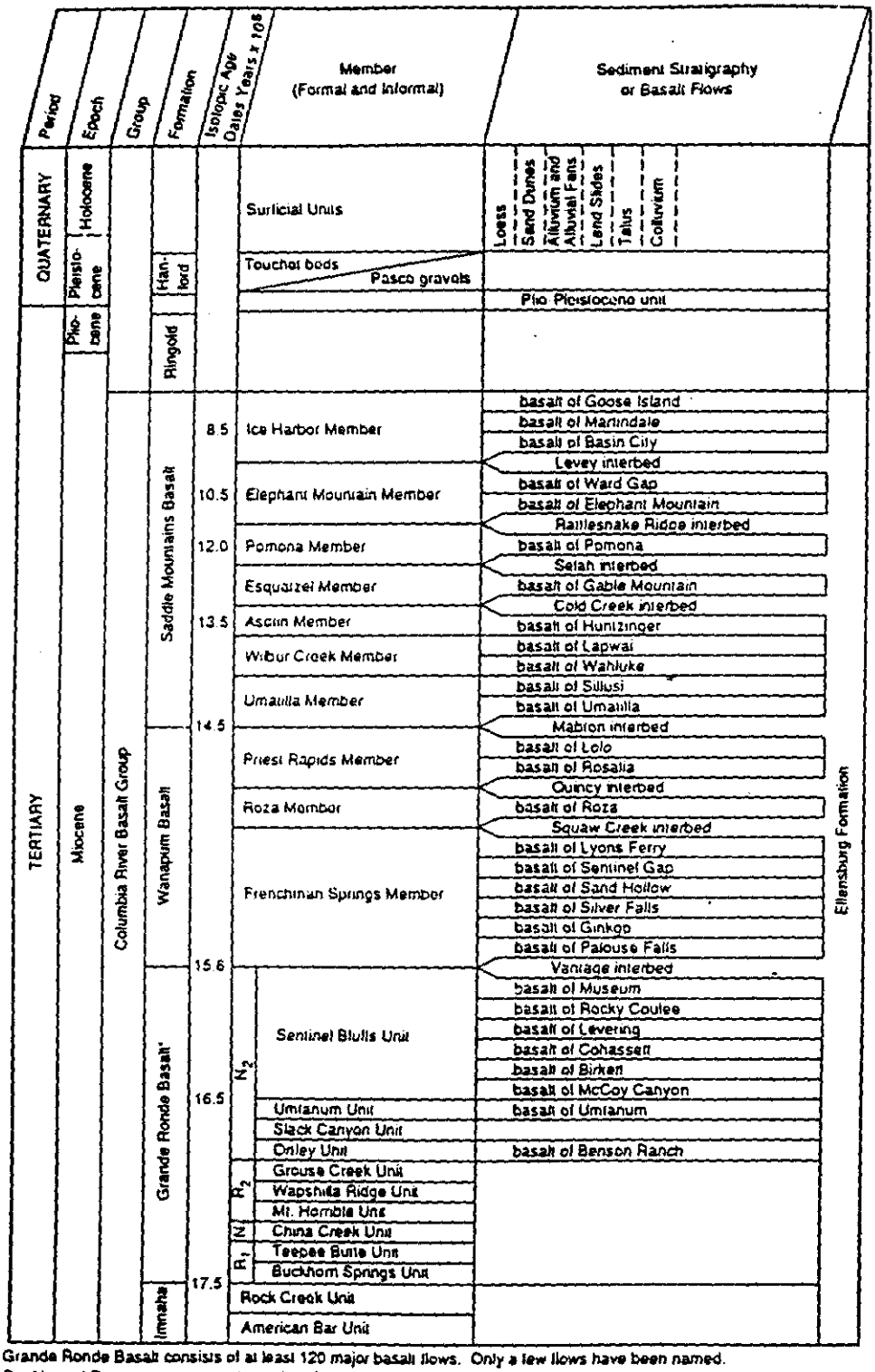


Figure 3-11. Geologic Structures of the Pasco Basin and the Hanford Site.



*The Grande Ronde Basalt consists of at least 120 major basalt flows. Only a few flows have been named.
N_2, R_2, N_1 and R_1 are magnetostratigraphic units.

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

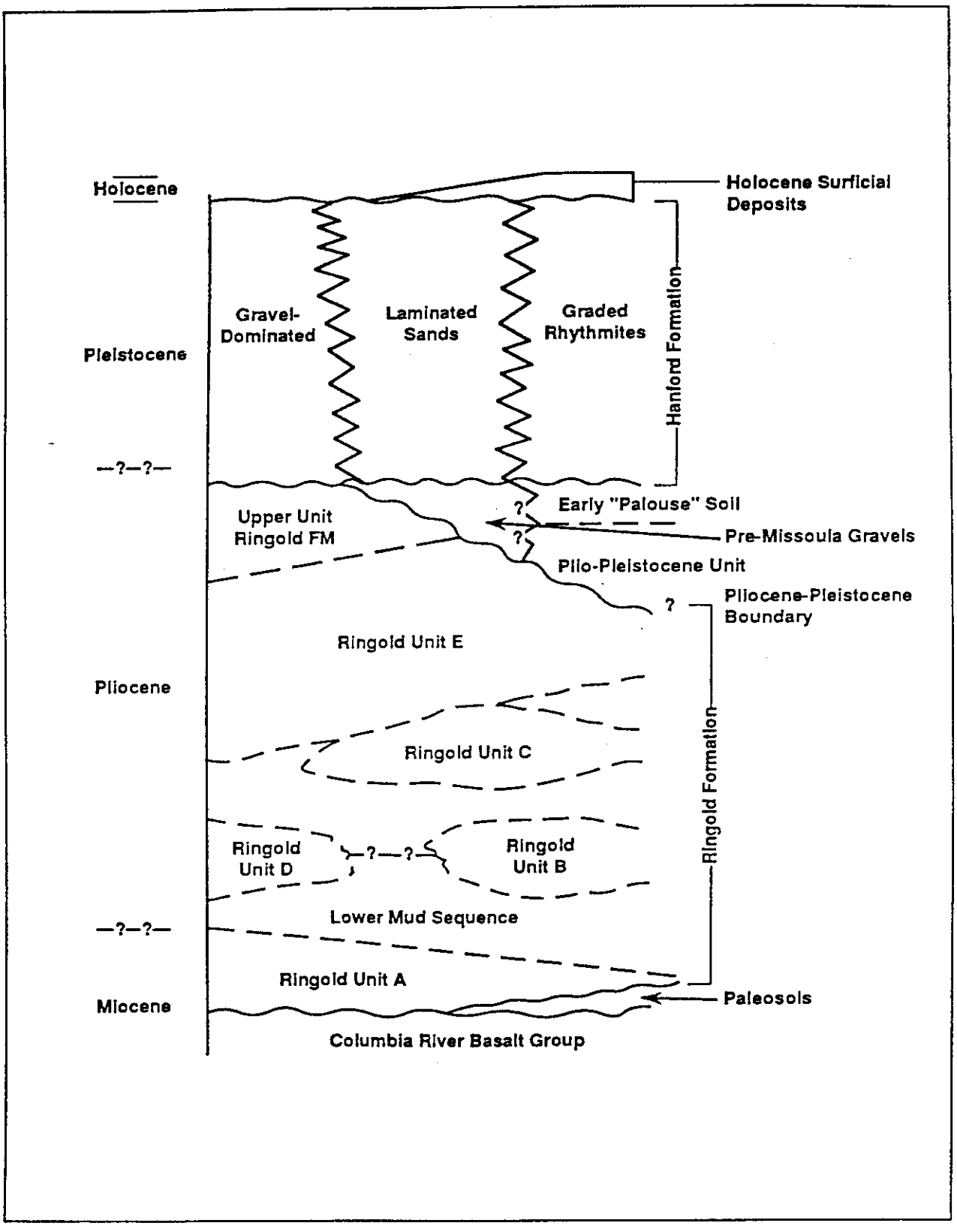


Figure 3-13. Generalized Stratigraphy of the Suprabasalt Sediments Beneath the Hanford Site.

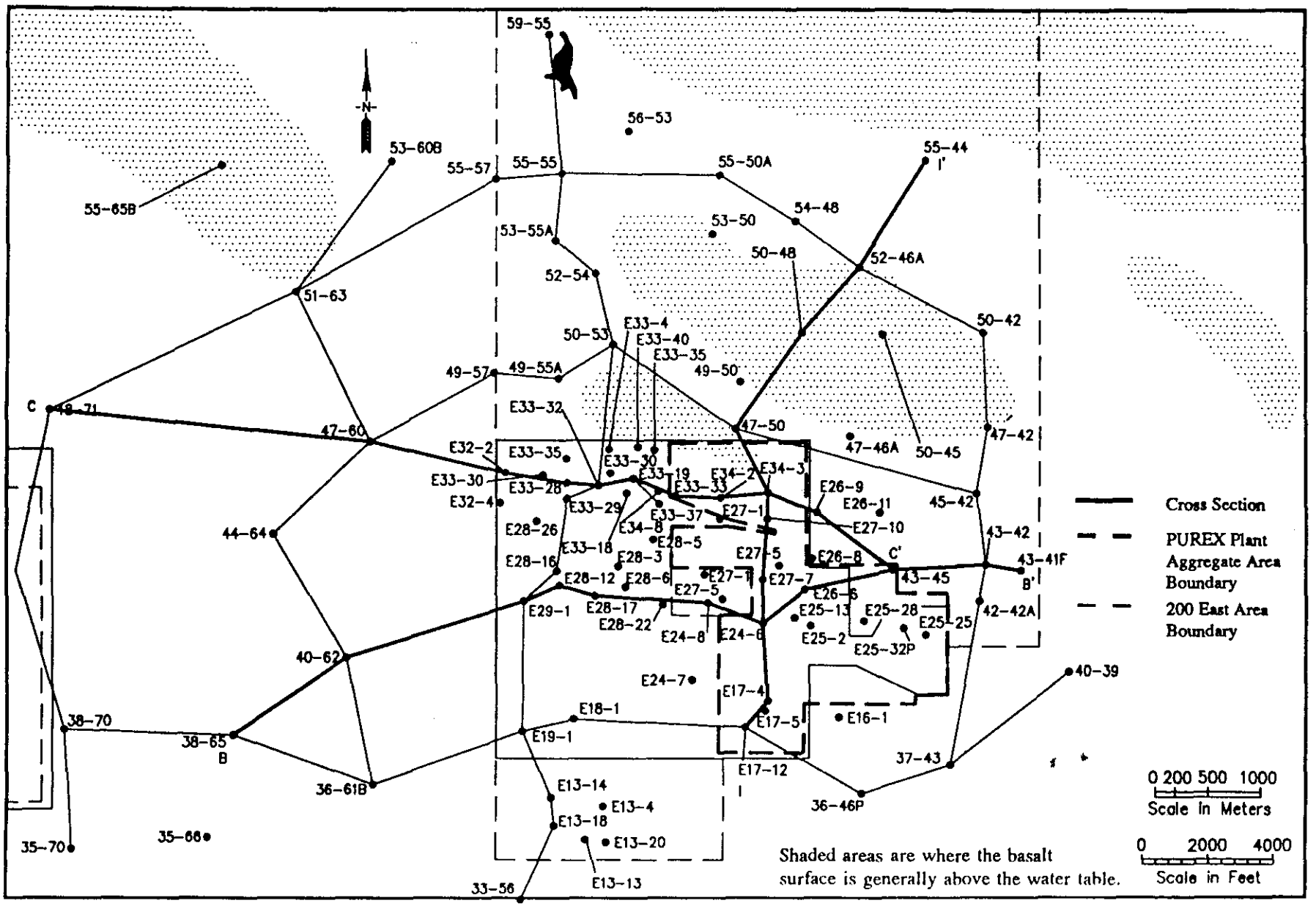


Figure 3-14. Location of Cross-sections.

Explanation

Grain Size Scale, Indicates Dominant Grain Size in an Interval

S P
C/Z C/B

C/Z	Clay and silt
S	Sand
P	Pebble Gravel
C/B	Cobble and boulder gravel

Additional Lithologic Symbols, Includes Subordinate Lithologies

- Clay rich
- Silt rich
- Sandy
- Pebbly to cobbly
- Bouldery
- Calcium carbonate present
- Paleosol
- Basalt

Scales

100 ft

974 ft

Vertical Exaggeration 8.7 X

Other Symbols

- Formational contact, ? where inferred
- Unit or sequence contact, ? where inferred
- Major facies contact

Stratigraphic Abbreviations

Eo	– Eolian (Holocene) deposits
Hug	– Upper gravel sequence, Hanford formation
Hs	– Sandy Sequence, Hanford formation
Hlg	– Lower gravel sequence, Hanford formation
H/R	– Hanford/Ringold contact
EP	– Early "Palouse" soil
PP	– Plio–Pleistocene unit
UP	– Upper unit, Ringold Formation
E	– Gravel Unit E, Ringold Formation
C	– Gravel unit C, Ringold Formation
LM	– Lower mud sequence, Ringold Formation
A	– Gravel unit A, Ringold Formation

Figure 3-15. Legend for Cross-sections.

THIS PAGE INTENTIONALLY
LEFT BLANK

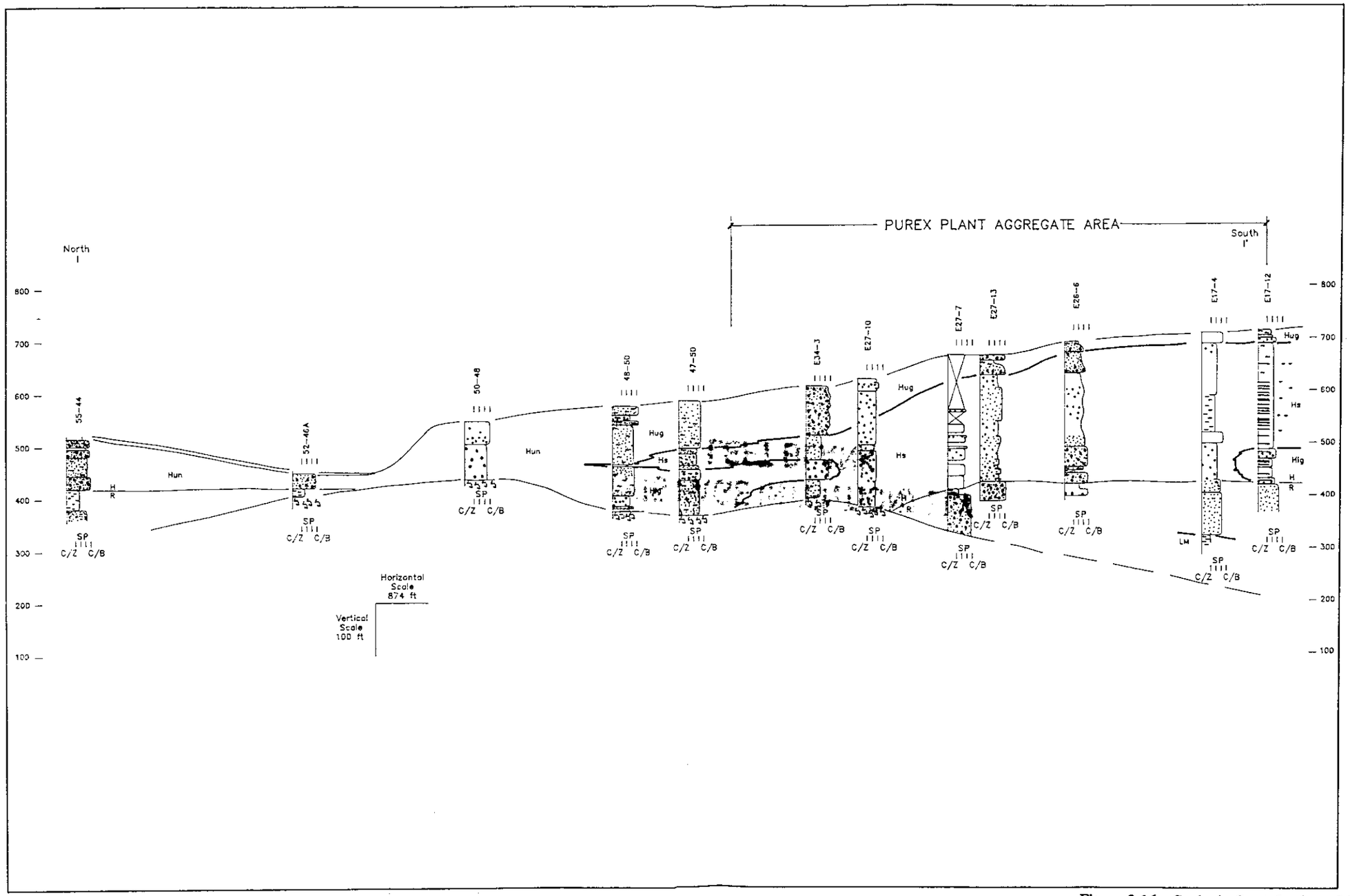


Figure 3-16. Geologic Cross-Section - I-I'.

THIS PAGE INTENTIONALLY
LEFT BLANK

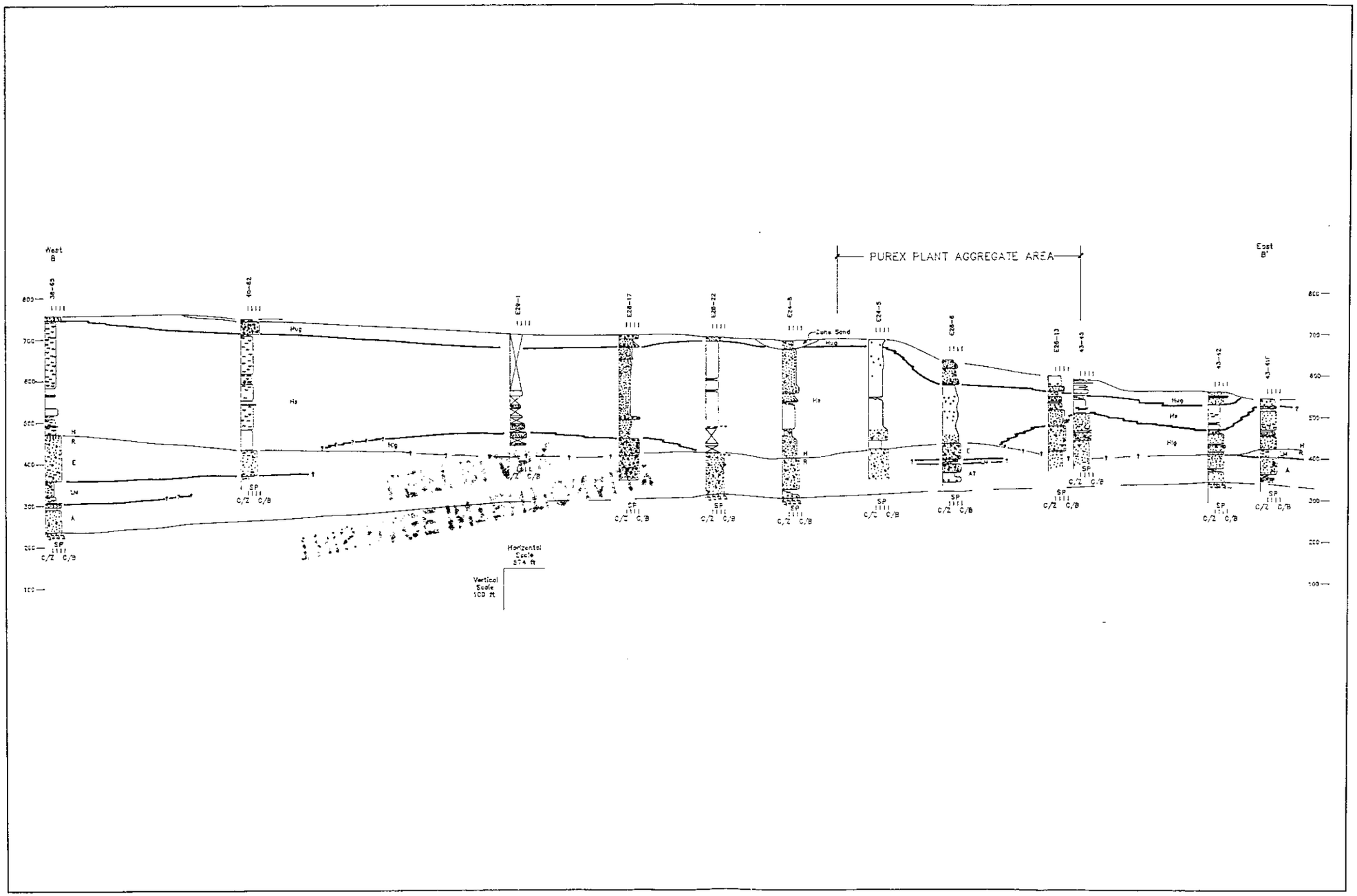


Figure 3-17. Geologic Cross-Section - B-B'.

THIS PAGE INTENTIONALLY
LEFT BLANK

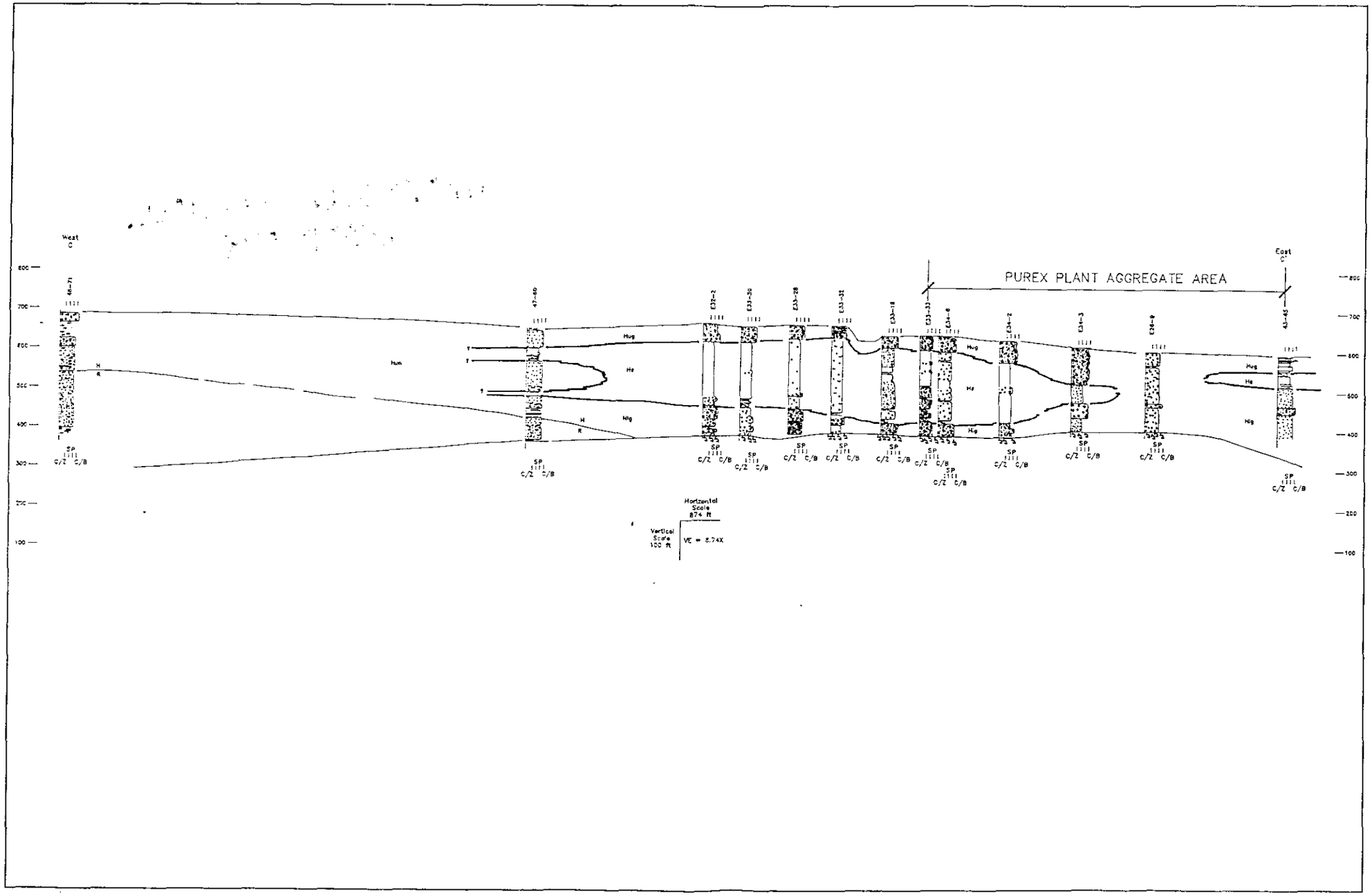


Figure 3-18. Geologic Cross-Section - C-C'.

THIS PAGE INTENTIONALLY
LEFT BLANK

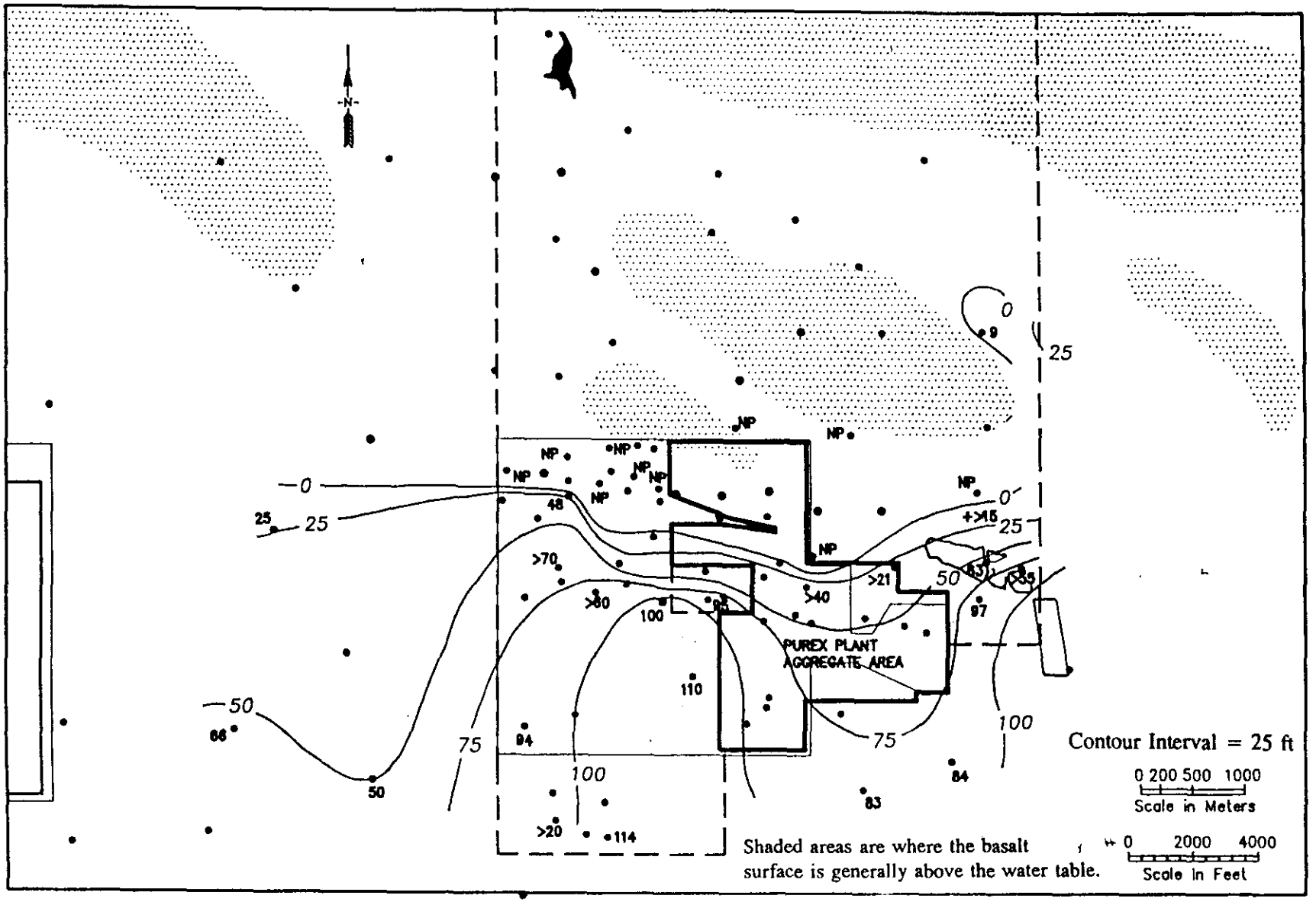


Figure 3-19. Isopach Map of the Ringold Gravel Unit A.

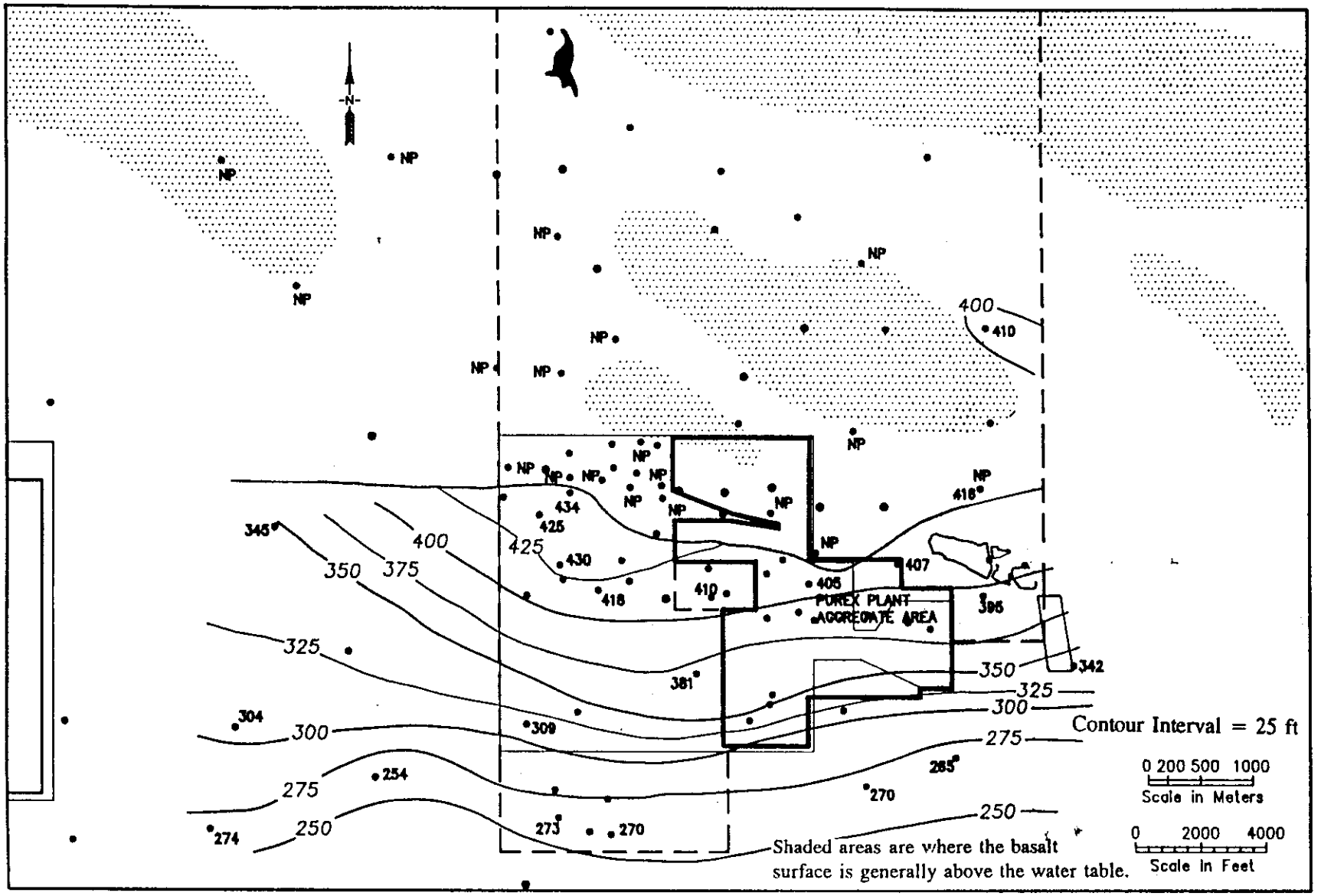


Figure 3-20. Top of the Ringold Gravel Unit A.

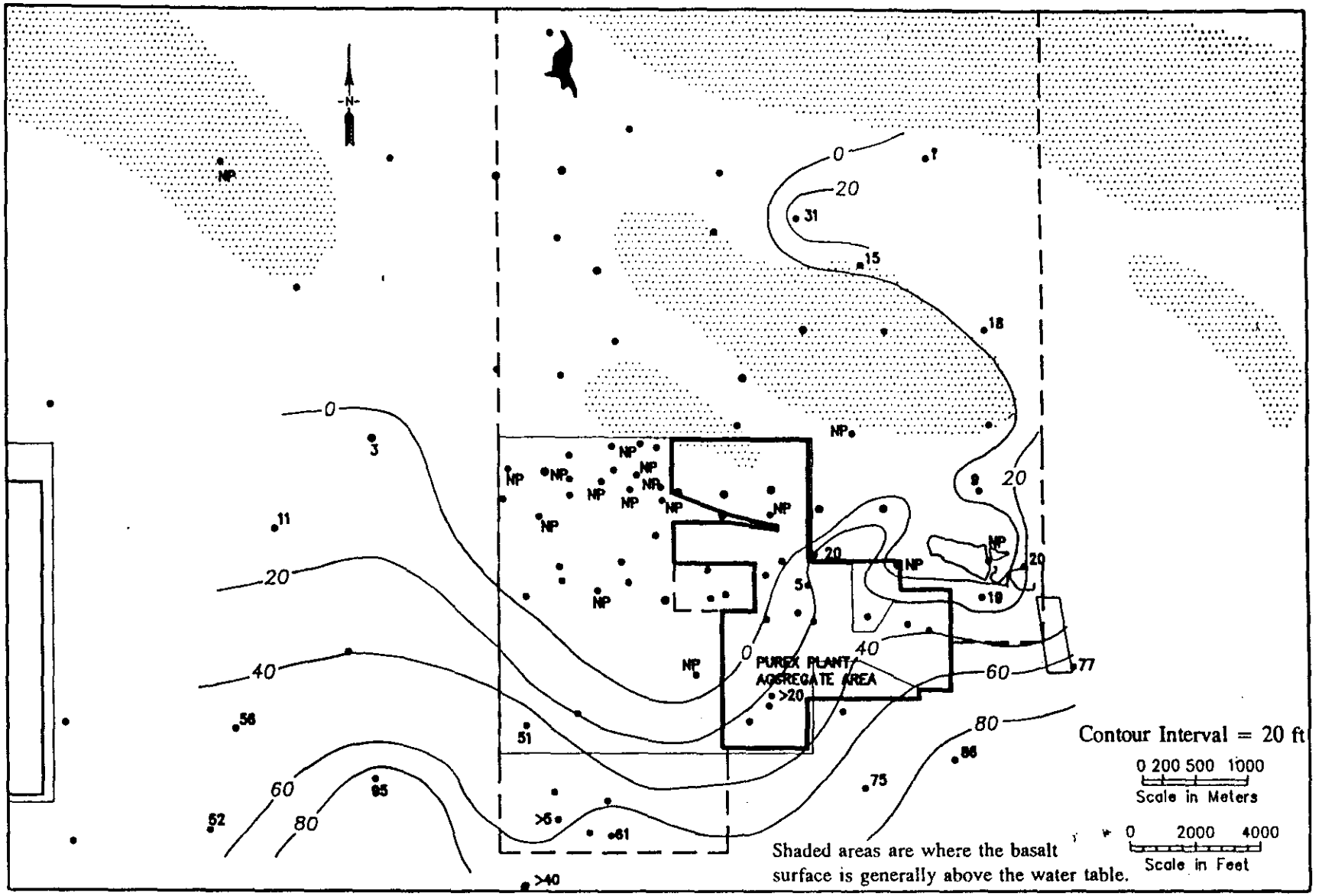


Figure 3-21. Isopach Map of the Lower Mud Sequence.

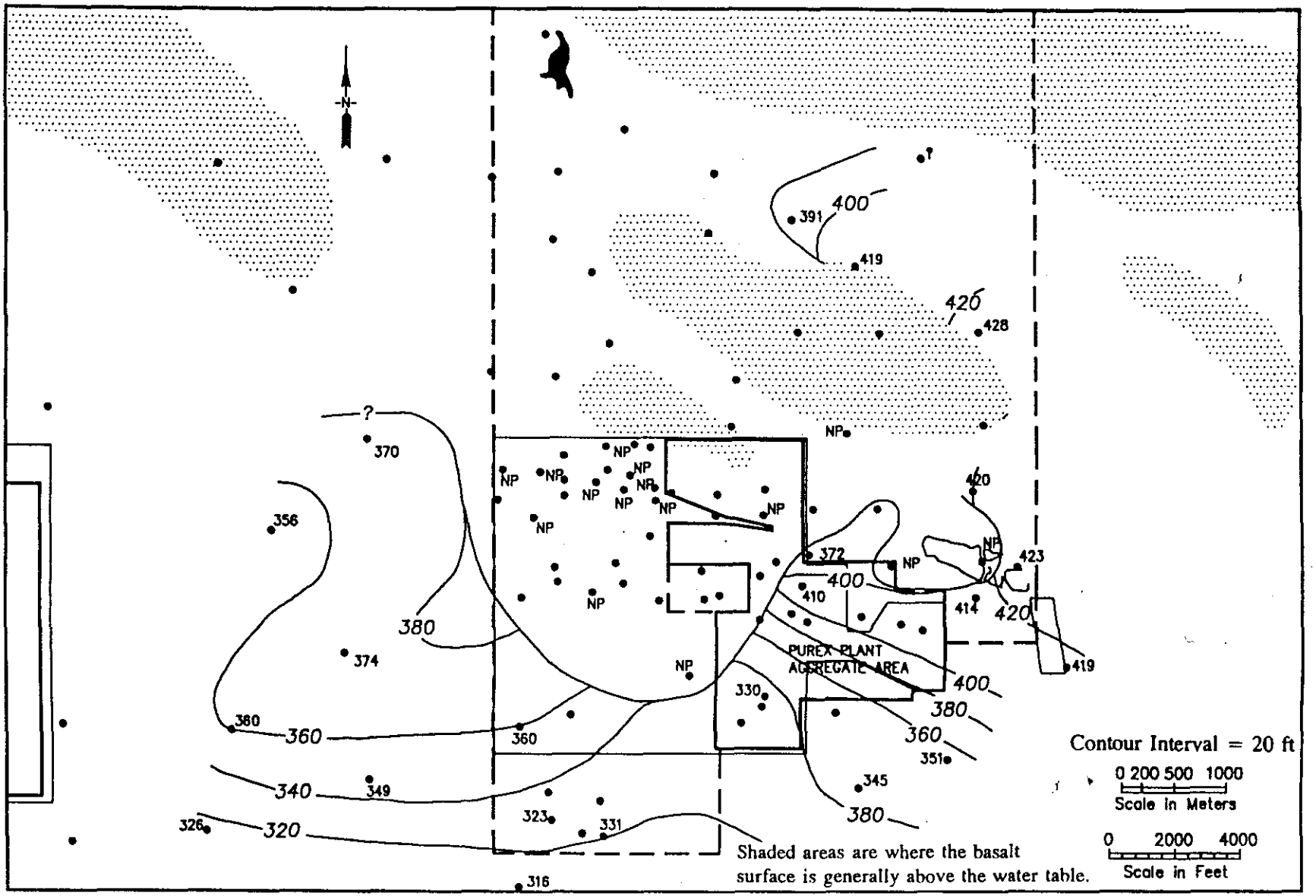


Figure 3-22. Structure Map of the Lower Mud Sequence.

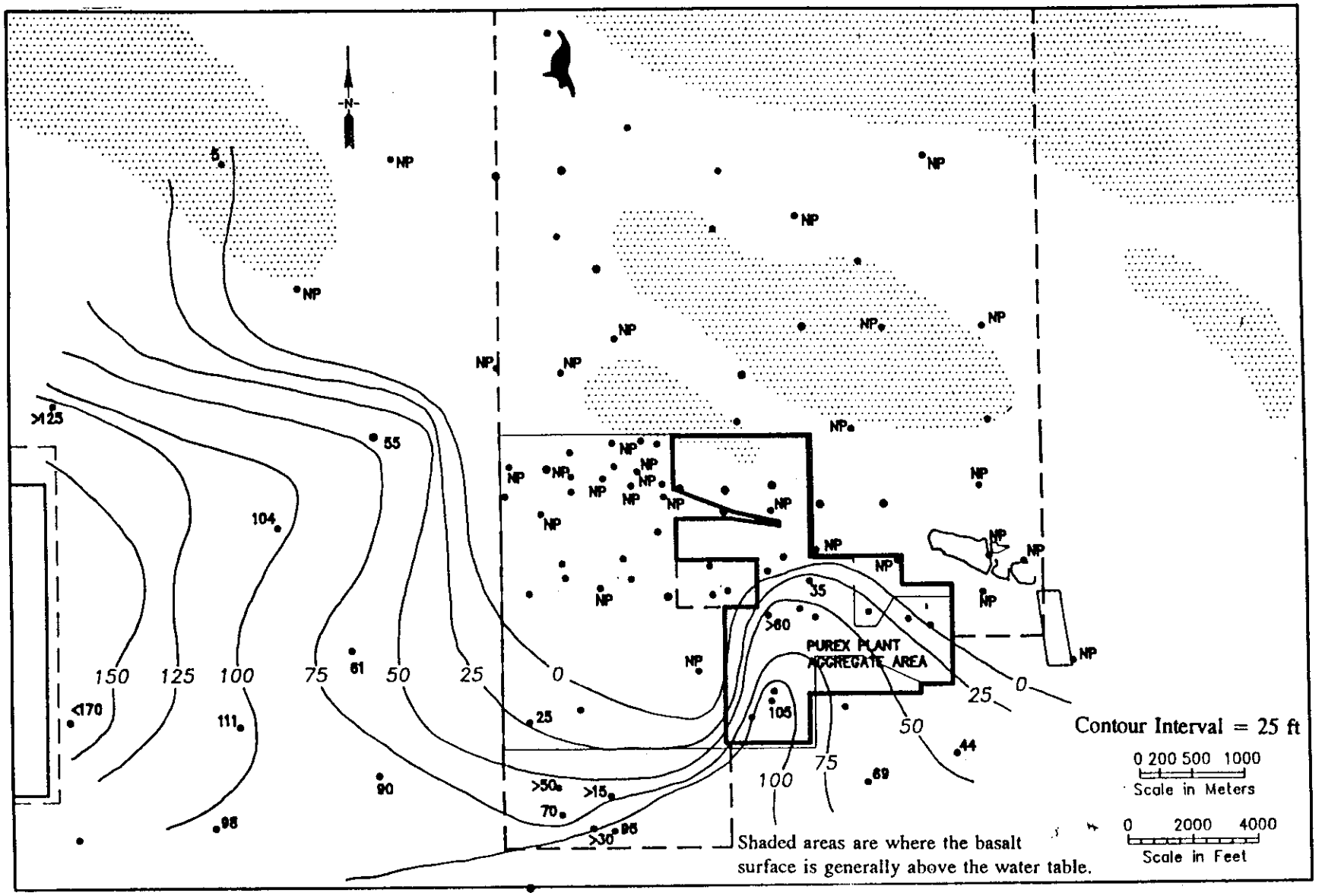


Figure 3-23. Isopach Map of the Ringold Gravel Unit E.

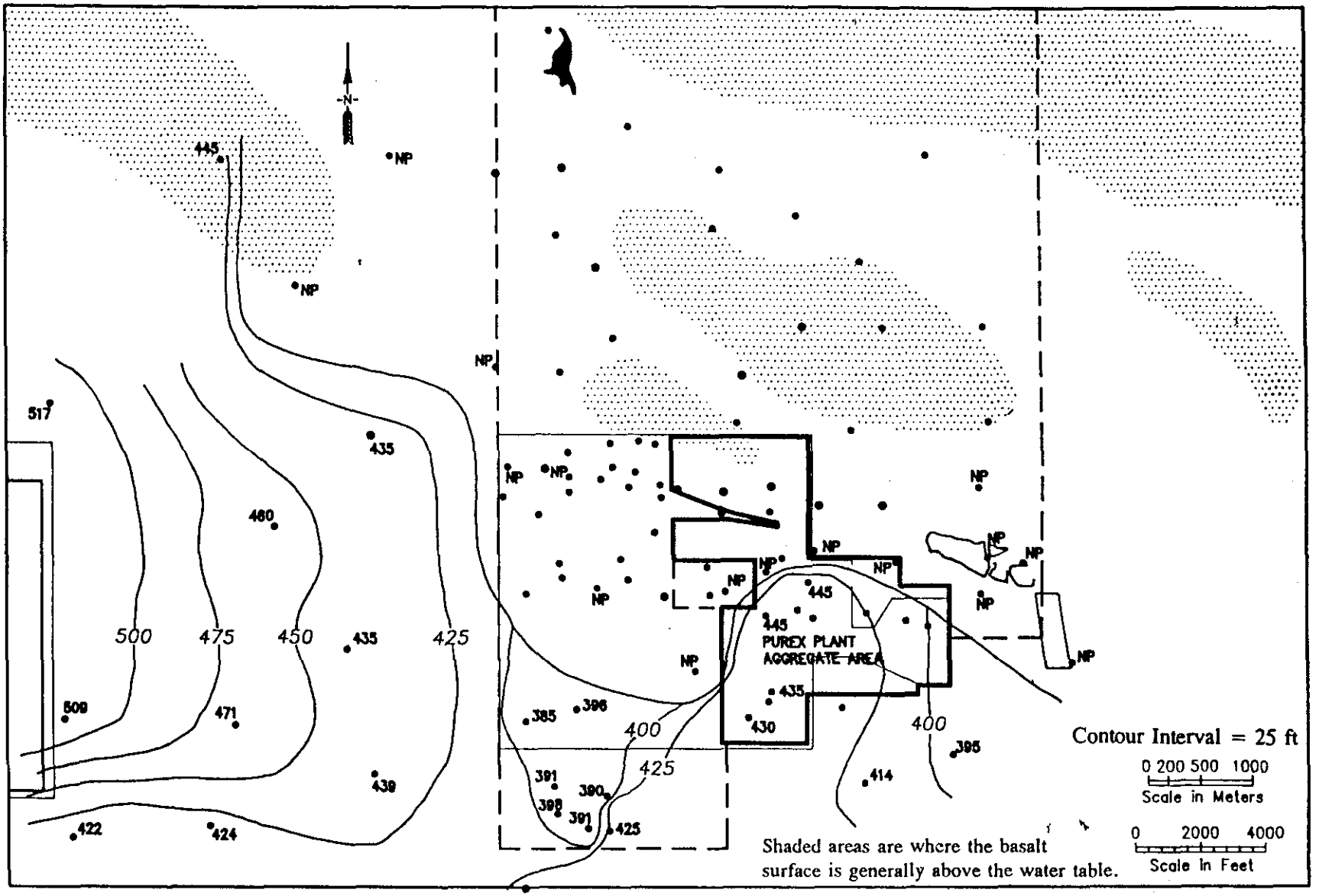


Figure 3-24. Structure Map of the Ringold Gravel Unit E.

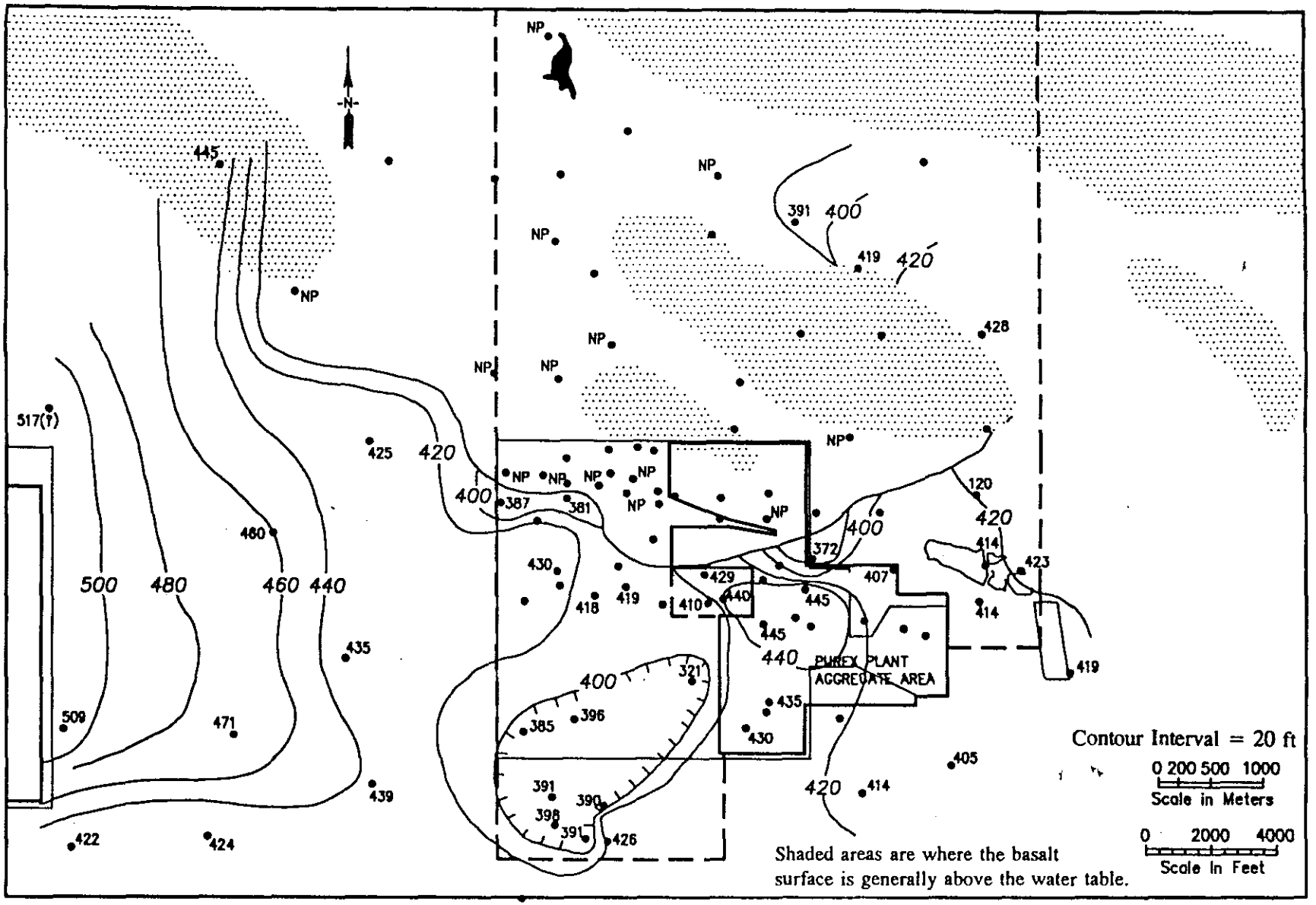


Figure 3-25. Top of the Ringold Formation.

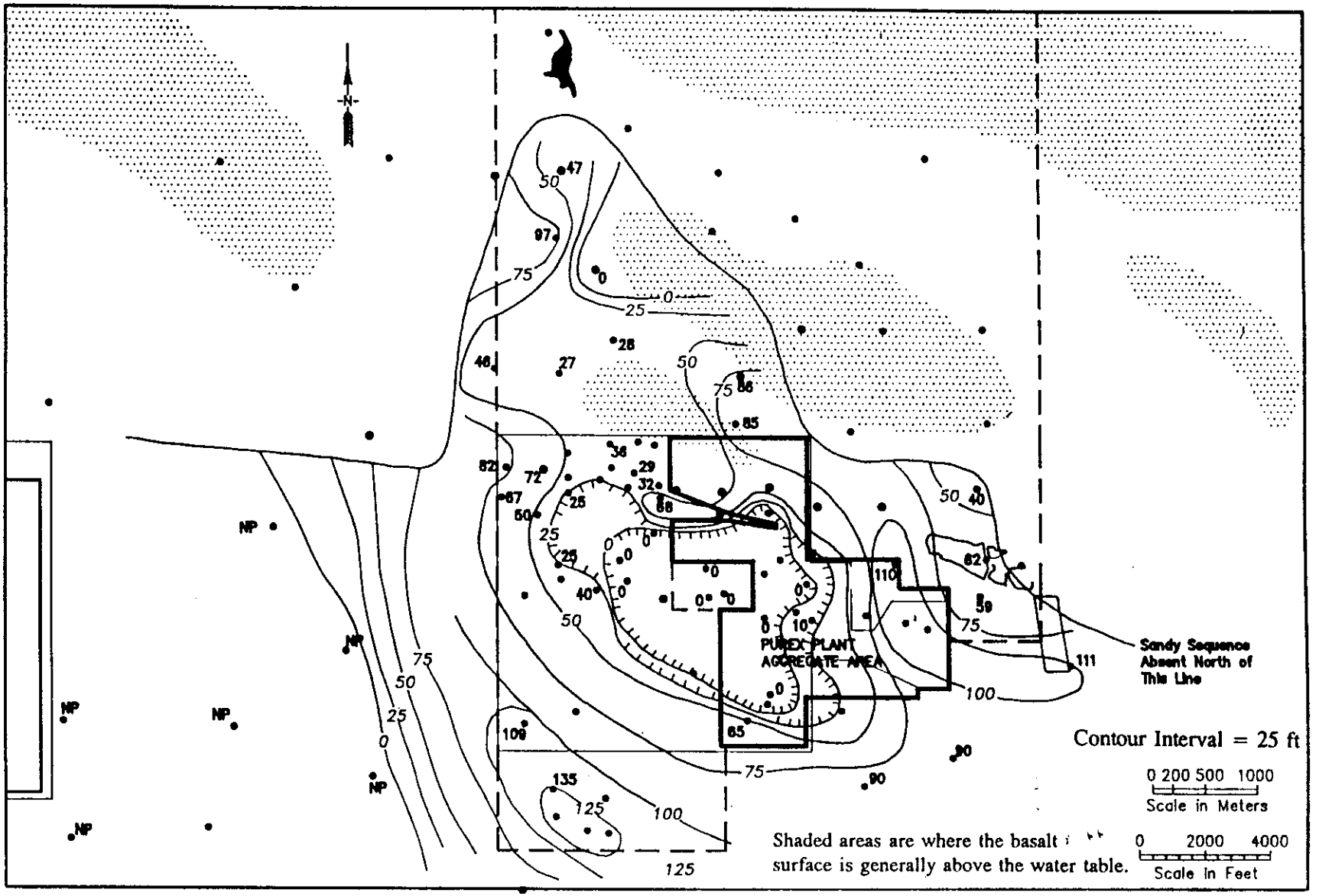


Figure 3-26. Isopach Map of the Lower Gravel Sequence.

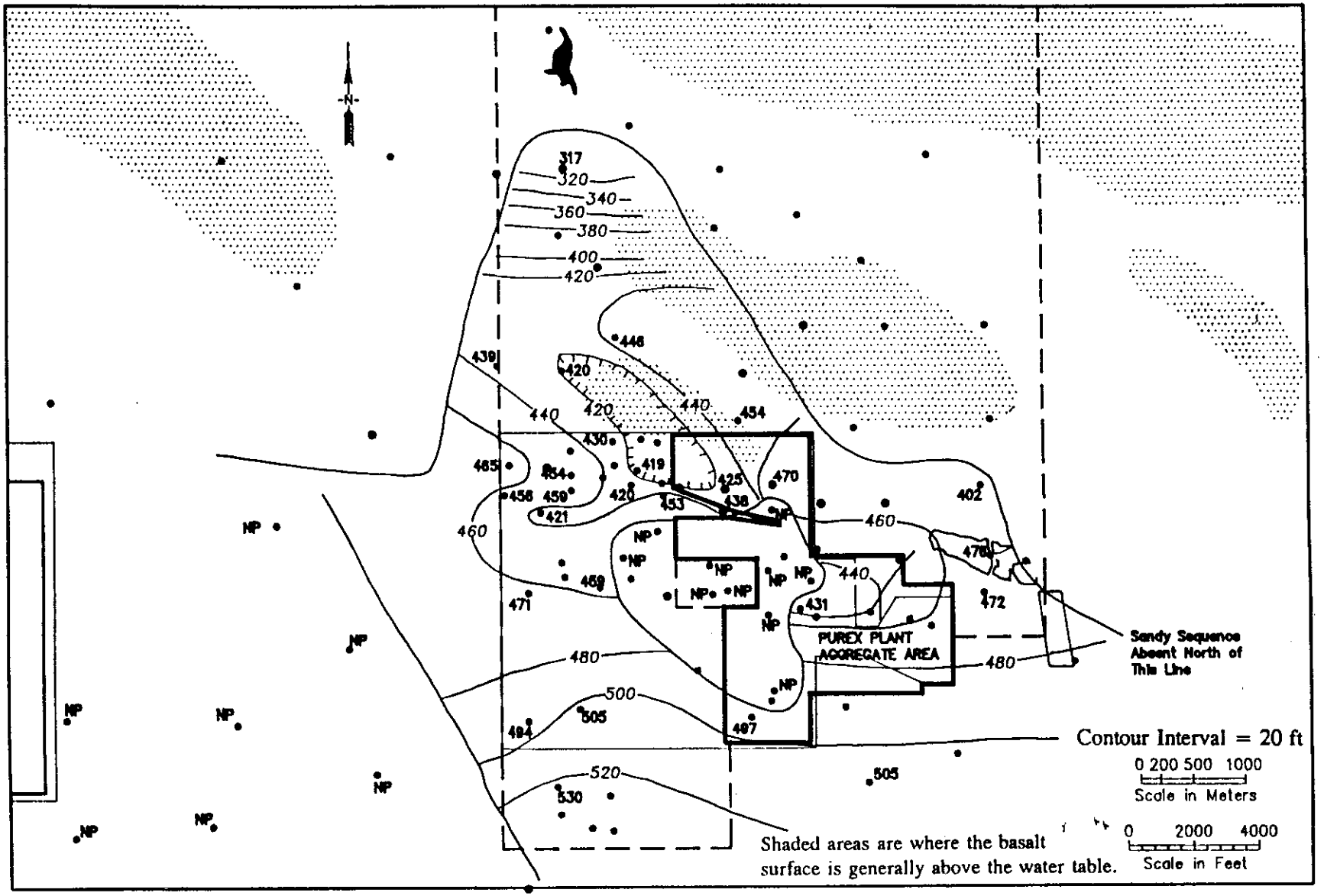


Figure 3-27. Structure Map of the Lower Gravel Sequence.

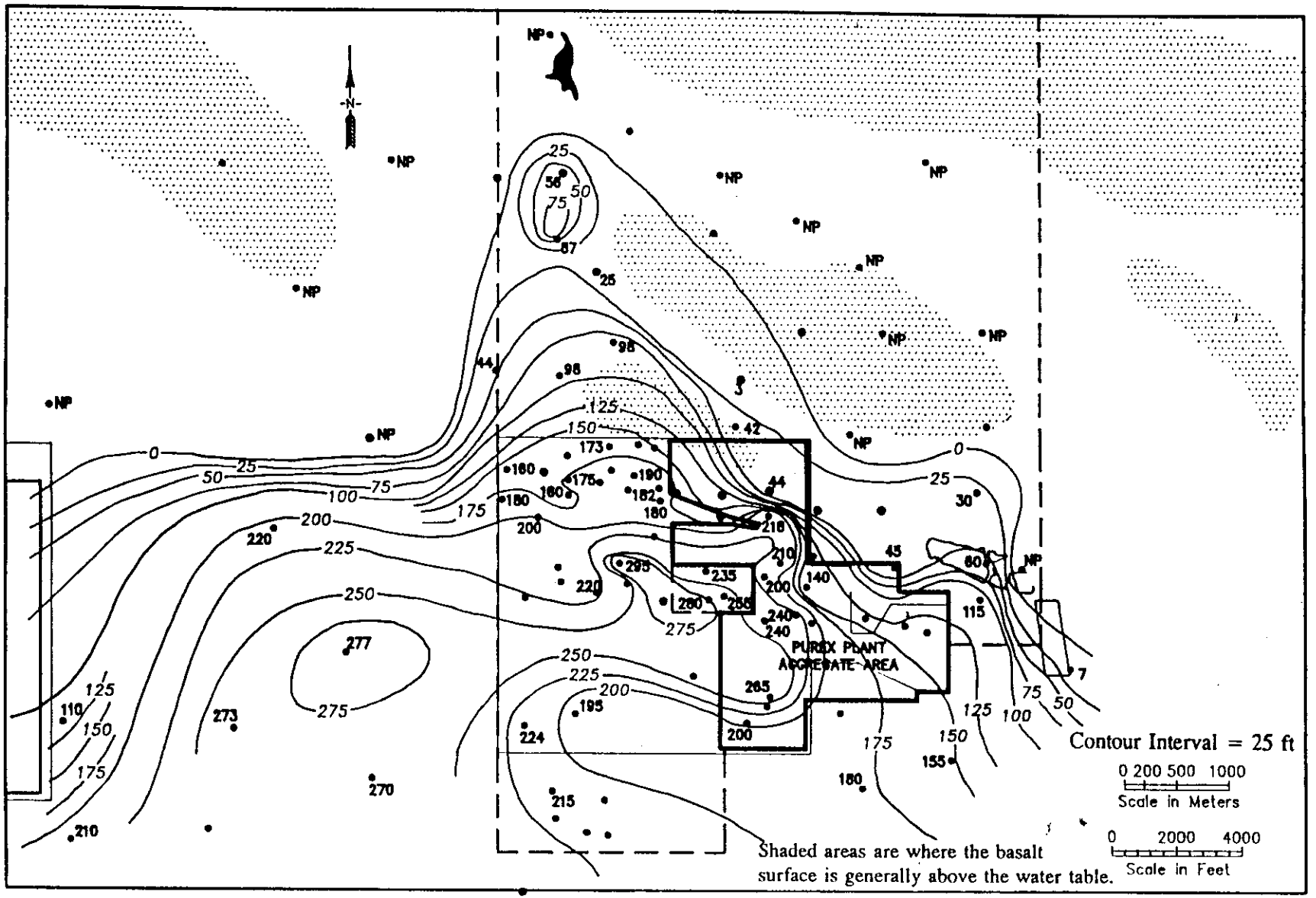


Figure 3-28. Isopach Map of the Sandy Sequence.

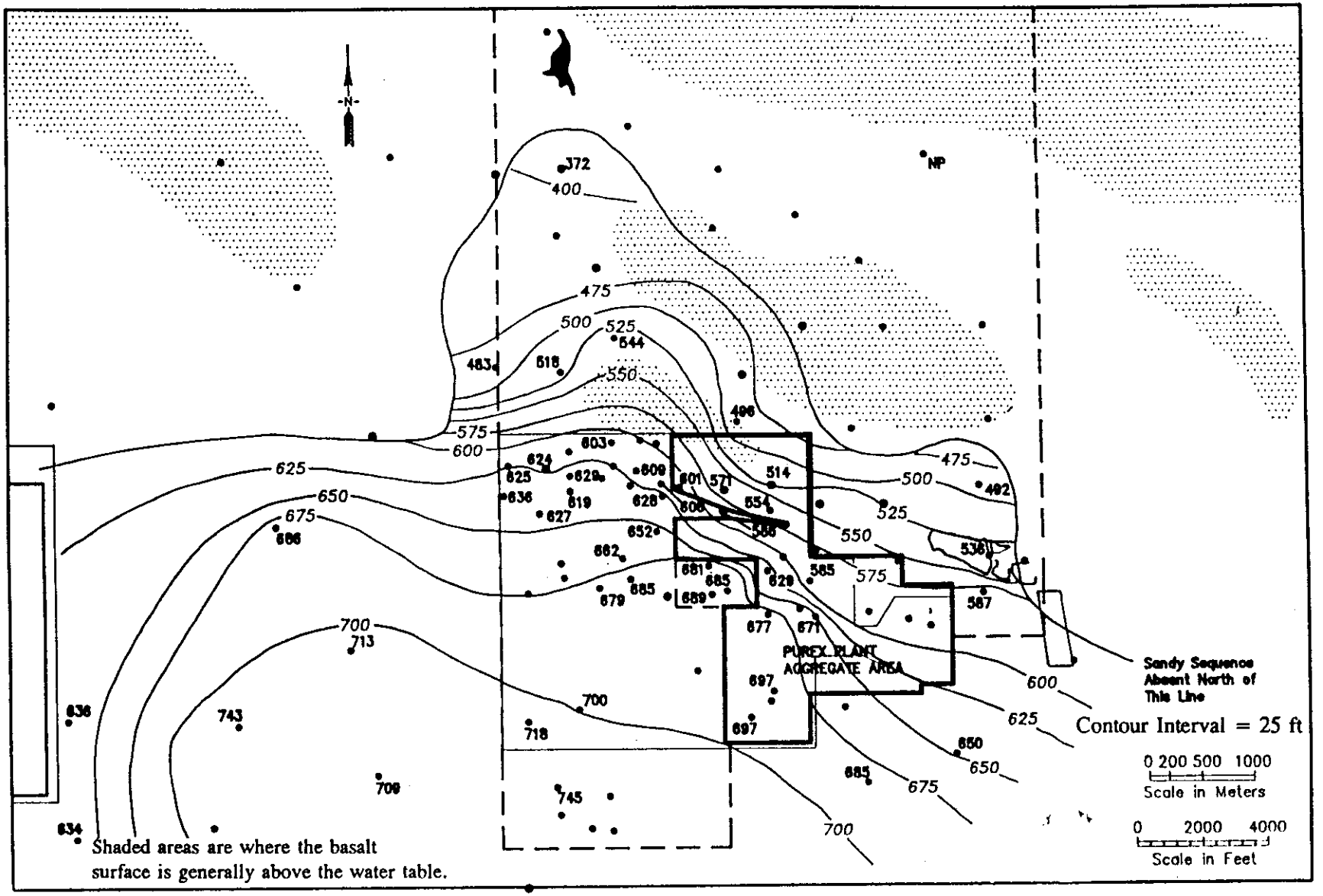


Figure 3-29. Structure Map of the Sandy Sequence.

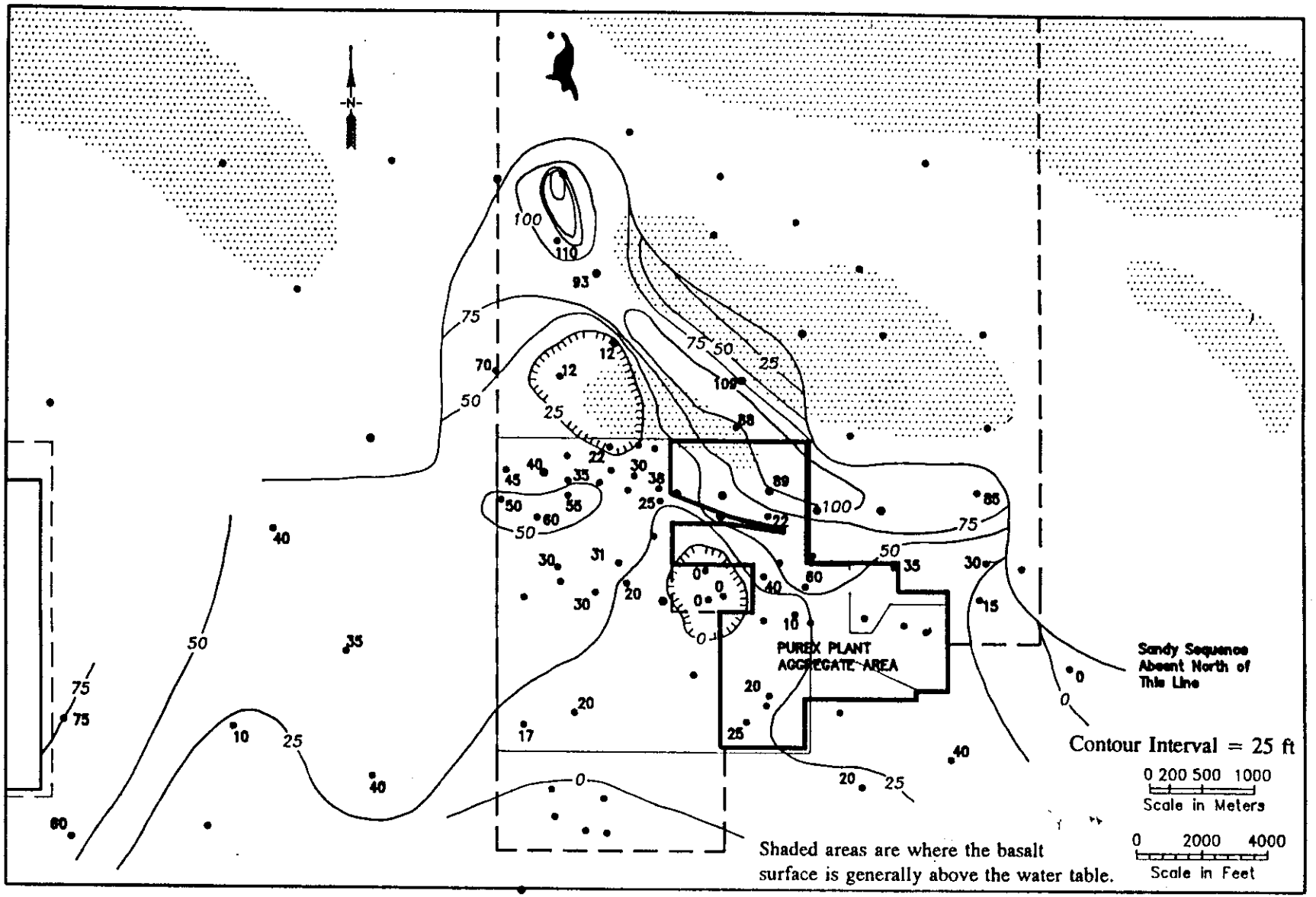


Figure 3-30. Isopach Map of the Upper Gravel Sequence.

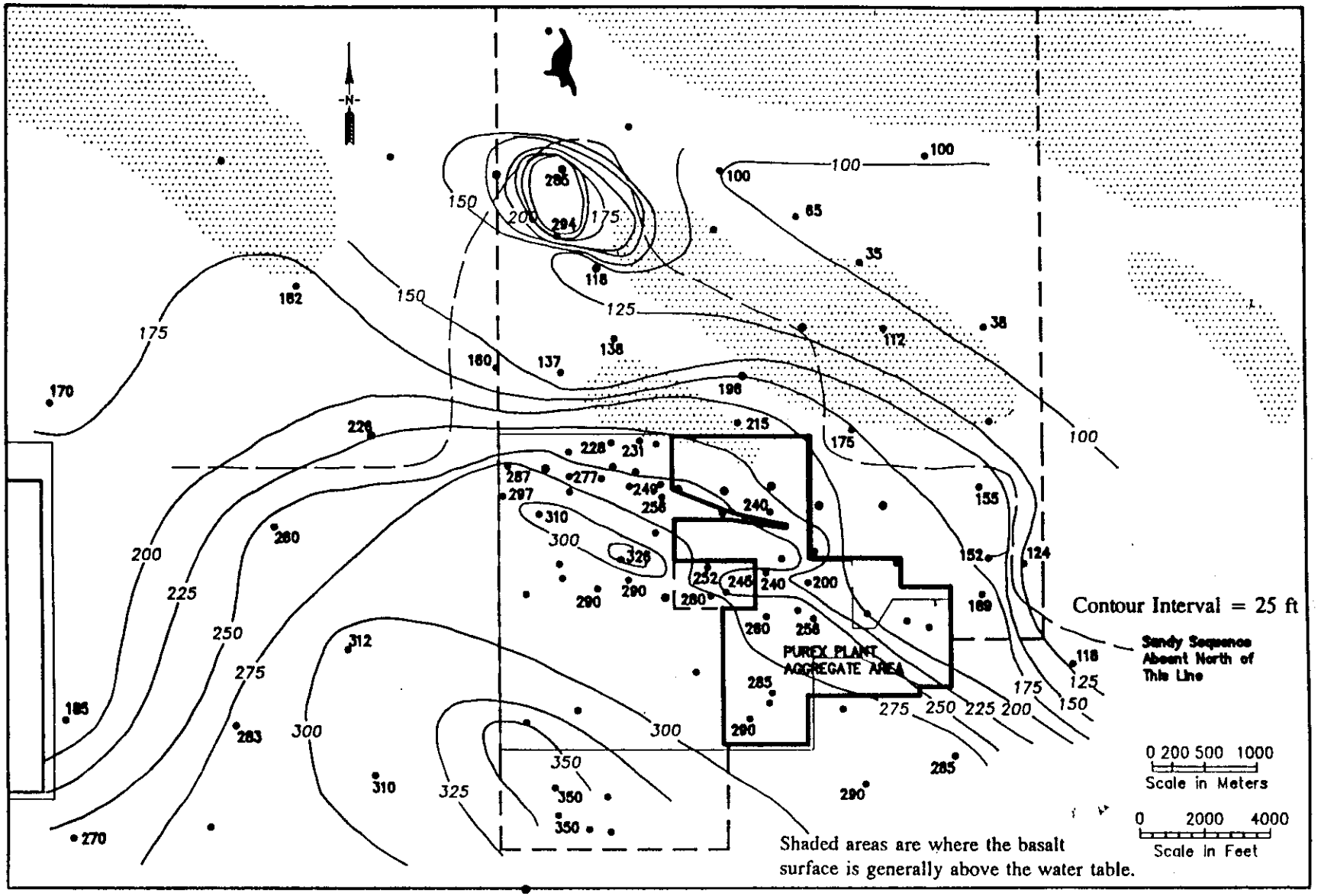


Figure 3-31. Isopach Map of the Entire Hanford Formation.

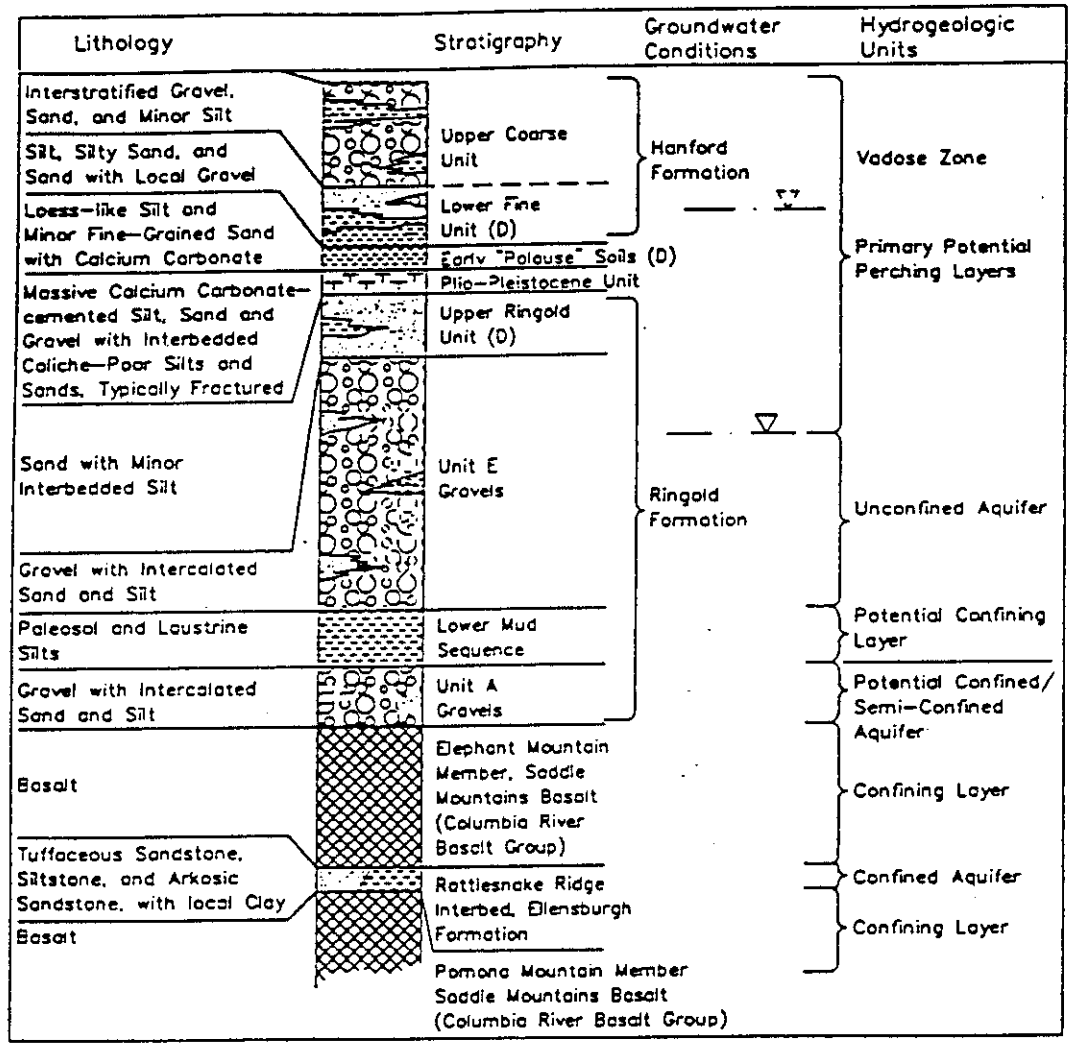


Figure 3-32. Conceptual Geologic Hydrocolumn for the Hanford Site.

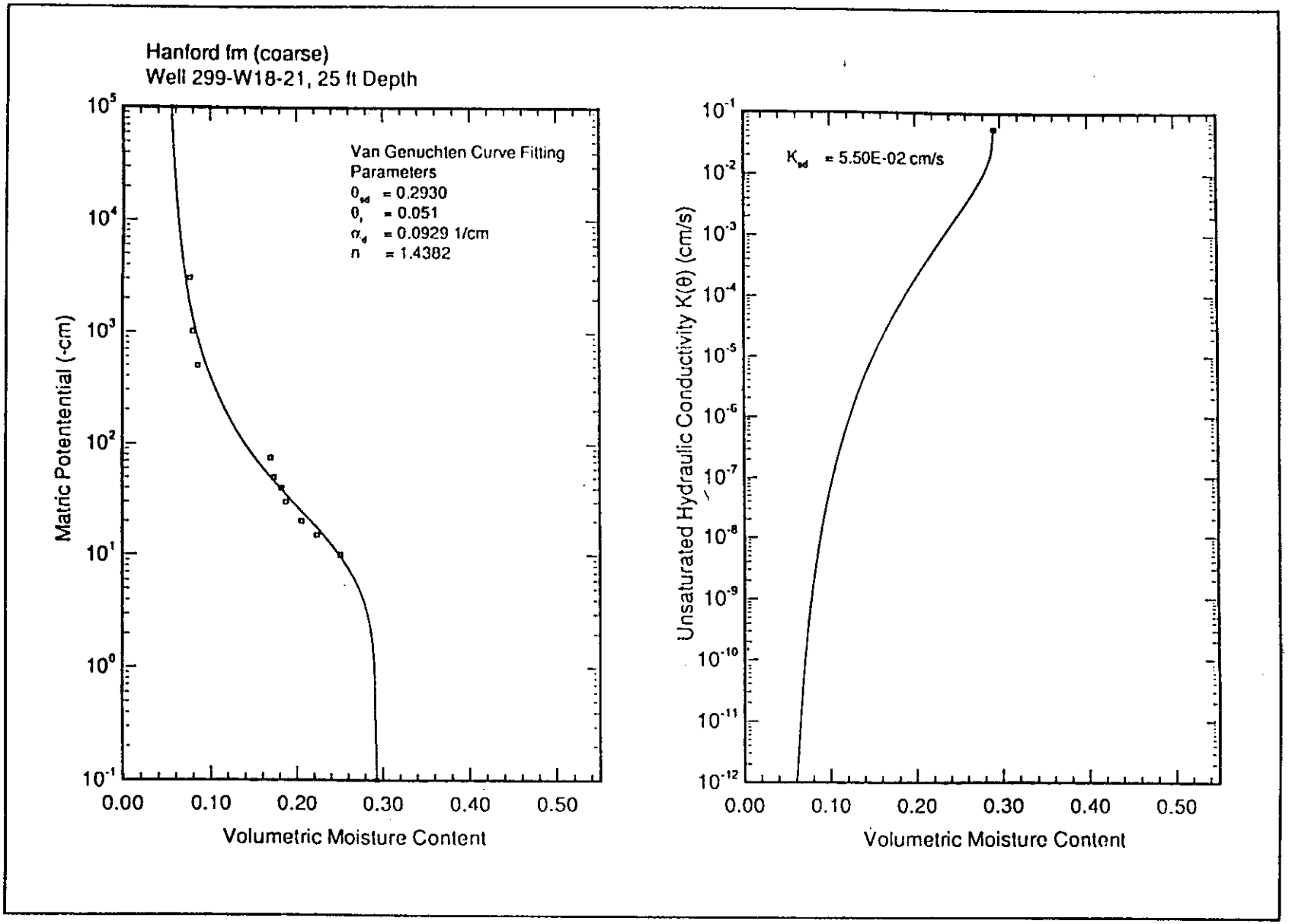
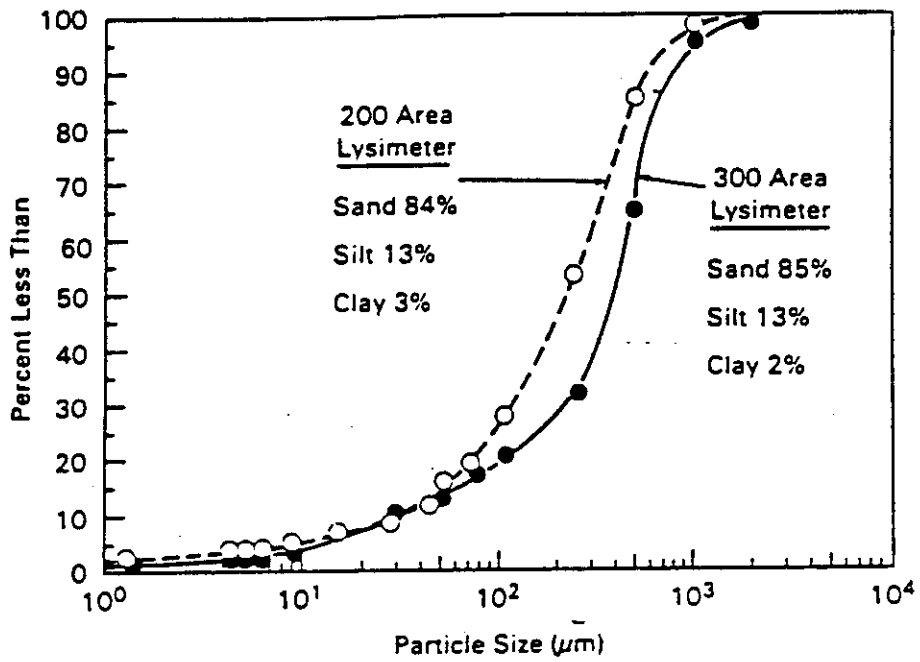
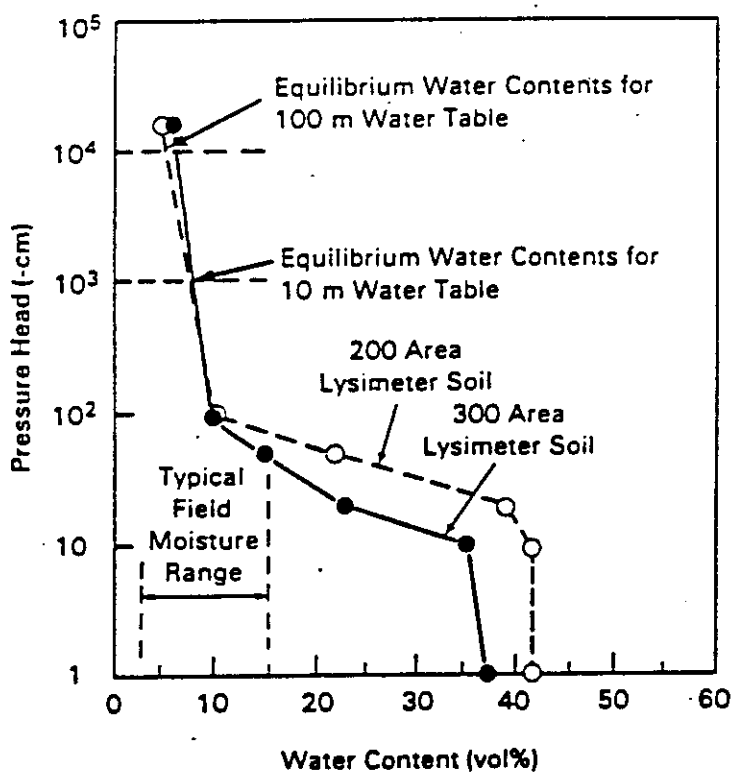


Figure 3-33. Wetting and Drying Curves for Well 299-W18-21.



a. Particle-Size Distribution



b. Water Retention Characteristics

Figure 3-34. Particle Size Distribution and Water Retention Characteristics of Soils From Hanford Site Lysimeters.

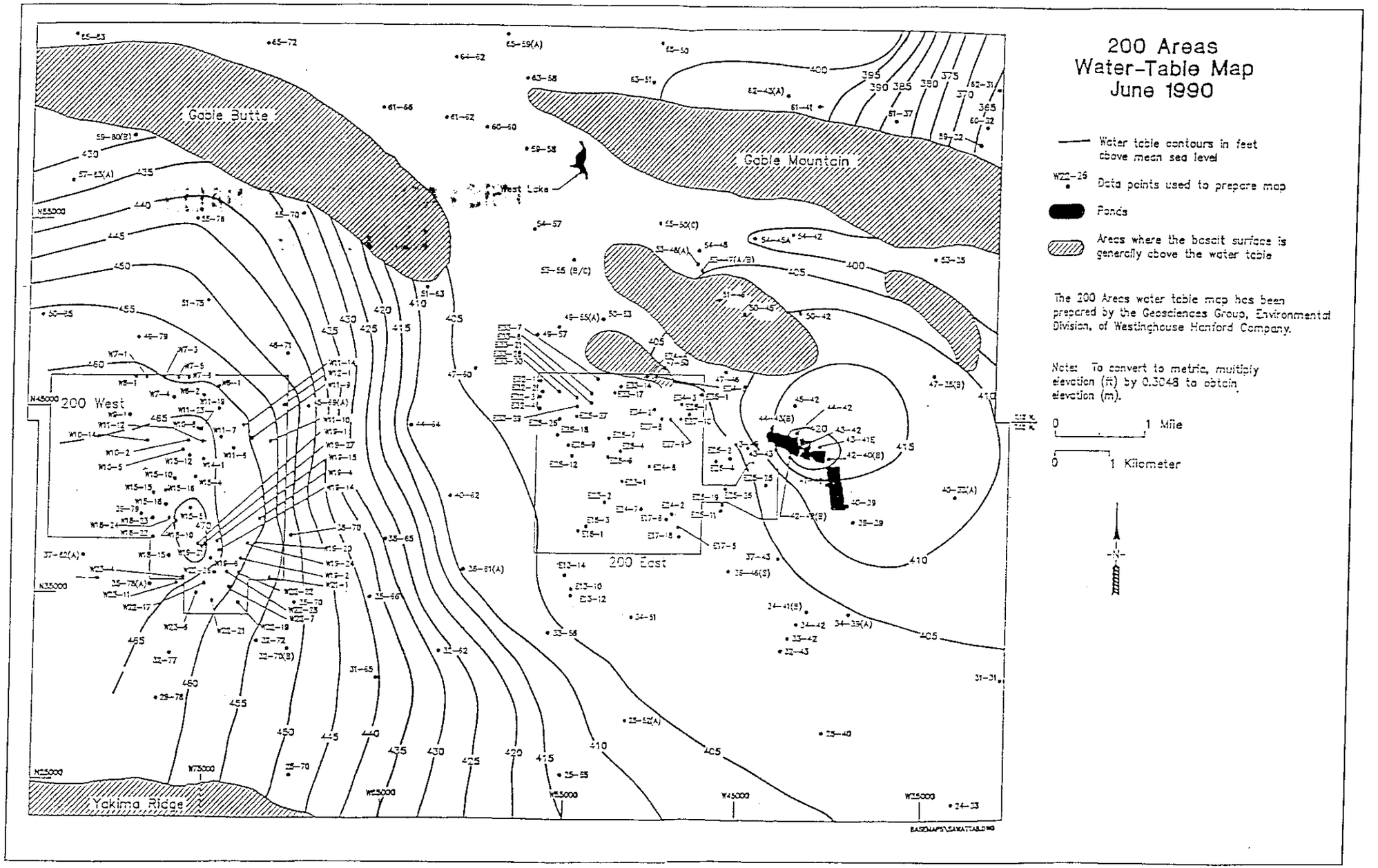


Figure 3-35. 200 Areas Water Table Map, June 1990. (Kasza et al. 1990)

THIS PAGE INTENTIONALLY
LEFT BLANK

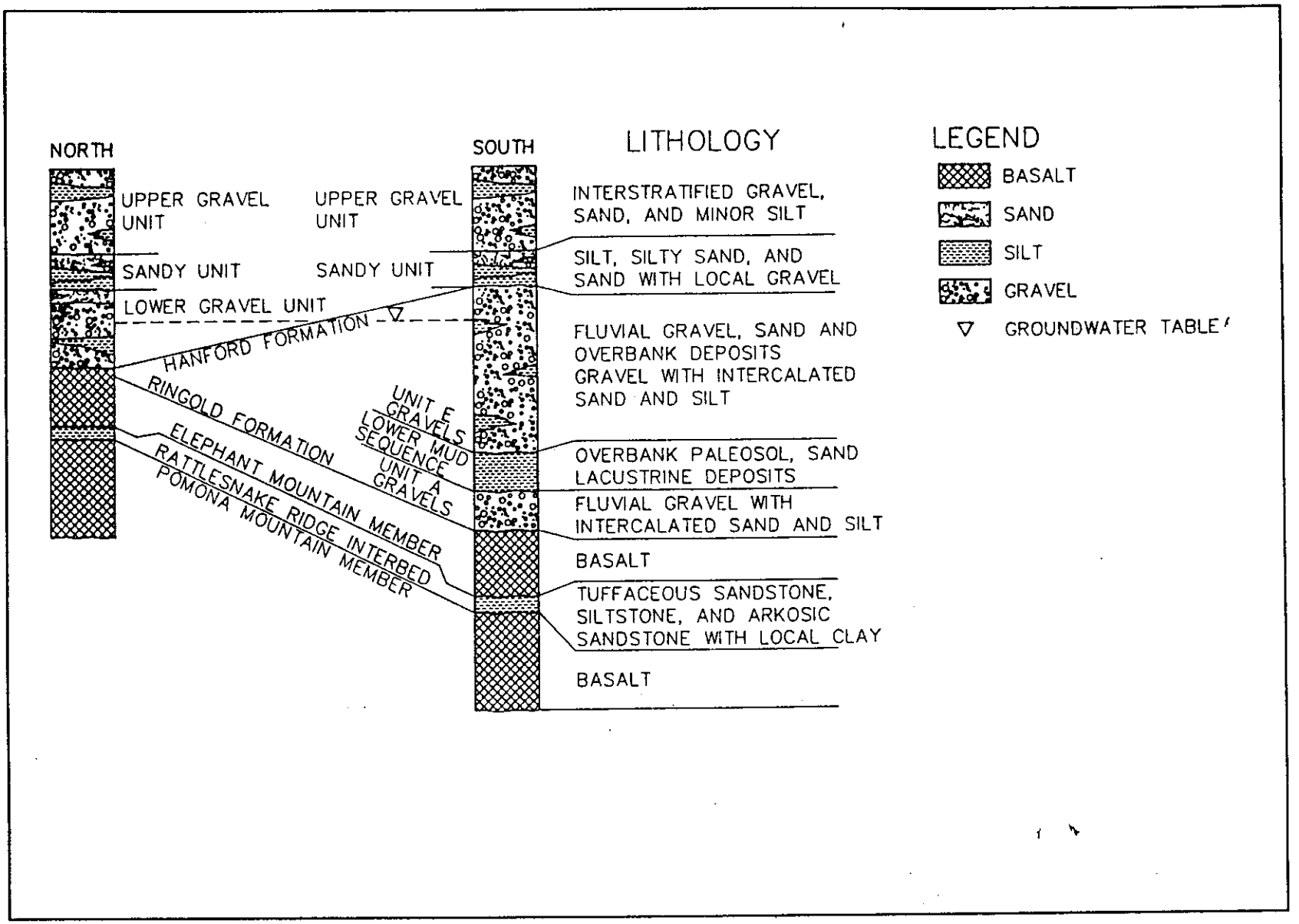


Figure 3-36. Conceptual Hydrogeologic Column for the PUREX Plant Aggregate Area. (Lindsey et al.; Delaney et al. 1991)

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

Location	Interval tested	Hydraulic conductivity (ft/d)	Transmissivity (ft^2/d)
Pasco Basin	Hanford Formation	500 - 20,300	
	Ringold Formation Unit E	20 - 600	
	Ringold Formation Unit A	0.1 - 10	
100 Area	Ringold Formation Unit E	29 - 1,297	5,750 - 26,700
200 Areas	Hanford Formation	2,000 - 10,000	
	Ringold Formation Unit E	9 - 230	
	Ringold Formation Unit A	1 - 12	
200 West Area	Ringold Formation Unit E	0.06 - 200	
	Ringold Formation Unit A	1.7 - 4	
	Lower Ringold laboratory	3×10^{-5} - 8×10^{-5}	
Slug Tests at U-12 Crib	Upper Ringold	8 - 44	
300 Area	Hanford Formation	11,000 - 50,000	
300 Area	Ringold Formation	1.9 - 10,000	
1100 Area	Ringold Formation Units C/B	3×10^{-1} - 5	
1100 Area	Ringold Formation Overbank Deposits	8×10^{-4} - 1×10^{-1}	

9 2 1 2 5 1 6 1 2 3 3

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

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

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

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

Notes:
na - Not identified in source.
sat - Value for saturated soil.
field saturation - Equilibrium water content after several days of gravity drainage.

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

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

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

WHC.23/5-17-92/02723A

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

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

*FE - Federal Endangered
FT - Federal Threatened
FC2 - Federal Candidate
SE - State Endangered
ST - State Threatened
SC - State Candidate
SM - State Monitor

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

4.0 PRELIMINARY CONCEPTUAL SITE MODEL

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

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

4.1 KNOWN AND SUSPECTED CONTAMINATION

There are two major categories of chemical and radiological data available for the PUREX Plant Aggregate Area: site-specific data that are applicable to individual waste management units and unplanned releases; and area-wide environmental data that are useful in characterizing regional contamination trends.

Some waste management units and unplanned releases have been the subject of chemical and radiological studies in the past. However, most of these studies were limited in scope and did not provide a comprehensive analysis of the character and distribution of the contamination at each site. The types of unit-specific data that are available for some sites include inventory information, surface radiological surveys, external radiation dose rate monitoring, soil and sediment sampling, biota sampling, borehole geophysics, and groundwater sampling.

Table 4-3 summarizes the types of site-specific data available for each of the waste management units. It should be emphasized that the table only summarizes what types of data are available; it does not indicate the sufficiency of the data, either in terms of quality

or quantity. These concerns are addressed in Section 8.0. The site-specific information is presented for each waste management unit in Section 4.1.2.

Although groundwater issues are considered outside the scope of this study, some groundwater data have been included. Groundwater contaminant plumes that are known to have originated from specific waste management units are described because they offer insight into the distribution of contaminants within the vadose zone. A limited amount of groundwater data are presented separately for some of the sites in Section 4.1.2.

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

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

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

Section 4.1 describes available data regarding known and suspected contamination in the PUREX Plant Aggregate Area on a media-specific basis (air, surface soil, surface water, biota, and vadose zone soil). The text summarizes sources of chemical and radiological

sampling information. Section 4.1.1 presents data on a media-specific basis. Section 4.1.1.1 presents results of air quality sampling data. Surface soil data are described in Section 4.1.1.2. Results of surface water sampling are presented in Section 4.1.1.3. Results of vegetation and other biota sample analyses are presented in Section 4.1.1.4. Available vadose zone sampling data are presented in Section 4.1.1.5. Section 4.1.1.5 also discusses evidence for contamination migration within the vadose zone to the unconfined aquifer underlying the site. Additional assessment of the nature and extent of groundwater contamination is presented in the 200 East Groundwater Aggregate Area Management Study Report (AAMSR).

To supplement available radiological and chemical analytical data, historical waste inventory information for the PUREX Plant Aggregate Area waste management units was also included in the evaluation of known and suspected contaminants. Historical waste inventory data are detailed in Section 2.0 of this report (Tables 2-3 and 2-4). As discussed in Section 2.0, the compilation is based on supporting data from the Waste Inventory Data System (WIDS) (WHC 1991a) and the Hanford Inactive Site Survey (HISS) Database (DOE 1986).

4.1.1 Affected Media

4.1.1.1 Air. Seventeen high volume air samplers are stationed within or adjacent to the PUREX Plant Aggregate Area (Plate 3). The samplers contain filters that collect particles entrained in the air.

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

The filters are analyzed quarterly for ^{90}Sr, ^{137}Cs, ^{239}Pu, and U total. The results have shown a steady decline in the concentration of these radionuclides from 1985 to 1987, a slight increase in 1988, and then a decline again in 1989 throughout the 200 East Area (Schmidt et al. 1990). The increased radionuclide concentrations in 1988 was on the average greater than 1987 concentrations; however, they were still lower than the first samples taken

in 1985. In 1989, four of the seventeen air sampling stations were removed from service. The stations removed from service included N006, N007, N008, and N012, located north, south, and east, respectively, of the 241-AP Tank Farm and northeast of the 207-A Retention Basins. The last 5 years of data for the PUREX Plant Aggregate Area have been averaged and the values are summarized in Table 4-4. The complete data set since 1985 is summarized in Appendix A.2.

4.1.1.2 Surface Soil. There are several sources of data available for characterizing surface soil contamination. These include: aerial and ground radiological surveys, external radiation measurements and surface soil sampling. These data will be presented in the following sections. In addition, there is a limited amount of site-specific radiological and soil sampling data that will be presented in the appropriate sections of Section 4.1.2.

4.1.1.2.1 Radiological Surveys. Radiological survey results may be influenced by buried or airborne radionuclide contamination but are generally indicative of surface and shallow soil contamination. An aerial gamma-ray radiation survey was performed over the 200 East Area in July and August 1988. The survey lines were flown with a 122 m (400 ft) spacing at an altitude of 61 m (200 ft). The data were normalized to a height of 1 m (2 ft) above the ground surface. Figure 4-1 presents the gross count data (ct/s) on an isoradiation contour map that covers the entire 200 East Area.

The entire area has gross gamma counts that are above background. The highest gross count results in the PUREX Plant Aggregate Area were between 220,000 and 700,000 ct/s measured over the railroad spur northwest of the 202-A Building (site number 4 on Figure 4-1). This is where equipment is stored that has been contaminated with fission products. The second highest results were between 70,000 and 220,000 ct/s as measured over the 241-C and 241-A Tank Farms (site number 5 and 2, respectively, on Figure 4-1). The third highest results were between 22,000 and 70,000 ct/s measured around the perimeter of the tank farms. The only other elevated radiation area in the aggregate area had counts of between 7,000 and 22,000 ct/s and was centered over the 202-A Building (site number 3 on Figure 4-1). It is nearly impossible to convert these gross gamma counts to a meaningful exposure rate because of the complex distribution of radionuclides on the site.

Spectral logs were only generated for four sites within the PUREX Plant Aggregate Area in this survey and these had identifiable photopeaks in three cases. A photopeak is the specific energy or wavelength that can be associated with the emissions from a specific radionuclide. Cesium-137 was the only radionuclide that could be identified from spectra information collected over the 241-C and 241-A/AW/AX/AZ Tank Farms during the 1988 survey. Both ^{137}Cs and ^{60}Co were found near the railroad spur north of the 202-A Building where equipment is stored that has been contaminated with fission products. Only ^{137}Cs and ^{60}Co were identified in the aggregate area. As such, the aerial radiation survey data should

only be used as a qualitative tool for identifying more highly contaminated areas within the survey boundaries. In addition, the gamma counts noted in the survey probably result from both surface and shallow buried radionuclides, and are thus not entirely indicative of surface contamination.

Elevated radiation zones identified by the aerial survey generally correspond to areas where surface contamination has been noted by surface radiation surveys. Figure 4-2 shows areas of known surface contamination, underground contamination and migration identified from surface surveys. The primary areas of surface contamination noted in the PUREX Plant Aggregate Area include:

- The 241-A Tank Farms
- The 241-C Tank Farm
- The 218-E-12B Burial Ground
- The miscellaneous site adjacent to the railroad spur northwest of the 202-A Building
- Along the railroad spur leading into the east end of the 202-A Building.

Most of these areas fall within the anomalously high zones noted in the radiation survey. Areas of active surface radiological contaminant migration include (Huckfeldt 1991):

- On the northeast side of the 241-C Tank Farm
- Small patches north and south of 8th Street
- On the south and west sides of the 241-ER-153 Diversion Box
- An area southeast of the 202-A Building and south of UPR-200-E-142.

Table 4-5 summarizes the maximum value reported on the radiological survey results for each waste management unit and unplanned release. The areas of surface contamination and contaminant migration will be discussed in more detail in the section dealing with the individual waste management units and unplanned releases (Section 4.1.2). Surface radiological surveys are done quarterly, semiannually, or annually at the waste management units. The surface contamination posting may change often because of resurveying results, posting requirements according to WHC-CM-4-10, or because of cleanups affected under the Radiation Reduction Program.

4.1.1.2.2 External Radiation Dose Rate Measurements. Dose rates from penetrating radiation were measured annually at 40 locations within or adjacent to the PUREX Plant Aggregate Area between 1985 and 1989. The sample locations are shown on Plate 3, and the survey results are listed on Table 4-6. The measurements were taken with thermoluminescent dosimeters (TLDs) and are reported in mrem/yr. The TLDs measure dose rates resulting from all types of external radiation sources including cosmic radiation, naturally occurring radioactivity, fallout from nuclear weapons testing and contributions from other Hanford Site activities. Most of the results averaged around or just below 100 mrem/yr except for the 241-A Tank Farms (-A, -AN, -AX, and -AZ) perimeter locations. The 1989 results from the 241-A Tank Farms had external radiation levels ranging from 125 to 2,519 mrem/yr, but readings were much lower in previous years. Sites 241-A Tank Farm No. 8, 241-A Tank Farm No. 9, and 241-A Tank Farm No. 10, near the 241-A Tank Farm, had consistently high readings throughout the 5-year period. The 242-A Evaporator is located just east of the 241-A Tank Farm No. 10 sampling site.

In 1990, new sampling locations were established giving the PUREX Plant Aggregate Area only twenty-five dosimeter sites. The new sites were generally located on or near areas of known contamination and the results appeared to be slightly elevated over the previous sampling rounds. Measurements were generally a little above 100 mrem/yr. The highest average reading was 1,200 mrem/yr from the 241-A Tank Farm No. 8, adjacent to the 241-A Tank Farm. These results are summarized in Table 4-7.

4.1.1.2.3 Surface Soil Sampling. Between 1978 and 1989, surface soil samples were collected annually from a regular rectangular grid that covers the 200 East Area with 36 sampling points. Eight of these sampling sites are located within or adjacent to the PUREX Plant Aggregate Area. The sample points have never been exactly surveyed, but are generally located close to the intersections of Hanford Site coordinate lines at 610 m (1,000 ft) spacings. In addition, between 1984 and 1989, soils have been sampled along fences enclosing the tank farms in the 200 East Area. There are two soil samples associated with the 241-C Tank Farm and one soil sample associated with each of the following tank farms; 241-A, 241-AN, 241-AW, and 241-AZ. None of the soil sampling locations were at waste management units or unplanned release sites, so these data cannot be applied directly.

The results of the two soil sampling programs since 1985 are summarized in Tables 4-8 and 4-9. Tables that present all of the data collected since 1985 are contained in Appendix A.2. Counting errors are included with each analytical result and those entries that are greater than the accompanying counting errors are denoted with shading.

The most commonly detected radionuclides were ^{90}Sr, ^{137}Cs, ^{214}Pb, U total, ^{238}Pu, ^{239}Pu, and ^{152}Eu. However, only ^{137}Cs, ^{90}Sr, ^{214}Pb, U total, and ^{239}Pu were found consistently at concentrations above counting errors (Schmidt et al. 1990).

The highest radionuclide concentrations were generally noted in the vicinity of the 241-C Tank Farm. The highest concentrations of ^{90}Sr were consistently found at Site 2E17, adjacent to the 241-C Tank Farm. The trend at these locations has been generally upward since 1984. This is believed to be due to residual low-level contamination from the 241-C-151 Diversion Box incident which is discussed in detail in Section 2.3.7.22 (Schmidt et al. 1990).

In 1990, new soil sampling locations were established that are located close to areas of known surface contamination. The locations of these new sites are shown on Plate 3. There are 18 new sample locations within or adjacent to the PUREX Plant Aggregate Area. Currently, no analytical data are available for these new sample locations.

4.1.1.3 Surface Water. No natural surface water bodies exist within the PUREX Plant Aggregate Area. However, the manmade 216-A-29 Ditch, commonly referred to as Snow's Canyon, formerly received a variety of wastes. The surface water and sediment within the ditch were suspected to be contaminated. The site has recently undergone dramatic change. In October 1991 the ditch was surface stabilized with gravel to grade and surrounded with a light chain barricade, posted with underground contamination placards.

There are data for water quality in the 216-A-29 Ditch before it was stabilized. The samples were taken weekly, composited, and analyzed monthly for total beta, total alpha, ^{137}Cs, and ^{90}Sr. The results are presented in Table 4-10, in the form of maximum and minimum recorded levels. Judging from the maximum concentrations (as the minimum levels were generally below detection) the radioactivities appeared to be trending downward.

4.1.1.4 Biota. Westinghouse Hanford and PNL have conducted various biota sampling activities beginning in 1971 through 1988 inside and outside the Hanford Site. No upward trends in radionuclide concentrations were detected for any of the wildlife species examined. A significant downward trend was exhibited in many sample types, particularly ^{137}Cs.

Three factors are believed to have contributed to the decline in concentration of these radionuclides: the cessation of atmospheric testing, the 1971 shutdown of the last Hanford reactor that discharged once-through cooling water to the river, and the reduction of environmental radionuclide contamination associated with some Hanford facilities and operations.

Biota samples have been collected since 1978 from sixteen sites within or adjacent to the PUREX Plant Aggregate Area. Vegetation samples were collected from the same locations as the grid soil samples described in Section 4.1.1.2 (Plate 3). Average analytical results from 1985 through 1989 are compiled on Table 4-11. The complete data set from this sampling is presented in Appendix A.2.

Vegetation samples have generally had radionuclide concentrations that are slightly elevated above regional background (Schmidt et al. 1990). The most commonly detected radionuclides include ^{7}Be, ^{40}K, ^{99}Tc, and ^{106}Ru. Grid site 2E29, south of the 202-A Building, has usually had the highest ^{106}Ru concentrations in the area. There have been no statistically significant trends in vegetation radionuclide concentration since 1979 (Schmidt et al. 1990).

4.1.1.5 Vadose Zone. The extent of contamination in the vadose zone has been most extensively studied by geophysical well logging. Geophysical well logging has been conducted in the PUREX Plant Aggregate Area since the late 1950's. Gross gamma-ray logs have been used since that time to evaluate radionuclide migration in the vadose zone beneath selected waste management units. However, very little gross gamma data have been published. Table 4-12 lists all of the logs that were reviewed as part of this study. The log interpretation generally consisted of identifying zones with anomalously high gamma-ray counts that could be indicative of radionuclide contamination. The depths, thicknesses, and intensities of these zones were then compared for logs from the same holes. Any significant changes may be indicative of contaminant migration in the vadose zone. Interpretations were complicated by the fact that logging equipment and procedures have not been consistent. Attempts made to normalize data collected at different times met with limited success, and quantitative interpretations were not possible. The log interpretations are discussed in detail in Appendix A. The results of the log interpretations are also summarized with the appropriate waste management units in Section 4.1.2.

Contaminant migration through the vadose zone is dependent upon a number of properties, including chemical form of the waste, characteristics of the soil matrix, physical properties of the vadose zone and the volume of liquid introduced to the soil column. The interaction between waste form and soil characteristics is discussed in Section 4.2.2.1.4.

Waste management units that have received large volumes of liquid are more likely to cause subsurface contaminant migration. The potential for liquid wastes to migrate through the vadose zone to the groundwater can be estimated by comparing the volume of waste discharged at each waste management unit to the estimated pore volume in the vadose zone soil column below the waste management unit. If the volume of liquid discharged to the ground is greater than the soil column field capacity calculated using 0.1 as the standard pore volume, then it is likely that wastewater would reach the groundwater. These calculations are summarized on Table 4-13. They are based upon several conservative assumptions: (1) the discharged water does not spread out laterally from the point of discharge (i.e., the area of affected vadose zone is equal to the depth to groundwater times the plan view cross-sectional area of the base of the waste management unit); (2) there is no significant change in liquid volume being introduced to the soil column due to evapotranspiration or precipitation; and (3) the average pore volume of the soil column is between 0.10 and 0.30 (the upper and

lower pore volumes estimates shown on Table 4-13). If the amount of waste received was greater than the most conservative pore volume (0.1) than the waste management unit was considered to have the potential to migrate to the groundwater. According to these calculations, twenty-five waste management units have the potential for the migration of liquid discharges to the unconfined aquifer.

As discussed in Section 3.0, perched water zones may form locally under waste management units with large liquid discharges. However, the occurrence of contaminated perched water has not been documented in the PUREX Plant Aggregate Area (Baker et al. 1988).

4.1.2 Site Specific Data

This section presents the site-specific data that are available for each waste management unit and unplanned release. The units are discussed in the same groups as were presented in Section 2.0. These groupings are useful because similar units tend to have similar types of available data.

4.1.2.1 Plants, Buildings, and Storage Areas. The Grout Treatment Facility is the only structure within the PUREX Plant Aggregate Area to have site-specific data compiled for it. The Grout Treatment Facility has five locations for soil and vegetation sampling, and two locations for TLD sampling. The greatest radionuclides present in the soil sampling were ^{40}K at 15.1 pCi/g and ^{137}Cs at 1.93 pCi/g (Table 4-8). The greatest radionuclides present in the vegetation sampling were ^{40}K at 13.0 pCi/g, ^{7}Be at 3.22 pCi/g, and ^{99}Tc at 2.58 pCi/g (Table 4-11). The external radiation monitoring TLDs averaged 95 and 107 mrem/yr for 1990 (Table 4-7).

4.1.2.2 Tanks and Vaults. The data available for the single-shell and double-shell tanks generally include: inventory information, limited waste sampling, surface radiological surveys, vadose zone well geophysics, and internal tank monitoring of chemical and physical parameters. In the past, there has been less emphasis in characterizing the catch tanks, settling tanks, and vaults, and little information is available regarding these units. The following section is subdivided between single-shell and double-shell tanks, and other tanks to reflect this difference.

4.1.2.2.1 Single-Shell and Double-Shell Tanks. All of the single-shell and double-shell tanks in the PUREX Plant Aggregate Area are located within the boundaries of the tank farms (241-A, 241-AN, 241-AP, 241-AW, 241-AX, 241-AY, 241-AZ, and 241-C). The tank farms are characterized as an area of surface contamination and there is an area of active surface migration on the northern end of the tank farm properties.

There are twelve TLDs surrounding some of the 241-A Tank Farms. The TLDs are located nearest to the 241-A, -AN, -AW, -AY, and -AZ Tank Farms. Four of the TLDs are located near the 241-A Tank Farm. The TLDs stationed on the western margin of the 241-A Tank Farm averaged between 224 and 220 mrem/yr between 1985 and 1989 (Table 4-6). During the same period, the southern-most station averaged 883 mrem/yr while the eastern-most station had the highest average of 2,585 mrem/yr. The monitoring period for 1990 saw a decrease in all stations with the exception of the TLD station on the southern margin of the 241-A Tank Farm. This station showed a slight average increase to 908 mrem/yr. These results are higher than any other monitoring location in the PUREX Plant Aggregate Area. The high annual dose rate is probably indicative of a combination of surface contamination in the tank farm area and some emissions from the tanks themselves. The upper surfaces of tanks 241-A-101 through 241-A-106 are all 2 m (7 ft) below grade so the waste contained within the tanks is largely, but not entirely shielded from the ground surface. There are no TLDs stationed close to the 241-AX Tank Farm nor are there any near the 241-C Tank Farm.

Surface radiation dose rate surveys are also performed regularly over the tank farm areas. The highest dose rates observed in the A tank farm during the September 1991 survey were 50,000 dis/min and 40 mrem/h over the 241-A-104 Single-Shell Tank and 50 mrad/h over the 241-A-101 Single-Shell Tank. The highest dose rate observed in the 241-AN Tank Farm was 20,000 dis/min between tanks 104-AN and 105-AN, and a contact reading of 50 mrem/h on the 105-AN Tank. The 241-AP Tank Farm had its highest contact reading on the 105-AP Valve Pit of 2.5 mrem/h. The 241-AW Tank Farm had two contact readings of 40 mrem/h with the 101-AW Tank and the exhaust filter. There was also a dose rate reading of 50,000 dis/min on the ground under the deentrainer. The highest dose rate observed in the 241-AX Tank Farm was 20 mrem/h over the 241-AX-103 Single-Shell Tank. The 241-AY Tank Farm had its highest reading of 70 mrad/h on the plastic wrapped raiser over the 101-AY Tank. The 241-AZ Tank Farm's highest contact reading was 30 mrem/h on the 101-AZ Tank. The 241-C Tank Farm had dose rates taken in the general area, on contact, and a scan at 0.3 m (1 ft). The highest general area dose rate was 110 mrem/h near the 241-C-105 Single-Shell Tank breather. The highest contact reading for the 241-C Tank Farm was 12 mrem/h on the 241-C-112 Single-Shell Tank observation port. The highest reading for a scan at 0.3 m (1 ft) was <1.0 mrem/h. These data were compiled directly from the Supplemental Scheduled Radiation Survey Reports kept at the Tank Farm Health Physics Department for the 200 East Area.

Several studies have been conducted to estimate tank contents and the probability of their release to the environment. The primary potential release mechanisms are tank failure and leaking, and the potential buildup and ignition of flammable material in the tanks. Three of the six single-shell tanks in the 241-A Tank Farm, two of the four single-shell tanks in the 241-AX Tank Farm, and seven of the sixteen single-shell tanks in the 241-C Tank Farm have

failed in the past, so it seems likely that some of the remaining tanks will fail in the future. Tank leaks are identified by monitoring liquid levels in the tanks and by running gamma logs in the monitoring wells surrounding each tank. There is less concern of potential release mechanisms for the double-shell tanks. All of them are of sound integrity. However, three of the tanks are on a watch list for potential buildup and ignition of flammable material (Hanlon 1992).

4.1.2.2.1.1 Inventory Studies. Chemical inventories for the single-shell tanks have been modeled with the Tracks Radioactive Components (TRAC) computer code developed by Westinghouse Hanford. This program calculated tank inventories for 68 radioactive constituents and 29 chemical constituents. The estimates were based on the historical records of the quantities of material initially placed in the tanks from nuclear fuel production and later modified by tank transfers and radioactive decay. General element solubilities and metal-complex formation interactions were also incorporated into the code. The TRAC inventories, though recognized as having serious limitations, represent the best current information on the contents of the single-shell tanks. The TRAC predictions for ^{14}C, ^{137}Cs, ^{137}Ba and uranium isotopes show the least agreement with other data sources.

The TRAC inventory data are presented in Table 4-14. These data are for the total tank inventories and do not differentiate between drainable liquid and solids within the single-shell tanks. As shown in Table 2-4, some of the unstabilized tanks still contain large volumes of liquid, drainable waste. It is the radionuclides that are partitioned to this liquid phase that are of primary concern should a tank begin to leak. From a comparison of solid and liquid phase data presented in an earlier TRAC report, it appears that ^{241}Am, ^{14}C, ^{135}Cs, ^{137}Cs, ^{93}Nb, ^{99}Tc, ^{79}Se and ^{90}Sr are most strongly partitioned to the liquid phase in the tanks and would be the most likely radionuclides, present at high concentrations, to migrate in the event of a leak (Jungfleisch 1984).

4.1.2.2.1.2 Tank Waste Sampling. Chemical sampling has been performed on some of the tanks. The usefulness of these samples is very limited because: 1) very few radionuclides or organic chemicals were analyzed; 2) material has been moved into and out of the tanks; and 3) no attempt was made to collect samples that were representative of the tank as a whole. Much of the sampling was done to characterize the chemical composition of liquid that was to be sent through an evaporator.

The available waste tank sampling data are summarized in Tables 4-15 through 4-23. Table 4-15 contains the results of analysis of supernatant liquid from Tank 241-AX-102. Based on available results, the solution contains chelating compounds (>10g/L total organic carbon, TOC) and transuranic (>100 nCi/g Pu + Am) waste. The isotopes with the highest concentration present in the 241-AX-102 Single-Shell Tank are ^{137}Cs and ^{90}Sr. Table 4-16 shows the results of analysis of volatile priority pollutants in vapor samples taken from tanks

241-C-101 and 241-C-102. The only analytes above detection level were benzene, tetrachloroethane, toluene, and 1,1,1-trichloroethane. Table 4-17 contains the results of analysis of vapor samples and a liquid sample from tank 241-C-103. The vapor samples only detected 1,1-Dichloroethene, Toluene, 1,1,1-trichloroethane and trichlorofluoromethane. No analytes were above the detection limit for the liquid sample from tank 241-C-103. Tables 4-18, 4-19, and 4-20 are results of an analysis of a core sample from single-shell tanks 241-C-103, 241-C-104, and 241-C-105, respectively. These tables include the total, maximum and drainable liquor. Tables 4-21 (McCown 1988) and 4-22 (Walker 1977) show the results of an analysis of a sludge sample from tanks 241-C-106 and 241-C-105, respectively. The sludge was analyzed for organics and radionuclides. Finally, Table 4-23 shows the results of analysis from two double-shell tanks, 241-AY-101 and 241-AZ-102.

4.1.2.2.1.3 Chemical Explosion Potential. The two most significant flammable materials generated in Hanford single-shell and double-shell tanks are ferrocyanide and hydrogen. Four of the 241-C Tank Farm tanks (241-C-108, 241-C-109, 241-C-111, and 241-C-112) are suspected of having a ferrocyanide problem (Hanlon 1992). A watch list has been generated to monitor any increasing trends in temperature. The monitoring of these tanks includes ferrocyanide quantity (g mole), estimated heat load and highest temperature reading for the month. The highest temperature readings ranged from 25 to 30 °C (78 to 87 °F) and ferrocyanide quantity ranged from 9,000 to 70,000 g moles. A watch list has also be generated that ranks tanks according to their potential for flammable gas generation. Six tanks within the 241-A, 241-AN, and 241-AX Tank Farms are on the hydrogen gas watch list (241-A-101, 241-AN-103, 241-AN-104, 241-AN-105, 241-AX-101, and 241-AX-103). The single-shell tanks had highest temperature readings of 49 to 69 °C (120 to 156 °F), and the double-shell tanks had highest temperature readings of 96 to 69 °C (114 to 120 °F). The temperatures for the single-shell tanks are on the higher end of the scale for the 23 tanks that are monitored. All six tanks are assumed to be of sound integrity.

4.1.2.2.1.4 Vadose Zone Well Geophysical Logging. Most of the single-shell and double-shell tanks are surrounded by an array of vadose zone wells. Gamma logging is performed on these wells on a regular basis to identify new tank leaks and to monitor the migration of existing contaminant releases to the soil. Table 4-24 summarizes the borehole geophysical data available for each tank.

4.1.2.2.1.5 Single-Shell Tanks Unplanned Releases. There are five unplanned releases associated with the single-shell tanks in the 241-A, -AX, and -C Tank Farms. There are no unplanned releases associated with the double-shell tanks. Four of these unplanned releases resulted from tank leaks (UPR-200-E-125, -126, -136, and -137) and one release occurred when an employee mistakenly pulled approximately 5 m (15 ft) of a contaminated electrode cable out of the 241-AX-104 Single-Shell Tank and set it on the ground (UPR-200-

E-119). Most of the available information on these releases is summarized in Table 2-5. Cesium inventory data for each of the four tank leaks are summarized in Table 4-25.

The vertical and lateral distribution of each of the tank leaks can be estimated from the borehole geophysics data (Table 4-24).

4.1.2.2.2 Catch Tanks and Vaults. Very little data are available for the catch tanks. For most units the total volume of waste is known but there is no chemical or radiological information available. The vaults only transported waste; therefore, there is no volume, chemical, or radiological data available for these units.

4.1.2.2.2.1 241-A-302A Catch Tank. This is an active waste management unit. It is currently reported to contain 13,645 L (3,605 gal) of waste.

4.1.2.2.2.2 241-A-302B Catch Tank. This is an inactive waste management unit. It is currently reported to contain 12,263 L (3,240 gal) of waste.

4.1.2.2.2.3 241-A-350 Catch Tank. This is an active waste management unit. Volumes were variable according to specific plant operations.

4.1.2.2.2.4 241-A-417 Catch Tank. This is an active waste management unit. It is currently reported to contain 120,590 L (31,860 gal) of waste.

4.1.2.2.2.5 241-AX-152CT Catch Tank. This is an active waste management unit. It is currently reported to contain 10,053 L (2,656 gal) of waste.

4.1.2.2.2.6 241-C-301 Catch Tank. This is an inactive waste management unit. It is currently reported to contain 120,590 L (31,860 gal) of waste.

4.1.2.3 Crib and Drains. The types of information available for the cribs, drains, and drain fields include inventory data, radiological survey results, and borehole geophysical data. Soil, vegetation, and air monitoring data are generally unavailable for these waste management units. Inventory and radiological information have largely been compiled from the WIDS sheets (WHC 1991a) and the HISS database (DOE 1986) entries.

4.1.2.3.1 216-A-1 Crib. This is an inactive waste management unit. It is currently barricaded as a surface contamination site.

The inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.1, approximately 98,400 L (25,997 gal) of uranium waste was discharged to the crib (DeFord 1991). The waste contained ^{137}Cs, ^{106}Ru, and ^{90}Sr. In 1984 a few spots

were found reading 90,000 ct/min. In 1990, 3,000 dis/min (beta) spots were found, but in 1991 a surface radiological survey showed the area to be below detection limits.

Grid sampling site 2E24 is near the 216-A-1 Crib. This site was monitored for external radiation, vegetation sampling, and grid soil sampling. The external radiation monitoring TLDs averaged 111 mrem/yr for 1985 to 1989 (Table 4-6). The greatest radionuclides present in the vegetation sampling were ^{40}K at 13.0 pCi/g, ^{7}Be at 3.23 pCi/g, and ^{106}Ru at 2.25 pCi/g (Table 4-11). The greatest radionuclide concentrations detected in the grid soil sampling were ^{137}Cs at 5.49 pCi/g, and ^{40}K at 13.7 pCi/g (Table 4-8).

4.1.2.3.2 216-A-2 Crib. This is an inactive waste management unit. It is currently marked as a surface contamination site.

The inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.2, approximately 230,000 L (60,766 gal) of organic waste containing normal paraffin hydrocarbons and tributyl phosphate was discharged to the crib (DeFord 1991). The radioisotopes thought to be present are ^{137}Cs, ^{106}Ru, and ^{90}Sr. The 1990 radiological survey did not identify any areas of contamination at this site.

4.1.2.3.3 216-A-3 Crib. This is an inactive waste management unit. Inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.3, the crib received over 3,000,000 L (792,602 gal) of waste containing ^{137}Cs, ^{106}Ru, and ^{90}Sr. The unit is monitored annually and no contamination was detected in the 1990 survey. The unit received waste from silica-gel regeneration, uranyl nitrate hexahydrate, liquid waste, liquid drainage, and heating soil condensate.

4.1.2.3.4 216-A-4 Crib. This is an inactive waste management unit. Inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.4, the crib received 6,210,000 L (1,640,687 gal) of laboratory cell drainage waste containing ^{137}Cs, ^{106}Ru, and ^{90}Sr. In 1958 the crib became plugged and flooded an area between the unit and the 291-A Stack, contaminating the ground surface. The contamination was removed, and in a 1990 radiological survey surface contamination was not detected.

4.1.2.3.5 216-A-5 Crib. This is an inactive waste management unit. Inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.5, the crib received 1,630,000,000 L (430,647,292 gal) of acidic waste containing ^{137}Cs, ^{106}Ru, and ^{90}Sr. Data from Wells 299-E24-1, 299-E24-56, 299-E24-57, and 299-E24-58 indicate that breakthrough to the groundwater could have occurred. In November 1983, the unit was stabilized when PUREX Plant exclusion area fences were installed (WHC 1991a). No contamination was detected in the 1989 radiological survey.

4.1.2.3.6 216-A-6 Crib. This is an inactive waste management unit. Inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.6, the crib received 3,400,000,000 L (898,282,695 gal) of waste containing ^{137}Cs, ^{106}Ru, and ^{90}Sr. The radiation zone denoting this site was enlarged to include the contaminated ground surface northeast of the unit.

This waste management unit has a known release, UPR-200-E-21. It was an overflow from the crib that contaminated the soil adjacent to the crib with unknown beta/gamma reading to 500 mR/h. Almost two years later another known release occurred, UPR-200-E-29. This release was also an overflow from the crib with unknown beta/gamma with readings to 30 R/h at 1.2 m (4 ft). After both of these releases, the ground was covered and the liquid level risers were filled with concrete. The valve station is barricaded with surface contamination placards and the crib is posted with both surface and underground radiation contamination signs. The 1990 radiological survey identified a new area of contamination of 2,000 to 5,000 dis/min.

Grid sampling site 2E30 is just south of the 216-A-6 Crib. This site was monitored for external radiation, vegetation sampling, and grid soil sampling. The external radiation monitoring TLDs averaged 80 mrem/yr for 1985 to 1989 (Table 4-6). The greatest radionuclides present in the vegetation sampling were ^{40}K at 10.9 pCi/g, ^{7}Be at 1.5 pCi/g, and ^{106}Ru at 1.73 pCi/g (Table 4-11). The greatest radionuclide concentration detected in the grid soil sampling was ^{40}K at 13.5 pCi/g (Table 4-8).

Site 2E30 is also near the 216-A-6 Crib where fenceline soil sampling was taken. The radionuclide with the highest concentration was ^{40}K at 14.3 pCi/g (Table 4-9).

4.1.2.3.7 216-A-7 Crib. This is an inactive waste management unit. The inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.7, the crib received 326,000 L (86,129 gal) of waste expected to contain ^{137}Cs, ^{106}Ru, and ^{90}Sr. In 1990 and 1991, spots of contamination with readings up to 30,000 dis/min (beta) were found. The surface radiation is generally at background levels, but radioactive tumbleweed are found occasionally.

4.1.2.3.8 216-A-8 Crib. This is an inactive waste management unit. The inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.8, the crib received 1,150,000,000 L (303,830,912 gal) of waste containing ^{137}Cs, ^{3}H, ^{106}Ru, and ^{90}Sr. In 1988, weeds with 500 to 20,000 ct/min, and soil with 400 to 70,000 ct/min, were found onsite. Contamination on risers was detected in 1990, but in 1991 the risers were below detection limit. The site surface was stabilized in September 1990. According to milestone M-17-28, all discharge to the 216-A-8 Crib was to cease September 1991. There shall be no further soil column discharge to this unit until BAT/AKART is implemented. In

the interim, effluent will be routed to the double-shell tanks. Following implementation of BAT/AKART and approval of the Sampling and Analysis Plan, discharge to the crib may resume if supported by the environmental impact assessment agreed to by the Washington State Department of Ecology, Department of Energy, and Environmental Protection Agency (Ecology et al. 1992).

External radiation monitoring was taken at two sites within the 216-A-8 Crib area. From 1985 to 1989 the average TLD readings for site No. 1 was 106 mrem/yr, and for site No. 2 was 124 mrem/yr (Table 4-6). In 1990 the sampling sites were designated as 216-A-8 S and 218-A-8 E. The average TLD readings for 216-A-8 S was 106 mrem/yr, and for 216-A-8 E was 121 mrem/yr (Table 4-7).

4.1.2.3.9 216-A-9 Crib. This is an inactive waste management unit. The inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.9, the crib received 981,000,000 L (259,180,978 gal) of waste containing the following radionuclides: ^{137}Cs, ^{106}Ru, and ^{90}Sr. The monitoring Wells 299-24-3 and 299-24-4 detected elevated radiation levels in 1963, yet by 1976 the radiation level was near background. The April 1990 surface radiological survey found one spot with a level of 30,000 dis/min, which is an increase from 1989.

Grid sampling site 2E23 is near the 216-A-9 Crib. This site was monitored for external radiation, vegetation sampling, and grid soil sampling. The external radiation monitoring TLDs averaged 103 mrem/yr for 1985 to 1989 (Table 4-6). The greatest radionuclides present in the vegetation sampling were ^{106}Ru at 3.25 pCi/g, and ^{99}Tc at 1.1 pCi/g (Table 4-11). The greatest radionuclide concentrations detected in the grid soil sampling were ^{137}Cs at 9.97 pCi/g, and ^{90}Sr at 2.2 pCi/g (Table 4-8).

4.1.2.3.10 216-A-10 Crib. This is an inactive waste management unit. The inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.10, the crib received a total of 3,210,000,000 L (848,084,544 gal) of waste containing ^{241}Am, ^{137}Cs, ^{3}H, ^{129}I, ^{147}Pm, ^{238}Pu, ^{239}Pu, ^{214}Pu, ^{106}Ru, and ^{90}Sr. Surveillance information suggests that since the beginning of 1984, ^{3}H concentrations beneath the site have been increasing for the first time since PUREX resumed operations. Nitrate concentrations have also been continually increasing since March 1984, tripling since September 1985. Measurements of alpha radiation in well number 299-E24-02 have increased sixfold since September 1985, and are presently twice the ^{238}U concentration limit. The nitrate level is currently fluctuating at about five times the drinking water standards since June 1985. However, no surface contamination was identified by the 1990 radiological survey.

External radiation monitoring was taken at two sampling sites within the 216-A-10 Crib area and at one site near the crib, Site 2E29. From 1985 to 1989 the average TLD readings

for Site No.1 was 88 mrem/yr, Site No.2 was 82 mrem/yr, and Site 2E29 was 80 mrem/yr (Table 4-6). In 1990, only Sites No.1 and No.2 were sampled for external radiation. The average TLD readings for 216-A-10 No.1 was 99 mrem/yr, and for 216-A-10 No.2 was 107 mrem/yr (Table 4-7).

Sampling site 2E29 also had vegetation sampling and grid soil sampling. The greatest radionuclides present in the vegetation sampling were ^{40}K at 14.9 pCi/g, and ^{106}Ru at 3.33 pCi/g (Table 4-11). The greatest radionuclide concentrations detected in the grid soil sampling were ^{40}K at 15.4 pCi/g, and ^{137}Cs at 2.62 pCi/g (Table 4-8).

4.1.2.3.11 216-A-21 Crib. This is an inactive waste management unit. The inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.11, the crib received a total of 77,900,000 L (20,581,242 gal) of sump waste and cell drainage expected to contain ^{137}Cs, ^{106}Ru, and ^{90}Sr. The unit was taken out of service in June 1958 for six months when a clay distribution pipe failed. The waste volume and waste inventory indicate breakthrough to groundwater has most likely not occurred. However, direct contamination was identified on the riser closest to the crib vent during the 1990 radiological survey. The contamination level was 15,000 dis/min (beta-gamma).

4.1.2.3.12 216-A-24 Crib. This is an inactive waste management unit. The inventory data for this unit are summarized in Table 2-2 and 2-3. As detailed in Section 2.3.3.12, the crib received 820,000,000 L (216,644,650 gal) of condensate from the waste storage tanks in the 241-A and 241-AX Tank Farms containing ^{137}Cs, ^{106}Ru, and ^{90}Sr. Because of inadvertent use, the radionuclide inventory is unknown for 1967 through 1979. In September 1990 the surface of the waste management unit was stabilized. The crib adjoins the area of unplanned release UN-200-E-56.

Sampling of rabbitbrush plants for radioactivity on the 216-A-24 Crib detected higher concentrations of primarily ^{137}Cs than other plant parts. Concentrations of ^{137}Cs in leaves averaged 145 nCi/gDW and those for ^{90}Sr averaged 0.316 nCi/gDW. Cesium-137 was detectable in the upper 1 cm (0.3 in.) of soil; however, at the 15 cm (6 in.) depth, ^{137}Cs was not detectable. Consequently, deep excavation may not be required for decontamination (Klepper et al. 1979).

Some insect and mammal samples collected on the crib contained ^{137}Cs. Those insect species associated with a rabbitbrush shrub containing ^{137}Cs and its litter showed higher levels of ^{137}Cs than other wider-ranging species caught in pitfall traps and by hand. Mammal samples of pocket mice indicated detectable amounts of ^{137}Cs with 70% of the total body burden in the muscle and skeleton (Klepper et al. 1979).

Data from wells 299-E26-2,-3,-4,-5, and -7 indicate that breakthrough to groundwater could have occurred from the first and second sections of the unit. Prior to 1988, radiation surveys identified brush with up to 30,000 ct/min (beta). Since then, the crib area has generally been below detectable limits. The unit was surface stabilized in 1988.

Grid sampling site 2E18 is just west of the 216-A-24 Crib. This site was monitored for external radiation, vegetation sampling, and grid soil sampling. The external radiation monitoring TLDs averaged 111 mrem/yr for 1985 to 1989 (Table 4-6). The greatest radionuclides present in the vegetation sampling were ^{40}K at 14.5 pCi/g, and ^{7}Be at 2.63 pCi/g (Table 4-11). The greatest radionuclide concentrations detected in the grid soil sampling were ^{40}K at 15.1 pCi/g, and ^{137}Cs at 6.24 pCi/g (Table 4-8).

There are also two fenceline soil sampling sites near the 216-A-24 Crib. Site A-TF-E2 is northwest of the crib and Site A-TF-E3 is just west of the crib. The radionuclides with the highest concentrations at Site A-TF-E2 were ^{137}Cs at 7.29 pCi/g, and ^{40}K at 13.9 pCi/g. The radionuclides with the highest concentrations at Site A-TF-E3 were ^{137}Cs at 10.3 pCi/g, and ^{40}K at 15.1 pCi/g (Table 4-9).

4.1.2.3.13 216-A-27 Crib. This is an inactive waste management unit. The inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.13, the crib received 23,200,000 L of waste expected to contain ^{137}Cs, ^{106}Ru, and ^{90}Sr. Data from Wells 299-E17-2 and 299-E17-3 indicate that breakthrough to groundwater has not occurred at this site and the 1990 radiological survey did not detect any contamination (WHC 1991a).

4.1.2.3.14 216-A-30 Crib. This is an active waste management unit. The inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.14, the crib received over 7,000,000,000 L (1,849,405,548 gal) of waste containing ^{241}Am, ^{137}Cs, ^{3}H, ^{147}Pm, ^{239}Pu, ^{106}Ru, ^{113}Sn, and ^{90}Sr. During the winter of 1971 to 1972, an alkaline deposit formed over the surface of the crib. It appeared to be a salt deposit condensing out of vapors being emitted from the unit through the porous soil. In June 1972, the ground was covered with layers of sand and plastic. A surface radiological survey in 1990 did not find any evidence of radioactivity above detection limits.

External radiation monitoring was performed at two sites within the 216-A-30 Crib area. From 1985 to 1989 the average TLD readings for Site No.1 was 87 mrem/yr, and for Site No.2 was 84 mrem/yr (Table 4-6).

4.1.2.3.15 216-A-31 Crib. This is an inactive waste management unit. The inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.15, the crib received 10,000 L (2,642 gal) of neutral organic waste from the 202-A Building. The waste was expected to contain ^{137}Cs, ^{106}Ru, and ^{90}Sr. The waste inventory and the waste

volume indicate that no breakthrough to groundwater has occurred and no surface contamination was detected during the 1988 radiological survey.

4.1.2.3.16 216-A-32 Crib. This is an inactive waste management unit. The inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.16, the crib received approximately 4,000 L (1,057 gal) of waste expected to contain less than 1 Ci total beta activity. There was intent to dispose of 246,025 L (65,000 gal) of 50% Soltrol (a brand of kerosene) diluent in this crib. To this date, this proposed disposal has not been confirmed as having taken place and there will be no future disposal of waste to this crib. The 1990 radiological survey failed to identify any contamination at this unit.

4.1.2.3.17 216-A-36A Crib. This is an inactive waste management unit. The inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.17, the crib received 1,070,000 L (282,695 gal) of ammonia scrubber waste. The waste was expected to contain ^{137}Cs, ^{106}Ru, and ^{90}Sr. The site was deactivated soon after initial operation when it became too radioactively contaminated for further use. Data from monitoring wells indicate breakthrough to the groundwater could have occurred at this unit (Fecht et al. 1977). The 1990 radiological survey did not identify any area of contamination.

4.1.2.3.18 216-A-36B Crib. This is an inactive waste management unit. The inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.18, the crib received 317,000,000 L (83,751,651 gal) of waste expected to contain ^{241}Am, ^{137}Cs, ^{3}H, ^{239}Pu, ^{241}Pu, ^{106}Ru, ^{113}Sn, and ^{90}Sr. The waste, ammonia scrubber distillate (ASD), came from the PUREX fuel-element decladding operations. The crib operated until 1987 when sampling and analysis of the ASD confirmed the presence of ammonium hydroxide in concentrations exceeding the State of Washington Department of Ecology Dangerous Waste Regulations (Chapter 173-303 Washington Administrative Code, WAC). The criteria for waste designation is WAC 173-303-070. Since then no waste has been discharged to the crib.

Table 4-26 shows data collected from three groundwater sampling locations, included is organics, pH, alkalinity, conductivity, ^{3}H, cations, and anions. Highest concentrations found in the groundwater were calcium, potassium, sodium, silicon and nitrate (Buelt et al. 1988).

Table 4-27 is a list of the waste inventory for the 216-A-36B Crib. The inventory includes volume, Pu, Beta, ^{90}Sr, ^{106}Ru, ^{137}Cs, and ^{238}U for 1966 through 1972 and 1981 through 1987, excluding 1982. Over the years the quantities of radionuclides have had a decreasing trend. Table 4-28 shows the average concentrations of radiological parameters for PUREX ammonia scrubber waste effluent and groundwater near the 216-A-36B Crib from 1983 to 1987. Two monitoring wells were sampled for total alpha, total beta, ^{3}H, ^{90}Sr, ^{137}Cs, ^{106}Ru, ^{60}Co, uranium, and nitrate. The concentrations generally increased from 1984

to 1985 and then began to decrease again. Table 4-29 shows groundwater parameters measured in Wells 299-E17-5 and 299-E17-9. The parameters measured for included ammonia, fluoride, nitrate, pH, TOC, chloride and conductivity. Most of the ammonia and fluoride readings were below detection, nitrate ranged from 89.5 to 261.0 p/m, and TOC ranged from 0.414 to 0.763 p/m (WHC 1988b).

Data from Well 299-E17-05 shows total alpha and total uranium concentrations are two times the concentration limit from ^{238}U. However, concentration of isotopes are below concentration limits. There is an increasing trend in ^{3}H since August 1984, and NO_3 from June 1984 to February 1985. Nitrate currently fluctuates around two times the drinking water standards. However, no surface contamination was detected during the 1990 survey.

External radiation monitoring was performed at two sampling sites within the 216-A-36B Crib area. In 1990 the average TLD readings for Site No.1 was 100 mrem/yr, and for Site No.2 was also 100 mrem/yr (Table 4-7).

4.1.2.3.19 216-A-37-1 Crib. This is an inactive waste management unit. The inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.19, the crib receives process condensate from the 242-A Evaporator. The 1990 annual radiological survey indicates a total volume of 377,000,000 L (99,603,699 gal) of waste received by the crib. The waste contains ^{241}Am, ^{137}Cs, ^{3}H, ^{129}I, ^{147}Pm, ^{239}Pu, ^{106}Ru, ^{113}Sn, and ^{90}Sr. Data from Well 299-E25-19 detected an increase in beta activity (excluding tritium) over the last seven months, but limits have not been exceeded. Tritium showed a decrease from April to October of 1985. The November sample was twice as high as the previous month and has shown an increase since then. Nitrate remains between two and four times the drinking water standards. Well 299-E25-20 shows that a decreasing trend of ^{3}H has been exhibited since February 1985. In August 1986 nitrate remained between three and five times the drinking water standard. A surface radiation survey did not detect any contamination (WHC 1991a). The crib surface is moderately covered with deep and shallow rooted vegetation.

External radiation monitoring was performed at one sampling site within the 216-A-37-1 Crib area. From 1985 to 1989 the average TLD reading was 87 mrem/yr (Table 4-6).

4.1.2.3.20 216-A-37-2 Crib. This is an active waste management unit. The inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.20, the crib received 1,090,000,000 L (287,978,864 gal) of waste expected to contain ^{241}Am, ^{137}Cs, ^{147}Pm, ^{239}Pu, ^{106}Ru, ^{113}Sn, and ^{90}Sr. The radionuclide inventory has been included in the inventory for the 216-A-30 Crib since the fourth quarter of 1983. The 1991 radiological survey found contamination at levels of 500 dis/min (alpha) and 200 dis/min

(beta). The WIDS hardfiles indicate that the 1990 radiation survey results were below detection limits (WHC 1991a).

External radiation monitoring was performed at one sampling site within the 216-A-37-2 Crib area. From 1985 to 1989 the average TLD reading was 88 mrem/yr (Table 4-6).

4.1.2.3.21 216-A-38-1 Crib. This crib was never activated. It is discussed in detail in Section 2.3.3.21. It was intended to receive the liquid waste discharged to the 261-A-10 Crib.

4.1.2.3.22 216-A-39 Crib. This is an inactive waste management unit. The inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.22, the crib only received 20 L (5.3 gal) of floor drainage waste. The waste is expected to contain ^{137}Cs.

4.1.2.3.23 216-A-41 Crib. This is an inactive waste management unit. The inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.23, the crib received 10,000 L (2,642 gal) of drainage waste from the 296-A-13 Stack. The waste is slightly acidic and expected to contain less than 1 Ci total beta activity. Exact location of this site has not been confirmed; several temporary buildings are located in the vicinity of the crib at the present time.

4.1.2.3.24 216-A-45 Crib. This is an inactive waste management unit. The inventory data for this unit are summarized in Tables 2-2 and 2-3. As detailed in Section 2.3.3.24, the 1990 survey indicates that this unit has received a total of 103,000,000 L (27,212,682 gal) of process condensate waste. The waste contains ^{241}Am, ^{137}Cs, ^{3}H, ^{129}I, ^{147}Pm, ^{238}Pu, ^{239}Pu, ^{241}Pu, ^{106}Ru, ^{113}Sn, and ^{90}Sr. The 1990 radiological survey did not identify areas of contamination at this site.

4.1.2.3.25 216-A-11 French Drain. This is an inactive waste management unit. It received a total of 100,000 L (26,420 gal) of drainage waste expected to contain less than 50 Ci total beta activity. The french drain extends 9 m (30 ft) deep into the ground and is 0.8 m (2.5 ft) in diameter. The PNL Hazardous Ranking System Migration Score for this drain is 1.04. The 1990 radiological survey did not identify any surface contamination.

4.1.2.3.26 216-A-12 French Drain. This is an inactive waste management unit. It received a total of 100,000 L (26,420 gal) of drainage waste expected to contain less than 50 Ci total beta activity. The unit is 10 m (33 ft) deep and 0.8 m (2.5 ft) in diameter. There has been no contamination detected or any change in activity between the 1987 survey and the 1988 survey.

4.1.2.3.27 216-A-13 French Drain. This is an inactive waste management unit. As detailed in Section 2.3.3.27, it received a total of 100,000 L (26,420 gal) of seal water expected to contain less than 1 Ci total beta activity. The drain extends 5.5 m (18 ft) deep into the ground and is 0.9 m (3 ft) in diameter. The base of the drain is in common with the underground radiation zone associated with the 216-A-35 French Drain. The 1990 survey did not detect any surface contamination.

4.1.2.3.28 216-A-14 French Drain. This is an inactive waste management unit. It received 1,000 L (305 gal) drainage waste containing less than 1 Ci total beta activity. The drain is placed to a depth of 8.8 m (29 ft) and the excavation extends below the bottom of the pipe 1.5 m (5 ft). The 1990 radiological survey identified spots of 56,000 dis/min (alpha) and 20,000 dis/min (beta) direct contamination. Smearable contamination of 700 dis/min (alpha) was also detected.

4.1.2.3.29 216-A-15 French Drain. This is an inactive waste management unit. It received 10,000,000 L (2,642,008 gal) of drainage waste containing less than 50 Ci total beta activity. This unit is also registered as an underground injection well. The drain is 13 m (44 ft) deep and 1.2 m (4 ft) in diameter. The drain also includes an inlet pipe entering at 10 m (33 ft) below grade and a 5 cm (2 in.) riser extending 1.2 m (4 ft) above grade. No surface contamination was detected during the 1988 annual radiological survey.

4.1.2.3.30 216-A-16 French Drain. This is an inactive waste management unit. It received 122,000 L (32,232 gal) of waste expected to contain less than 10 Ci total beta activity. The drain is 5.1 m (17 ft) deep and 1.1 m (3.5 ft) in diameter. Currently there is no piping, or other surface feature, to indicate the location of this drain.

4.1.2.3.31 216-A-17 French Drain. This is an inactive waste management unit. It received 60,000 L (15,852 gal) of waste expected to contain less than 1 Ci total beta activity. The site is 5.1 m (17 ft) deep with a 1.1 m (3.5 ft) diameter. The site also has a 10 cm (4 in.) inlet pipe 0.6 m (2 ft) long, and an overflow pipe leading to the 216-A-16 French Drain.

4.1.2.3.32 216-A-22 French Drain. This is an inactive waste management unit. It received 10,000 L (2,642 gal) of drainage containing less than 1 Ci total beta activity. The site is made up of two 10-cm (4-in.) effluent pipes; one is vertical, the other enters horizontally 2.4 m (8 ft) below grade. The vertical pipe is not visible from grade. The 1988 radiological survey did not detect any surface contamination or any change from the last survey in 1987.

The 216-A-22 French Drain has one unplanned release associated with it: UPR-200-E-17. The release occurred when a crib inlet failed and contaminated the soil on top of the crib. The waste type and amount deposited during the spill is unknown.

4.1.2.3.33 216-A-23A French Drain. This is an inactive waste management unit. It received 6,000 L (1,585 gal) of waste expected to contain less than 50 Ci total beta activity. The unit is 4 m (13 ft) deep and 1.1 m (3.5 ft) in diameter. The site also has a carbon steel vent riser extending from the top to 0.9 m (3 feet) above grade, and an inlet pipe entering at 2.7 m (9 ft) below grade.

4.1.2.3.34 216-A-23B French Drain. This is an inactive waste management unit. It received 6,000 L (1,585 gal) of waste containing less than 5 Ci total beta activity. The unit is 2.1 m (7 ft) deep with a 1.1 m (3.5 ft) diameter. The site also contains an inlet pipe entering at 2.7 m (9 ft) below grade.

4.1.2.3.35 216-A-26 French Drain. This is an active waste management unit. The unit has been receiving floor drainage containing less than 1 Ci of total beta activity. The drain is accessed by a subsurface feeder pipe and is constructed 4.6 m (15 ft) deep with 1.2 m (4 ft) diameter. The 1990 radiological survey did not identify any surface contamination.

4.1.2.3.36 216-A-26A French Drain. This is an inactive waste management unit. It has received 1,000 L (304.8 gal) of waste containing less than 1 Ci total beta activity. The construction design is the same as the 216-A-26 French Drain. The 1990 radiological survey did not identify any surface contamination. This unit cannot be distinguished from the 216-A-26 French Drain from indications at the surface.

4.1.2.3.37 216-A-28 French Drain. This is an inactive waste management unit. It has received 30,000 L (7,926 gal) of waste. The unit is 3.4 m (11 ft) deep with a grade diameter of 6.1 m (20 ft) and a bottom diameter of 3 m (10 ft). The unit also contains a perforated pipe extending horizontally 1.2 m (4 ft) below grade.

In 1981, the center of the unit was excavated and disposed of prior to installation of a PUREX Plant security system. After the security system was installed and the unit backfilled to grade, no posting or identification markers were placed at the french drain. Currently, the french drain is inside a posted surface contamination area immediately north of the uranyl nitrate hexahydrate tanks and south of the security fence. The 1988 survey did not identify any surface contamination at this unit. However, during the 1990 radiological survey direct readings of 10,000 dis/min (beta-gamma) and 2,300 dis/min (alpha) were identified.

4.1.2.3.38 216-A-33 French Drain. This is an inactive waste management unit. It was designed to receive bearing cooling waste from the 291-A-1 Stack electrical exhaust fans. However, no coolant was ever used; therefore, no waste was ever discharged to this unit. The french drain is 1.8 m (6 ft) in diameter and has a depth of 3.7 m (12 ft). At 1.5 m (5 ft) below grade there is a 5 cm (2 in.) inlet pipe entering the unit. The 1990 radiological survey did not detect any contamination at this french drain.

4.1.2.3.39 216-A-35 French Drain. This is an inactive waste management unit. It received 10,000 L (2,642 gal) seal cooling water from the air sampler vacuum pumps in the 202-A Building. The waste is expected to contain less than 1 Ci total beta activity. The unit is 4.9 m (16 ft) deep and 1.8 m (6 ft) in diameter. There is an inlet pipe located 3.2 m (10.5 ft) below grade. This unit was a replacement for the 216-A-13 French Drain. The drain is marked by a large diameter yellow concrete pipe with a "confined space" warning posted; however, there are no identification posts. It is assumed to be in the same radiological unit as the 216-A-13 French Drain. No contamination was detected in the 1990 radiological survey.

4.1.2.3.40 216-C-8 French Drain. This is an inactive waste management unit. It received an unknown volume of ion-exchange waste from the 271-CR Building. The waste is expected to contain less than 10 Ci total beta. The unit is a 1.8 m (6 ft) diameter by 2.4 m (8 ft) long concrete culvert placed vertically 1.2 m (4 ft) below grade. The culvert is in a 4.9 m (16 ft) deep excavation. The drain also has an inlet pipe from the 271-C Building. Currently, the drain is marked by a gooseneck pipe in a 3 x 3 m (10 x 10 ft) area stabilized with sand. The 1988 survey identified 2,000 ct/min contamination on the surface. The site was surface stabilized in April 1991 and is posted "Underground Radioactive Material."

4.1.2.4 Reverse Wells. Well 299-E24-111 is the only injection well in the PUREX Plant Aggregate Area. It is located just west of the 216-A-38-1 Crib and has similar functions to a reverse well. It is an inactive waste management unit that is 4.6 m (15 ft) deep, has 32 observation wells, and has a 5,678 L (1,500 gal) mixing tank. The unit received eleven 3,785 L (1,000 gal) injections of uniform solutions of calcium chloride, calcium nitrate and selected tracers composed of ^{134}Cs and ^{90}Sr. The well was built for testing purposes only and was never activated to accept waste from any operations on the Hanford Site.

The area is enclosed within the PUREX surface contaminated area, which is paved with asphalt or covered with gravel. Two enclosures are present at the well site; one light chain enclosure marked with surface contamination, and one marked underground contamination, enclosing a vertical pipe assumed to be the injection well and one monitoring well. Wells drilled for monitoring the injection well are marked by 15.2 cm (6 in.) tall pipes with steel caps.

4.1.2.5 Ponds, Ditches, and Trenches. The PUREX Plant Aggregate Area has two ditches, 216-A-29 and 216-A-34, and four trenches, 216-A-18 through -20 and 216-A-40. A series of sediment and vegetation samples have been analyzed from these waste management units.

4.1.2.5.1 216-A-29 Ditch. This is an inactive waste management unit. The site was surface stabilized in October 1991. The depth of the ditch varies from 0.6 to 4.6 m (2 to 15 ft). This unit receives discharge from PUREX Plant chemical sewer that is composed of acid fractionator condensate, demineralizer recharge effluents, nonprocess steam condensate, and chemical storage tank overflows. The waste from the PUREX Plant is directed to the 216-B-3-3 Ditch which leads to the 216-B-3 Pond, which is active. The flow rates may vary from approximately 378 to 5,290 L/min (100 to 1,400 gal/min). Average flow is about 970 gal/min (3,670 L/min). Discharges of sodium hydroxide and sulfuric acid solution occurred on a daily basis until February 1986.

Known and potential discharges include demineralizer regenerant, oxalic acid, nitric acid, hydrogen peroxide, calcium nitrate, potassium permanganate, sodium carbonate solution, hydrate solution, potassium hydroxide, sodium nitrate, sodium hydroxide, cadmium nitrate, and hydrazine. The majority of these discharges were Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) reportable releases. The document *216-A-29 Ditch Preliminary Closure/Post-Closure Plan* has a table of a single sampling period of organics and inorganics in the PUREX chemical sewer (DOE/RL 1987). These could possibly have been in the discharge to the 216-A-29 Ditch.

The U.S. Department of Energy, Richland Operations Office (DOE/RL) has a plan to administer the unit so that any future releases are within acceptable limits and will not harm the public or the environment. The general closure plan involves several steps, some of which have already been initiated as a demonstration of DOE/RL intent. The general steps are the following:

1) Discontinue discharges of hazardous materials to the facility

2) Sample site soils and sediments

3) Analyze soil and sediment samples for hazardous components

4) Close facility under Resource Conservation and Recovery Act (RCRA) (inventory removal/decontamination or alternate closure option).

Within the 216-A-29 Ditch area surface water sampling and aquatic vegetation sampling was conducted. The surface water sampling looked for total beta, total alpha, ^{137}Cs, and

^{90}Sr. From 1985 to 1990 the majority of the readings were below detection limit (Table 4-10). The aquatic vegetation sampling was conducted from 1985 to 1989 and looked for the following radionuclides: ^{214}Bi, ^{134}Cs, ^{212}Pb, ^{214}Pb, ^{239}Pu, ^{106}Ru, ^{125}Sb, ^{90}Sr, ^{208}Tl, and U. The highest readings were ^{137}Cs at 36 pCi/g, ^{239}Pu at 8.3 pCi/g, ^{106}Ru at 280 pCi/g, and ^{125}Sb at 19 pCi/g.

4.1.2.5.2 216-A-34 Ditch. This is an inactive waste management unit. The ditch contains an inlet pipe which is placed 0.6 m (2 ft) below grade. This unit has been designated as an underground contamination site.

4.1.2.5.3 216-A-18 Trench. This is an inactive waste management unit. The trench is 4.6 m (15 ft) deep. The trench received the depleted uranium waste from the cold start-up run at the 202-A Building. It was surface stabilized in September 1990.

4.1.2.5.4 216-A-19 Trench. This is an inactive waste management unit. The trench is 4.6 m (15 ft) deep. The trench received contact condenser cooling water via the 216-A-34 Ditch and the depleted uranium waste from the cold start-up run at the 202-A Building.

4.1.2.5.5 216-A-20 Trench. This is an inactive waste management unit. The trench is 4.6 m (15 ft) deep. The trench received the 241-A-431 Building contact condenser cooling water via the 216-A-34 Ditch, and the depleted uranium waste from the cold start-up run at the 202-A Building. This unit received the same waste as the 216-A-19 Trench.

4.1.2.5.6 216-A-40 Trench. This is an inactive waste management unit. This trench is 4.9 m (16 ft) deep. The unit contains three large sealed bladders designed for storing effluents. A pipe runs through the trench horizontally 3.7 m (12 ft) below grade. The trench received the diverted cooling water and steam condensate from the 244-AR Vault. Currently, the ditch is enclosed within a box-wire fence and several tumbleweeds fill the ditch bottom.

4.1.2.6 Septic Tanks and Associated Drain Fields. None of the septic tanks and drain fields are thought to have received any hazardous waste so there is no significant sampling information available.

4.1.2.6.1 2607-EA Septic Tank and Drain Field. This unit is still active and receives 0.06 m^3 (2 ft^3) of sanitary wastewater and sewage per day. It is not thought to have received any hazardous waste and no chemical or radiological data are available.

4.1.2.6.2 2607-EC Septic Tank and Drain Field. This unit is still active and receives an estimated 0.45 m^3 (16 ft^3) of sanitary wastewater and sewage per day. It is not

thought to have received any hazardous waste and no chemical or radiological data are available.

4.1.2.6.3 2607-ED Septic Tank and Drain Field. This unit is still active and receives an estimated 0.28 m^3 (10 ft^3) of sanitary wastewater and sewage per day. It is not thought to have received any hazardous waste and no chemical or radiological data are available.

4.1.2.6.4 2607-EG Septic Tank. This unit is still active and receives an estimated 0.17 m^3 (6 ft^3) of sanitary wastewater and sewage per day. It is not thought to have received any hazardous waste and no chemical or radiological data are available.

4.1.2.6.5 2607-EJ Septic Tank. This unit is still active and receives an estimated 0.32 m^3 (11 ft^3) of sanitary wastewater and sewage per day. It is not thought to have received any hazardous waste and no chemical or radiological data are available.

4.1.2.6.6 2607-EL Septic Tank. This unit is still active and receives an estimated 7.9 m^3 (279 ft^3) of sanitary wastewater and sewage per day. It is not thought to have received any hazardous waste and no chemical or radiological data are available.

4.1.2.6.7 2607-E6 Septic Tank and Drain Field. This unit is still active and receives an estimated 43.5 m^3 (1,536 ft^3) of sanitary wastewater and sewage per day. It is not thought to have received any hazardous waste and no chemical or radiological data are available.

4.1.2.7 Transfer Facilities, Diversion Boxes, and Pipelines. No chemical or radiological data are available for the diversion boxes in the PUREX Plant Aggregate Area. Some of the process sewer lines are thought to have leaked; however, no inventory or sampling data are available to estimate the magnitude of these leaks. One diversion box, 241-CR-151, has an unplanned release associated with it. A puddle of contaminated liquid was discovered near the diversion box. More detailed information regarding the unplanned release is in Section 2.3.10.

4.1.2.8 Basins. There are two retention basins in the PUREX Plant Aggregate Area. Most of the data available for the basins are summarized from WIDS (WHC 1991a).

4.1.2.8.1 207-A Retention Basins. These are active waste management units. The retention basins are constructed to a depth of 2.1 m (7 ft). No inventory data are available for these units. In the past they have generally received only low-level waste, steam condensate and process condensate from the 242-A Evaporator.

4.1.2.8.2 216-A-42 Retention Basin. This is an active waste management unit. The retention basin is constructed to a depth of 7 m (23 ft). No inventory data are available for this unit. The basin receives chemically or radioactively contaminated diversions from the PUREX chemical sewer line, cooling water line, and steam condensate discharge.

4.1.2.9 Burial Sites. There are five burial grounds and one burning pit in the PUREX Plant Aggregate Area. Most of the data available for the burial sites and burning pit are summarized from WIDS (WHC 1991a).

4.1.2.9.1 200-E Burning Pit. This is an inactive waste management unit. It is reported to have received 1,500 m^3 (52,972 ft^3) of construction and office waste, paint wastes, and chemical solvents. There are three areas within the burning pit that are designated as areas of surface contamination and one area warning of asbestos in the middle of the basin. There is a an area roped off with a sign labeled "RCRA Waste Site." This enclosure marks the location of a single detonation event in 1984, used to dispose of a quantity of unstable liquids. The chemicals detonated include:

Butoxyethanol	19 L (5 gal)
Dioxane	0.95 L (0.25 gal)
1,4 Dioxane	1.25 L (0.33 gal)
Hydrogen Peroxide	11.36 L (3.00 gal)
Isopropyl Ether	8 L (2.1 gal)
Methyl Ethyl Ketone	0.18 L (0.05 gal)
Phosphoric Acid	189 L (50 gal)
Polyethylene Glycol Monoethyl Ether	0.95 L (0.25 gal)
Sodium Azide	0.47 L (0.12 gal)

This unit has two unplanned releases associated with it: UN-200-E-62 and UPR-200-E-106. Unplanned release UPR-200-E-106 consisted of contaminated paper towels from the control laboratory with radiation readings as high as 2.5 R/h found at the burning ground.

Site 2E12 is just west of the 200-E Burning Pit. This site was monitored for external radiation, vegetation sampling, and grid soil sampling. The external radiation monitoring TLDs averaged 89 mrem/yr for 1985 to 1989 (Table 4-6). The greatest radionuclides present in the vegetation sampling were ^{40}K at 10.6 pCi/g, ^{7}Be at 1.85 pCi/g, and ^{90}Sr at 1.75 pCi/g (Table 4-11). The greatest radionuclide concentrations detected in the grid soil sampling were ^{40}K at 11.9 pCi/g, and ^{137}Cs at 13.6 pCi/g (Table 4-8).

4.1.2.9.2 218-E-1 Burial Ground. This is an inactive waste management unit. The unit is made up of fifteen 61-m (200-ft) long trenches, all have been filled to ground level since 1974. The trenches were filled with cinders from the 200 East Power Plant and then

covered with coarse gravel and backfilled in an attempt to stabilize the site. In October 1981 the entire surface of the unit was covered with a minimum of 46 cm (18 in.) of clean overburden and revegetated.

The unit received about 3,030 m^3 (107,003 ft^3) of both mixed fission products and transuranic (TRU) dry waste. This waste is expected to contain ^{137}Cs, ^{106}Ru, and ^{90}Sr. The 1990 annual radiological survey identified weeds in the southeast corner of the site that were contaminated to a level of 5,000 ct/min.

UPR-200-E-53. The 218-E-1 Burial Ground has an unplanned release associated with it, UPR-200-E-53. The release occurred during a burial operation when contamination was spread by uncovering previously buried waste at the south end of a waste trench in the burial ground. The release had unknown beta/gamma contamination with readings to 150 mR/h. Currently, there are no signs indicative of an unplanned release.

4.1.2.9.3 218-E-8 Burial Ground. This is an inactive waste management unit. The unit is constructed to a depth of 4.6 m (15 ft) with an unknown number of backfilled trenches. The burial ground received mixed fission products and transuranic waste, including repair and construction wastes from the 293-A Building and the PUREX Plant new crane addition. The unit received 2,265 m^3 of waste expected to contain ^{137}Cs, ^{106}Ru, and ^{90}Sr. On February 21, 1979, residue from broken tumbleweeds blown in along the west boundary line of this site were found to be reading greater than 100,000 ct/min beta/gamma activity.

4.1.2.9.4 218-E-12A Burial Ground. This is an inactive waste management unit. The site is constructed to a depth of 4.9 m (16 ft) with 28 dry waste burial trenches. Operational experience has shown that the backfill was substantially less than the present requirement of 1.2 m (4 ft). Some waste was visible at the surface prior to stabilization efforts. The unit is designated as an area of underground contamination and surface contamination.

The wastes received by the trenches included dry waste packaged in cardboard boxes and plastic bags, and acid-soaked material. The total volume of waste received by the burial ground is 15,249 m^3 (538,511 ft^3) containing ^{137}Cs, ^{106}Ru, and ^{90}Sr. The 1990 survey detected unidentified contamination in small areas reading 20,000 dis/min and contaminated tumbleweed up to 40,000 dis/min.

4.1.2.9.4.1 Unplanned Releases UPR-200-E-24 and UPR-200-E-30. The 218-E-12A Burial Ground has two unplanned releases associated with it. Unplanned release UPR-200-E-24 occurred on June 17, 1960 when a burial box collapsed during burial operations, causing spotty ground contamination from the burial ground to the east area perimeter fence, a

distance of about 3.2 km (2 mi). The contamination had unknown beta/gamma readings up to 2,000 mR/h at the site. Average radiation level inside the burial ground fence was 30 mR/h at 10 cm (4 in.). Unplanned release UPR-200-E-30 occurred on April 20, 1961 when another burial box collapsed during burial operations spreading contamination throughout the burial ground. The contamination had unknown beta/gamma with readings up to 500 R/h. The unit was stabilized immediately after the burial and the trench involved was backfilled.

4.1.2.9.5 218-E-12B Burial Ground. This is an active waste management unit. The burial ground is divided into two general sections, north and south. The southern section contains an eastern portion that is stabilized with soil and designated as an area of underground contamination. A barrier with surface contamination warning signs extends along the road separating the northern and southern portions of the burial grounds. One of the trenches in the northern portion contains Navy reactor compartments that contain lead shielding with an anticipated minimum life expectancy for containment of 300 yr. The burial ground is partially stabilized.

Grid sampling site 2E5 is near the 218-E-12B Burial Ground and sampling site 2E11 is just north of the burial ground. These sampling sites were both monitored for external radiation. However, only Site 2E11 also had vegetation sampling and soil sampling performed. The external radiation monitoring TLDs averaged 94 mrem/yr for Site 2E5 and 100 mrem/yr for Site 2E11 from 1985 to 1989 (Table 4-6). The greatest quantity of radionuclides present in the vegetation sampling were ^{212}Pb at 0.93 pCi/g and ^{214}Pb at 2.0 pCi/g (Table 4-11). The greatest radionuclide concentrations detected in the grid soil sampling were ^{137}Cs at 11.9 pCi/g, and ^{90}Sr at 1.92 pCi/g (Table 4-8).

4.1.2.9.6 218-E-13 Burial Ground. This is an inactive waste management unit. This was an unplanned site constructed to a depth of 2.4 m (8 ft). In August 1966, this unit received broken pieces of contaminated concrete from a pipe trench, which were left in the excavation hole and buried following repair to the piping at that location. The unit contains less than 1 Ci fission products. The contaminated soil volume is estimated at 184 m^3 (6,498 ft^3) with an overburden soil volume of 175 m^3 (6,180 ft^3).

4.1.2.10 Unplanned Releases. There is very little chemical or radiological data available for any of the other unplanned releases. Any information which was found is summarized in Table 2-5.

4.2 POTENTIAL IMPACTS TO HUMAN HEALTH AND THE ENVIRONMENT

This preliminary assessment is intended to provide a qualitative evaluation of potential human health hazards associated with the known and suspected contaminants at the PUREX

Plant Aggregate Area. The assessment includes a discussion of release mechanisms, potential transport pathways, develops a conceptual model of human exposure based on these pathways, and presents the physical, radiological, and toxicological characteristics of the known or suspected contaminants.

In developing the conceptual model, potential exposures to groundwater have not been addressed in detail. Since migration to groundwater is the primary route for potential future exposures to many of the chemicals disposed of at the Hanford Site, this pathway (i.e., travel time, receptors) will be addressed in the 200 East Groundwater AAMSR.

It is important to note that these evaluations do not attempt to quantify potential human health risks associated with exposure to PUREX Plant Aggregate Area waste management unit contaminants. Such a risk assessment cannot be performed until additional waste unit characterization data are acquired. Risk assessment activities will be performed in accordance with the *Hanford Site Baseline Risk Assessment Methodology* document (DOE/RL 1992b) being prepared in response to the M-29 milestone.

4.2.1 Release Mechanisms

The PUREX Plant Aggregate Area waste management units can be divided into two general categories based on the nature of the waste release: 1) units where waste was discharged directly to the environment; and 2) units where waste was disposed of inside a containment structure and bypassed an engineered barrier (e.g. a membrane liner) to reach the environment (i.e., through the vadose zone to the aquifer or through the aquifer).

In the first group are those waste management units where release of wastes to the soil column was an integral part of the waste disposal strategy. Included in this group are pipelines to ponds/ditches/cribs, tile fields, septic system drain fields, ditches, french drains, seepage basins, cribs without liners, injection wells, and some disposal trenches. Also in this group are unplanned releases that involved waste material released to the soil. For this group of waste management units, if discharges to the unit contained contaminants of concern, it can be assumed that soils underlying the waste management unit are contaminated. The first task in developing a conceptual model for these units is to determine whether contaminants of concern are retained in soil near the waste management unit, or are likely to migrate to the underlying aquifer and then to receptor points such as drinking water wells or surface water bodies. Factors affecting migration of chemicals away from the point of release will be discussed in the following section.

In the second group are waste management units that were intended to act as a barrier to environmental releases. Included in this group are burial grounds containing drums or

other containers, cribs with membrane liners, tanks, waste transfer facilities, and unplanned releases that occurred within containment structures. Waste management units that received only dry waste could also be included in this category, since the potential for wastes to migrate to soils outside of the unit is low due to the negligible natural recharge rate at the Hanford Site. For these waste management units, the first consideration to be addressed in developing a conceptual model is the integrity of the containment structure.

The ability of this report to evaluate the efficacy of engineered barriers is limited by the lack of vadose zone soil sampling data and air sampling data for many waste management units. Available sampling information for the waste management units and unplanned releases has been summarized in Section 4.1. The data indicate that membrane liner systems used in waste management units with significant liquid inputs (e.g., 216-A-40 Crib) were ineffective in preventing releases to the subsurface.

The efficacy and integrity of concrete liners (216-A-42 Retention Basin) has not been determined. For those units that received only dry wastes, such as gloves, pumps, contaminated dirt, and process equipment, the potential for release is expected to be low. However, small amounts of liquid wastes (^3H, lab wastes) are known to have been disposed of in these waste management units, and early disposal records (prior to about 1968) are incomplete. Thus, releases from these structures to the surrounding soil are possible.

In addition to evaluating releases to the subsurface, the conceptual model must address the potential for releases to air and, for radionuclides, the potential for direct irradiation. All units have some type of barrier to releases to the surface; however, barriers can fail over time or may not be designed to prevent migration by certain transport pathways (e.g., volatilization).

4.2.2 Transport Pathways

Transport pathways expected within the PUREX Plant Aggregate Area are summarized in this section, including:

- Drainage and leaching from soil to groundwater
- Volatilization from wastes and shallow soils
- Wind erosion of contaminated surface soils
- Deposition of fugitive dust on soils, plants, and surface water

- Uptake from soils by vegetation
- Uptake from soils by animals via direct contact with soils or ingestion of vegetation, and
- Direct radiation.

In addition, transport within the saturated zone and subsequent release to groundwater wells or to offsite surface water (i.e., the Columbia River) is of potential concern, but will not be addressed in this document, since this topic will be the focus of the 200 East Groundwater AAMSR.

4.2.2.1 Transport from Soils to Groundwater. Soil is the initial receiving medium for waste discharges in the PUREX Plant Aggregate Area, whether the release is directly to soil or through failure of a containment system. Several factors determine whether chemicals that are introduced into the vadose zone will reach the unconfined aquifer, which lies at a depth of approximately 60 m (200 ft) below ground surface. These factors are discussed in the following sections.

4.2.2.1.1 Depth of Release. Waste management units that released wastes at a greater depth below the surface are more likely to contaminate groundwater than waste management units where the release was shallow. The 299-E24-111 Injection Well is a primary example of a deep release at the PUREX Plant Aggregate Area. However, since the injection well only received test solutions and did not receive waste, it is not suspected of transporting contaminants to the groundwater. Other possible contributors to the groundwater are units with membranes, such as the 216-A-10 Crib which is believed to have released effluent to the ground.

4.2.2.1.2 Liquid Volume or Recharge Rate. For waste constituents to migrate to the underlying water table, some source of recharge must be present. In the PUREX Plant Aggregate Area, the primary source of moisture for mobilizing contaminants are waste management units that discharge liquid waste to the soil column and precipitation recharge. As discussed in Section 3.5.2, estimates of natural precipitation recharge range from 0 to 10 cm/yr (0 to 4 in./yr), primarily depending on surface soil type, vegetation, and topography. Gravelly surface soils with no or minor shallow rooted vegetation appear to facilitate precipitation recharge. One modelling study (Smoot et al. 1989) indicated that some radionuclide (^{137}Cs and ^{106}Ru) transport could occur with as little as 5 cm/yr (2 in./yr) of natural recharge. However, other researchers (Routson and Johnson 1990) have concluded that no net precipitation recharge occurs in the 200 Areas, particularly at waste management units that are capped with fine-grained soils or impermeable covers.

With respect to artificial recharge, some waste management units (e.g., the 216-A-6 Crib) were identified in which the known volume of liquid waste discharged substantially exceeded the total estimated soil pore volume present below the footprint of the facility. In this case, the moisture content of soil below the waste management units likely approached saturation during the periods of use of these facilities. Because vadose zone hydraulic conductivities are maximized at water contents near saturation, the volume of liquid wastewater historically discharged to the waste management units probably enhanced fluid migration in the vadose zone beneath these units.

Contaminants that are not initially transported to the water table by drainage may be mobilized at a later date if a large volume of liquid is added to the unit. In addition, liquids discharged to one unit could mobilize wastes discharged to an adjacent unit if lateral migration takes place within the vadose zone. There are no known cases of this occurring in the PUREX Plant Aggregate Area waste management units, although the potential exists. An example of this process occurred at the 216-U-16 Crib in the U Plant Aggregate Area, where lateral migration of acidic waste above a caliche layer mobilized radionuclides in the 216-U-1 and 216-U-2 Cribs (Baker et al. 1988).

4.2.2.1.3 Soil Moisture Transport Properties. The moisture flux in the vadose zone is dependent on hydraulic conductivity and gradients of moisture content or matrix suction. Higher unsaturated hydraulic conductivities are associated with higher moisture contents. However, higher unsaturated hydraulic conductivities may be associated with fine-grained soils compared to coarse-grained soils at low moisture contents. Because of the stratified nature of the Hanford Site vadose zone soils and the moisture content dependence of unsaturated hydraulic conductivity, vadose zone soils are likely to be more permeable in the horizontal direction than in the vertical. This may substantially reduce the potential for contaminant migration to the unconfined aquifer.

4.2.2.1.4 Retardation. The rate at which contaminants will migrate out of a complex waste mixture and be transported through unsaturated soils depends on a number of characteristics of the chemical, the waste, and the soil matrix. In general, chemicals that have low solubilities in the leaching fluid or are strongly adsorbed to soils will be retarded in their migration velocity compared to the movement of soil pore water. Studies have been conducted of soil parameters affecting waste migration at the Hanford Site to attempt to identify the factors that control migration of radionuclides and other chemicals. Recent studies of soil sorption are summarized in Serne and Wood (1990). Some of the processes that have been shown to control the rate of transport are:

- **Adsorption to Soils.** Most contaminants are chemically attracted to some degree to the solid components of the soil matrix. For organic compounds, the adsorption is generally to the organic fraction of the soil, although in extremely

low-organic soils, adsorption to inorganic components may be of greater importance. Soil components contributing to adsorption of inorganic compounds include clays, organic matter, and iron and aluminum oxyhydroxides. In general, Hanford surface soils are characterized as sandy or gravelly with very low organic content (<0.1%) and low clay content (<12%) (Tallman et al. 1981). Thus, site-specific adsorption factors are likely to be lower, and rate of transport higher, than the average for soils nationwide.

- **Filtration.** Filtration of suspended particulates by fine-grained sediments has been suggested as a mechanism for concentration of radionuclides in certain sedimentary layers. This finding suggests that migration of suspended particulates may be an important mechanism of transport for poorly soluble contaminants.

- **Solubility.** The rate of release of some chemicals is controlled by the rate of dissolution of the chemical from a solid form. The concentration of these chemicals in the pore water will be extremely low, even if they are poorly sorbed. An example cited by Serne and Wood (1990) is the solubility of plutonium oxide, which appears to be the limiting factor controlling the release of plutonium from waste materials at neutral and basic pH.

- **Ionic Strength of Waste.** For some inorganics, the dominant mechanism leading to desorption from the soil matrix is ion exchange. Leachate having high ionic strength (high salt content) can bias the sorption equilibrium toward desorption, leading to higher concentrations of the contaminant in the soil pore water. Wastes within the PUREX Plant Aggregate Area that can be considered high ionic strength include any releases from tanks.

- **Waste pH.** The pH of a leachant has a strong effect on inorganic contaminant transport. Acidic leachates tend to increase migration both by increasing the solubility of precipitates and by changing the distribution of charged species in solution. The exact impact of acidic or basic wastes will depend on whether the chemical is normally in cationic, anionic, or neutral form, and the form that it takes at the new pH. Cationic species tend to be more strongly adsorbed to soils than neutral or anionic species. The extent to which addition of acidic leachate will cause a contaminant to migrate will also depend on the buffering or neutralizing capacity of the soil, which is correlated with the $CaCO_3$ content of the soil. The soils in the Hanford formation beneath the PUREX Plant Aggregate Area generally have carbonate contents in the range of 0.1 to 5%.

Once the leaching solution has been neutralized, the dissolved constituents may re-precipitate or become reabsorbed to the soil. Although there are no known cases of this occurring in the PUREX Plant Aggregate Area, observations of pH impacts on waste transport at the Hanford Site include:

- The remobilization of uranium beneath the 216-U-1 and 216-U-2 Cribs in the U Plant Aggregate Area is believed to have occurred in part because of this introduction of low pH solutions.

- Leaching of americium from the Z Plant Aggregate Area 216-Z-9 Crib sediments was found to be solubility controlled and correlated to solution pH.

4.2.2.1.5 Complexation by Organics. Certain organic materials disposed of at the PUREX Plant Aggregate Area are known to form complexes with inorganic ions, which can enhance their solubility and mobility. Tributyl phosphate is the primary organic complexing agent disposed of at the PUREX Plant Aggregate Area.

4.2.2.1.6 Contaminant Loss Mechanisms. Processes that can lead to loss of chemicals from soils, and thus decrease the amount of chemical available for leaching to groundwater, include:

- **Radioactive Decay.** Radioactivity decays over time, generally decreasing the quantities and concentrations of radioactive isotopes.

- **Biotransformation.** Microorganisms in the soil may degrade organic contaminants such as kerosene and inorganic chemicals such as nitrate. They may also effect the mobility of metals through redox chemistry and complexation with metabolic products.

- **Chemical Transformation.** Hydrolysis, oxidation, reduction, radiolytic degradation and other chemical reactions are possible degradation mechanisms for contaminants.

- **Vegetative Uptake.** Vegetation may remove chemicals from the soil, bring them to the surface, and introduce them to the food web.

- **Volatilization.** Organic chemicals and volatile radionuclides can be transported in the vapor phase through open pores in soil either to adjacent soil or to the atmosphere. These volatilized compounds could include acetone, radon (a decay product of uranium), and tritium (HTO in tritiated water). Some elements

(mainly fission products such as iodine, ruthenium, cerium, and antimony) are referred to as "semivolatiles" because they have a lesser tendency to volatilize.

4.2.2.2 Transport from Soils to Air. Transport of contaminants from waste management units to the atmosphere can occur by means of vapor transport or by fugitive dust emissions.

Vapor transport may occur from waste management units where volatile organics (e.g., acetone) or volatile radionuclides (^{14}C, $^{14}CO_2$, ^{129}I, or ^{3}H) have been released. Transport mechanisms include diffusion down a concentration gradient and gas-driven flow. Situations where the latter process may occur include production of methane gas from degradation of organic compounds in soil, or production of hydrogen and oxygen gases by radiolytic hydrolysis of water.

For fugitive dust emissions to occur, contaminants must be exposed at the surface of the waste management unit. A number of mechanisms could lead to exposure of contaminants in soil-covered waste management units. These mechanisms include uptake by vegetation, transport by animals, disruption of the waste management unit (e.g., cave-ins at cribs), and wind erosion. Wind erosion can strip off surface soil and uncover waste materials. This mechanism has been identified as an ongoing problem in some of the waste management unit areas. The processes by which biota may expose contaminated soils are discussed in Section 4.2.2.4.

The PUREX Plant Aggregate Area has been suspected of contributing to the overall fugitive dust emissions at the Hanford Site. A 1 mi^2 area just northeast of the northeast corner of the 200 East Area is posted for contamination from windblown vegetation that has jumped the fence. The nearest upwind sources for this contamination would be the PUREX burial grounds.

4.2.2.3 Transport from Soils to Surface Water. The only surface water available in the PUREX Plant Aggregate Area is at the 216-A-29 Ditch and the 207-A Retention Basins. The 216-A-29 Ditch has been active since 1955 and has received waste liquids from a variety of sources (Section 4.1). The portion of the ditch south of the grout treatment facility perimeter fence has recently been backfilled to grade with gravel.

Transport of contaminants to surface water bodies outside of the PUREX Plant Aggregate Area via groundwater discharge and deposition of fugitive dust on water bodies are the primary pathways of potential concern for surface water effects. Groundwater discharge will be addressed in the 200 East Groundwater AAMSR.

4.2.2.4 Transport from Soils to Biota. Biota, plants and animals, have the potential for taking up (bio-uptake), concentrating (bioaccumulating), transporting, and depositing

contamination beyond its original extent. Transfer from one species to another in the food chain is also possible because of predation. The possibility of these processes contributing significantly to the transport of contamination from the PUREX Plant Aggregate Area waste management units is uncertain.

4.2.2.4.1 Uptake by Vegetation. Release of radioactivity to the surface by growth of vegetation is an ongoing problem at PUREX Plant Aggregate Area waste management units. Roots of sagebrush and other native species can take up radionuclides from soils below the surface and transport these chemicals to the foliage. Wind dispersal of portions of the contaminated vegetation, or entire plants (tumbleweeds) can lead to transport of contaminants outside of the unit. Westinghouse Hanford has an ongoing vegetation control (herbicide application, reseeding with shallow-rooted vegetation, and mechanical removal) and radiological survey program to prevent radioactivity from being transported by this mechanism. However, the program does not ensure complete removal of vegetation, and incidents of detection of contaminated vegetation are reported occasionally in the radiological surveys.

4.2.2.4.2 Transport by Animals. Disturbance of waste management unit barriers by animals occasionally leads to release of contaminants to the surface. Subsurface soils can be transported to the surface by burrowing animals, thus exposing contaminants for release to the air. Additionally, animals that become contaminated by direct contact with subsurface waste or through ingestion of subsurface contaminants (e.g., chemical salts) and contaminated vegetation, water, or other animals can spread contamination in their feces on the surface and outside of the waste management unit. There are no known cases of contaminants spread through animal feces in the PUREX Plant Aggregate Area; however, an example of transport through this mechanism is the UN-200-W-86 Unplanned Release in the U Plant Aggregate Area, in which pigeon feces containing ^{134}Cs, ^{137}Cs, ^{90}Sr, and ^{106}Ru were detected around the U Plant Aggregate Area and the 204-S Basin.

4.2.3 Conceptual Model

Figure 4-3 presents a graphical summary of the physical characteristics and mechanisms at the site which could potentially affect the generation, transport, and impact of contamination in the PUREX Plant Aggregate Area on humans and biota (conceptual model).

The sources of contamination include stack emissions and drainage; process wastes (condensates, cooling water, chemical sewage, pump waste) from PUREX; condensate from 241-A Tank Farm; laboratory wastes; depleted uranium wastes; tributyl phosphate and bismuth phosphate metal wastes; high-level liquid wastes; drainage from diversion boxes; sanitary wastes; process feed materials; materials from outside the aggregate area (e.g.,

201-C Building (Semiworks), N Reactor, reduction-oxidation (REDOX), PNL, Hanford laboratory, and B Plant wastes); and contaminated equipment or waste material that was spilled during transit or disposed of in the burial grounds.

Contaminants from these sources have been disposed of at the waste management units that are under investigation. These include the ditches, retention basins, settling tanks, trenches, cribs, french drains, reverse wells, diversion boxes and catch tanks, septic tanks and drain fields, single-shell tanks, burial grounds, and the various unplanned releases that have occurred on the site. These releases and disposal activities are described in Sections 2 and 4.1. Some of the unplanned releases are associated with specific waste sites, and are shown on Figure 4-3 as dashed lines with "U" designations.

From these waste management units, various release mechanisms may have transported contamination to the potentially affected media. Volatilization could release chemicals from surface waters into the atmosphere. Materials in the ditches may have seeped into the vadose zone, or deposited into the sediments in the ditch. The 207-A Retention Basins may have released contaminants in a similar fashion, with the exception of offsite flow. Biota may have taken up contaminants from the surface water and near-surface contaminated soils (via deep roots or burrowing animals).

Many waste management units discharge their waste effluents directly to the near surface (vadose zone) soils. The trenches are potential release points via leaching or drainage of the liquid portion of the disposed materials. The cribs provide seepage discharge and similarly the french drains, injection wells, and septic system drain fields directly inject their effluents into the subsurface sediments. The unplanned releases have mainly impacted surface soils although some contamination may have also taken place on building surfaces. Fugitive dust from sediment and surface soils has also been released or resuspended due to wind effects or surface disturbances, and some surface soils have been buried or removed to off-site disposal.

The primary mechanism of vertical contaminant migration is the downward movement of water from the surface through the vadose zone to the unconfined aquifer. The contaminants generally move as a dissolved phase in the water and their rate of migration is controlled both by groundwater movement rates and by adsorption and desorption reactions involving the surrounding sediments. Some contaminants are strongly sorbed on sediments and their downward movement through the stratigraphic column is greatly retarded. Significant lateral migration of contaminants is restricted to perched water zones and to the unconfined aquifer, where water is moving laterally. Again adsorption and desorption reactions may greatly retard lateral contaminant migration. Contaminants that were introduced to the soil column outside of the aggregate area may migrate into the area along with perched or aquifer water.

There are four exposure routes by which humans (offsite and onsite) and other biota (plants and animals) can be exposed to these possible contaminants:

- Inhalation of airborne volatiles or fugitive dusts with adsorbed contamination
- Ingestion of surface water, fugitive dust, surface soils, biota (either directly or through the food chain), or groundwater
- Direct contact with the waste materials (such as those exhumed by burrowing animals), contaminated surface soils, buildings, or plants
- Direct radiation from waste materials, surface soils, building surfaces, or fugitive dusts.

4.2.4 Characteristics of Contaminants

Table 4-30 is a list of radioactive and nonradioactive chemical substances that represent candidate contaminants of potential concern for this study based on their known presence in wastes, usage, disposal in waste management units, historical association, or detection in environmental media at the PUREX Plant Aggregate Area. Table 4-31 summarizes the types of known or suspected contamination that are thought to exist at the individual waste sites. Known contaminants have been proven to exist from sampling and inventory data (Tables 2-2 and 2-3). Suspected contaminants are those which could occur at a site based upon historical practices or chemical associations. Given the large number of chemicals known or suspected to be present, it is appropriate to focus this assessment on those contaminants that have been detected through sampling efforts and which pose the greatest risk to human health or the environment. Table 4-32 lists the contaminants of concern for the PUREX Plant Aggregate Area. This list was developed from Table 4-30 and includes only those contaminants which meet the following criteria:

- Radionuclides that have a half-life of greater than one year
- Radionuclides with a half-life of less than one year and are part of long-lived decay chains that result in the buildup of the short-lived radionuclide activity to a level of 1% or greater of the parent radionuclide's activity within the time period of interest
- Contaminants that are known or suspected carcinogens or have a U.S. Environmental Protection Agency (EPA) noncarcinogenic toxicity factor.

The following characteristics will be discussed for the contaminants listed in Table 4-31:

- Detection of contaminants in environmental media
- Historical association with plant activities
- Mobility
- Persistence
- Toxicity
- Bioaccumulation.

4.2.4.1 Detection of Contaminants in Environmental Media. The nature and extent of surface and subsurface soils, surface water, groundwater, air, and biota contamination have not yet been adequately characterized for the PUREX Plant Aggregate Area. All recent environmental monitoring data were reviewed and summarized for each media in Section 4.1.

The most extensive monitoring data available has been for groundwater. Because groundwater will be evaluated in the 200 East Groundwater AAMSR, it will not be discussed further here. Surface soil and biota samples have been collected from locations on a regular rectangular grid. These sampling locations do not correspond to any of the waste management units, but are intended to characterize the PUREX Plant Aggregate Area as a whole. Air and external radiation samples have been collected at several locations within or adjacent to the PUREX Plant Aggregate Area. These sampling stations are also not located directly on any of the waste management units and therefore the sampling results cannot be attributed to any particular unit. The only routine sampling data that correspond directly to waste management units are the external radiation surveys, which are performed on a regular basis. There is little soil or vegetation sampling data available for any of the units.

4.2.4.2 Historical Association with PUREX Plant Activities. Radionuclides that are known components of PUREX waste streams are listed in Table 2-9. This list includes chemicals in the process wastes as well as chemicals that were detected at elevated levels in wastewater. Since these waste streams are known to have been disposed of directly to the soil column in some waste management units, it is probable that the chemicals on this list have affected environmental media.

Based on the WIDS data (WHC 1991a), radionuclides that are known to have been disposed of to PUREX Plant Aggregate Area waste management units in the greatest quantities are as follows:

- ^{239}Pu
- ^{240}Pu
- ^{241}Pu
- ^{137}Cs
- ^{90}Sr
- ^{3}H
- ^{99}Tc
- ^{238}U.

Note that a complete radionuclide analysis of the PUREX waste streams is not available. Thus, it is possible that additional radionuclides were disposed of to PUREX Plant Aggregate Area waste management units that are not included in the waste inventories.

Nonradioactive chemicals reportedly released into PUREX Plant Aggregate Area waste management units in large quantities include nitrates, sodium, sulfate, tributyl phosphate, ammonium nitrate, and ammonium carbonate.

4.2.4.3 Mobility. Since most wastes at the PUREX Plant Aggregate Area were released directly to subsurface soils via injection, infiltration, or burial, the mobility of the wastes in the subsurface will determine the potential for future exposures. The mobility of the contaminants listed in Table 4-27 varies widely and depends on site-specific factors as well as the intrinsic properties of the contaminant. Much of the site-specific information needed to characterize mobility is not available and will need to be obtained during future field investigations. However, it is possible to make general statements about the relative mobility of the candidate contaminants of concern.

4.2.4.3.1 Transport to the Subsurface. The mobility of radionuclides and other inorganic elements in groundwater depends on the chemical form and charge of the element or molecule, which in turn depends on site-related factors such as the pH, REDOX state, and ionic composition of the groundwater. Cationic species (e.g., Cd^{2+}, Pu^{4+}) generally are

retarded in their migration relative to groundwater to a greater extent than anionic species such as NO_3^-). The presence in groundwater of complexing or chelating agents can increase the mobility of metals by forming neutral or negatively charged compounds.

The chemical properties of radionuclides are essentially identical to the nonradioactive form of the element; thus, discussions of the chemical properties affecting the transport of contaminants can apply to both radionuclides and nonradioactive chemicals.

A soil-water distribution coefficient (K_d) can be used to predict mobility of inorganic chemicals in the subsurface. Table 4-33 presents a summary of soil-water distribution coefficients (K_d) that have been developed for many of the inorganic chemicals of concern at the PUREX Plant Aggregate Area. As discussed above, the pH and ionic strength of the leaching medium has an impact on the absorption of inorganics to soil; thus, the listed K_ds are valid only for a limited range of pH and waste composition. In addition, soil sorption of inorganics is highly dependent on the mineral composition of the soil, the ionic composition of the soil pore water, and other site-specific factors. Thus, a high degree of uncertainty is involved with use of K_ds that have not been verified by experimentation with site soils.

Serne and Wood (1990) recommended K_ds for use with Hanford waste assessments for a limited number of important radionuclides (Am, Cs, Co, Cu, I, Pu, Ru, Sr, and ^3H) based on soil column or batch desorption studies, and have proposed conservative average values for a more extensive list of elements based on a review of the literature. An assumed retardation of <1 is recommended for Am, Cs, Pu, and Sr under acidic conditions.

Strenge and Peterson (1989) developed default K_ds for a large number of elements for use in the Multimedia Environmental Pollution Assessment System (MEPAS) (Droppo et al. 1989), a computerized waste management unit evaluation system. The K_ds were based on findings in the scientific literature, and include non-site-specific as well as Hanford Site values. Values are provided for nine sets of environmental conditions: three ranges of waste pH and three ranges of soil adsorbent material (sum of percent clay, organic material, and metal hydrous oxides). The values presented in Table 4-33 are for conditions of neutral waste pH and less than 10% adsorbent material, which is likely to be most representative of Hanford Site soils.

The mobility of inorganic species in soil can be divided roughly into three classes, using site-specific values (Serne and Wood 1990) where available and generic values otherwise: highly mobile ($K_d < 5$), moderately mobile ($5 < K_d < 100$), and low mobility ($K_d > 100$). Table 4-34 lists the class ranking for each of the inorganic contaminants of concern.

The tendency of organic compounds to adsorb to the organic fraction of soils is indicated by the soil organic matter partition coefficient, K_{oc}. Partition coefficients for the organic chemicals of concern at the PUREX Plant Aggregate Area are listed in Table 4-35. Chemicals with low K_{oc} values are weakly absorbed by soils and will tend to migrate in the subsurface, although their rate of travel will be retarded somewhat relative to the pore water or groundwater flow. Soils at the Hanford Site have very little organic carbon content and thus sorption to the inorganic fraction of soils may dominate over sorption to soil organic matter.

4.2.4.3.2 Transport to Air. Transport between soils and air can occur either by fugitive dust emissions or volatilization. Chemicals subject to transport via airborne dust dispersion are those that are nonvolatile and persistent on the soil surface, including most radionuclides and inorganics, and some organics such as creosote and coal tar.

Chemicals subject to volatilization are mostly organic compounds; however, some of the radionuclides detected at the site are subject to evaporation and could be lost from shallow soils to the ambient air. The most important species in this category are ^{14}C, ^{3}H, and ^{129}I.

The tendency of an organic compound to volatilize can be predicted from its Henry's Law Constant, K_h, a measured or calculated parameter with units of atmospheres per cubic meter per mole of chemical. Henry's Law Constants of the organic candidate contaminants of concern are presented in Table 4-35. Compounds with a K_h greater than about 10^{-3} will be lost rapidly to the atmosphere from surface water and shallow soils. Organic contaminants of concern that fall into this class include:

- Chloroform
- Methylene chloride
- Toluene
- Tributyl phosphate
- 1,1,1-Trichloroethane.

4.2.4.4 Persistence. Once released to environmental media, the concentration of a contaminant may decrease because of biological or chemical transformation, radioactive decay, or the intermediate transfer processes discussed above that remove the chemical from the medium (e.g., volatilization to air). Radiological, chemical, and biological decay

processes affecting the persistence of the PUREX Plant Aggregate Area contaminants of concern are discussed below.

The persistence of radionuclides depends primarily on their half-lives. A comparison of the half-lives and specific activities for most radionuclide contaminants of concern for PUREX Plant Aggregate Area is presented in Table 4-36. The specific activity is the decay rate per unit mass, and is inversely proportional to the half-life of the radionuclide. Half-lives for the radionuclides listed in Table 4-36 range from seconds to over one billion years. Also listed are the decay mechanisms of primary concern for the radionuclide. Note that radionuclides often undergo several decay steps in quick succession, (e.g., an alpha decay followed by release of one or more gamma rays). The daughter products of these decays are often themselves radioactive.

Decay will occur during transport (e.g., through the vadose zone to the aquifer, through the aquifer) and may lead to significant reductions in levels discharging to the Columbia River. For direct exposures (e.g., to surface soils or air), the half-life of the radionuclide is of less importance, unless the half-life is so short that the radionuclide undergoes substantial decay between the time of disposal and release to the environment.

Nonradioactive inorganic chemicals detected at the site are generally persistent in the environment, although they may decline in concentration due to transport processes or change their chemical form due to chemical or biological reactions. Nitrate undergoes chemical and biological transformations that may lead to its loss to the atmosphere (as N_2) or incorporation into living organisms, depending on the reduction-oxidation environment and microbiological communities present in the medium.

Biotransformation rates for organics vary widely and are highly dependent on site-specific factors such as soil moisture, reduction-oxidation conditions, and the presence of nutrients and of organisms capable of degrading the compound. Ketones, such as acetone, are easily degraded by microorganisms in soil and thus would tend not to persist. Chlorinated solvents (e.g., methylene chloride) may undergo slow biotransformation in the subsurface under anoxic conditions. Volatile aromatics, such as toluene, are generally intermediate in their biodegradability.

4.2.4.5 Toxicity. Contaminants may be of potential concern for impacts to human health if they are known or suspected to have carcinogenic properties, or if they have adverse noncarcinogenic human health effects. The toxicity characteristics of the chemicals detected at the aggregate area are summarized below.

4.2.4.5.1 Radionuclides. All radionuclides are classified by EPA as known human carcinogens based on their property of emitting ionizing radiation and on the evidence

provided by epidemiological studies of radiation-induced cancers in humans. Non-carcinogenic health effects associated with radiation exposure include genetic and teratogenic effects; however, these effects generally occur at higher exposure levels than those required to induce cancer. Thus, the carcinogenic effect of radionuclides is the primary identified health concern for these chemicals.

Risks associated with radionuclides differ for various routes of exposure depending on the type of ionizing radiation emitted. Nuclides that emit alpha or beta particles are hazardous primarily if the materials are inhaled or ingested, since these particles expend their energy within a short distance after penetrating body tissues. Gamma-emitting radioisotopes, which deposit energy over much larger distances, are of concern as both external and internal hazards. A fourth mode of radioactive decay, neutron emission, is generally not of major health concern, since this mode of decay is much less frequent than other decay processes. In addition to the mode of radioactive decay, the degree of hazard from a particular radionuclide depends on the rate at which particles or gamma radiation are released from the material.

Excess cancer risks for exposure to the primary radionuclide contaminants of concern by inhaling air, drinking water, ingesting soil, and by external irradiation are shown in Table 4-37. These values represent the increase in probability of cancer to an individual exposed for a lifetime to a radionuclide at a level of 1 pCi/m^3 in air, 1 pCi/L in drinking water, 1 pCi/g in ingested soil, or to external radiation from soil having a radionuclide content of 1 pCi/g (EPA 1991).

For those radionuclides without EPA (1991) slope factors, the *Hanford Site Baseline Risk Assessment Methodology* (DOE/RL 1992b) proposes to use the dose conversion factors developed by the International Commission on Radiological Protection (ICRP) to calculate a risk value. Any Hanford site risk assessments will be performed in accordance with the *Hanford Site Baseline Risk Assessment Methodology* document (DOE/RL 1992b).

The unit risk factors for different radionuclides are roughly proportional to their specific activities, but also incorporate factors to account for distribution of each radionuclide within various body organs, the type of radiation emitted, and the length of time that the nuclide is retained in the organ of interest.

Based on the factors listed in Table 4-36, the highest risk for exposure to 1 pCi/m^3 in air is from plutonium, americium and uranium isotopes, which are alpha emitters. Among the radionuclide contaminants of concern for the PUREX Plant Aggregate Area, the highest risks from ingestion of soil at 1 pCi/g are from ^{227}Ac, ^{241}Am, ^{243}Am, ^{238}Pu, ^{244}Cm, ^{134}Cs, ^{129}I, ^{237}Np, ^{231}Pa, ^{210}Pb, ^{225}Ra, ^{226}Ra, ^{229}Th, and the uranium isotopes. The primary gamma-emitters are ^{214}Bi, ^{60}Co, ^{134}Cs, ^{137}Cs (because of its metastable decay product,

^{137m}Ba), ^{152}Eu, ^{154}Eu, ^{239}Np, and ^{214}Pb. It is important to note that this table only presents unit risk factors for the listed radionuclides and does not include potential contributions from daughter products.

The standard EPA risk assessment methodology assumes that the probability of a carcinogenic effect increases linearly with dose at low dose levels, i.e., there is no threshold for carcinogenic response. The EPA methodology also assumes that the combined effect of exposure to multiple carcinogens is additive without regard to target organ or cancer mechanism.

4.2.4.5.2 Hazardous Chemicals. Carcinogenic and non-carcinogenic health effects associated with chemicals anticipated at the aggregate area are summarized in Table 4-38.

The EPA has not derived toxicity criteria for many of the chemicals suspected of being present or detected at the PUREX Plant Aggregate Area. Many of the chemicals that lack toxicity criteria have negligible toxicity or are necessary nutrients in the human diet.

Several of the chemicals have known toxic effects but no toxicity criterion is presently available. In some instances the criteria have been withdrawn by EPA pending review of the toxicological data and will be reissued at a future date. Chemicals with known toxicity for which toxicity factors are presently not available include lead and tributyl phosphate.

4.2.4.6 Bioaccumulation potential. Contaminants may be of concern for exposure if they have a tendency to accumulate in plant or animal tissues at levels higher than those in the surrounding medium (bioaccumulation) or if their levels increase at higher trophic levels in the food chain (biomagnification). Contaminants may be bioaccumulated because of element-specific uptake mechanisms (e.g., incorporation of strontium into bone) or by passive partitioning into body tissues (e.g., concentration of organic chemicals in fatty tissues).

THIS PAGE INTENTIONALLY
LEFT BLANK

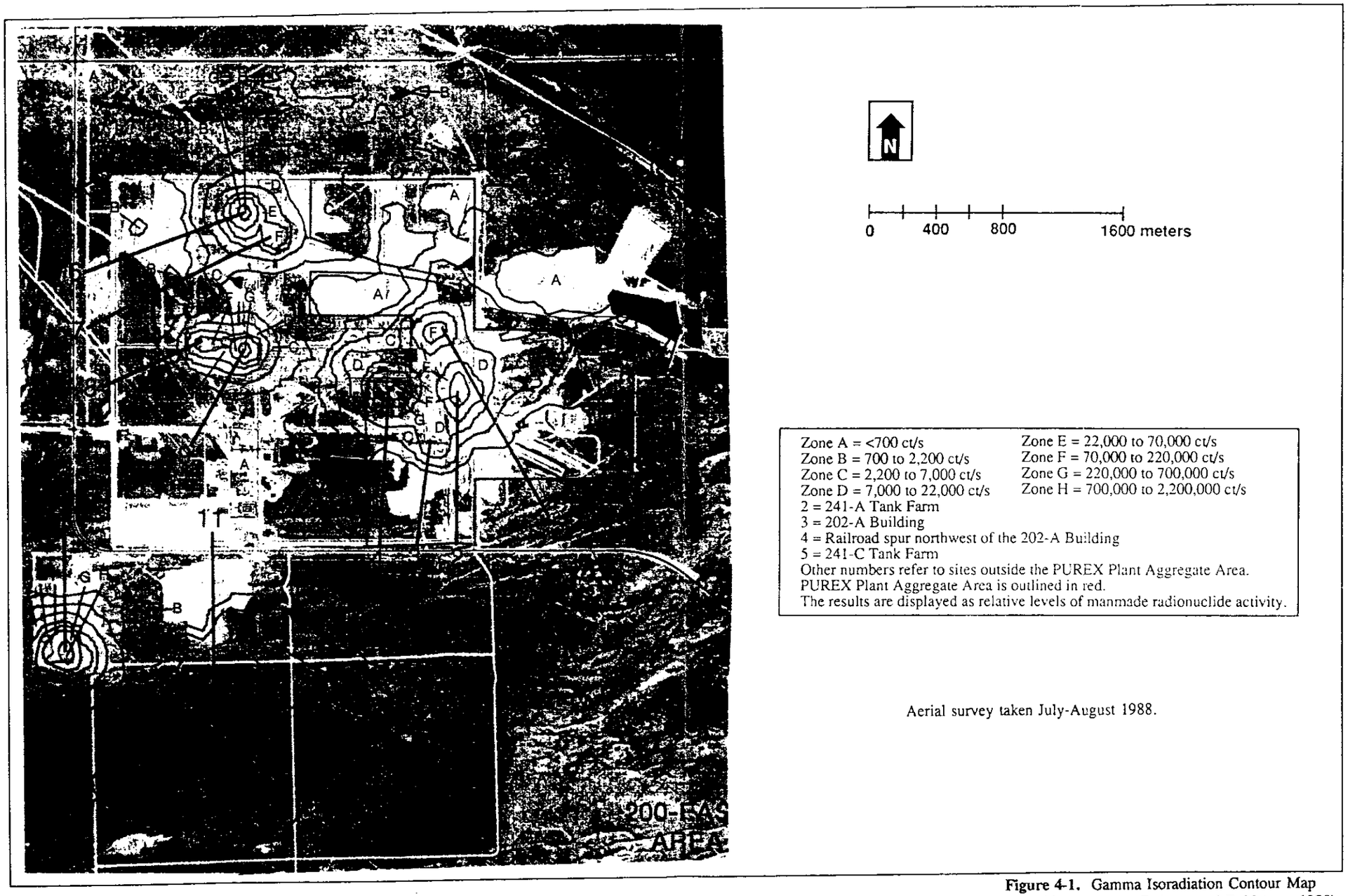


Figure 4-1. Gamma Isoradiation Contour Map of the 200 East Area. (Reiman and Dahlstrom 1988)

9 2 1 2 5 5 0 3 3 3 5

THIS PAGE INTENTIONALLY
LEFT BLANK

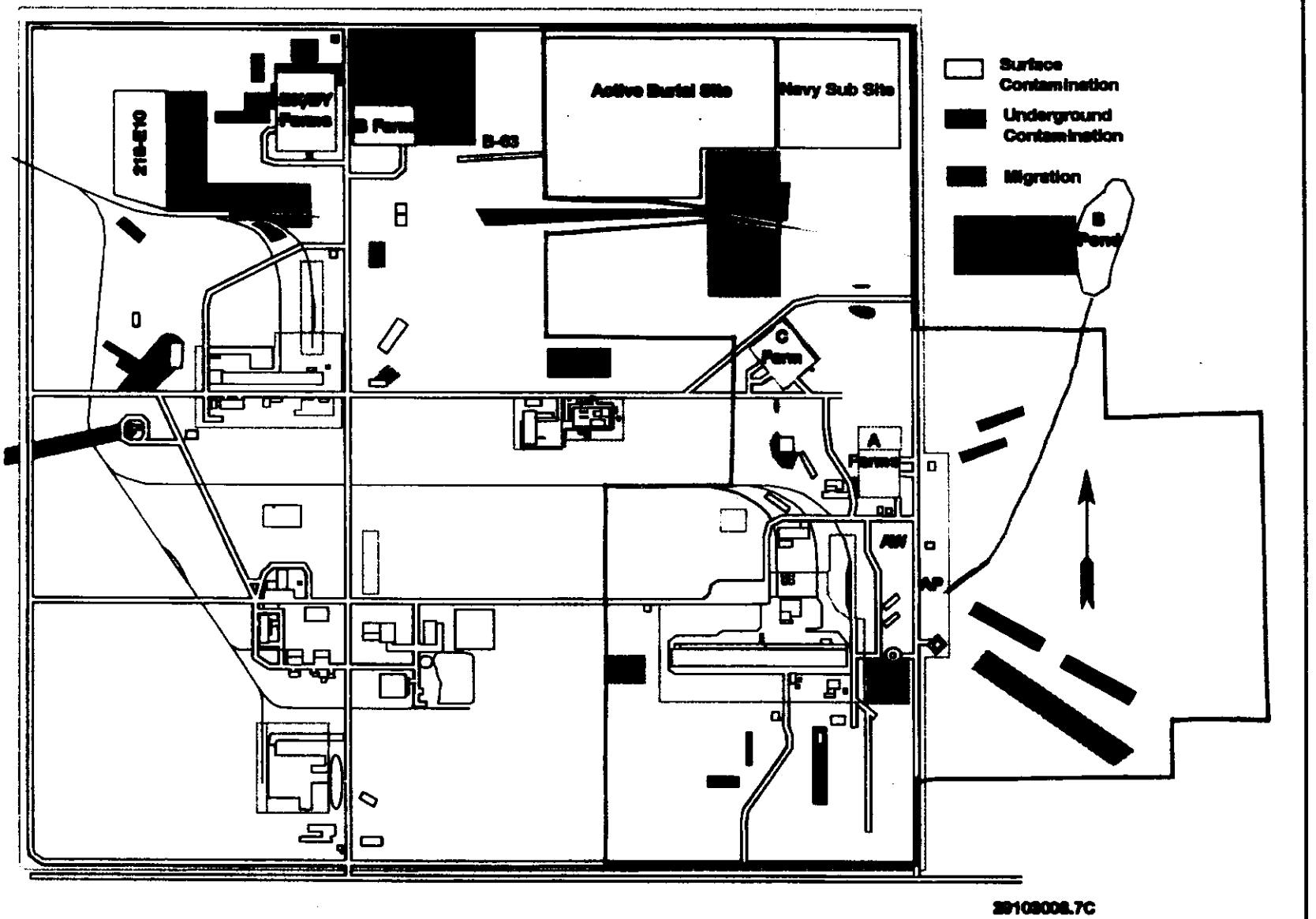


Figure 4-2. Surface, Underground and Migrating Contamination Map of the 200 East Area. (Huckfeldt 1991b)

THIS PAGE INTENTIONALLY
LEFT BLANK

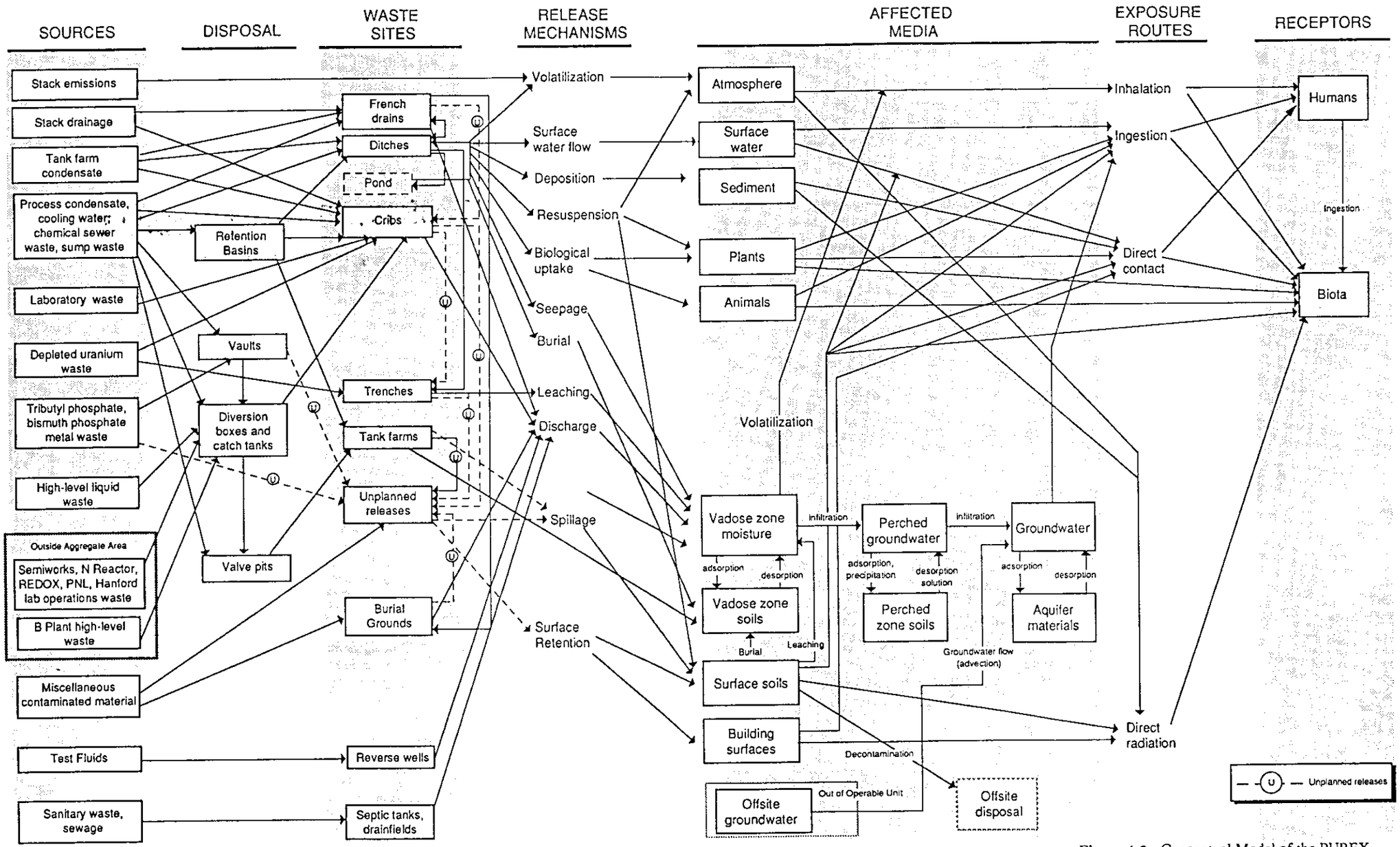


Figure 4-3. Conceptual Model of the PUREX Plant Aggregate Area.

THIS PAGE INTENTIONALLY
LEFT BLANK

Table 4-14. TRAC Inventory Data.

Total (1/1/90)	A-101 Curies	A-102 Curies	A-103 Curies	A-104 Curies	A-105 Curies	A-106 Curies	AX-101 Curies	AX-102 Curies	AX-103 Curies	AX-104 Curies
67, Y90	3E+06	7E+06	2E+04	4E+06	3E-02	5E-03	3E-06	1E-10	2E+04	9E+06
68, Zr93	7E+02	1E+02	2E+02	1E+02	5E-07	5E+02	2E+02	8E+01	9E-07	3E+02
TOTAL CURIES	6.09E+06 6.09E+06	1.47E+07 1.47E+07	1.03E+05 1.03E+05	8.04E+06 8.04E+06	7.00E+04 7.00E+04	5.24E+04 5.24E+04	2.42E+03 2.42E+03	1.11E+04 1.11E+04	8.23E+04 8.23E+04	1.83E+07 1.83E+07
TOTAL TRU	3083.204041	3748.6609	873.72023	2122.908	5.040.181	1350.801	350.10005	129.00004	29.13214	520.26423

Table 4-14. TRAC Inventory Data.

Total (1/1/90)	A-101 Moles	A-102 Moles	A-103 Moles	A-104 Moles	A-105 Moles	A-106 Moles	AX-101 Moles	AX-102 Moles	AX-103 Moles	AX-104 Moles
69. Ag	0E+00	2E-05	8E-06	8E-24	1E-06	2E-14	1E-15	2E-22	1E-06	3E-06
70. Al	2E+05	1E+06	4E+05	1E-06	7E+04	6E+05	2E+05	2E+03	1E+05	5E+04
71. Ba	5E+02	8E+01	9E+01	1E+02	2E+00	3E+02	1E+02	1E+01	4E-01	2E+02
72. Bi	2E-11	1E-11	1E-12	1E-11	6E-14	8E-12	4E-13	8E-13	7E-14	3E-13
73. C2H303	6E-39	4E+04	4E+02	0E+00	0E+00	3E-05	4E-08	5E-13	1E+03	0E+00
74. C6H507	2E-38	9E+04	3E+04	0E+00	0E+00	6E-05	5E-06	1E-13	5E+03	2E+03
75. CO3	4E-37	1E+06	1E+04	5E+05	7E+03	1E+02	8E+02	1E-11	4E+04	1E+04
76. C2O4	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00
77. Ca	1E+01	7E+01	2E+02	6E-29	2E-17	1E+02	8E+02	5E-20	3E-02	5E+03
78. Cd	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00
79. Ce	0E+00	6E+01	2E+00	3E-23	4E-05	1E-07	3E-10	2E-21	6E+00	7E-02
80. Cl	0E+00	2E-05	6E-07	4E-27	2E-09	3E-14	8E-17	2E-25	2E-06	3E-07
81. Cr	2E-04	4E+03	3E+03	5E-37	6E-19	1E+03	2E+04	1E+04	1E+02	9E+04
82. EDTA	1E-38	6E+04	6E+02	0E+00	0E+00	6E-05	8E-08	9E-13	2E+03	0E+00
83. F	1E-38	1E+04	5E+02	1E-19	3E-02	2E-05	4E-08	2E-18	1E+03	6E+03
84. Fe	2E+06	3E+05	2E+05	5E+05	5E-04	8E+05	7E+04	4E+04	2E+03	1E+05
85. Fe(CN)6	0E+00	3E+00	4E-03	2E-20	2E-02	4E-09	7E-01	7E-18	1E-01	7E+01
86. HEDTA	2E-38	1E+05	1E+03	0E+00	0E+00	1E-04	2E-07	2E-12	4E+03	0E+00
87. Hg	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00
88. K	6E-39	9E+03	6E+02	6E-16	2E+02	2E-05	8E-08	1E-14	1E+03	4E+02
89. La	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00
90. Mn	8E+03	2E+04	4E+02	1E+04	7E-01	5E+03	2E+03	9E+02	1E+03	9E+03

Table 4-14. TRAC Inventory Data.

Total (1/1/90)	A-101 Moles	A-102 Moles	A-103 Moles	A-104 Moles	A-105 Moles	A-106 Moles	AX-101 Moles	AX-102 Moles	AX-103 Moles	AX-104 Moles
91. NO2	2E-37	3E+05	9E+03	4E-14	2E+04	5E-04	1E-06	9E-13	3E+04	8E+03
92. NO3	2E+07	2E+07	5E+05	2E+07	1E+05	3E-02	8E-05	1E-10	5E+05	3E+05
93. Na	2E+07	2E+07	5E+05	2E+07	2E+05	4E+01	3E+02	2E+01	3E+05	2E+05
94. Ni	2E+03	2E+03	9E+02	7E-27	4E-31	1E+02	5E+02	5E+00	2E+02	1E+03
95. OH	6E+06	1E+06	2E+06	1E+06	2E+05	4E+06	8E+05	2E+05	1E+03	7E+05
96. PO4	6E-39	7E+03	5E+02	1E-16	2E+02	2E-05	8E-08	1E-14	8E+02	6E+02
97. Pb	3E+01	1E-01	3E+00	8E-10	8E-11	3E+00	6E+01	5E+00	1E-02	4E+02
98. SeO4	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00
99. SiO3	1E-38	1E+04	5E+02	6E-16	4E+02	2E-05	8E-08	1E-14	2E+03	3E+03
100. Sn	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00
101. SO4	5E+02	6E+05	3E+03	7E+05	4E+03	3E+02	1E+02	1E+01	8E+03	2E+03
102. Sr	6E-08	3E+02	4E-01	3E-21	0E+00	6E-08	4E-11	7E-15	9E-01	1E-01
103. WO4	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00
104. ZrO	8E+02	3E+02	2E+02	3E+02	3E-06	5E+02	4E+01	3E+01	5E-01	6E+02
105. Volume (kgal)	1E+03	3E+02	5E+02	3E+02	2E+01	1E+02	8E+02	5E+01	1E+02	6E+00

Table 4-14. TRAC Inventory Data.

Total (1/1/90)	C-101 Curies	C-102 Curies	C-103 Curies	C-104 Curies	C-105 Curies	C-106 Curies	C-107 Curies	C-108 Curies	C-109 Curies	C-110 Curies	C-111 Curies
1. Ac225	3E-07	9E-09	3E-07	2E-08	3E-07	3E-07	1E-08	6E-09	1E-08	5E-10	1E-08
2. Ac227	3E-05	1E-04	5E-05	6E-05	8E-04	3E-05	3E-05	2E-05	4E-06	2E-06	1E-05
3. Am241	5E+01	1E+03	1E+02	9E+02	1E+04	4E+02	1E+02	4E+01	1E-01	2E+01	2E+01
4. Am242	3E-02	1E+00	1E-01	1E+00	2E+01	4E-01	7E-02	3E-02	3E-06	4E-04	9E-03
5. Am242m	3E-02	1E+00	1E-01	1E+00	2E+01	4E-01	7E-02	3E-02	3E-06	4E-04	9E-03
6. Am243	1E-02	7E-01	7E-02	7E-01	1E+01	1E-01	3E-02	8E-03	6E-06	2E-04	4E-03
7. At217	3E-07	8E-09	3E-07	2E-08	3E-07	3E-07	1E-08	6E-09	1E-08	4E-10	1E-08
8. Ba135m	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00
9. Ba137m	2E+05	1E-04	1E-04	4E-05	2E+05	0E+00	8E+03	4E+00	5E+03	1E-06	4E+03
10. Bi210	9E-11	4E-10	2E-10	7E-10	2E-09	2E-10	9E-11	7E-11	1E-11	1E-10	1E-10
11. Bi211	3E-05	1E-04	5E-05	6E-05	8E-04	3E-05	3E-05	2E-05	4E-06	2E-06	1E-05
12. Bi213	4E-07	9E-09	4E-07	2E-08	3E-07	3E-07	1E-08	6E-09	1E-08	5E-10	1E-08
13. Bi214	3E-10	2E-09	9E-10	4E-09	8E-09	7E-10	4E-10	3E-10	6E-11	6E-10	4E-10
14. C14	2E+01	1E-03	5E+02	3E-05	5E+02	8E-01	3E+00	3E-01	2E+00	8E-11	8E-01
15. Cm242	2E-02	1E+00	1E-01	9E-01	1E+01	3E-01	6E-02	2E-02	2E-06	3E-04	7E-03
16. Cm244	2E-02	1E-09	9E-11	1E-11	7E+01	0E+00	7E-03	1E-07	6E-04	7E-13	5E-04
17. Cm245	4E-07	9E-14	5E-15	8E-16	4E-03	0E+00	4E-07	4E-12	2E-08	3E-17	1E-08
18. Cs135	7E-01	4E-10	3E-10	2E-10	9E-01	0E+00	3E-02	6E-05	3E-02	6E-12	2E-02
19. Cs137	2E+05	1E-04	1E-04	4E-05	3E+05	0E+00	8E+03	4E+00	5E+03	1E-06	4E+03
20. Fr221	3E-07	9E-09	3E-07	2E-08	3E-07	3E-07	1E-08	6E-09	1E-08	5E-10	1E-08
21. Fr223	4E-07	2E-06	7E-07	9E-07	1E-05	4E-07	5E-07	2E-07	6E-08	3E-08	2E-07
22. I129	7E-02	5E-11	4E-11	1E-11	2E+00	0E+00	3E-03	2E-06	2E-03	5E-13	2E-03
23. Nb93m	6E+00	5E+01	8E+00	1E+01	3E+02	4E+01	8E+00	5E+00	2E-01	7E-01	3E+00
24. Ni59	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00

Table 4-14. TRAC Inventory Data.

Total (1/1/90)	C-101 Curies	C-102 Curies	C-103 Curies	C-104 Curies	C-105 Curies	C-106 Curies	C-107 Curies	C-108 Curies	C-109 Curies	C-110 Curies	C-111 Curies
25. Ni63	1E+02	3E+03	9E+03	7E+02	5E+04	8E+02	9E+00	5E+02	6E+02	5E-10	5E+02
26. Np237	2E-01	7E-03	9E-04	5E-03	8E-02	2E-03	8E-03	3E-04	6E-03	1E-04	5E-03
27. Np239	1E-02	6E-01	6E-02	7E-01	9E+00	1E-01	3E-02	7E-03	6E-06	2E-04	4E-03
28. Pa231	7E-05	4E-04	2E-04	2E-04	1E-03	7E-05	9E-05	4E-05	9E-06	5E-06	3E-05
29. Pa233	2E-01	7E-03	1E-03	5E-03	8E-02	2E-03	8E-03	3E-04	6E-03	1E-04	5E-03
30. Pa234m	2E+00	2E+01	7E+00	9E+00	1E+01	3E+00	4E+00	1E+00	2E-01	1E-01	1E+00
31. Pb209	3E-07	9E-09	3E-07	2E-08	3E-07	3E-07	1E-08	6E-09	1E-08	5E-10	1E-08
32. Pb210	8E-11	4E-10	2E-10	7E-10	2E-09	2E-10	8E-11	7E-11	1E-11	1E-10	9E-11
33. Pb211	3E-05	1E-04	5E-05	6E-05	8E-04	3E-05	3E-05	2E-05	4E-06	2E-06	1E-05
34. Pb214	3E-10	2E-09	9E-10	4E-09	9E-09	8E-10	4E-10	3E-10	6E-11	6E-10	4E-10
35. Pd107	1E-01	1E-10	5E-11	3E-11	4E+00	0E+00	6E-03	3E-06	4E-03	6E-13	3E-03
36. Po210	8E-11	4E-10	2E-10	6E-10	2E-09	2E-10	8E-11	7E-11	1E-11	1E-10	9E-11
37. Po213	3E-07	8E-09	3E-07	2E-08	3E-07	3E-07	1E-08	6E-09	1E-08	4E-10	1E-08
38. Po214	4E-10	3E-09	1E-09	5E-09	1E-08	9E-10	5E-10	3E-10	7E-11	8E-10	5E-10
39. Po215	3E-05	1E-04	5E-05	6E-05	8E-04	3E-05	3E-05	2E-05	4E-06	2E-06	1E-05
40. Po218	3E-10	2E-09	9E-10	4E-09	9E-09	8E-10	4E-10	3E-10	6E-11	6E-10	4E-10
41. Pu238	2E+00	5E+01	9E+00	5E+01	6E+01	7E+00	4E+00	2E+00	1E-01	1E+01	3E+00
42. Pu239	1E+02	2E+03	3E+02	7E+02	1E+03	3E+02	3E+02	9E+01	1E+00	1E+02	7E+01
43. Pu240	3E+01	5E+02	8E+01	2E+02	3E+02	7E+01	6E+01	2E+01	8E-02	3E+01	1E+01
44. Pu241	3E+02	7E+03	1E+03	3E+03	3E+03	7E+02	6E+02	2E+02	1E-01	2E+02	1E+02
45. Ra223	3E-05	1E-04	5E-05	6E-05	8E-04	3E-05	3E-05	2E-05	4E-06	2E-06	1E-05
46. Ra225	3E-07	9E-09	4E-07	2E-08	3E-07	3E-07	1E-08	6E-09	1E-08	5E-10	1E-08
47. Ra226	3E-10	2E-09	9E-10	4E-09	9E-09	8E-10	4E-10	3E-10	6E-11	6E-10	4E-10
48. Ru106	2E-03	1E+00	1E-01	2E+00	3E+00	4E-02	4E-03	1E-03	4E-08	5E-09	3E-05

Table 4-14. TRAC Inventory Data.

Total (1/1/90)	C-101 Curies	C-102 Curies	C-103 Curies	C-104 Curies	C-105 Curies	C-106 Curies	C-107 Curies	C-108 Curies	C-109 Curies	C-110 Curies	C-111 Curies
49. Sb126	1E+00	1E+01	2E+00	3E+00	6E+01	1E+01	3E+00	9E-01	4E-02	1E-01	6E-01
50. Sb126m	1E+00	1E+01	2E+00	3E+00	6E+01	1E+01	3E+00	9E-01	4E-02	1E-01	6E-01
51. Se79	1E+00	8E-10	6E-10	4E-10	3E+01	0E+00	6E-02	4E-05	4E-02	1E-11	3E-02
52. Sm151	2E+03	1E+04	2E+03	4E+03	7E+04	1E+04	3E+03	2E+03	1E+02	3E+02	1E+03
53. Sn126	1E+00	1E+01	2E+00	3E+00	6E+01	1E+01	3E+00	9E-01	4E-02	1E-01	6E-01
54. Sr90	7E+04	1E+06	4E+05	4E+05	3E+06	5E+05	9E+04	2E+04	7E+01	1E+04	9E+04
55. Tc99	5E+01	3E-08	3E-08	8E-09	1E+03	0E+00	2E+00	1E-03	1E+00	3E-10	1E+00
56. Th227	3E-05	1E-04	5E-05	6E-05	8E-04	3E-05	3E-05	1E-05	4E-06	2E-06	1E-05
57. Th229	3E-07	9E-09	3E-07	2E-08	3E-07	3E-07	1E-08	6E-09	1E-08	4E-10	1E-08
58. Th230	6E-08	7E-07	2E-07	9E-07	1E-06	1E-07	1E-07	5E-08	1E-08	1E-07	7E-08
59. Th231	8E-02	6E-01	3E-01	4E-01	6E-01	1E-01	1E-01	6E-02	1E-02	6E-03	4E-02
60. Th233	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00
61. Th234	2E+00	2E+01	7E+00	9E+00	1E+01	3E+00	4E+00	1E+00	2E-01	1E-01	1E+00
62. Tl207	3E-05	1E-04	5E-05	6E-05	8E-04	3E-05	3E-05	2E-05	4E-06	2E-06	1E-05
63. U233	2E-04	3E-06	2E-04	1E-05	1E-04	1E-04	4E-06	2E-06	6E-06	2E-08	4E-06
64. U234	4E-04	5E-03	2E-03	7E-03	7E-03	8E-04	7E-04	3E-04	5E-05	8E-04	4E-04
65. U235	8E-02	6E-01	3E-01	4E-01	6E-01	1E-01	1E-01	6E-02	1E-02	6E-03	4E-02
66. U238	2E+00	2E+01	7E+00	9E+00	1E+01	3E+00	4E+00	1E+00	2E-01	1E-01	1E+00
67. Y90	7E+04	1E+06	4E+05	4E+05	3E+06	5E+05	9E+04	2E+04	7E+01	1E+04	9E+04
68. Zr93	7E+00	7E+01	1E+01	2E+01	4E+02	6E+01	1E+01	6E+00	3E-01	8E-01	4E+00
TOTAL CURIES	5.44E+05 5.44E+05	2.02E+06 2.02E+06	8.13E+05 8.13E+05	8.10E+05 8.10E+05	6.64E+06 6.64E+06	1.01E+06 1.01E+06	1.90E+05 1.90E+05	4.29E+04 4.29E+04	1.09E+04 1.09E+04	2.07E+04 2.07E+04	1.90E+05 1.90E+05
TOTAL TRU	172.39049	3054.3082	909.431	1654.3052	11429.377	709.10206	427.27387	132.39735	3.1061196	130.0016	93.788321

Table 4-14. TRAC Inventory Data.

Total (1/1/90)	C-101 Moles	C-102 Moles	C-103 Moles	C-104 Moles	C-105 Moles	C-106 Moles	C-107 Moles	C-108 Moles	C-109 Moles	C-110 Moles	C-111 Moles
69. Ag	7E-06	5E-15	3E-15	2E-15	1E-04	0E+00	3E-07	2E-10	2E-07	4E-17	2E-07
70. Al	1E+06	7E+06	5E+06	6E+06	1E+07	7E+05	2E+06	5E+05	5E+04	8E+02	4E+05
71. Ba	1E+02	3E+00	1E+02	8E+00	3E+02	1E+02	2E+00	3E+00	4E+00	6E-01	4E+00
72. Bi	8E-12	3E-13	8E-12	1E-12	1E-11	7E-12	7E+04	1E+04	1E+03	7E+04	7E+03
73. C2H3O3	0E+00	0E+00	2E-05	5E-06	6E+02	0E+00	1E+03	0E+00	0E+00	0E+00	0E+00
74. C6H5O7	0E+00	0E+00	1E-06	1E-06	6E+05	0E+00	1E+02	0E+00	0E+00	0E+00	0E+00
75. C03	3E+04	4E+03	1E+06	1E-01	8E+04	4E+04	5E+04	4E+04	1E+05	4E-05	5E+04
76. C204	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00
77. Ca	0E+00	5E-22	5E-02	1E-01	1E+03	0E+00	3E-05	3E+04	1E+05	4E-14	3E+04
78. Cd	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00
79. Ce	6E-03	3E-16	7E-09	9E-15	3E-04	6E-39	6E-01	1E-02	2E+00	1E-08	1E+00
80. Cl	3E-07	3E-22	1E-14	6E-19	3E-09	0E+00	2E-06	4E-08	6E-06	1E-14	3E-06
81. Cr	1E-16	5E-31	3E-08	2E+01	6E+03	0E+00	9E+03	1E+03	2E+02	1E+04	1E+03
82. EDTA	0E+00	0E+00	2E-05	5E-06	9E+02	0E+00	1E+03	0E+00	0E+00	0E+00	0E+00
83. F	5E+00	3E+06	1E+07	9E-12	3E+01	0E+00	6E+02	1E+01	3E+03	4E-05	9E+02
84. Fe	8E-02	5E-02	1E+02	2E+01	8E+05	1E+05	1E+05	2E+04	3E+03	2E+05	2E+04
85. Fe(CN)6	4E+00	1E-16	7E-12	9E-12	7E+01	0E+00	5E-04	9E+03	3E+04	1E-08	1E+04
86. HEDTA	0E+00	0E+00	3E-05	1E-05	2E+03	0E+00	3E+03	0E+00	0E+00	0E+00	0E+00
87. Hg	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00
88. K	0E+00	0E+00	1E-07	8E-08	5E+03	1E-39	1E+01	1E-36	3E+00	2E-08	0E+00
89. La	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00
90. Mn	0E+00	2E+04	3E+03	8E+04	7E+03	9E+03	3E+02	0E+00	0E+00	0E+00	0E+00

Table 4-14. TRAC Inventory Data.

Total (1/1/90)	C-101 Moles	C-102 Moles	C-103 Moles	C-104 Moles	C-105 Moles	C-106 Moles	C-107 Moles	C-108 Moles	C-109 Moles	C-110 Moles	C-111 Moles
91. NO2	9E+03	1E-03	5E-04	1E-05	2E+03	5E-38	4E+04	2E+01	7E+04	1E-05	5E+04
92. NO3	4E+06	5E-03	6E+07	5E+06	2E+07	3E+06	5E+05	4E+06	4E+05	2E-04	3E+05
93. Na	4E+06	3E+06	8E+07	5E+06	2E+07	3E+06	5E+05	4E+06	4E+05	8E+01	3E+05
94. Ni	5E-02	4E-04	2E+04	3E+00	3E+04	1E-20	4E-07	2E+04	6E+04	2E-11	3E+04
95. OH	3E+06	3E+07	2E+07	2E+07	3E+07	3E+06	8E+06	2E+06	1E+04	6E+05	1E+06
96. PO4	2E+02	6E-13	9E+04	4E-08	4E+03	0E+00	6E+04	1E+04	5E+03	7E+04	9E+03
97. Pb	9E-10	2E-09	2E+04	5E-06	1E+02	6E-10	1E-08	4E-10	1E-10	6E-11	3E-10
98. SeO4	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00
99. SiO3	2E+02	1E-05	2E-05	2E-07	4E+01	1E-39	1E+03	2E+00	2E+03	1E-06	1E+03
100. Sn	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00
101. SO4	1E+04	3E+00	1E+06	8E+00	3E+03	1E+02	8E+03	3E+01	5E+03	6E-01	2E+03
102. Sr	0E+00	0E+00	7E-12	1E-07	2E+00	7E-09	4E-04	0E+00	1E+01	8E-08	0E+00
103. WO4	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00
104. ZrO	1E+01	3E+06	3E+05	5E+01	4E+02	8E+01	2E+04	3E+03	4E+02	2E+04	2E+03
105. Volume (kgal)	8E+01	5E+02	9E+02	3E+02	3E+02	3E+02	3E+02	7E+01	6E+01	2E+02	6E+01

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
Plants, Buildings, and Storage Areas						
204-AR Waste Unloading Station						
241-A-431 Ventilation Building						
241-C-801 Support Facility						
242-A Evaporator						
Grout Treatment Facility						
244-AR Lift Station		s				
Tanks and Vaults						
241-A-101 Single-Shell Tank						Tank status is sound
241-A-102 Single-Shell Tank						Tank status is sound
241-A-103 Single-Shell Tank		s			s	Assumed leaker
241-A-104 Single-Shell Tank		s			s	Assumed leaker
241-A-105 Single-Shell Tank		s			s	Assumed leaker
241-A-106 Single-Shell Tank						Tank status is sound
241-AN-101 Double-Shell Tank						Tank status is sound
241-AN-102 Double-Shell Tank						Tank status is sound
241-AN-103 Double-Shell Tank						Tank status is sound
241-AN-104 Double-Shell Tank						Tank status is sound
241-AN-105 Double-Shell Tank						Tank status is sound
241-AN-106 Double-Shell Tank						Tank status is sound
241-AN-107 Double-Shell Tank						Tank status is sound
241-AP-101 Double-Shell Tank						Tank status is sound
241-AP-102 Double-Shell Tank						Tank status is sound
241-AP-103 Double-Shell Tank						Tank status is sound
241-AP-104 Double-Shell Tank						Tank status is sound
241-AP-105 Double-Shell Tank						Tank status is sound
241-AP-106 Double-Shell Tank						Tank status is sound
241-AP-107 Double-Shell Tank						Tank status is sound
241-AP-108 Double-Shell Tank						Tank status is sound
241-AW-101 Double-Shell Tank						Tank status is sound
241-AW-102 Double-Shell Tank						Tank status is sound
241-AW-103 Double-Shell Tank						Tank status is sound
241-AW-104 Double-Shell Tank						Tank status is sound

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
241-AW-105 Double-Shell Tank						Tank status is sound
241-AW-106 Double-Shell Tank						Tank status is sound
241-AX-101 Single-Shell Tank						Tank status is sound
241-AX-102 Single-Shell Tank		s			s	Assumed leaker
241-AX-103 Single-Shell Tank						Tank status is sound; UPR-200-E-115
241-AX-104 Single-Shell Tank		s			s	Assumed leaker
241-AY-101 Double-Shell Tank						Tank status is sound
241-AY-102 Double-Shell Tank						Tank status is sound
241-AZ-101 Double-Shell Tank						Tank status is sound
241-AZ-102 Double-Shell Tank						Tank status is sound
241-C-101 Single-Shell Tank		s			s	Assumed leaker
241-C-102 Single-Shell Tank						Tank status is sound
241-C-103 Single-Shell Tank						Tank status is sound
241-C-104 Single-Shell Tank						Tank status is sound
241-C-105 Single-Shell Tank						Tank status is sound
241-C-106 Single-Shell Tank						Tank status is sound
241-C-107 Single-Shell Tank						Tank status is sound
241-C-108 Single-Shell Tank						Tank status is sound
241-C-109 Single-Shell Tank						Tank status is sound
241-C-110 Single-Shell Tank		s			s	Assumed leaker
241-C-111 Single-Shell Tank		s			s	Assumed leaker
241-C-112 Single-Shell Tank						Tank status is sound
241-C-201 Single-Shell Tank		s			s	Assumed leaker
241-C-202 Single-Shell Tank		s			s	Assumed leaker
241-C-203 Single-Shell Tank		s			s	Assumed leaker
241-C-204 Single-Shell Tank		s			s	Assumed leaker
241-A-302A Catch Tank						
241-A-302B Catch Tank						
241-A-350 Catch Tank						
241-A-417 Catch Tank						
241-AX-152CT Catch Tank						
241-C-301C Catch Tank						
244-A Receiving Vault						

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
244-AR Vault		s, r?			s, r?	UPR-200-E-59
244-CR Vault						
Cribs and Drains						
216-A-1 Crib		k			s	
216-A-2 Crib		s			s	
216-A-3 Crib		s			s	
216-A-4 Crib		s, r?			s, r?	Known release in 1958; UN-200-E-13
216-A-5 Crib		s			s	
216-A-6 Crib		k			k	UPR-200-E-21; UPR-200-E-29
216-A-7 Crib		k			k	
216-A-8 Crib		s			s	
216-A-9 Crib		s			s	
216-A-10 Crib		s			s	
216-A-21 Crib		k			k	
216-A-24 Crib		s			s	UN-200-E-56
216-A-27 Crib		s			s	
216-A-30 Crib		s, r?			s, r?	
216-A-31 Crib		s			s	
216-A-32 Crib		s			s	
216-A-36A Crib		s			s	
216-A-36B Crib		k			k	
216-A-37-1 Crib		s			s	
216-A-37-2 Crib		s			s	
216-A-38-1 Crib		s			s	
216-A-39 Crib		s			s	
216-A-41 Crib		s			s	
216-A-45 Crib		s			s	
216-A-11 French Drain		s			s	
216-A-12 French Drain		s			s	
216-A-13 French Drain		s			s	
216-A-14 French Drain		s			s	
216-A-15 French Drain		s			s	
216-A-16 French Drain						

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
216-A-17 French Drain						
216-A-22 French Drain		s			s	UPR-216-E-17
216-A-23A French Drain						
216-A-23B French Drain						
216-A-26 French Drain		s			s	
216-A-26A French Drain		s			s	
216-A-28 French Drain		s			s	
216-A-33 French Drain		s			s	
216-A-35 French Drain		s			s	
216-C-8 French Drain		k			k	Cave in potential
Reverse Wells						
299-E24-111 Injection Well						No reported release
Ponds, Trenches, and Ditches						
216-A-18 Trench		s			s	
216-A-19 Trench						
216-A-20 Trench		s			s	
216-A-40 Trench		s			s	UPR-200-E-59
216-A-29 Ditch		k	s	k	k	
216-A-34 Ditch		s			s	
Septic Tanks and Drain Fields						
2607-EA Septic Tank & Field						No reported release
2607-EC Septic Tank & Field						No reported release
2607-ED Septic Tank & Field						No reported release
2607-EG Septic Tank & Field						No reported release
2607-EJ Septic Tank & Field						No reported release
2607-EL Septic Tank & Field						No reported release
2607-E6 Septic Tank & Field						No reported release
Transfer Facilities, Diversion Boxes, and Pipelines						
241-A-A Diversion Box						
241-A-B Diversion Box						
241-A-151 Diversion Box		s			s	UN-200-E-26; UN-200-E-65
241-A-152 Diversion Box						
241-A-153 Diversion Box						

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
241-AN-A Diversion Box						
241-AN-B Diversion Box						
241-AR-151 Diversion Box						
241-AW-A Diversion Box						
241-AW-B Diversion Box						
241-AX-A Diversion Box						
241-AX-B Diversion Box						
241-AX-151 Diversion Box						
241-AX-152DS Diversion Box						
241-AX-155 Diversion Box						
241-AY-151 Diversion Box						
241-AY-152 Diversion Box						
241-AZ-151DS Diversion Box						
241-AZ-152 Diversion Box	s	s				
241-C-151 Diversion Box						
241-C-152 Diversion Box						
241-C-153 Diversion Box						
241-C-252 Diversion Box						
241-CR-151 Diversion Box						
241-CR-152 Diversion Box						
241-CR-153 Diversion Box						
241-ER-153 Diversion Box						
216-A-524 Control Structure	s	s			s	
241-AP Valve Pit						
241-AX-501 Valve Pit						
Retention Basins						
207-A Retention Basins		s			s	
216-A-42 Retention Basin		s	s		s	UPR-200-E-66
Burial Sites						
218-E-1 Burial Ground		s, r?			s, r?	UPR-200-E-53
218-E-8 Burial Ground		s		k	s	
218-E-12A Burial Ground		s, r?			s, r?	UPR-200-E-24; UPR-200-E-30
218-E-12B Burial Ground						

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
218-E-13 Burial Ground						
200-E Burning Pit						UPR-200-E-62; UPR-200-E-106
Unplanned Releases						
UN-200-E-10		s, r?			s, r?	
UN-200-E-11		s, r?			s, r?	
UN-200-E-12		s			s	
UN-200-E-13		r				
UN-200-E-15		s			s	
UN-200-E-16		s			s	
UN-200-E-18		s			s	
UN-200-E-19		s			s	
UN-200-E-20		s			s	
UN-200-E-22		s			s	
UN-200-E-25		s			s	
UN-200-E-26		s			s	
UN-200-E-27		s			s	
UN-200-E-28		s			s	
UN-200-E-31		s			s	
UN-200-E-33		r				
UN-200-E-35		s			s	
UN-200-E-39		s			s	
UN-200-E-40		s			s	
UN-200-E-42						
UN-200-E-47		r				
UN-200-E-48		r				
UN-200-E-49		r				
UN-200-E-56		s			s	
UN-200-E-58		r				
UN-200-E-60		r				
UN-200-E-62		r				
UN-200-E-65		r				
UN-200-E-67		r				
UN-200-E-68		r?				

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
UN-200-E-72						
UN-200-E-81		s			s	
UN-200-E-82		r				
UN-200-E-86		s			s	
UN-200-E-88		s			s	
UN-200-E-91		r				
UN-200-E-94						
UN-200-E-96		s, r			s	
UN-200-E-97		r?				
UN-200-E-99		r				
UN-200-E-100		s			s	
UN-200-E-107		s			s	
UN-200-E-114						
UN-200-E-117		s			s	
UN-200-E-118						
UN-200-E-142						
UPR-200-E-17		s			s	
UPR-200-E-21		s			s	
UPR-200-E-24		s			s	
UPR-200-E-29		s			s	
UPR-200-E-30		r?				
UPR-200-E-50		s			s	
UPR-200-E-53		s			s	
UPR-200-E-59		r				
UPR-200-E-66		r				
UPR-200-E-70		r				
UPR-200-E-106		s			s	
UPR-200-E-115		s			s	
UPR-200-E-119		s			s	
UPR-200-E-125		s			s	

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
UPR-200-E-126		s			s	
UPR-200-E-136		s			s	
UPR-200-E-137						

s = Suspected contamination, primarily based on WIDS (WHC 1991a) and other inventory data.

k = Known contamination, primarily based on chemical analytical data, WIDS (WHC 1991a) or other sources.

r = Complete remediation reported.

r? = Remediation attempted, effectiveness not determined.

Table 4-2. Summary of Chemical Contamination in Various Affected Media for PUREX Plant Aggregate Area.

Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
Plants, Buildings, and Storage Areas						
204-AR Waste Unloading Station						
241-A-431 Ventilation Building						
241-C-801 Support Facility						
242-A Evaporator						
Grout Treatment Facility						
244-AR Lift Station		s				
Tanks and Vaults						
241-A-101 Single-Shell Tank						
241-A-102 Single-Shell Tank						
241-A-103 Single-Shell Tank		s			s	
241-A-104 Single-Shell Tank		s			s	Associated with UPR-200-E-125
241-A-105 Single-Shell Tank		s			s	Associated with UPR-200-E-126
241-A-106 Single-Shell Tank						
241-AN-101 Double-Shell Tank						
241-AN-102 Double-Shell Tank						
241-AN-103 Double-Shell Tank						
241-AN-104 Double-Shell Tank						
241-AN-105 Double-Shell Tank						
241-AN-106 Double-Shell Tank						
241-AN-107 Double-Shell Tank						
241-AP-101 Double-Shell Tank						
241-AP-102 Double-Shell Tank						
241-AP-103 Double-Shell Tank						
241-AP-104 Double-Shell Tank						
241-AP-105 Double-Shell Tank						
241-AP-106 Double-Shell Tank						
241-AP-107 Double-Shell Tank						
241-AP-108 Double-Shell Tank						
241-AW-101 Double-Shell Tank						

Table 4-2. Summary of Chemical Contamination in Various Affected Media for PUREX Plant Aggregate Area.

Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
241-AW-102 Double-Shell Tank						
241-AW-103 Double-Shell Tank						
241-AW-104 Double-Shell Tank						
241-AW-105 Double-Shell Tank						
241-AW-106 Double-Shell Tank						
241-AX-101 Single-Shell Tank						
241-AX-102 Single-Shell Tank		s			s	
241-AX-103 Single-Shell Tank						UPR-200-E-115
241-AX-104 Single-Shell Tank		s			s	
241-AY-101 Double-Shell Tank						
241-AY-102 Double-Shell Tank						
241-AZ-101 Double-Shell Tank						
241-AZ-102 Double-Shell Tank						
241-C-101 Single-Shell Tank		s			s	UPR-200-E-136
241-C-102 Single-Shell Tank						
241-C-103 Single-Shell Tank						
241-C-104 Single-Shell Tank						
241-C-105 Single-Shell Tank						
241-C-106 Single-Shell Tank						
241-C-107 Single-Shell Tank						
241-C-108 Single-Shell Tank						
241-C-109 Single-Shell Tank						
241-C-110 Single-Shell Tank		s			s	
241-C-111 Single-Shell Tank		s			s	
241-C-112 Single-Shell Tank						
241-C-201 Single-Shell Tank		s			s	
241-C-202 Single-Shell Tank		s			s	
241-C-203 Single-Shell Tank		s			s	UPR-200-E-137
241-C-204 Single-Shell Tank		s			s	
241-A-302A Catch Tank						

Table 4-2. Summary of Chemical Contamination in Various Affected Media for PUREX Plant Aggregate Area.

Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
241-A-302B Catch Tank						
241-A-350 Catch Tank						
241-A-417 Catch Tank						
241-AX-152CT Catch Tank						Scheduled for deletion, duplicate of 241-AX-152DS
241-C-301C Catch Tank						
244-A Receiving Vault						
244-AR Vault						UPR-200-E-59
244-CR Vault						
Cribs and Drains						
216-A-1 Crib		k			k	
216-A-2 Crib		s			s	
216-A-3 Crib		s			s	
216-A-4 Crib		s, r?			s, r?	Known release in December 1958; UN-200-E-13
216-A-5 Crib		s			s	
216-A-6 Crib		k, r?			k, r?	UPR-200-E-21; UPR-200-E-29
216-A-7 Crib		k			k	
216-A-8 Crib		s			s	
216-A-9 Crib		k			k	
216-A-10 Crib		s			s	
216-A-21 Crib		k			k	
216-A-24 Crib		s			s	UN-200-E-56
216-A-27 Crib		s			s	
216-A-30 Crib		s			s	
216-A-31 Crib		s			s	
216-A-32 Crib		s			s	
216-A-36A Crib		s			s	
216-A-36B Crib		s			s	
216-A-37-1 Crib		s			s	
216-A-37-2 Crib		s			s	
216-A-38-1 Crib		s			s	

Table 4-2. Summary of Chemical Contamination in Various Affected Media for PUREX Plant Aggregate Area.

Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
216-A-39 Crib		s			s	
216-A-41 Crib		s			s	
216-A-45 Crib		s			s	
216-A-11 French Drain		s			s	
216-A-12 French Drain		s			s	
216-A-13 French Drain		s			s	
216-A-14 French Drain		s			s	
216-A-15 French Drain		s			s	
216-A-16 French Drain		s			s	
216-A-17 French Drain		s			s	
216-A-22 French Drain		s			s	UPR-216-E-17
216-A-23A French Drain		s			s	
216-A-23B French Drain		s			s	
216-A-26 French Drain		s			s	
216-A-26A French Drain		s			s	
216-A-28 French Drain		s			s	
216-A-33 French Drain		s			s	
216-A-35 French Drain		s			s	
216-C-8 French Drain		k			k	
Reverse Wells						
299-E24-111 Injection Well						
Ponds, Ditches, and Trenches						
216-A-18 Trench		s			s	
216-A-19 Trench		s			s	
216-A-20 Trench		s			s	
216-A-40 Trench		k			k	UPR-200-E-59
216-A-29 Ditch		s			s	Several known releases including hydrazine
216-A-34 Ditch		s			s	
Septic Tanks and Associated Drain Fields						
2607-EA Septic Tank & Field						No reported release of contaminants

Table 4-2. Summary of Chemical Contamination in Various Affected Media for PUREX Plant Aggregate Area.

Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
2607-EC Septic Tank & Field						No reported release of contaminants
2607-ED Septic Tank & Field						No reported release of contaminants
2607-EG Septic Tank & Field						No reported release of contaminants
2607-EJ Septic Tank & Field						No reported release of contaminants
2607-EL Septic Tank & Field						No reported release of contaminants
2607-E6 Septic Tank & Field						No reported release of contaminants
Transfer Facilities, Diversion Boxes, and Pipelines						
241-A-A Diversion Box						
241-A-B Diversion Box						
241-A-151 Diversion Box		s			s	UN-200-E-26; UN-200-E-65
241-A-152 Diversion Box						
241-A-153 Diversion Box						
241-AN-A Diversion Box						
241-AN-B Diversion Box						
241-AR-151 Diversion Box						
241-AW-A Diversion Box						
241-AW-B Diversion Box						
241-AX-A Diversion Box						
241-AX-B Diversion Box						
241-AX-151 Diversion Box						
241-AX-152DS Diversion Box						
241-AX-155 Diversion Box						
241-AY-151 Diversion Box						
241-AY-152 Diversion Box						
241-AZ-151DS Diversion Box						
241-AZ-152 Diversion Box						
241-C-151 Diversion Box	s	s				
241-C-152 Diversion Box						
241-C-153 Diversion Box						
241-C-252 Diversion Box						

Table 4-2. Summary of Chemical Contamination in Various Affected Media for PUREX Plant Aggregate Area.

Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
241-CR-151 Diversion Box						
241-CR-152 Diversion Box						
241-CR-153 Diversion Box						
241-ER-153 Diversion Box						
216-A-524 Control Structure						
241-AP Valve Pit						
241-AX-501 Valve Pit						
Basins						
207-A Retention Basins						
216-A-42 Retention Basin		s			s	UPR-200-E-66
Burial Sites and Burning Pits						
218-E-1 Burial Ground		s		k	s	UPR-200-E-53
218-E-8 Burial Ground		s			s	
218-E-12A Burial Ground		k			k	UPR-200-E-24; UPR-200-E-30
218-E-12B Burial Ground		s			s	
218-E-13 Burial Ground		s			s	
200-E Burning Pit						UPR-200-E-62; UPR-200-E-106
Unplanned Releases						
UN-200-E-10		r?			r?	
UN-200-E-11		r?			r?	
UN-200-E-12		s			s	
UN-200-E-13		r?			r?	
UN-200-E-15		s			s	
UN-200-E-16		s			s	
UN-200-E-18		s			s	
UN-200-E-19		s			s	
UN-200-E-20		s			s	
UN-200-E-22		s			s	
UN-200-E-25		s			s	
UN-200-E-26		k			k	

Table 4-2. Summary of Chemical Contamination in Various Affected Media for PUREX Plant Aggregate Area.

Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
UN-200-E-27		k			k	
UN-200-E-28		s			s	
UN-200-E-31		k			k	
UN-200-E-33		s,r			s,r	
UN-200-E-35						Scheduled for deletion, duplicate of 218-E-13
UN-200-E-39		s			s	
UN-200-E-40		k			k	
UN-200-E-42		k			k	
UN-200-E-47		k			k	
UN-200-E-48		k			k	
UN-200-E-49		k			k	
UN-200-E-56		k			k	
UN-200-E-58		s,r?		s	s,r?	
UN-200-E-60						
UN-200-E-62						
UN-200-E-65	s	s			s	
UN-200-E-67						
UN-200-E-68	s					
UN-200-E-72		s			s	
UN-200-E-81		s			s	
UN-200-E-82		s			s	
UN-200-E-86		k			k	
UN-200-E-88		k			k	
UN-200-E-91						
UN-200-E-94		s			s	
UN-200-E-96						
UN-200-E-97		r			r	
UN-200-E-99		r			r	
UN-200-E-100		s			s	
UN-200-E-107		s			s	

Table 4-2. Summary of Chemical Contamination in Various Affected Media for PUREX Plant Aggregate Area.

Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
UN-200-E-114						
UN-200-E-117		s			s	
UN-200-E-118	s					
UN-200-E-142		s,r?			s,r?	
UPR-200-E-17		s			s	
UPR-200-E-21		s			s	
UPR-200-E-24		s			s	
UPR-200-E-29		s			s	
UPR-200-E-30						
UPR-200-E-50	s	s			s	
UPR-200-E-53		s			s	
UPR-200-E-59		r?			r?	
UPR-200-E-66		s, r?			s, r?	
UPR-200-E-70		r			r	
UPR-200-E-106						
UPR-200-E-115		s			s	
UPR-200-E-119						
UPR-200-E-125						
UPR-200-E-126						
UPR-200-E-136						
UPR-200-E-137						

s = Suspected contamination, based on WIDS (WHC 1991a), or other waste inventory data and available sampling and analysis information.

k = Known contamination, based on WIDS (WHC 1991a), or other sources.

r = Complete remediation reported.

r? = Remediation attempted, effectiveness not documentred.

Table 4-3. Types of Data Available for Each Waste Management Unit.

Waste Management Unit	Inventory	Surface Radiological Survey	External Radiation Monitoring	Waste, Soil or Sediment Sampling	Biota Sampling	Borehole Geophysics
Plants, Buildings, and Storage Areas						
204-AR Waste Unloading Station						
241-A-431 Ventilation Building						
241-C-801 Support Facility						
242-A Evaporator						
Grout Treatment Facility						
244-AR Lift Station		R				
Tanks and Vaults						
241-A-101 Single-Shell Tank	R,C	R	R			R
241-A-102 Single-Shell Tank	R,C	R	R			R
241-A-103 Single-Shell Tank	R,C	R	R			R
241-A-104 Single-Shell Tank	R,C	R	R			R
241-A-105 Single-Shell Tank	R,C	R	R			R
241-A-106 Single-Shell Tank	R,C	R	R			R
241-AN-101 Double-Shell Tank		R	R			R
241-AN-102 Double-Shell Tank		R	R			R
241-AN-103 Double-Shell Tank		R	R			R
241-AN-104 Double-Shell Tank		R	R			R
241-AN-105 Double-Shell Tank		R	R			R
241-AN-106 Double-Shell Tank		R	R			R
241-AN-107 Double-Shell Tank		R	R			R
241-AP-101 Double-Shell Tank		R	R			R
241-AP-102 Double-Shell Tank		R	R			R
241-AP-103 Double-Shell Tank		R	R			R
241-AP-104 Double-Shell Tank		R	R			R
241-AP-105 Double-Shell Tank		R	R			R
241-AP-106 Double-Shell Tank		R	R			R
241-AP-107 Double-Shell Tank		R	R			R
241-AP-108 Double-Shell Tank		R	R			R
241-AW-101 Double-Shell Tank		R	R			R
241-AW-102 Double-Shell Tank		R	R			R
241-AW-103 Double-Shell Tank		R	R			R
241-AW-104 Double-Shell Tank		R	R			R

Table 4-3. Types of Data Available for Each Waste Management Unit.

Waste Management Unit	Inventory	Surface Radiological Survey	External Radiation Monitoring	Waste, Soil or Sediment Sampling	Biota Sampling	Borehole Geophysics
241-AW-105 Double-Shell Tank		R	R			R
241-AW-106 Double-Shell Tank		R	R			R
241-AX-101 Single-Shell Tank	R,C	R	R			R
241-AX-102 Single-Shell Tank	R,C	R	R			R
241-AX-103 Single-Shell Tank	R,C	R	R			R
241-AX-104 Single-Shell Tank	R,C	R	R			R
241-AY-101 Double-Shell Tank		R	R			R
241-AY-102 Double-Shell Tank		R	R			R
241-AZ-101 Double-Shell Tank		R	R			R
241-AZ-102 Double-Shell Tank		R	R			R
241-C-101 Single-Shell Tank	R,C	R	R			R
241-C-102 Single-Shell Tank	R,C	R	R			R
241-C-103 Single-Shell Tank	R,C	R	R	R,C		R
241-C-104 Single-Shell Tank	R,C	R	R	R,C		R
241-C-105 Single-Shell Tank	R,C	R	R	R,C		R
241-C-106 Single-Shell Tank	R,C	R	R	R,C		R
241-C-107 Single-Shell Tank	R,C	R	R			R
241-C-108 Single-Shell Tank	R,C	R	R			R
241-C-109 Single-Shell Tank	R,C	R	R			R
241-C-110 Single-Shell Tank	R,C	R	R			R
241-C-111 Single-Shell Tank	R,C	R	R			R
241-C-112 Single-Shell Tank	R,C	R	R			R
241-C-201 Single-Shell Tank	R,C	R	R			R
241-C-202 Single-Shell Tank	R,C	R	R			R
241-C-203 Single-Shell Tank	R,C	R	R			R
241-C-204 Single-Shell Tank	R,C	R	R			R
241-A-302A Catch Tank						
241-A-302B Catch Tank						
241-A-350 Catch Tank						
241-A-417 Catch Tank						
241-AX-152CT Catch Tank						
241-C-301C Catch Tank						
244-A Receiving Vault		R	R			R

Table 4-3. Types of Data Available for Each Waste Management Unit.

Waste Management Unit	Inventory	Surface Radiological Survey	External Radiation Monitoring	Waste, Soil or Sediment Sampling	Biota Sampling	Borehole Geophysics
244-AR Vault		R	R			R
244-CR Vault		R	R			R
Cribs and Drains						
216-A-1 Crib	R,C	R	R	R	R	
216-A-2 Crib	R,C	R		R		
216-A-3 Crib	R	R		R		
216-A-4 Crib	R,C	R		R		
216-A-5 Crib	R,C	R		R		
216-A-6 Crib	R,C	R	R	R	R	
216-A-7 Crib	R,C	R		R		
216-A-8 Crib	R,C	R	R	R		
216-A-9 Crib	R,C	R	R	R	R	
216-A-10 Crib	R	R	R	R	R	
216-A-21 Crib	R,C	R		R		
216-A-24 Crib	R,C	R	R	R	R	
216-A-27 Crib	R,C	R		R		
216-A-30 Crib	R,C	R	R	R		
216-A-31 Crib	R,C	R		R		
216-A-32 Crib		R				
216-A-36A Crib	R,C	R		R		
216-A-36B Crib	R,C	R	R	R		
216-A-37-1 Crib	R,C	R	R	R		
216-A-37-2 Crib	R,C	R	R	R		
216-A-38-1 Crib		R				
216-A-39 Crib	R,C			R		
216-A-41 Crib	C					
216-A-45 Crib	R	R		R		
216-A-11 French Drain	C	R		R		
216-A-12 French Drain	C	R		R		
216-A-13 French Drain	C	R		R		
216-A-14 French Drain	C	R		R		
216-A-15 French Drain	C	R		R		
216-A-16 French Drain	C	R		R		

Table 4-3. Types of Data Available for Each Waste Management Unit.

Waste Management Unit	Inventory	Surface Radiological Survey	External Radiation Monitoring	Waste, Soil or Sediment Sampling	Biota Sampling	Borehole Geophysics
216-A-17 French Drain	C	R		R		
216-A-22 French Drain	C	R		R		
216-A-23A French Drain	C					
216-A-23B French Drain	C					
216-A-26 French Drain		R				
216-A-26A French Drain	C	R				
216-A-28 French Drain	R,C	R		R		
216-A-33 French Drain		R				
216-A-35 French Drain	C	R				
216-C-8 French Drain	C	R				
Reverse Wells						
299-E24-111 Injection Well	R,C					
Ponds, Ditches, and Trenches						
216-A-18 Trench	R,C	R		R		
216-A-19 Trench	R,C	R		R		
216-A-20 Trench	R,C	R		R		
216-A-40 Trench	C	R				
216-A-29 Ditch		R	R	R	R	
216-A-34 Ditch		R				
Septic Tanks and Associated Drain Fields						
2607-EA Septic Tank & Field						
2607-EC Septic Tank & Field						
2607-ED Septic Tank & Field						
2607-EG Septic Tank & Field						
2607-EJ Septic Tank & Field						
2607-EL Septic Tank & Field						
2607-E6 Septic Tank & Field						
Transfer Facilities, Diversion Boxes, and Pipelines						
241-A-A Diversion Box						
241-A-B Diversion Box						
241-A-151 Diversion Box		R				
241-A-152 Diversion Box						
241-A-153 Diversion Box						

Table 4-3. Types of Data Available for Each Waste Management Unit.

Waste Management Unit	Inventory	Surface Radiological Survey	External Radiation Monitoring	Waste, Soil or Sediment Sampling	Biota Sampling	Borehole Geophysics
241-AR-151 Diversion Box						
241-AN-A Diversion Box						
241-AN-B Diversion Box						
241-AW-A Diversion Box						
241-AW-B Diversion Box						
241-AX-A Diversion Box						
241-AX-B Diversion Box						
241-AX-151 Diversion Box						
241-AX-152DS Diversion Box						
241-AX-155 Diversion Box						
241-AY-151 Diversion Box						
241-AY-152 Diversion Box						
241-AZ-151DS Diversion Box						
241-AZ-152 Diversion Box						
241-C-151 Diversion Box		R				
241-C-152 Diversion Box						
241-C-153 Diversion Box						
241-C-252 Diversion Box						
241-CR-151 Diversion Box						
241-CR-152 Diversion Box						
241-CR-153 Diversion Box						
241-ER-153 Diversion Box						
216-A-524 Control Structure						
241-AP Valve Pit						
241-AX-501 Valve Pit						
Basins						
207-A Retention Basins	R,C	R				
216-A-42 Retention Basin						
Burial Sites and Burning Pits						
218-E-1 Burial Ground	R	R		R		
218-E-8 Burial Ground				R		
218-E-12A Burial Ground		R		R		
218-E-12B Burial Ground			R			

Table 4-3. Types of Data Available for Each Waste Management Unit.

Waste Management Unit	Inventory	Surface Radiological Survey	External Radiation Monitoring	Waste, Soil or Sediment Sampling	Biota Sampling	Borehole Geophysics
218-E-13 Burial Ground		R				
200-E Burning Pit						
Unplanned Releases						
UN-200-E-10						
UN-200-E-11						
UN-200-E-12		R				
UN-200-E-13						
UN-200-E-15		R				
UN-200-E-16						
UN-200-E-18						
UN-200-E-19						
UN-200-E-20		R				
UN-200-E-22						
UN-200-E-25		R				
UN-200-E-26		R				
UN-200-E-27		R				
UN-200-E-28						
UN-200-E-31		R				
UN-200-E-33						
UN-200-E-35						
UN-200-E-39		R				
UN-200-E-40		R				
UN-200-E-42		R				
UN-200-E-47		R				
UN-200-E-48		R				
UN-200-E-49		R				
UN-200-E-56		R				
UN-200-E-58		R				
UN-200-E-60		R				
UN-200-E-62		R				
UN-200-E-65		R				
UN-200-E-67		R				
UN-200-E-68		R				

Table 4-3. Types of Data Available for Each Waste Management Unit.

Waste Management Unit	Inventory	Surface Radiological Survey	External Radiation Monitoring	Waste, Soil or Sediment Sampling	Biota Sampling	Borehole Geophysics
UN-200-E-72		R				
UN-200-E-81	R	R				
UN-200-E-82	R					
UN-200-E-86	R	R				
UN-200-E-88		R				
UN-200-E-91						
UN-200-E-94		R				
UN-200-E-96						
UN-200-E-97						
UN-200-E-99						
UN-200-E-100						
UN-200-E-107		R				
UN-200-E-114		R				
UN-200-E-117		R				
UN-200-E-118		R				
UN-200-E-142						
UPR-200-E-17						
UPR-200-E-21		R				
UPR-200-E-24		R				
UPR-200-E-29		R				
UPR-200-E-30		R				
UPR-200-E-50		R				
UPR-200-E-53		R				
UPR-200-E-59		R				
UPR-200-E-66	R	R				
UPR-200-E-70		R				
UPR-200-E-106		R				
UPR-200-E-115		R				
UPR-200-E-119						

Table 4-3. Types of Data Available for Each Waste Management Unit.

Waste Management Unit	Inventory	Surface Radiological Survey	External Radiation Monitoring	Waste, Soil or Sediment Sampling	Biota Sampling	Borehole Geophysics
UPR-200-E-125	R					
UPR-200-E-126	C					
UPR-200-E-136	R					
UPR-200-E-137	C					

R = Radionuclide-related data; C = Chemical-related data.

Table 4-4. Summary of Air Monitoring Results.

	RADIONUCLIDE (pCi/m³)			
SITE	Sr-90	Cs-137	Pu-239	U (total)
N006	1.46E-04	2.62E-04	6.28E-06	-9.25E-07
N007	1.19E-04	1.17E-04	2.46E-06	6.70E-06
N008	1.10E-04	8.55E-05	3.42E-06	2.03E-05
N012	2.18E-04	5.53E-04	2.49E-06	-9.06E-06
N158	6.07E-04	1.72E-03	1.34E-04	4.18E-05
N969	3.20E-04	1.30E-04	2.67E-05	7.96E-05
N970	2.21E-04	4.72E-04	3.46E-05	6.10E-05
N971	9.65E-04	3.59E-04	4.08E-05	2.69E-05
N976	7.75E-04	3.26E-04	5.41E-06	4.68E-05
N977	5.40E-04	3.07E-04	2.13E-05	3.98E-05
N984	9.31E-04	1.39E-03	9.53E-06	3.41E-05
N985	3.70E-04	4.32E-04	3.87E-05	4.95E-05
N991	1.17E-04	3.03E-04	1.50E-05	3.97E-05
N992	1.89E-04	1.22E-04	1.79E-06	2.10E-05
N993	1.63E-04	7.43E-04	7.11E-06	4.95E-05
N996	2.00E-04	1.76E-04	7.92E-06	3.66E-05
N997	3.57E-04	9.68E-04	8.51E-06	3.17E-05

Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, and 1989.

Table 4-5. Radiation and Dose Rate Surveys at the PUREX Plant Aggregate Area Waste Management Units.

Site Name	Site Type	Radiation Surveys ct/min	dis/min	mrem/h	Survey Date	Radiation Type
Plants, Buildings, and Storage Areas						
204-AR	Waste Unloading Station	NA	NA	NA	--	--
241-A-431	Ventilation Building	NA	NA	NA	--	--
241-C-801	Support Facility	NA	NA	NA	--	--
242-A	Evaporator	NA	NA	NA	--	--
Grout Treatment Facility	--	NA	NA	NA	--	--
244-AR	Lift Station	NA	NA	NA	--	--
Tanks and Vaults						
241-A-101	Single-Shell Tank	NA	NA	NA	--	--
241-A-102	Single-Shell Tank	NA	NA	NA	--	--
241-A-103	Single-Shell Tank	NA	NA	NA	--	--
241-A-104	Single-Shell Tank	NA	NA	NA	--	--
241-A-105	Single-Shell Tank	NA	NA	NA	--	--
241-A-106	Single-Shell Tank	NA	NA	NA	--	--
241-AN-101	Double-Shell Tank	NA	NA	NA	--	--
241-AN-102	Double-Shell Tank	NA	NA	NA	--	--
241-AN-103	Double-Shell Tank	NA	NA	NA	--	--
241-AN-104	Double-Shell Tank	NA	NA	NA	--	--
241-AN-105	Double-Shell Tank	NA	NA	NA	--	--
241-AN-106	Double-Shell Tank	NA	NA	NA	--	--

Table 4-5. Radiation and Dose Rate Surveys at the PUREX Plant Aggregate Area Waste Management Units.

Site Name	Site Type	Radiation Surveys ct/min	dis/min	mrem/h	Survey Date	Radiation Type
241-AN-107	Double-Shell Tank	NA	NA	NA	--	--
241-AP-101	Double-Shell Tank	NA	NA	NA	--	--
241-AP-102	Double-Shell Tank	NA	NA	NA	--	--
241-AP-103	Double-Shell Tank	NA	NA	NA	--	--
241-AP-104	Double-Shell Tank	NA	NA	NA	--	--
241-AP-105	Double-Shell Tank	NA	NA	NA	--	--
241-AP-106	Double-Shell Tank	NA	NA	NA	--	--
241-AP-107	Double-Shell Tank	NA	NA	NA	--	--
241-AP-108	Double-Shell Tank	NA	NA	NA	--	--
241-AW-101	Double-Shell Tank	NA	NA	NA	--	--
241-AW-102	Double-Shell Tank	NA	NA	NA	--	--
241-AW-103	Double-Shell Tank	NA	NA	NA	--	--
241-AW-104	Double-Shell Tank	NA	NA	NA	--	--
241-AW-105	Double-Shell Tank	NA	NA	NA	--	--
241-AW-106	Double-Shell Tank	NA	NA	NA	--	--
241-AX-101	Single-Shell Tank	NA	NA	NA	--	--
241-AX-102	Single-Shell Tank	NA	NA	NA	--	--
241-AX-103	Single-Shell Tank	NA	NA	NA	--	--
241-AX-104	Single-Shell Tank	NA	NA	NA	--	--
241-AY-101	Double-Shell Tank	NA	NA	NA	--	--
241-AY-102	Double-Shell Tank	NA	NA	NA	--	--

Table 4-5. Radiation and Dose Rate Surveys at the PUREX Plant Aggregate Area Waste Management Units.

Site Name	Site Type	Radiation Surveys ct/min	dis/min	mrem/h	Survey Date	Radiation Type
241-AZ-101	Double-Shell Tank	NA	NA	NA	--	--
241-AZ-102	Double-Shell Tank	NA	NA	NA	--	--
241-C-101	Single-Shell Tank	NA	NA	NA	--	--
241-C-102	Single-Shell Tank	NA	NA	NA	--	--
241-C-103	Single-Shell Tank	NA	NA	NA	--	--
241-C-104	Single-Shell Tank	NA	NA	NA	--	--
241-C-105	Single-Shell Tank	NA	NA	NA	--	--
241-C-106	Single-Shell Tank	NA	NA	NA	--	--
241-C-107	Single-Shell Tank	NA	NA	NA	--	--
241-C-108	Single-Shell Tank	NA	NA	NA	--	--
241-C-109	Single-Shell Tank	NA	NA	NA	--	--
241-C-110	Single-Shell Tank	NA	NA	NA	--	--
241-C-111	Single-Shell Tank	NA	NA	NA	--	--
241-C-112	Single-Shell Tank	NA	NA	NA	--	--
241-C-201	Single-Shell Tank	NA	NA	NA	--	--
241-C-202	Single-Shell Tank	NA	NA	NA	--	--
241-C-203	Single-Shell Tank	NA	NA	NA	--	--
241-C-204	Single-Shell Tank	NA	NA	NA	--	--
241-A-302A	Catch Tank	NA	NA	NA	--	--
241-A-302B	Catch Tank	NA	NA	NA	--	--
241-A-350	Catch Tank	NA	NA	NA	--	--

Table 4-5. Radiation and Dose Rate Surveys at the PUREX Plant Aggregate Area Waste Management Units.

Site Name	Site Type	Radiation Surveys ct/min	dis/min	mrem/h	Survey Date	Radiation Type
241-A-417	Catch Tank	NA	NA	NA	--	--
241-AX-152CT	Catch Tank	NA	NA	NA	--	--
241-C-301C	Catch Tank	NA	NA	NA	--	--
244-A	Receiving Vault	NA	NA	NA	--	--
244-AR	Vault	NA	NA	NA	--	--
244-CR	Vault	NA	NA	NA	--	--
Cribs and Drains						
216-A-1	Crib	NC	NC	NC	1991	--
216-A-2	Crib	NC	NC	NC	1990	--
216-A-3	Crib	NC	NC	NC	1990	--
216-A-4	Crib	NC	NC	NC	1990	--
216-A-5	Crib	NC	NC	NC	1989	--
216-A-6	Crib	--	5,000	00	1990	unknown
216-A-7	Crib	--	30,000	--	1991	beta
216-A-8	Crib	NC	NC	0.01	1990	--
216-A-9	Crib	--	30,000	--	1990	unknown
216-A-10	Crib	NC	NC	NC	1990	--
216-A-21	Crib	--	15,000	--	1990	beta, gamma
216-A-24	Crib	NC	NC	NC	Oct-90	--
216-A-27	Crib	NC	NC	NC	1990	--

Table 4-5. Radiation and Dose Rate Surveys at the PUREX Plant Aggregate Area Waste Management Units.

Site Name	Site Type	Radiation Surveys ct/min	dis/min	mrem/h	Survey Date	Radiation Type
216-A-30	Crib	NC	NC	0.01	1990	--
216-A-31	Crib	NC	NC	NC	1988	--
216-A-32	Crib	NC	NC	NC	1990	--
216-A-36A	Crib	NC	NC	NC	1990	--
216-A-36B	Crib	NC	NC	NC	1990	--
216-A-37-1	Crib	NC	NC	NC	1990	--
216-A-37-2	Crib	--	500	--	1991	alpha
		--	200	--	1991	beta
216-A-38-1	Crib	NC	NC	NC	1989	--
216-A-39	Crib	NA	NA	NA	--	--
216-A-41	Crib	NA	NA	NA	--	--
216-A-45	Crib	NC	NC	NC	1990	--
216-A-11	French Drain	NC	NC	NC	1990	--
216-A-12	French Drain	NC	NC	NC	1988	--
216-A-13	French Drain	NC	NC	NC	1990	--
216-A-14	French Drain	--	56,000	--	1990	alpha
216-A-15	French Drain	NC	NC	NC	1988	--
216-A-16	French Drain	NA	NA	NA	--	--
216-A-17	French Drain	NA	NA	NA	--	--
216-A-22	French Drain	NC	NC	NC	1988	--
216-A-26	French Drain	NC	NC	NC	1990	--

Table 4-5. Radiation and Dose Rate Surveys at the PUREX Plant Aggregate Area Waste Management Units.

Site Name	Site Type	Radiation Surveys ct/min	dis/min	mrem/h	Survey Date	Radiation Type
216-A-26A	French Drain	NC	NC	NC	1990	--
216-A-28	French Drain	--	10,000	--	1990	beta, gamma
		--	2,300	--	1990	alpha
216-A-33	French Drain	NC	NC	NC	1990	--
216-A-35	French Drain	NC	NC	NC	1990	--
216-C-8	French Drain	2,000	--	--	1988	unknown
Reverse Wells						
299-E24-111	Injection Well	NA	NA	NA	--	--
Ponds, Ditches, and Trenches						
216-A-29	Ditch	2,000	--	--	1989	beta
216-A-34	Ditch	NC	NC	NC	1991	--
216-A-18	Trench	NC	NC	NC	1990	--
216-A-19	Trench	NC	NC	NC	1990	--
216-A-20	Trench	NC	NC	NC	1990	--
216-A-40	Trench	--	--	4	Apr-90	gamma
Septic Tanks and Associated Drain Fields						
2607-EA	Septic Tank/Drain Field	NA	NA	NA	--	--
2607-EC	Septic Tank/Drain Field	NA	NA	NA	--	--
2607-ED	Septic Tank/Drain Field	NA	NA	NA	--	--
2607-EG	Septic Tank	NA	NA	NA	--	--

Page 4T-5g
NOT included

Table 4-5. Radiation and Dose Rate Surveys at the PUREX Plant Aggregate Area Waste Management Units.

Site Name	Site Type	Radiation Surveys ct/min	dis/min	mrem/h	Survey Date	Radiation Type
241-AZ-151DS	Diversion Box	NA	NA	NA	--	--
241-AZ-152	Diversion Box	NA,NC	NA,NC	NA,NC	--	--
241-C-151	Diversion Box	NA	NA	NA	--	--
241-C-152	Diversion Box	NA	NA	NA	--	--
241-C-153	Diversion Box	NA	NA	NA	--	--
241-C-252	Diversion Box	NA	NA	NA	--	--
241-CR-151	Diversion Box	NA	NA	NA	--	--
241-CR-152	Diversion Box	NA	NA	NA	--	--
241-CR-153	Diversion Box	NA	NA	NA	--	--
241-ER-153	Diversion Box	NA	NA	NA	--	--
216-A-524	Control Structure	NA	NA	NA	--	--
241-AP	Valve Pit	NA	NA	NA	--	--
241-AX-501	Valve Pit	NA	NA	NA	--	--
Basins						
207-A	Retention Basins	1,500	--	--	1990	unknown
216-A-42	Retention Basin	--	200,000	--	1988	unknown
Burial Sites						
200-E	Burning Pit	--	--	0.01	1989	--
218-E-1	Burial Ground	5,000	--	--	1990	unknown
218-E-8	Burial Ground	NA	NA	NA	--	--
218-E-12A	Burial Ground	--	20,000	--	1990	unknown

Table 4-5. Radiation and Dose Rate Surveys at the PUREX Plant Aggregate Area Waste Management Units.

Site Name	Site Type	Radiation Surveys ct/min	dis/min	mrem/h	Survey Date	Radiation Type
218-E-12B	Burial Ground	--	--	0.01	1989	--
218-E-13	Burial Ground	NA	NA	NA	--	--
Unplanned Releases						
UN-200-E-10	Unplanned Release	NA	NA	NA	--	--
UN-200-E-11	Unplanned Release	NA	NA	NA	--	--
UN-200-E-12	Unplanned Release	NA	NA	NA	--	--
UN-200-E-13	Unplanned Release	NA	NA	NA	--	--
UN-200-E-15	Unplanned Release	NA	NA	NA	--	--
UN-200-E-16	Unplanned Release	NA	NA	NA	--	--
UN-200-E-17	Unplanned Release	NA	NA	NA	--	--
UN-200-E-18	Unplanned Release	NA	NA	NA	--	--
UN-200-E-19	Unplanned Release	NA	NA	NA	--	--
UN-200-E-20	Unplanned Release	NA	NA	NA	--	--
UN-200-E-21	Unplanned Release	NA	NA	NA	--	--
UN-200-E-22	Unplanned Release	NA	NA	NA	--	--
UN-200-E-23	Unplanned Release	NA	NA	NA	--	--
UN-200-E-24	Unplanned Release	NA	NA	NA	--	--
UN-200-E-25	Unplanned Release	NA	NA	NA	--	--
UN-200-E-26	Unplanned Release	NA	NA	NA	--	--
UN-200-E-27	Unplanned Release	NA	NA	NA	--	--
UN-200-E-28	Unplanned Release	NA	NA	NA	--	--

Table 4-5. Radiation and Dose Rate Surveys at the PUREX Plant Aggregate Area Waste Management Units.

Site Name	Site Type	Radiation Surveys ct/min	dis/min	mrem/h	Survey Date	Radiation Type
UN-200-E-29	Unplanned Release	NA	NA	NA	--	--
UN-200-E-30	Unplanned Release	NA	NA	NA	--	--
UN-200-E-31	Unplanned Release	NC	NC	NC	1991	--
UN-200-E-33	Unplanned Release	NA	NA	NA	--	--
UN-200-E-35	Unplanned Release	NA	NA	NA	--	--
UN-200-E-39	Unplanned Release	NA	NA	NA	--	--
UN-200-E-40	Unplanned Release	NA	NA	NA	--	--
UN-200-E-42	Unplanned Release	NA	NA	NA	--	--
UN-200-E-47	Unplanned Release	NA	NA	NA	--	--
UN-200-E-49	Unplanned Release	NA	NA	NA	--	--
UN-200-E-50	Unplanned Release	NA	NA	NA	--	--
UN-200-E-53	Unplanned Release	NA	NA	NA	--	--
UN-200-E-56	Unplanned Release	NA	NA	NA	--	--
UN-200-E-58	Unplanned Release	NA	NA	NA	--	--
UN-200-E-60	Unplanned Release	NA	NA	NA	--	--
UN-200-E-62	Unplanned Release	NA	NA	NA	--	--
UN-200-E-65	Unplanned Release	NA	NA	NA	--	--
UN-200-E-67	Unplanned Release	NA	NA	NA	--	--
UN-200-E-68	Unplanned Release	NA	NA	NA	--	--
UN-200-E-72	Unplanned Release	NA	NA	NA	--	--
UN-200-E-81	Unplanned Release	NA	NA	NA	--	--

Table 4-5. Radiation and Dose Rate Surveys at the PUREX Plant Aggregate Area Waste Management Units.

Site Name	Site Type	Radiation Surveys ct/min	dis/min	mrem/h	Survey Date	Radiation Type
N-200-E-82	Unplanned Release	NA	NA	NA	--	--
UN-200-E-86	Unplanned Release	NC	NC	NC	Sep-91	--
UN-200-E-88	Unplanned Release	--	60,000	--	1991	unknown
UN-200-E-91	Unplanned Release	NA	NA	NA	--	--
UN-200-E-94	Unplanned Release	NA	NA	NA	--	--
UN-200-E-96	Unplanned Release	NA	NA	NA	--	--
UN-200-E-97	Unplanned Release	NA	NA	NA	--	--
UN-200-E-99	Unplanned Release	NA	NA	NA	--	--
UN-200-E-100	Unplanned Release	--	--	5	Oct-91	unknown
UN-200-E-106	Unplanned Release	NA	NA	NA	--	--
UN-200-E-107	Unplanned Release	NA	NA	NA	--	--
UN-200-E-114	Unplanned Release	NA	NA	NA	--	--
UN-200-E-117	Unplanned Release	NA	NA	NA	--	--
UN-200-E-118	Unplanned Release	NA	NA	NA	--	--
UN-200-E-142	Unplanned Release	NA	NA	NA	--	--
UPR-200-E-66	Unplanned Release	NA	NA	NA	--	--
UPR-200-E-70	Unplanned Release	NA	NA	NA	--	--
UPR-200-E-115	Unplanned Release	NA	NA	NA	--	--
UPR-200-E-119	Unplanned Release	NA	NA	NA	--	--
UPR-200-E-125	Unplanned Release	NA	NA	NA	--	--
UPR-200-E-126	Unplanned Release	NA	NA	NA	--	--

Table 4-5. Radiation and Dose Rate Surveys at the PUREX Plant Aggregate Area Waste Management Units.

Site Name	Site Type	Radiation Surveys ct/min	dis/min	mrem/h	Survey Date	Radiation Type
UPR-200-E-136	Unplanned Release	NA	NA	NA	--	--
UPR-200-E-137	Unplanned Release	NA	NA	NA	--	--

NA = No data available
NC = No contamination detected
Note: Values presented in the table represent the maximum value reported in the radiation survey results.

Table 4-6. Results of External Radiation Monitoring, 1985 through 1989 TLDs (mrem/yr).

Site	1985	1986	1987	1988	1989	Average Total
2 E 5: 218-E-12B						
Max	84	108	125	123	N/A	
Min	72	73	85	98	N/A	
Total	79	88	100	110	N/A	94
2E 6: 200-E NE						
Max	85	101	132	119	N/A	
Min	64	72	83	92	N/A	
Total	77	83	101	103	N/A	91
2E 11: 218-E-12B N						
Max	97	96	112	134	128	
Min	69	80	83	107	92	
Total	85	89	97	117	114	100
2E 12: 218-E-12B E						
Max	85	100	103	119	N/A	
Min	68	74	69	93	N/A	
Total	78	84	88	105	N/A	89
2E 17: 241-C TF W						
Max	104	121	122	134	140	
Min	76	83	92	108	104	
Total	89	98	104	124	119	107
2E 18: 241-C TF E						
Max	102	124	137	139	N/A	
Min	84	90	104	117	N/A	
Total	96	109	115	125	N/A	111
2E 23: PUREX N						
Max	100	135	132	138	N/A	
Min	67	81	90	65	N/A	
Total	85	107	106	115	N/A	103
2E 24: PUREX NE						
Max	112	129	131	148	N/A	
Min	85	94	100	70	N/A	
Total	100	111	117	114	N/A	111

9 2 1 2 6 1 3 7 4

Table 4-6. Results of External Radiation Monitoring, 1985 through 1989 TLDs (mrem/yr).

Site	1985	1986	1987	1988	1989	Average Total
2E 29: PUREX S						
Max	73	96	92	104	N/A	
Min	64	68	75	64	N/A	
Total	68	77	84	89	N/A	80
2E 30: PUREX SE						
Max	76	85	94	114	N/A	
Min	63	68	71	65	N/A	
Total	68	78	81	92	N/A	80
2E 35: 200-E S						
Max	80	93	96	111	N/A	
Min	62	68	74	59	N/A	
Total	70	77	84	89	N/A	80
2E 36: 200-E SW						
Max	75	96	90	109	124	
Min	58	66	75	62	72	
Total	67	77	81	89	96	82
2E D: 216-A-29 Ditch E						
Max	94	116	108	122	120	
Min	69	79	84	72	100	
Total	81	91	96	103	111	96
216-A-29 Ditch						
Max	90	92	91	114	124	
Min	67	72	71	62	84	
Total	75	81	81	90	105	86
216-A-36B Crib #1						
Max	80	89	87	110	132	
Min	69	70	56	56	76	
Total	74	82	77	88	110	86
216-A-36B Crib #2						
Max	127	135	89	104	128	
Min	90	99	55	54	96	
Total	107	120	79	83	112	100

Table 4-6. Results of External Radiation Monitoring, 1985 through 1989 TLDs (mrem/yr).

Site	1985	1986	1987	1988	1989	Average Total
216-A-10 Crib #1						
Max	82	99	92	110	136	
Min	70	73	71	59	88	
Total	74	83	83	88	112	88
216-A-10 Crib #2						
Max	76	96	89	107	108	
Min	85	63	72	51	88	
Total	67	77	82	84	101	82
PUREX #1						
Max	73	98	91	117	120	
Min	66	60	74	51	88	
Total	69	77	83	88	106	85
PUREX #2						
Max	80	118	101	110	124	
Min	68	67	78	52	76	
Total	73	90	88	88	103	88
PUREX #3						
Max	84	119	98	105	128	
Min	67	70	81	70	76	
Total	76	98	90	90	105	92
241-A TF #1						
Max	278	272	264	295	348	
Min	176	237	210	176	200	
Total	230	248	237	233	273	244
241-A TF #2						
Max	178	137	156	153	1812	
Min	133	111	127	97	136	
Total	154	121	138	123	562	220
241-A TF #3						
Max	119	119	126	151	2840	
Min	112	86	107	96	116	
Total	115	101	118	129	1158	324

Table 4-6. Results of External Radiation Monitoring, 1985 through 1989 TLDs (mrem/yr).

Site	1985	1986	1987	1988	1989	Average Total
241-A TF #4						
Max	93	107	113	140	9636	
Min	82	90	93	86	112	
Total	88	98	102	119	2545	590
241-A TF #5						
Max	81	97	104	119	140	
Min	74	66	77	80	108	
Total	78	79	89	101	125	94
241-A TF #6						
Max	109	111	108	126	164	
Min	72	73	84	77	100	
Total	88	91	97	106	125	101
241-A TF #7						
Max	240	133	149	149	196	
Min	85	125	110	110	108	
Total	127	129	120	132	151	132
241-A TF #8						
Max	6348	1918	2036	2778	3832	
Min	1956	1393	1535	1316	1660	
Total	4693	1721	1781	2212	2519	2585
241-A TF #9						
Max	775	823	809	864	844	
Min	353	657	438	464	652	
Total	555	748	666	616	740	665
241-A TF #10						
Max	1585	1418	832	1075	1316	
Min	463	822	649	453	848	
Total	899	1045	729	742	998	883
241-A TF #11						
Max	120	141	125	150	152	
Min	20	99	103	104	108	
Total	81	120	115	122	136	115

Table 4-6. Results of External Radiation Monitoring, 1985 through 1989 TLDs (mrem/yr).

Site	1985	1986	1987	1988	1989	Average Total
241-A TF #12						
Max	697	130	156	146	140	
Min	118	117	92	112	108	
Total	281	123	122	129	131	157
241-A TF #13						
Max	147	144	146	131	240	
Min	98	113	92	108	124	
Total	127	127	121	120	165	132
216-A-30 Crib #1						
Max	85	94	99	105	116	
Min	66	68	77	68	76	
Total	74	82	88	92	100	87
216-A-30 Crib #2						
Max	77	80	90	105	128	
Min	68	62	74	63	84	
Total	72	74	81	89	105	84
216-A-37-1 Crib #1						
Max	76	90	105	112	116	
Min	70	70	76	69	84	
Total	72	81	89	94	100	87
216-A-37-1 Crib #2						
Max	84	101	83	120	128	
Min	68	68	77	66	88	
Total	74	81	80	96	111	88
216-A-8 Crib #1						
Max	121	114	113	117	124	
Min	105	97	88	73	84	
Total	113	106	99	103	110	106
216-A-8 Crib #2						
Max	118	137	140	154	196	
Min	103	96	101	98	72	
Total	112	122	118	133	134	124

Table 4-7. Results of External Radiation Monitoring 1990 TLDs (mrem/yr).

Site	Maximum	Minimum	Total
216-A-37-1 E	116	100	107
216-A-37-1 N	124	96	103
216-A-29	104	88	98
216-A-8 S	120	100	106
216-A-8 E	132	100	121
218-E-12	116	100	105
216-A-10-1	112	92	99
216-A-10-2	120	96	107
216-A-36-1	112	92	100
216-A-36-B-2	120	88	100
202-A-1 (PUREX)	112	96	100
202-A-1 SE (PUREX)	108	96	104
202-A-1 PL (PUREX)	280	96	194
241-A TF No. 1	332	136	216
241-A TF No. 2	160	116	132
241-A TF No. 3	144	108	122
241-A TF No. 4	140	100	113
241-A TF No. 5	124	104	110
241-A TF No. 6	128	96	116
241-A TF No. 7	2300	112	1100
241-A TF No. 8	2000	384	1200
241-A TF No. 10	1900	384	908
241-A TF No. 11	576	132	236
241-A TF No. 12	140	124	129
241-A TF No. 13	156	92	112

Table 4-8. Summary of Grid Soil Sampling Results (pCi/g).

Radionuclide	Site 2E 11	Site 2E 12	Site 2E 17	Site 2E 18	Site 2E 23	Site 2E 24	Site 2E 29	Site 2E 30
Ce-141	-1.80E-02	4.88E-02	5.38E-02	-1.13E-02	2.00E-02	2.59E-02	3.03E-02	-3.44E-02
Ce-144	1.35E-01	1.07E-01	1.24E-02	-1.30E-02	3.50E-02	2.20E-03	-1.03E-01	-5.43E-03
Co-58	-5.00E-03	-9.73E-04	2.04E-02	-4.18E-03	-1.24E-02	-3.28E-03	2.91E-02	-4.03E-03
Co-60	1.39E-02	5.01E-03	-2.44E-03	2.65E-03	2.43E-02	6.90E-03	7.21E-03	2.05E-03
Cs-134	3.99E-02	4.20E-02	3.19E-02	2.65E-02	-6.67E-04	3.95E-02	3.53E-02	-4.20E-03
Cs-137	1.19E+01	1.36E+01	4.35E+00	6.24E+00	9.97E+00	5.49E+00	2.62E+00	2.79E-01
Eu-152	1.77E-01	6.52E-02	4.93E-02	8.72E-02	1.46E-01	1.24E-01	6.80E-02	5.85E-02
Eu-154	-5.50E-02	1.78E-02	6.51E-02	2.75E-02	3.90E-02	-5.96E-03	6.74E-03	9.03E-03
Eu-155	1.80E-02	9.54E-02	1.39E-02	3.82E-02	1.24E-01	1.52E-02	2.12E-02	4.82E-02
I-129		2.37E-02	3.55E-02	1.85E-01		-7.30E-02	1.74E-01	6.30E-02
K-40		1.19E+01	1.50E+01	1.51E+01		1.37E+01	1.54E+01	1.35E+01
Mn-54	2.60E-02	2.14E-02	5.49E-03	1.75E-02	1.22E-02	-1.30E-03	-4.83E-03	3.96E-03
Nb-95		1.21E-01	7.69E-02	3.44E-02		-1.07E-01	4.52E-02	-1.14E-02
Pb-212		7.85E-01	7.90E-01	7.48E-01		8.55E-01	8.75E-01	7.04E-01
Pb-214	7.90E-01	6.91E-01	5.79E-01	6.89E-01	6.80E-01	6.72E-01	7.14E-01	6.26E-01
Pu-238	1.49E-03	1.39E-03	7.47E-04	2.63E-04	4.11E-02	6.84E-04	1.84E-03	1.13E-03
Pu-239	6.27E-02	3.97E-02	2.34E-02	9.98E-03	1.26E-01	3.03E-02	6.04E-02	2.23E-02
Ru-106	3.50E-02	-3.33E-04	1.46E-01	-2.64E-02	7.55E-02	1.80E-02	2.23E-01	3.83E-01
Sr-90	1.92E+00	1.24E+00	3.49E+00	1.33E+00	2.20E+00	7.94E-01	7.86E-01	3.68E-01
Tc-99		3.41E-01	2.35E-01	6.86E-01		1.66E-01	2.24E-01	1.66E-01
U (total)	3.12E-01	2.06E-01	2.29E-01	3.38E-01	3.48E-01	3.32E-01	4.48E-01	3.07E-01
Zn-65	-1.60E-02	-4.31E-02	-1.28E-02	-1.42E-02	2.03E-02	-2.47E-02	-1.74E-02	-1.44E-02
Zr-95	1.40E-02	5.52E-02	4.10E-02	1.98E-02	4.47E-02	1.98E-02	2.13E-02	1.90E-02

Table 4-8. Summary of Grid Soil Sampling Results (pCi/g).

Radionuclide	Site 2ED	Site 2EDB	Site GRT1	Site GRT2	Site GRT4	Site GRT5	Site GRT6
Ce-141	5.30E-02	1.90E-02	-2.44E-02	4.85E-03	-5.80E-03	-1.60E-02	-3.00E-02
Ce-144	-1.12E-02	9.20E-03	-4.10E-02	-1.26E-02	-7.00E-04	-2.61E-02	-2.71E-02
Co-58	7.70E-03	7.60E-03	4.47E-03	3.40E-03	5.73E-03	-9.86E-03	-8.13E-03
Co-60	3.00E-03	8.40E-03	-1.24E-02	-1.23E-03	-1.85E-02	1.43E-03	5.27E-03
Cs-134	3.43E-02	6.60E-02	1.14E-02	-5.87E-03	-7.77E-03	2.45E-02	1.19E-02
Cs-137	3.82E+00	2.80E+00	1.50E+00	1.93E+00	1.01E+00	1.61E+00	1.73E+00
Eu-152	1.06E-01	1.50E-01	1.08E-01	4.78E-02	1.06E-01	6.05E-02	5.70E-02
Eu-154	3.28E-02	-3.90E-02	2.13E-02	1.38E-02	-7.13E-03	-4.67E-03	1.63E-02
Eu-155	6.45E-02	5.80E-02	4.53E-02	3.24E-02	5.81E-02	2.95E-02	4.71E-02
I-129	1.54E-01	1.00E-01	5.00E-03	9.73E-02	-5.90E-01	-7.90E-02	3.20E-01
K-40	1.63E+01		1.45E+01	1.42E+01	1.51E+01	1.48E+01	1.50E+01
Mn-54	9.00E-03	1.70E-02	2.12E-02	1.64E-03	9.69E-03	6.62E-03	9.73E-04
Nb-95	-6.84E-02		-5.28E-02	-8.71E-02	-2.89E-02	-1.49E-01	-1.38E-01
Pb-212	7.70E-01		7.63E-01	8.43E-01	7.91E-01	7.67E-01	8.28E-01
Pb-214	6.83E-01		5.89E-01	6.22E-01	6.44E-01	6.71E-01	6.24E-01
Pu-238	9.42E-04	5.00E-04	3.55E-04	4.96E-04	4.45E-04	3.37E-04	3.31E-04
Pu-239	4.08E-02	4.00E-02	1.48E-02	3.05E-02	1.45E-02	1.28E-02	1.07E-02
Ru-106	5.37E-02	1.00E-01	-7.75E-02	9.04E-02	3.59E-02	-5.18E-02	-5.37E-03
Sr-90	9.00E-01	6.60E-01	3.68E-01	3.51E-01	3.00E-01	5.09E-01	2.86E-01
Tc-99	1.26E-01	5.20E-01	2.85E-01	3.89E-01	3.32E-01	4.16E-01	3.05E-01
U (total)	4.96E-01	3.70E-01	3.31E-01	3.86E-01	3.17E-01	3.82E-01	3.99E-01
Zn-65	-6.68E-02	4.00E-03	-8.67E-03	-3.20E-02	-5.46E-02	-2.77E-02	-4.53E-03
Zr-95	1.44E-02	-2.00E-03	1.93E-02	1.62E-02	8.10E-03	5.70E-03	4.23E-02

Table 4-9. Summary of Fenceline Soil Sampling Results (pCi/g).

Radionuclide	Site 2E -1	Site 2E -2	Site 2E -3	Site 2E -4	Site 2E-NE	Site 2E-SE	Site A-TF-E1	Site A-TF-E2
Ce-141	-9.67E-04	7.83E-03	-6.87E-03		-7.60E-03	-8.67E-04	-2.46E-02	1.62E-02
Ce-144	1.43E-02	1.88E-02	-8.49E-02		-2.37E-02	2.50E-02	-4.20E-02	-1.79E-02
Co-58	1.70E-03	-5.95E-03	-3.45E-04		-9.58E-03	-6.05E-04	1.39E-02	2.20E-02
Co-60	2.49E-02	-4.40E-03	5.93E-03		1.02E-02	1.57E-02	-5.00E-04	6.28E-03
Cs-134	1.32E-02	2.94E-02	4.13E-02		4.38E-02	2.26E-02	2.01E-02	3.76E-02
Cs-137	2.47E+00	1.80E+01	4.77E-01	8.60E+01	1.19E+00	3.58E-01	2.40E+00	7.29E+00
Eu-152	1.21E-01	9.25E-02	1.10E-01		3.17E-02	8.28E-02	1.06E-01	9.50E-02
Eu-154	3.79E-02	3.69E-02	8.36E-03		1.94E-02	8.43E-03	1.37E-02	-1.85E-02
Eu-155	5.40E-03	4.82E-02	3.42E-02		4.30E-02	4.16E-02	5.11E-02	5.48E-02
I-129								
K-40	1.32E+01	1.36E+01	1.43E+01		1.38E+01	1.51E+01	1.21E+01	1.39E+01
Mn-54	6.43E-03	1.06E-02	1.25E-02		2.36E-02	4.98E-03	3.08E-03	2.03E-02
Nb-95	2.00E-03	-1.64E-02	-4.15E-02		-4.63E-02	-5.54E-02	-4.77E-02	2.95E-02
Pb-212	6.29E-01	6.13E-01	6.61E-01		7.27E-01	7.48E-01	4.82E-01	6.68E-01
Pb-214	4.60E-01	4.69E-01	5.28E-01		6.00E-01	6.14E-01	5.01E-01	5.27E-01
Pu-238	7.60E-05	2.46E-04	3.85E-04		3.27E-04	2.19E-04	4.88E-04	5.03E-04
Pu-239	8.18E-03	6.65E-03	1.88E-02	1.20E+01	5.40E-03	1.60E-03	2.04E-03	4.08E-03
Ru-106	6.18E-02	2.19E-01	3.80E-01		-6.50E-03	6.64E-02	8.43E-02	8.30E-02
Sr-90	6.08E-01	2.43E+00	5.32E-01	7.80E+00	1.64E+00	6.93E-01	4.28E-01	2.15E+00
Tc-99								
U (total)	2.65E-01	3.29E-01	3.06E-01		2.30E-01	3.02E-01	2.22E-01	3.62E-01
Zn-65	-8.40E-02	2.94E-02	8.50E-03		1.43E-02	-4.99E-02	-5.25E-02	-1.71E-02
Zr-95	-6.72E-03	-1.41E-02	1.01E-02		3.76E-02	1.56E-02	4.79E-03	3.87E-02

Table 4-9. Summary of Fenceline Soil Sampling Results (pCi/g). Page 2 of 2

Radionuclide	Site A-TF-E3	Site A-TF-E4	Site A-TF-W1	Site A-TF-W2	Site A-TF-E	Site C-TF-NE	Site C-TF-SE
Ce-141	8.40E-01	-1.87E-03	5.23E-02	-1.50E-02	-8.65E-03	1.30E-02	-2.80E-03
Ce-144	-2.99E-02	-7.96E-03	8.75E-03	-1.35E-02	5.30E-04	7.82E-02	-7.85E-02
Co-58	1.54E-03	1.65E-02	1.55E-03	-1.54E-02	-1.30E-02	1.38E-02	-2.81E-03
Co-60	9.03E-03	-5.93E-03	1.81E-02	5.60E-03	1.10E-02	1.38E-02	2.06E-02
Cs-134	5.63E-02	1.07E-02	1.09E-02	1.26E-02	3.85E-02	3.00E-02	-1.59E-02
Cs-137	1.03E+01	3.67E+01	2.24E+00	3.31E+00	3.27E-01	2.35E+01	3.19E+01
Eu-152	6.32E-02	7.07E-02	8.99E-02	5.15E-02	1.94E-02	5.17E-02	7.49E-02
Eu-154	3.17E-02	2.82E-02	2.68E-02	-1.13E-02	-3.50E-03	6.50E-02	3.17E-03
Eu-155	3.60E-02	8.32E-02	3.05E-02	4.92E-02	-3.60E-03	5.23E-02	4.77E-02
I-129							
K-40	1.51E+01	1.29E+01	1.49E+01	1.55E+01	2.43E-02	1.45E+01	1.56E+01
Mn-54	2.29E-02	9.44E-03	6.40E-03	9.21E-03	1.05E-01	3.90E-03	2.00E-03
Nb-95	-8.16E-02	-2.98E-02	-4.25E-02	-1.52E-01		6.66E-02	-8.14E-02
Pb-212	7.07E-01	6.06E-01	6.41E-01	9.38E-01		7.40E-01	6.19E-01
Pb-214	5.00E-01	5.25E-01	5.96E-01	8.16E-01		6.57E-01	5.56E-01
Pu-238	2.10E-04	6.93E-04	1.80E-04	2.30E-04	9.37E-04	5.43E-04	7.50E-04
Pu-239	2.93E-03	1.03E-02	3.13E-03	1.90E-03	2.04E-02	1.83E-02	9.80E-03
Ru-106	2.44E-01	5.06E-02	4.43E-02	4.87E-02	6.27E-02	-8.33E-02	-1.77E-02
Sr-90	2.45E+00	5.55E+00	1.11E+00	2.98E+00	2.93E-01	5.54E+00	1.68E+01
Tc-99							
U (total)	2.55E-01	2.87E-01	2.63E-01	3.15E-01	3.83E-01	3.36E-01	2.55E-01
Zn-65	2.12E-02	-1.51E-02	-3.58E-02	-4.20E-02	1.10E-02	1.53E-02	-1.90E-02
Zr-95	-7.13E-02	1.21E-02	2.43E-02	3.77E-02	1.80E-03	-4.23E-03	3.11E-02

RM20: 216-A-29 Ditch

Table 4-10. Results of Surface Water Sampling (pCi/L).

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	1990 Result	1990 Error
Total beta												
Max	8.8E-02		1.24E-01		2.7E-02		<1.00E+02		<1.00E+02		<4.0E+01	
Min	1.7E-02		<1E-01		<1E-01		<1.00E+02		<1.00E+02		<4.0E+01	
Average	4.9E-02											
SD	5.1E-02											
Total alpha												
Max	1.2E-02		<1.0E-02		1.1E-02		5E+00		<1.00E+02		1.04E+02	
Min	1E-03		<1E-01		<1E-01		<1.00E+02		<1.00E+02		<4.0E+01	
Average	3E-03											
SD	6E-03											
Cesium-137												
Max	5.8E-02		<9.0E-02		<1.27E-01		<1.00E+02		6.2E+01		<4.0E+01	
Min	4.2E-02		<1E-01		<1E-01		<1.00E+02		<1.00E+02		<4.0E+01	
Average	4.7E-02											
SD	9E-03											
Strontium-90												
Max	4.0E-02		<8.3E-02		<3.0E-02		<1.00E+02		<1.00E+02		<4.0E+01	
Min	1.5E-02		<1E-01		<1E-01		<1.00E+02		<1.00E+02		<4.0E+01	
Average	2.7E-02											
SD	1.7E-02											

Table 4-11. Summary of Vegetation Sampling Results (pCi/g).

Radionuclide	Site 2E 11	Site 2E 12	Site 2E 17	Site 2E 18	Site 2E 23	Site 2E 24	Site 2E 29	Site 2E 30
Be-7	< -1.8E-02	1.85E+00	2.64E+00	2.63E+00		3.23E+00	2.01E+00	1.50E+00
Ce-141	< 1.10E-03	1.46E-03	-8.41E-03	-1.99E-02	2.10E-02	1.90E-03	-3.64E-02	3.05E-03
Co-60	8.81E-02	9.38E-03	2.12E-02	6.63E-03	-1.12E-02	2.75E-02	1.56E-02	5.94E-03
Cs-134	2.85E-01	1.06E-01	2.46E-01	1.50E-01	7.80E-02	1.26E-01	1.16E-01	
Cs-137	5.85E-02	3.23E-01	6.79E-01	9.83E-01	1.51E-01	1.10E+00	1.23E-01	2.33E-01
Eu-152	9.10E-02	2.16E-02	2.32E-03	5.13E-02	-3.10E-02	8.63E-03	-5.70E-02	-1.55E-02
Eu-154	5.64E-02	1.32E-02	6.18E-02	-1.29E-02	-1.04E-02	4.30E-02	9.35E-03	-2.34E-02
Eu-155		-5.56E-03	9.83E-02	2.77E-02	-2.10E-02	-2.06E-03	-1.07E-02	8.60E-03
I-129		6.08E-02	-2.30E-02	2.76E-01	-3.80E-01	2.67E-03	0.00E+00	7.35E-02
K-40		1.06E+01	1.39E+01	1.45E+01		1.30E+01	1.49E+01	1.09E+01
Nb-95	< -5.60E-02	-9.50E-03	1.26E-02	-8.93E-04	-2.37E-02	-8.44E-03	-1.43E-02	-3.05E-03
Pb-212	9.30E-01	2.78E-02	7.77E-02	5.86E-02		5.13E-02	1.98E-02	7.60E-02
Pb-214	2.00E+00	4.11E-02	8.68E-02	8.79E-02		9.76E-02	3.28E-02	7.13E-02
Pu-238		3.03E-04	1.27E-03	2.72E-04	1.94E-04	6.40E-04	2.47E-04	5.30E-04
Pu-239		1.08E-03	6.56E-03	1.63E-03	2.45E-03	8.90E-03	1.17E-03	4.67E-03
Ru-103		1.13E-01	4.85E-01	2.16E-01	5.12E-01	2.57E-01	5.38E-01	
Ru-106			7.25E-01	3.23E-01	3.25E+00	2.25E+00	3.33E+00	1.73E+00
Sr-90		1.75E+00	1.19E+01	6.09E-01	4.34E-01	9.97E-01	1.61E-01	5.20E-01
Tc-99		7.38E-01	1.76E+00	1.36E+00	1.10E+00	1.33E+00	1.11E+00	5.78E-01
Zr-95	< 4.20E-02	1.45E-02	1.74E-02	2.98E-02	-2.06E-02	-2.77E-03	1.43E-02	2.44E-02

Note: Values are averages for each year with a detection since 1985.

Table 4-11. Summary of Vegetation Sampling Results (pCi/g).

Radionuclide	Site 2ED	Site 2EDB	Site 2EDC	Site GRT1	Site GRT2	Site GRT4	Site GRT5	Site GRT6
Be-7			2.98E+00	3.00E+00	2.61E+00	3.22E+00	2.82E+00	2.09E+00
Ce-141	-9.50E-02		-2.25E-02	-1.34E-02	-2.78E-03	1.96E-02	7.83E-03	-2.45E-04
Co-60	8.80E-03	1.40E-02	6.69E-03	1.30E-03	-3.67E-04	9.09E-03	-3.57E-03	5.95E-03
Cs-134	1.19E-01	5.20E-02		6.10E-02	8.30E-02	5.00E-02	8.50E-02	5.55E-02
Cs-137	7.83E-01	2.80E-01	4.27E+00	5.77E-01	8.53E-01	3.57E-01	2.98E-01	4.33E-01
Eu-152	1.50E-02	4.80E-02	6.64E-02	5.09E-02	4.21E-02	2.33E-02	-1.41E-02	2.75E-02
Eu-154	-6.45E-02	-2.90E-02	6.04E-02	-1.42E-02	2.53E-02	8.53E-03	-2.44E-02	-1.92E-02
Eu-155	1.77E-02	1.40E-02	2.10E-02	-8.07E-03	3.57E-03	-3.37E-03	-2.41E-02	7.12E-03
I-129	3.00E-02	-1.40E-01	-5.80E-02	-4.77E-02	-7.63E-02	1.24E-01	-1.43E-02	1.19E-01
K-40			1.32E+01	1.18E+01	1.30E+01	1.17E+01	1.29E+01	1.10E+00
Nb-95	6.93E-02	1.80E-02	7.19E-03	-6.17E-03	-6.37E-04	-3.60E-03	3.49E-03	-4.73E-03
Pb-212			1.06E-01	9.51E-02	1.05E-01	7.78E-02	6.58E-02	5.95E-02
Pb-214			9.76E-02	3.71E-02	1.37E-01	1.15E-01	5.77E-02	7.54E-02
Pu-238	9.05E-05	8.90E-05	4.83E-04	1.92E-03	2.38E-04	1.75E-04	2.47E-04	4.48E-05
Pu-239	1.15E-02	8.00E-03	1.60E-02	6.45E-03	3.62E-03	5.88E-03	2.91E-03	7.68E-03
Ru-103	2.36E-01							
Ru-106	1.10E+00		5.09E-01	1.05E+00	2.53E-01	2.34E+00	4.60E-01	4.24E-01
Sr-90	3.35E-01	3.30E-01	4.19E-01	3.15E-01	2.48E-01	2.39E-01	2.57E-01	3.38E-01
Tc-99	8.90E-01	9.60E-01	7.47E-01	1.48E+00	2.58E+00	9.78E-01	1.25E+00	9.79E-01
Zr-95	6.56E-02	8.90E-03	2.16E-02	7.40E-03	8.57E-03	-7.87E-03	-2.03E-04	5.60E-03

Note: Values are averages for each year with a detection since 1985.

Table 4-12. Summary of Gamma-Ray Logs that were Reviewed.

Waste Management Unit	Well Number	Number of Times Logged	Inclusive Dates
216-A-1 Crib	E25-2		
216-A-2 Crib	E24-53		5/63 to 8/82
216-A-4 Crib	E24-54		5/63 to 9/87
216-A-6 Crib	E25-3		
	E25-53		
216-A-7 Crib	E25-54		
216-A-21 Crib	E24-12		4/70 to 4/76
216-A-26 French Drain	E24-53		5/63 to 8/82
216-A-26A French Drain	E24-54		5/63 to 9/87
216-A-27 Crib	E17-2		5/63 to 7/87
	E17-3		5/63 to 7/86
216-A-30 Crib	E16-2		5/63 to 9/82
	E25-11		5/63 to 10/80
	E25-12		5/63 to 3/90
	(01-30-06)		
	E25-190		10/82 to 3/90
	(01-30-11)		
	E25-191		10/82 to 3/90
	(01-30-23)		
	E25-193		10/82 to 9/90
	(01-30-03)		
216-A-31 Crib	E24-9		5/63 to 9/87
216-A-36A Crib	E17-4		4/68 to 7/87
	(01-36-01)		
	E17-9		4/68 to 4/79
	E17-10		4/70 to 9/86
216-A-36B Crib	E17-5		10/65 to 9/82
	E17-6		7/65 to 4/76
	E17-7		7/65 to 9/88
	(01-36-07)		
	E17-11		9/82 to 9/88
	(01-36-11)		
	E17-51		9/82 to 9/88
	(01-36-06)		

Table 4-12. Summary of Gamma-Ray Logs that were Reviewed.

Waste Management Unit	Well Number	Number of Times Logged	Inclusive Dates
216-A-37-1 Crib	E25-17		12/76 to 3/90
	E25-18		12/76 to 6/88
	(01-37-11)		
	E25-19		12/76 to 9/82
	(01-37-05)		
	E25-20		12/76 to 9/82
216-A-37-2 Crib	E25-21		na
	E25-22		na
	(01-37-22)		
	E25-23		na
	(01-37-17)		
	E25-24		na
216-A-45 Crib	E25-12		
	E25-13		
	E25-53		
	E25-54		

na = not available

Table 4-13. Potential for Migration of Liquid Discharges to the Unconfined Aquifer.

Waste Management Unit	Range of Soil Column Pore Volumes in m3	Liquid Effluent Volume Received in m3	Potential Migration to Unconfined Aquifer
Cribs and Drains			
216-A-1 Crib	660 to 1,980	98	No
216-A-2 Crib	307 to 921	230	No
216-A-3 Crib	317 to 952	3,050	Yes
216-A-4 Crib	316 to 948	6,210	Yes
216-A-5 Crib	975 to 2,925	1,630,049	Yes
216-A-6 Crib	7,675 to 23,024	3,400,102	Yes
216-A-7 Crib	73 to 220	326	Yes
216-A-8 Crib	11,747 to 35,241	1,150,035	Yes
216-A-9 Crib	6,685 to 20,054	981,029	Yes
216-A-10 Crib	9,357 to 28,072	3,210,096	Yes
216-A-21 Crib	791 to 2,373	77,902	Yes
216-A-24 Crib	18,000 to 54,001	820,025	Yes
216-A-27 Crib	1,665 to 4,996	23,201	Yes
216-A-30 Crib	10,586 to 31,758	7,110,213	Yes
216-A-31 Crib	567 to 1,701	10	No
216-A-32 Crib	446 to 1,337	4	No
216-A-36A Crib	910 to 2,729	1,070	Yes
216-A-36B Crib	4,533 to 13,598	317,010	Yes
216-A-37-1 Crib	5,293 to 15,879	377,011	Yes
216-A-37-2 Crib	10,190 to 30,569	1,090,033	Yes
216-A-38 Crib	6,163 to 18,489	ni	ni
216-A-39 Crib	ni	ni	ni
216-A-41 Crib	79 to 237	10	No
216-A-45 Crib	19,358 to 58,074	103,003	Yes
216-A-11 French Drain	4 to 11	100	Yes
216-A-12 French Drain	4 to 11	100	Yes
216-A-13 French Drain	6 to 17	100	Yes
216-A-14 French Drain	4 to 12	1	No
216-A-15 French Drain	10 to 29	10,000	Yes
216-A-16 French Drain	7 to 22	122	Yes
216-A-17 French Drain	7 to 22	60	Yes
216-A-22 French Drain	23 to 68	10	No
216-A-23A French Drain	7 to 22	6	No
216-A-23B French Drain	7 to 22	6	No
216-A-26 French Drain	10 to 31	ni	ni
216-A-26A French Drain	6 to 17	1	No
216-A-28 French Drain	64 to 191	30	No
216-A-33 French Drain	23 to 70	ni	ni
216-A-35 French Drain	23 to 70	10	No
216-C-8 French Drain	20 to 61	10	No
Ponds, Ditches, and Trenches			
216-A-29 Ditch	14,341 to 43,024	10,400,312	Yes
216-A-34 Ditch	3,997 to 11,990	ni	ni
216-A-18 Trench	4,350 to 13,050	488	No
216-A-19 Trench	411 to 1,232	1,100	Yes
216-A-20 Trench	425 to 1,274	961	Yes
216-A-40 Trench	6,072 to 18,215	946	No

ni = no information available

Table 4-14. TRAC Inventory Data.

Total (1/1/90)	A-101 Curies	A-102 Curies	A-103 Curies	A-104 Curies	A-105 Curies	A-106 Curies	AX-101 Curies	AX-102 Curies	AX-103 Curies	AX-104 Curies
1. Ac225	8E-07	6E-07	5E-08	4E-07	4E-09	3E-07	3E-08	1E-08	3E-09	1E-08
2. Ac227	2E-05	1E-04	4E-05	7E-06	3E-06	9E-06	2E-06	8E-08	5E-06	1E-05
3. Am241	1E+03	3E+03	5E+02	8E+02	1E-05	3E+02	3E+01	2E+01	2E+01	1E+02
4. Am242	9E-01	5E+00	9E-01	8E-01	1E-08	2E-01	9E-11	6E-17	3E-02	6E-02
5. Am242m	9E-01	5E+00	9E-01	8E-01	1E-08	2E-01	9E-11	6E-17	3E-02	6E-02
6. Am243	3E-01	2E+00	6E-01	3E-01	4E-09	7E-02	6E-11	1E-17	1E-02	3E-02
7. At217	8E-07	6E-07	5E-08	4E-07	4E-09	3E-07	3E-08	1E-08	3E-09	1E-08
8. Ba135m	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00
9. Ba137m	0E+00	3E+05	2E+04	1E-13	3E+04	3E-04	3E-06	4E-12	2E+04	1E+05
10. Bi210	3E-10	7E-10	1E-10	1E-10	9E-14	2E-10	5E-11	4E-11	6E-12	9E-11
11. Bi211	2E-05	1E-04	4E-05	7E-06	3E-06	9E-06	2E-06	8E-08	5E-06	1E-05
12. Bi213	8E-07	6E-07	5E-08	4E-07	5E-09	3E-07	3E-08	1E-08	3E-09	1E-08
13. Bi214	2E-09	3E-09	5E-10	8E-10	2E-13	1E-09	3E-10	1E-10	3E-11	4E-10
14. C14	0E+00	4E+02	3E+01	7E+02	5E+00	6E-02	1E-01	2E-15	9E+00	9E+01
15. Cm242	8E-01	4E+00	7E-01	7E-01	9E-09	2E-01	7E-11	5E-17	3E-02	5E-02
16. Cm244	0E+00	5E+00	4E+00	2E-20	4E-03	8E-10	5E-10	1E-18	6E-02	2E-01
17. Cm245	0E+00	3E-04	2E-04	7E-25	1E-07	4E-14	3E-14	7E-23	4E-06	1E-05
18. Cs135	0E+00	1E+00	8E-02	7E-19	1E-01	2E-09	1E-11	2E-17	1E-01	3E-01
19. Cs137	0E+00	3E+05	2E+04	1E-13	4E+04	3E-04	3E-06	4E-12	2E+04	1E+05
20. Fr221	8E-07	6E-07	5E-08	4E-07	4E-09	3E-07	3E-08	1E-08	3E-09	1E-08
21. Fr223	3E-07	2E-06	6E-07	1E-07	4E-08	1E-07	3E-08	1E-09	6E-08	1E-07
22. I129	0E+00	3E-01	1E-01	1E-19	1E-02	3E-10	1E-11	3E-18	2E-02	4E-02

Table 4-14. TRAC Inventory Data.

Total (1/1/90)	A-101 Curies	A-102 Curies	A-103 Curies	A-104 Curies	A-105 Curies	A-106 Curies	AX-101 Curies	AX-102 Curies	AX-103 Curies	AX-104 Curies
23. Nb93m	4E+02	3E+02	9E+01	9E+01	1E-01	2E+02	8E+01	4E+01	3E+00	2E+02
24. Ni59	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00
25. Ni63	4E+04	1E+04	2E+04	7E+03	2E-05	4E+04	7E+02	2E+00	3E+02	8E+02
26. Np237	4E-03	3E-01	1E-02	5E-03	4E-02	1E-03	5E-05	4E-05	2E-02	3E-02
27. Np239	3E-01	2E+00	5E-01	3E-01	4E-09	7E-02	6E-11	1E-17	1E-02	3E-02
28. Pa231	9E-05	2E-04	1E-04	3E-05	4E-06	5E-05	1E-05	5E-07	8E-06	2E-05
29. Pa233	4E-03	3E-01	1E-02	5E-03	4E-02	1E-03	5E-05	4E-05	2E-02	3E-02
30. Pa234m	7E+00	1E+00	1E+00	2E+00	5E-09	4E+00	1E+00	4E-02	5E-09	1E-01
31. Pb209	8E-07	6E-07	5E-08	4E-07	4E-09	3E-07	3E-08	1E-08	3E-09	1E-08
32. Pb210	3E-10	6E-10	1E-10	1E-10	9E-14	2E-10	5E-11	4E-11	6E-12	9E-11
33. Pb211	2E-05	1E-04	4E-05	7E-06	3E-06	9E-06	2E-06	8E-08	5E-06	1E-05
34. Pb214	2E-09	3E-09	5E-10	8E-10	2E-13	1E-09	3E-10	1E-10	3E-11	4E-10
35. Pd107	0E+00	6E-01	2E-01	1E-19	3E-02	4E-10	3E-11	6E-18	3E-02	8E-02
36. Po210	3E-10	6E-10	1E-10	1E-10	9E-14	2E-10	5E-11	4E-11	5E-12	8E-11
37. Po213	8E-07	6E-07	5E-08	4E-07	4E-09	3E-07	3E-08	1E-08	3E-09	1E-08
38. Po214	3E-09	4E-09	7E-10	1E-09	2E-13	1E-09	3E-10	1E-10	4E-11	5E-10
39. Po215	2E-05	1E-04	4E-05	7E-06	3E-06	9E-06	2E-06	8E-08	5E-06	1E-05
40. Po218	2E-09	3E-09	5E-10	8E-10	2E-13	1E-09	3E-10	1E-10	3E-11	4E-10
41. Pu238	8E+01	1E+01	2E+01	2E+01	4E-04	5E+01	2E+01	9E+00	2E-03	2E+01
42. Pu239	2E+03	3E+02	3E+02	6E+02	2E-06	1E+03	3E+02	1E+02	3E-05	3E+02
43. Pu240	6E+02	8E+01	9E+01	1E+02	1E-05	3E+02	8E+01	4E+01	1E-04	8E+01
44. Pu241	6E+03	7E+02	1E+03	1E+03	2E-06	3E+03	1E+03	7E-02	9E-05	1E+03

Table 4-14. TRAC Inventory Data.

Total (1/1/90)	A-101 Curies	A-102 Curies	A-103 Curies	A-104 Curies	A-105 Curies	A-106 Curies	AX-101 Curies	AX-102 Curies	AX-103 Curies	AX-104 Curies
45. Ra223	2E-05	1E-04	4E-05	7E-06	3E-06	9E-06	2E-06	8E-08	5E-06	1E-05
46. Ra225	8E-07	6E-07	5E-08	4E-07	4E-09	3E-07	3E-08	1E-08	3E-09	1E-08
47. Ra226	2E-09	3E-09	5E-10	8E-10	2E-13	1E-09	3E-10	1E-10	3E-11	4E-10
48. Ru106	4E-01	3E-01	2E+00	4E-02	1E-07	1E+00	8E+00	7E+00	7E-03	6E+00
49. Sb126	3E+01	1E+02	7E-01	3E+01	1E-07	6E+00	7E-11	2E+01	2E+00	6E+01
50. Sb126m	3E+01	1E+02	7E-01	3E+01	1E-07	6E+00	7E-11	2E+01	2E+00	6E+01
51. Se79	0E+00	6E+00	2E+00	2E-18	3E-01	5E-09	2E-10	4E-17	4E-01	8E-01
52. Sm151	4E+04	1E+05	7E+02	3E+04	9E-05	7E+03	7E-08	1E+04	2E+03	6E+04
53. Sn126	3E+01	1E+02	7E-01	3E+01	1E-07	6E+00	7E-11	2E+01	2E+00	6E+01
54. Sr90	3E+06	7E+06	2E+04	4E+06	3E-02	5E-03	3E-06	1E-10	2E+04	9E+06
55. Tc99	0E+00	2E+02	7E+01	6E-17	1E+01	2E-07	2E-08	1E-15	1E+01	3E+01
56. Th227	2E-05	1E-04	4E-05	7E-06	3E-06	9E-06	2E-06	8E-08	4E-06	9E-06
57. Th229	8E-07	6E-07	5E-08	4E-07	4E-09	3E-07	3E-08	1E-08	3E-09	1E-08
58. Th230	8E-07	5E-07	2E-07	2E-07	3E-12	4E-07	1E-07	4E-08	5E-09	1E-07
59. Th231	3E-01	4E-02	6E-02	8E-02	1E-10	2E-01	5E-02	2E-03	3E-13	6E-03
60. Th233	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00	0E+00
61. Th234	7E+00	1E+00	1E+00	2E+00	5E-09	4E+00	1E+00	4E-02	5E-09	1E-01
62. Tl207	2E-05	1E-04	4E-05	7E-06	3E-06	9E-06	2E-06	8E-08	5E-06	1E-05
63. U233	6E-04	7E-05	5E-05	2E-04	4E-06	2E-04	3E-05	5E-06	9E-07	5E-06
64. U234	8E-03	1E-03	2E-03	2E-03	3E-08	4E-03	2E-03	5E-04	6E-08	1E-03
65. U235	3E-01	4E-02	6E-02	8E-02	1E-10	2E-01	5E-02	2E-03	3E-13	6E-03
66. U238	7E+00	1E+00	1E+00	2E+00	5E-09	4E+00	1E+00	4E-02	5E-09	1E-01

Table 4-14. TRAC Inventory Data.

Total (1/1/90)	C-112 Curies	C-201 Curies	C-202 Curies	C-203 Curies	C-204 Curies
1. AC225	9E-09	1E-11	3E-10	3E-10	5E-14
2. Ac227	1E-05	3E-08	4E-06	4E-07	1E-09
3. Am241	2E+01	1E-02	3E-02	3E-03	9E-06
4. Am242	2E-02	2E-07	5E-07	5E-08	1E-10
5. Am242m	2E-02	2E-07	5E-07	5E-08	1E-10
6. Am243	4E-03	4E-07	1E-06	1E-07	3E-10
7. At217	9E-09	1E-11	3E-10	3E-10	5E-14
8. Ba135m	0E+00	0E+00	0E+00	0E+00	0E+00
9. Ba135m	3E+03	2E+00	4E-13	5E-06	7E-02
10. Bi210	1E-10	1E-12	8E-12	8E-13	3E-15
11. Bi211	1E-05	3E-08	4E-06	4E-07	1E-09
12. Bi213	9E-09	1E-11	3E-10	3E-10	5E-14
13. Bi214	4E-10	4E-12	3E-11	3E-12	1E-14
14. C14	2E+00	5E-05	3E-03	3E-04	2E-06
15. Cm242	2E-02	1E-07	4E-07	4E-08	1E-10
16. Cm244	6E-04	4E-10	1E-22	1E-15	2E-11
17. Cm245	3E-08	5E-15	1E-27	1E-20	2E-16
18. Cs135	1E-02	3E-05	9E-18	8E-11	1E-06
19. Cs137	4E+03	2E+00	4E-13	6E-06	8E-02
20. Fr221	9E-09	1E-11	3E-10	3E-10	5E-14
21. Fr223	2E-07	5E-10	6E-08	6E-09	2E-11
22. I129	1E-03	9E-07	3E-19	3E-12	4E-08

WHC.13F/5-26-92/02265T

Table 4-14. TRAC Inventory Data.

Total (1/1/90)	C-112 Curies	C-201 Curies	C-202 Curies	C-203 Curies	C-204 Curies
23. Nb93m	3E+00	1E-02	5E-02	5E-03	1E-05
24. Ni59	0E+00	0E+00	0E+00	0E+00	0E+00
25. Ni63	2E+03	7E-04	9E-17	2E-09	3E-05
26. Np237	4E-03	2E-06	4E-07	4E-08	9E-08
27. Np239	4E-03	4E-07	1E-06	1E-07	3E-10
28. Pa231	4E-05	8E-08	9E-06	9E-07	3E-09
29. Pa233	4E-03	2E-06	4E-07	4E-08	1E-07
30. Pa234m	1E+00	2E-03	2E-01	2E-02	9E-05
31. Pb209	9E-09	1E-11	3E-10	3E-10	5E-14
32. Pb210	1E-10	1E-12	7E-12	7E-13	3E-15
33. Pb211	1E-05	3E-08	4E-06	4E-07	1E-09
34. Pb214	4E-10	4E-12	3E-11	3E-12	1E-14
35. Pd107	2E-03	9E-07	2E-19	2E-12	4E-08
36. Po210	1E-10	1E-12	7E-12	7E-13	3E-15
37. Po213	9E-09	1E-11	3E-10	3E-10	5E-14
38. Po214	5E-10	5E-12	4E-11	4E-12	1E-14
39. Po215	1E-05	3E-08	4E-06	4E-07	1E-09
40. Po218	4E-10	4E-12	3E-11	3E-12	1E-14
41. Pu238	1E+00	3E-05	1E-04	2E-05	4E-08
42. Pu239	6E+01	2E-02	6E-02	6E-03	2E-05
43. Pu240	1E+01	2E-03	5E-03	5E-04	2E-06
44. Pu241	1E+02	3E-03	7E-03	7E-04	3E-06

WHC.13F/5-26-92/02265T

Table 4-14. TRAC Inventory Data.

Total (1/1/90)	C-112 Curies	C-201 Curies	C-202 Curies	C-203 Curies	C-204 Curies
45. Ra223	1E-05	3E-08	4E-06	4E-07	1E-09
46. Ra225	9E-09	1E-11	3E-10	3E-10	5E-14
47. Ra226	4E-10	4E-12	3E-11	3E-12	1E-14
48. Ru106	5E-04	6E-12	9E-10	8E-11	2E-13
49. Sb126	6E-01	3E-03	8E-03	8E-04	3E-06
50. Sb126m	6E-01	3E-03	8E-03	8E-04	3E-06
51. Se79	3E-02	2E-05	5E-18	5E-11	8E-07
52. Sm151	9E+02	8E+00	2E+01	2E+00	9E-03
53. Sn126	6E-01	3E-03	8E-03	8E-04	3E-06
54. Sr90	4E+04	6E+00	5E-14	6E+02	3E-01
55. Tc99	9E-01	6E-04	2E-16	2E-09	3E-05
56. Th227	1E-05	3E-08	4E-06	4E-07	1E-09
57. Th229	9E-09	1E-11	3E-10	3E-10	5E-14
58. Th230	6E-08	6E-10	5E-09	5E-10	2E-12
59. Th231	6E-02	1E-04	1E-02	1E-03	4E-06
60. Th233	0E+00	0E+00	0E+00	0E+00	0E+00
61. Th234	1E+00	2E-03	2E-01	2E-02	9E-05
62. Tl207	1E-05	3E-08	4E-06	4E-07	1E-09
63. U233	3E-06	5E-10	7E-08	9E-08	2E-11
64. U234	3E-04	3E-07	3E-05	3E-06	1E-08
65. U235	6E-02	1E-04	1E-02	1E-03	4E-06
66. U238	1E+00	2E-03	2E-01	2E-02	9E-05

WHC.13F/5-26-92/02265T

Table 4-14. TRAC Inventory Data.

Total (1/1/90)	C-112 Curies	C-201 Curies	C-202 Curies	C-203 Curies	C-204 Curies
67. Y90	4E+04	6E+00	5E-14	6E+02	3E-01
68. Zr93	4E+00	2E-02	5E-02	5E-03	2E-05
TOTAL CURIES	9.01E+04 9.01E+04	2.41E+01 2.41E+01	2.08E+01 2.08E+01	1.20E+03 1.20E+03	7.59E-01 7.59E-01
TOTAL TRU	83.472424	0.0300864	0.0931118	0.0093212	3.123E-05

Table 4-14. TRAC Inventory Data.

Total (1/1/90)	C-112 Moles	C-201 Moles	C-202 Moles	C-203 Moles	C-204 Moles
69. Ag	1E-07	7E-11	1E-23	2E-16	3E-12
70. Al	4E+05	0E+00	0E+00	0E+00	0E+00
71. Ba	2E+00	6E-03	8E-02	8E-02	1E-05
72. Bi	8E+02	5E-16	1E-14	1E-14	1E-18
73. C2H303	0E+00	0E+00	0E+00	0E+00	0E+00
74. C6H507	0E+00	0E+00	0E+00	0E+00	0E+00
75. CO3	1E+05	2E+02	8E+03	8E+02	7E+00
76. C204	0E+00	0E+00	0E+00	0E+00	0E+00
77. Ca	1E+05	0E+00	0E+00	0E+00	0E+00
78. Cd	0E+00	0E+00	0E+00	0E+00	0E+00
79. Ce	6E+00	0E+00	0E+00	0E+00	0E+00
80. Cl	3E-06	0E+00	0E+00	0E+00	0E+00
81. Cr	1E+02	0E+00	0E+00	0E+00	0E+00
82. EDTA	0E+00	0E+00	0E+00	0E+00	0E+00
83. F	1E+04	0E+00	0E+00	0E+00	0E+00
84. Fe	2E+03	0E+00	0E+00	0E+00	0E+00
85. Fe(CN)6	5E+04	0E+00	0E+00	0E+00	0E+00
86. HEDTA	0E+00	0E+00	0E+00	0E+00	0E+00
87. Hg	0E+00	0E+00	0E+00	0E+00	0E+00
88. K	2E+01	0E+00	0E+00	0E+00	0E+00
89. La	0E+00	0E+00	0E+00	0E+00	0E+00
90. Mn	0E+00	0E+00	0E+00	0E+00	0E+00

Table 4-14. TRAC Inventory Data.

Total (1/1/90)	C-112 Moles	C-201 Moles	C-202 Moles	C-203 Moles	C-204 Moles
91. NO2	4E+04	0E+00	0E+00	0E+00	0E+00
92. NO3	3E+05	1E+01	2E-07	4E-05	6E-01
93. Na	3E+05	4E+02	1E+04	1E+03	4E+01
94. Ni	1E+05	0E+00	0E+00	0E+00	0E+00
95. OH	1E+06	2E+01	9E+01	5E+01	2E+01
96. PO4	9E+03	2E+01	7E-12	7E-05	1E+00
97. Pb	4E-10	9E-13	1E-10	1E-11	4E-14
98. SeO4	0E+00	0E+00	0E+00	0E+00	0E+00
99. SiO3	2E+03	0E+00	0E+00	0E+00	0E+00
100. Sn	0E+00	0E+00	0E+00	0E+00	0E+00
101. SO4	3E+03	3E+01	8E-02	8E-02	1E+00
102. Sr	1E+02	0E+00	0E+00	0E+00	0E+00
103. WO4	0E+00	0E+00	0E+00	0E+00	0E+00
104. ZrO	3E+02	3E-02	1E-02	9E-02	5E-05
105. Volume (kgal)	1E+02	4E+00	1E+00	9E+00	3E+00

Table 4-15. Results of Analysis of Supernatant Liquid from 241-AX-102 Single-Shell Tank.

Analyte	Results	Results (ug/L)
Aluminum	6.00E-03 M	1.60E+05 ug/L
Ammonium	2.50E-02 M	4.50E+04 ug/L
Barium	< 1.00E-04 M	<1.40E+04 ug/L
Bismuth	< 4.00E-04 M	<8.40E+04 ug/L
Boron	2.00E-03 M	2.00E+04 ug/L
Cadmium	< 4.00E-04 M	<4.50E+06 ug/L
Calcium	1.40E-02 M	5.60E+05 ug/L
Carbonate	9.80E-01 M	5.88E+07 ug/L
Cerium	9.00E-04 M	1.30E+05 ug/L
Chromium	4.00E-03 M	2.10E+05 ug/L
Cobalt	< 9.00E-04 M	<5.30E+06 ug/L
Copper	6.00E-04 M	3.80E+06 ug/L
Iron	3.30E-02 M	1.84E+07 ug/L
Lanthanum	4.00E-04 M	5.60E+06 ug/L
Lead	2.00E-03 M	4.10E+05 ug/L
Lithium	< 2.00E-03 M	1.40E+06 ug/L
Magnesium	5.00E-04 M	1.20E+06 ug/L
Manganese	1.10E-02 M	6.00E+05 ug/L
Molybdenum	4.00E-04 M	3.80E+04 ug/L
Neodymium	1.00E-03 M	1.14E+05 ug/L
Nickel	9.00E-03 M	5.30E+05 ug/L
Nitrate	3.70E+00 M	2.30E+08 ug/L
Nitrite	1.40E+00 M	6.40E+07 ug/L
Palladium	6.00E-04 M	6.40E+04 ug/L
pH	11.3	na
Phosphate	< 5.60E-02 M	5.30E+06 ug/L
Phosphorous	2.30E-02 M	7.10E+05 ug/L
Potassium	2.00E-03 M	7.80E+06 ug/L
Silicon	9.00E-04 M	2.50E+04 ug/L
Silver	< 4.00E-03 M	4.00E+05 ug/L
Sodium	7.32E+00 M	1.70E+08 ug/L
Strontium	< 3.00E-04 M	2.60E+04 ug/L
Tantium	< 3.00E-04 M	5.40E+04 ug/L
Tin	< 1.00E-03 M	1.20E+05 ug/L
Titanium	7.00E-05 M	3.40E+03 ug/L
TOC	3.68E+01 g/L	3.68E+07 ug/L
Zinc	1.30E-03 M	8.50E+04 ug/L
Zirconium	1.60E-03 M	1.50E+05 ug/L
Americium	1.00E+03 uCi/L	na
Cesium-137	3.50E+05 uCi/L	na
Cobalt-60	7.10E+02 uCi/L	na
Europium-154	3.50E+03 uCi/L	na
Europium-155	4.70E+03 uCi/L	na
Plutonium	9.70E+01 uCi/L	na
Strontium-90	1.70E+05 uCi/L	na

na = not applicable

Table 4-16. Results of Analysis of Volatile Priority Pollutants in Vapor Samples (ng).

	Tank 241-C-101		Tank 241-C-102	
Analyte	52454-32-A	52454-32-B	52454-32-F	52454-32-G
Benzene	5	6	27	6
Bromodichloromethane	< 5	< 5	< 5	< 5
Bromoform	< 5	< 5	< 5	< 5
Carbon Tetrachloride	< 5	< 5	< 5	< 5
Chlorobenzene	< 5	< 5	< 5	< 5
Chloroform	< 5	< 5	< 5	< 5
Dibromochloromethane	< 5	< 5	< 5	< 5
1,2-Dichloroethane	< 5	< 5	< 5	< 5
1,1-Dichloroethene	< 5	< 5	< 5	< 5
cis-1,2-Dichloroethene	< 5	< 5	< 5	< 5
trans-1,2-Dichloroethene	< 5	< 5	< 5	< 5
1,2-Dichloropropane	< 5	< 5	< 5	< 5
cis-1,3-Dichloropropene	< 5	< 5	< 5	< 5
trans-1,3-Dichloropropene	< 5	< 5	< 5	< 5
Ethylbenzene	< 5	< 5	< 5	< 5
Methylene Chloride	a	a	a	a
1,1,2,2-Tetrachloroethane	< 5	< 5	< 5	< 5
Tetrachloroethene	5	7	51	28
Toluene	19	20	67	26
1,1,1-Trichloroethane	18	17	< 5	< 5
1,1,2-Trichloroethane	< 5	< 5	< 5	< 5
1,1,2-Trichloroethene	< 5	< 5	< 5	< 5
Trichlorofluoromethane	< 5	< 5	< 5	< 5

a - Methylene chloride was found as a contaminant in the internal standard spike at approximately the same levels and found in the sample

Table 4-17. Results of Analysis of Volatile Priority Pollutants in Vapor Samples and a Liquid Sample.

Analyte	Tank 241-C-103			
	52454-4-A (ng)	52454-4-B (ng)	52454-4-C (ng)	52454-3 (ug/L)
Benzene	51	< 25	< 25	< 5
Bromodichloromethane	< 25	< 25	< 25	< 5
Bromoform	< 25	< 25	< 25	< 5
Carbon Tetrachloride	< 25	< 25	< 25	< 5
Chlorobenzene	< 25	< 25	< 25	< 5
Chloroform	< 25	< 25	< 25	< 5
Dibromochloromethane	< 25	< 25	< 25	< 5
1,2-Dichloroethane	< 25	< 25	< 25	< 5
1,1-Dichloroethene	1530	< 25	1240	< 5
cis-1,2-Dichloroethene	< 25	< 25	< 25	< 5
trans-1,2-Dichloroethene	< 25	< 25	< 25	< 5
1,2-Dichloropropane	< 25	< 25	< 25	< 5
cis-1,3-Dichloropropene	< 25	< 25	< 25	< 5
trans-1,3-Dichloropropene	< 25	< 25	< 25	< 5
Ethylbenzene	< 25	< 25	< 25	< 5
Methylene Chloride	< 25	< 25	< 25	< 5
1,1,2,2-Tetrachloroethane	< 25	< 25	< 25	< 5
Tetrachloroethene	< 25	< 25	< 25	< 5
Toluene	53	< 25	< 25	< 5
1,1,1-Trichloroethane	2110	< 25	1722	< 5
1,1,2-Trichloroethane	< 25	< 25	< 25	< 5
1,1,2-Trichloroethene	< 25	< 25	< 25	< 5
Trichlorofluoromethane	190	< 25	130	< 5

Table 4-18. Results of Analysis of a Core Sample from 241-C-103 Single-Shell Tank, Riser R-2.

Analyte	Units	Report Total a/	Maximum Total b/	Drainable Liquor
Aluminum	ug/g	1.53E+04	1.53E+04	< 1.390E+01
Barium	ug/g	4.92E+03	4.92E+03	2.170E+00
Bismuth	ug/g	2.54E+02	6.80E+02	1.610E+02
Boron	ug/g	0.00E+00	0.00E+00	4.480E+00
Cadmium	ug/g	2.19E+02	5.70E+02	< 1.020E+01
Calcium	ug/g	1.07E+04	1.07E+04	1.520E+01
Chromium	ug/g	7.31E+02	7.31E+02	6.660E+01
Cobalt	ug/g	5.42E+01	5.42E+01	
Copper	ug/g	1.53E+03	1.53E+03	1.970E+02
Iron	ug/g	1.05E+05	1.05E+05	9.690E+00
Lead	ug/g	4.33E+03	4.37E+03	< 3.320E+01
Magnesium	ug/g	5.81E+03	5.81E+03	5.490E+00
Manganese	ug/g	2.56E+03	2.56E+03	< 8.200E+01
Nickel	ug/g	3.27E+03	3.27E+03	6.040E+01
Phosphorous	ug/g	4.09E+03	4.09E+03	1.450E+03
Potassium	ug/g	1.45E+03	1.45E+03	3.510E+02
Silicon	ug/g	6.80E+04	6.80E+04	1.290E+02
Silver	ug/g	3.73E+02	3.73E+02	2.360E+01
Sodium	ug/g	4.03E+04	4.03E+04	4.020E+04
Strontium	ug/g	1.38E+02	1.38E+02	4.770E-01
Zinc	ug/g	2.69E+02	2.69E+02	7.300E+00
Zirconium	ug/g	1.55E+04	1.55E+04	3.590E+02
Uranium	ug/g	2.19E+03	2.19E+03	2.630E+00
Nitrate	ug/g	1.79E+03	1.79E+03	7.540E-02
TOC	ug/g	3.90E+03	3.90E+03	7.370E+00
Pu-239, 240	uCi/g	1.90E+01	1.15E+01	3.320E+01
C-14	uCi/g	3.81E-04	3.81E-04	9.690E-01
Sr-90	uCi/g	4.16E+03	4.16E+03	1.950E+03
Tc-99	uCi/g	4.67E-01	4.67E-01	3.700E+01
Am-241	uCi/g	0.00E+00	1.57E+00	< 3.740E+00
Co-60	uCi/g	6.06E+00	6.75E+00	< 5.730E+00
Cs-137	uCi/g	1.39E+02	1.39E+02	2.210E+04
I-129	uCi/g	2.30E-05	2.30E-05	2.700E-01
Total Gamma	uCi/g	2.26E+02	2.26E+02	2.200E+04
Radiation	mR/h	2.00E+03	2.00E+03	7.000E+01

a/ Sum of all values reported greater than limit of confirmation ("less than values" not summed).

b/ Sum of all values reported with limit of confirmation values taken as actual value.

Table 4-19. Results of Analysis of a Core Sample From 241-C-104 Single-Shell Tank.

Analyte	Units	Report Total a/	Maximum Total b/	Drainable Liquor
Aluminum	ug/g	3.01E+04	3.01E+04	
Barium	ug/g	3.90E+03	3.90E+03	
Bismuth	ug/g	3.64E+03	3.70E+03	
Boron	ug/g	1.71E+01	1.71E+01	
Cadmium	ug/g	1.28E+03	1.28E+03	
Calcium	ug/g	1.13E+04	1.13E+04	
Chromium	ug/g	1.12E+03	1.12E+03	
Cobalt	ug/g	1.62E+01	1.62E+01	
Copper	ug/g	1.12E+02	1.12E+02	
Iron	ug/g	2.61E+04	2.61E+04	
Lead	ug/g	8.18E+02	9.98E+02	
Magnesium	ug/g	5.46E+03	5.46E+03	
Manganese	ug/g	3.28E+03	3.30E+03	
Nickel	ug/g	1.91E+03	1.91E+03	
Phosphorous	ug/g	3.13E+03	3.13E+03	
Potassium	ug/g	1.35E+03	1.35E+03	
Silicon	ug/g	5.64E+04	5.64E+04	
Silver	ug/g	4.68E+02	4.69E+02	
Sodium	ug/g	9.55E+04	9.55E+04	
Strontium	ug/g	8.12E+01	8.12E+01	
Zinc	ug/g	1.17E+02	1.17E+02	
Zirconium	ug/g	6.18E+04	6.18E+04	
Uranium	ug/g	2.48E+04	2.48E+04	2.540E-02
Nitrate	ug/g	2.34E+04	2.34E+04	
TOC	ug/g	4.41E+03	4.41E+03	1.030E+01
Pu-239, 240	uCi/g	9.72E+00	8.68E+00	7.730E+00
C-14	uCi/g	6.22E-04	7.66E-04	1.330E+00
Sr-90	uCi/g	3.70E+02	3.70E+02	1.300E+04
Tc-99	uCi/g	2.77E+00	2.77E+00	2.780E+01
Am-241	uCi/g	3.11E+00	3.12E+00	< 8.230E-01
Co-60	uCi/g	5.58E-01	5.58E-01	3.980E+02
Cs-137	uCi/g	3.14E+01	3.14E+01	1.180E+05
I-129	uCi/g	0.00E+00	0.00E+00	
Total Gamma	uCi/g	4.84E+01	4.84E+01	1.180E+05
Radiation	mR/h	1.00E+02	1.00E+02	5.000E+01

a/ Sum of all values reported greater than limit of confirmation ("less than values" not summed).

b/ Sum of all values reported with limit of confirmation values taken as actual value.

Table 4-20. Results of Analysis of a Core Sample from 241-C-105 Single-Shell Tank.

Analyte	Units	Report Total a/	Maximum Total b/	Drainable Liquor
Aluminum	ug/g	6.18E+04	6.18E+04	< 9.020E+00
Barium	ug/g	2.56E+03	2.56E+03	2.660E+00
Bismuth	ug/g	4.80E+02	6.25E+02	1.010E+02
Boron	ug/g	1.23E+01	1.23E+01	3.700E+00
Cadmium	ug/g	0.00E+00	1.58E+02	
Calcium	ug/g	7.79E+03	7.79E+03	4.150E+00
Chromium	ug/g	9.43E+02	9.43E+02	1.120E+03
Cobalt	ug/g	1.03E+01	1.03E+01	
Copper	ug/g	1.55E+02	1.55E+02	3.620E+00
Iron	ug/g	1.06E+04	1.06E+04	3.290E+00
Lead	ug/g	4.63E+02	8.98E+02	< 1.230E+02
Magnesium	ug/g	3.69E+03	3.69E+03	5.670E+00
Manganese	ug/g	2.45E+03	2.47E+03	< 1.360E+01
Nickel	ug/g	2.14E+03	2.15E+03	< 6.150E+00
Phosphorous	ug/g	2.53E+03	2.53E+03	2.563E+03
Potassium	ug/g	1.11E+03	1.11E+03	1.567E+03
Silicon	ug/g	3.99E+04	3.99E+04	1.030E+02
Silver	ug/g	6.69E+01	6.69E+01	< 2.050E+01
Sodium	ug/g	7.18E+04	7.18E+04	1.148E+05
Strontium	ug/g	1.84E+02	1.84E+02	
Zinc	ug/g	1.54E+02	1.54E+02	
Zirconium	ug/g	7.03E+02	7.15E+02	3.640E+02
Uranium	ug/g	1.27E+04	1.27E+04	9.660E-01
Nitrate	ug/g	1.05E+04	1.05E+04	5.530E-01
TOC	ug/g	9.99E+02	9.99E+02	2.870E+00
Pu-239, 240	uCi/g	3.06E+00	2.90E+00	3.320E+01
C-14	uCi/g	6.55E-04	8.57E-04	2.820E+00
Sr-90	uCi/g	8.64E+02	8.64E+02	5.120E+03
Tc-99	uCi/g	1.05E-01	1.05E-01	2.580E+02
Am-241	uCi/g	1.50E+00	1.51E+00	< 5.700E+00
Co-60	uCi/g	7.34E-01	7.35E-01	< 1.660E+01
Cs-137	uCi/g	1.47E+02	1.47E+02	4.420E+05
I-129	uCi/g	1.20E-04	1.20E-04	2.700E-01
Total Gamma	uCi/g	1.62E+02	1.62E+02	4.480E+05
Radiation	mR/h	1.00E+02	1.00E+02	2.000E+02

a/ Sum of all values reported greater than limit of confirmation ("less than values" not summed).

b/ Sum of all values reported with limit of confirmation values taken as actual value.

Table 4-21. Results of Analysis of a Sludge Sample from 241-C-106 Single-Shell Tank.

Analyte	Units	Sample	Blank
Aluminum	g/Kg	110	< 1
Antimony	mg/Kg	< 50	< 50
Arsenic	mg/Kg	37	< 10
Barium	mg/Kg	345	7
Beryllium	mg/Kg	0.72	< 0.2
Cadmium	mg/Kg	48	< 2
Calcium	mg/Kg	1,480	53
Chromium	mg/Kg	1,560	< 2
Cobalt	mg/Kg	9.7	< 5
Copper	mg/Kg	227	< 5
Cyanide	mg/Kg	60	na
Iron	g/Kg	78.2	< 0.1
Lead	mg/Kg	2,750	< 200
Magnesium	mg/Kg	372	< 29
Manganese	mg/Kg	4,130	< 2
Mercury	mg/Kg	327	< 1
Nickel	mg/Kg	1,450	< 7
Selenium	mg/Kg	< 10	< 1
Silicon	mg/Kg	2,580	116
Silver	mg/Kg	104	5
Sodium	g/Kg	16.1	0.4
Thallium	mg/Kg	< 10	< 10
Zinc	mg/Kg	113	7
Zirconium	mg/Kg	33.8	< 5
Fluoride	mg/Kg	205	< 3
Chloride	mg/Kg	255	< 3
Nitrite	mg/Kg	26,320	6
Nitrate	mg/Kg	1,690	< 26
Phosphate	mg/Kg	1,170	< 13
Sulfate	mg/Kg	5,170	< 26
TIC	mg/Kg	18,900	178
TOC	mg/Kg	7,500	385
Total Alpha	uCi/kg	7.8	
Total Beta	uCi/kg	9,330	
Sr-90	uCi/g	4,030	
Tc-99	uCi/g	0.055	
Co-60	uCi/g	1.15	
Cs-137	uCi/g	536	
Sb-125	uCi/g	6.49	
Eu-154	uCi/g	14.4	

Table 4-22. Results of Analysis of a Sludge Sample from 241-C-105 Single-Shell Tank.

Analyte	Units	241-C-105
Sr	uCi/g	1.49E+04
Cs-137	uCi/g	1.73E+03
Cs-134	uCi/g	1.80E+01
Ce-144 and Pr-144	uCi/g	1.08E+02
Eu-154	uCi/g	2.40E+01
Eu-155	uCi/g	7.90E+01
Sb-125	uCi/g	2.60E+01
Ru-106	uCi/g	1.30E+01
Zr-98	uCi/g	3.00E+00
Co-57	uCi/g	1.10E+01
Co-60	uCi/g	1.30E+01

9 2 1 2 5 4 6 0 4 1 4

Table 4-23. Sampling Analysis of Complexed Double-Shell Tanks.

Analyte	241-AY-101 Liquid	241-AZ-102 Total	241-AZ-102 Filtrate
Sodium	5.47	7.1	8.14
Aluminum	0.315	0.06	0.025
Fluorine	0.028	0.0546	0.0165
EDTA	0.0046	0.072	0.0585
HEDTA	0.025	0.211	0.206

Table 4-24. Summary of Tank Farm Vadose Zone Well Geophysical Logging Results.

Single-Shell Tank	Number of Assoc. Dry Wells	Geophysical Evidence of Leaking ?	Comments
A Tank Farm			
241-A-101	18	No	High levels of activity in fill attributed to surface source
241-A-102	7	Yes	Recent appearance of low activity levels on two intervals beneath tank
241-A-103	7	Yes	Persistent low activity levels found on fixed interval beneath tank
241-A-104	7	No	Tank is classified as a confirmed leaker
241-A-105	7	Yes	Thick interval of elevated radiation associated with known leak
241-A-106	7	No	
AX Tank Farm			
241-AX-101	7	No	
241-AX-102	10	Yes	Near surface elevated radiation attributed to leak from tank ventilation system
241-AX-103	6	No	Thick interval of elevated radiation in the near surface with unknown source
241-AX-104	7	Yes	Elevated levels attributed to leaking tank have reached background levels
C Tank Farm			
241-C-101	4	Yes	Elevated radiation found on two intervals beneath tank attributed to leaking tank
241-C-102	0	No	No monitoring wells in place
241-C-103	5	Yes	Two intervals of elevated radiation, upper has possible surface source near background levels detected on lower interval have unknown source
241-C-104	7	No	Elevated radiation in two areas attributed to near surface sources
241-C-105	9	No	Region of elevated radiation attributed to tank overflow
241-C-106	6	No	No comment
241-C-107	7	No	No comment
241-C-108	3	No	Area of elevated radiation attributed to migration of surface contamination
241-C-109	6	Yes	Three areas of elevated radiation, two attributed to migration of surface contamination, one of unknown origin
241-C-110	4	Yes	Small region of elevated radiation attributed to leaking tank
241-C-111	5	No	Tank is an assumed leaker
241-C-112	4	No	Region of elevated radiation attributed to leaking transfer line
241-C-201	0	No	Tank is an assumed leaker, no monitoring wells in place
241-C-202	0	No	Tank is an assumed leaker, no monitoring wells in place
241-C-203	0	No	Tank is an assumed leaker, no monitoring wells in place
241-C-204	0	No	Tank is an assumed leaker, no monitoring wells in place

Source: Welty et al, 1988.

Table 4-25. Cesium Inventories for Tank Leak Unplanned Releases.

Unplanned Release	Tank	Gallons/Liters Leaked	Cesium-137
UPR-200-E-125	241-A-104	2,500 / 9,450	18000 Ci
UPR-200-E-126	241-A-105	5,000 / 18,900	ni
UPR-200-E-136	241-C-101	24,000 / 90,720	2000 Ci
UPR-200-E-137	241-C-203	400 / 1,512	ni

ni = no information available

Table 4-26. Results of Groundwater Sampling for the 216-A-36B Crib (mg/L).

Analyte	Well No. 299-E-17-5	Well No. 299-E-27-7	Well No. 299-E-28-18
Aluminum	< 0.03	< 0.03	< 0.03
Boron	0.017	< 0.01	< 0.01
Barium	0.035	0.005	0.012
Calcium	81.4	25.2	70.4
Iron	0.02	0.02	0.01
Potassium	9.7	5.3	5.0
Lithium	0.01	< 0.01	0.01
Magnesium	24.3	7.2	16.2
Manganese	0.003	0.002	0.007
Sodium	32.7	10.3	27.6
Silicon	21.2	17.8	19.4
Strontium	0.41	0.11	0.24
Ammonium	0.123	< 0.04	0.134
Chloride	5.8	4.6	11
Nitrate	240	1.9	48
Sulfate	40	16	120
Alkalinity (as CO3)	60.72	57.9	66.2
Conductivity (S/cm)	776	233	580
pH (laboratory)	7.80	8.05	7.91
pH (field)	7.7	7.90	7.35
Eh (mv)	397	391	394
Temperatrue (C)	20.5	20.5	20.8
Titrium (Ci/L)	1.8	< 0.02	< 0.02
Cations (meq/L)	7.74	2.44	6.18
Anions (meq/L)	6.89	2.42	5.79

Samples taken on 9/25/87.
Source: Buelt et al. 1988.

Table 4-27. Waste Inventory for the 216-A-36B Crib.

Date	Volume	Pu (g)	Beta (Ci)	Sr-90 (Ci)	Ru-106 (Ci)	Cs-137 (Ci)	U-238 (Kg)
1966	4.19E+06	7.00E+01	4.20E+03	6.00E+01	2.00E+02	5.80E+01	5.00E+01
1967	4.94E+06	1.39E+01	5.00E+03	2.50E+01	7.00E+01	1.50E+01	1.03E+01
1968	1.26E+07	1.94E+01	9.28E+02	1.40E+01	1.61E+02	1.48E+01	1.83E+01
1969	1.78E+07	7.20E+00	1.79E+03	9.91E+01	4.54E+02	1.10E+02	1.00E+01
1970	9.00E+06	3.58E+00	1.13E+04	2.29E+02	1.67E+03	1.31E+02	2.62E+01
1971	2.27E+07	< 1.49E+01	7.01E+03	< 2.11E+01	3.28E+03	7.01E+01	2.09E+00
1972	2.28E+07	4.81E+01	3.28E+03	9.84E+01	7.73E+02	1.65E+02	1.95E+00
Total Decayed through 1981	9.40E+07	1.77E+02	< 1.72E+03	4.08E+02	4.07E+00	4.27E+02	1.19E+02
1983	1.00E+07	3.68E+01	1.88E-01	2.28E-02	na	6.59E-02	4.13E+01
1984	4.78E+07	2.21E+01	1.54E+01	3.53E-02	7.08E+00	4.05E-01	< 3.81E-01
1985	7.54E+07	2.66E-01	4.68E+01	2.42E+00	2.54E+01	7.49E-01	ni
1986	5.66E+07	3.50E-02	4.77E+01	2.11E-01	2.38E+00	3.48E-01	ni
1987	2.82E+07	2.37E-03	7.87E-01	2.49E-02	4.30E-01	9.32E-02	ni

na = Values not available
ni = No information found
Source: WHC, 1988b

Table 4-28. Average Concentrations of Radiological Parameters for PUREX (ASD) Waste Effluent and Groundwater Near the 216-A-36B Crib from 1983 through 1987.

1983	Total Alpha (pCi/ml)	Total Beta (pCi/ml)	Tritium (pCi/ml)	Sr-90 (pCi/ml)	Cs-137 (pCi/ml)	Ru-106 (pCi/ml)	Co-60 (pCi/ml)	Uranium (pCi/ml)	Nitrate (mg/L)
PUREX (ASD)	1.61E+00	1.88E+01	5.63E+02	2.28E+00	6.59E+00	na	na	1.38E+00	na
Monitoring Wells									
299-E17-5	1.39E-02	4.59E-02	5.01E+02	1.04E-02	3.91E-03	1.36E-02	2.47E-03	7.69E-03	2.50E+01
299-E17-9	1.19E-03	4.09E-02	7.02E+03	4.24E-03	5.43E-03	4.97E-03	2.8E-03	na	1.06E+02

1984	Total Alpha (pCi/ml)	Total Beta (pCi/ml)	Tritium (pCi/ml)	Sr-90 (pCi/ml)	Cs-137 (pCi/ml)	Ru-106 (pCi/ml)	Co-60 (pCi/ml)	Uranium (pCi/ml)	Nitrate (mg/L)
PUREX (ASD)	9.00E-02	3.00E+02	5.00E+03	1.62E+01	7.00E-01	8.00E+00	na	2.00E+02	BDL
Monitoring Wells									
299-E17-5	4.45E-03	5.95E-02	1.06E+03	4.47E+01	3.31E-03	1.35E-03	1.75E-03	1.97E-02	5.15E-03
299-E17-9	a	4.05E-02	3.03E+03	7.33E+01	6.75E-03	1.98E-03	6.51E-03	2.69E-02	a

1985	Total Alpha (pCi/ml)	Total Beta (pCi/ml)	Tritium (pCi/ml)	Sr-90 (pCi/ml)	Cs-137 (pCi/ml)	Ru-106 (pCi/ml)	Co-60 (pCi/ml)	Uranium (pCi/ml)	Nitrate (mg/L)
PUREX (ASD)	< 4E+02	6E+05	3E+06	na	3E+04	1E+04	na	3E+05	nn
Monitoring Wells									
299-E17-5	8.29E+00	3.28E+01	2.03E+06	9.18E+01	3.14E+00	-4.65E-01	2.11E+00	-5.24E+00	1.17E+01
299-E17-9	3.54E+00	2.71E+01	4.68E+06	1.40E+02	4.17E+00	-4.87E-02	1.96E+00	1.32E+01	5.24E+00

1986	Total Alpha (pCi/ml)	Total Beta (pCi/ml)	Tritium (pCi/ml)	Sr-90 (pCi/ml)	Cs-137 (pCi/ml)	Ru-106 (pCi/ml)	Co-60 (pCi/ml)	Uranium (pCi/ml)	Nitrate (mg/L)
PUREX (ASD)	3.71E+02	8.44E+05	2.42E+06	na	3.72E+03	6.14E+03	na	4E+05	nn
Monitoring Wells									
299-E17-5	9.18E+00	3.37E+01	3.88E+06	9.90E+01	2.84E+00	5.55E-01	1.51E+00	5.48E+00	6.60E+00
299-E17-9	3.90E+00	2.10E+01	5.84E+06	1.38E+02	3.67E+00	9.24E-01	-1.90E-01	1.31E+01	nn

Table 4-28. Average Concentrations of Radiological Parameters for PUREX (ASD) Waste Effluent and Groundwater Near the 216-A-36B Crib from 1983 through 1987.

1987	Total Alpha (pCi/ml)	Total Beta (pCi/ml)	Tritium (pCi/ml)	Sr-90 (pCi/ml)	Cs-137 (pCi/ml)	Ru-106 (pCi/ml)	Co-60 (pCi/ml)	Uranium (pCi/ml)	Nitrate (mg/L)
Monitoring Wells									
299-E17-5	6.68E+00	1.75E+02	4.42E+06	9.78E+01	2.78E+00	9.65E-01	1.22E+01	9.28E+01	8.16E+00
299-E17-9	3.26E+00	2.32E+01	5.53E+06	1.54E+02	3.33E+00	-1.49E+00	-1.53E+00	1.91E+01	3.61E+00

na = No analysis for this constituent.

BDL = Below detectable limit.

nn = Analyses not necessary (as determined from inventory, effluent history, or gross alpha/beta analyses).

Source: WHC, 1988b

Table 4-29. Groundwater Parameters Measured in Monitoring Wells for the 216-A-36B Crib.

Well	Date	Ammonia (ppm)	Fluoride (ppm)	Nitrate (ppm)	pH	TOC (ppm)	Chloride (ppm)	Conductivity (mho/cm)
299-E17-5	4-Mar-87	< 0.050	< 0.050	99.8	7.85	0.516	6.87	452
	9-Apr-87	< 0.050	< 0.050	89.5	7.62	0.763	6.83	435
	20-Jul-87	0.064	0.675	118.0	7.77	0.531	6.22	422
	10-Oct-87	< 0.050	< 0.050	261.0	na	na	na	na
299-E17-9	4-Mar-87	< 0.050	< 0.050	171.0	7.63	0.414	8.31	639
	9-Apr-87	< 0.050	< 0.050	153.0	7.50	0.455	6.87	728
	20-Jul-87	< 0.050	0.812	128.0	7.54	0.466	6.95	477
	10-Oct-87	< 0.050	< 0.050	123.0	na	na	na	na

na = Not received from the laboratory at the time the report was prepared.

Source: WHC, 1988b

Table 4-30. Candidate Contaminants of Potential Concern for the PUREX Plant Aggregate Area.

RADIONUCLIDES

Gross alpha
Gross beta

TRANSURANICS

Americium-241
Americium-242
Americium-242m
Americium-243
Curium-242
Curium-244
Curium-245
Neptunium-237
Neptunium-239
Plutonium-238
Plutonium-239/240
Plutonium-241

URANIUM

Uranium-233
Uranium-234
Uranium-235
Uranium-238

FISSION PRODUCTS

Actinium-225
Actinium-227
Antimony-126
Antimony-126m
Astitine-217*
Barium-135m*
Barium-137m
Beryllium-7*
Bismuth-210
Bismuth-211
Bismuth-213
Bismuth-214
Carbon-14
Cerium-141*
Cerium-144*
Cesium-134
Cesium-135
Cesium-137
Cobalt-58*
Cobalt-60
Europium-152

FISSION PRODUCTS (Cont.)

Europium-154
Europium-155
Francium-221
Francium-223*
Iodine-129
Lead-209
Lead 210
Lead 211
Lead-212*
Lead-214
Manganese-54*
Nickel-59
Nickel 63
Niobium-93m
Palladium-107*
Polonium-210
Polonium-213*
Polonium-214
Polonium-215
Polonium-218
Potassium-40
Promethium-147*
Protactinium-231
Protactinium-233*
Protactinium-234m*
Radium
Radium-223
Radium-225
Radium-226
Ruthenium-103*
Ruthenium-106
Samarium-151
Selenium-79
Strontium-90
Technetium-99
Thallium-207
Thallium-208*
Thorium-227
Thorium-229
Thorium-230
Thorium-231
Thorium-233*
Thorium-234
Tin-113*
Tin-126*
Tritium
Yttrium-90
Zinc-65*
Zirconium-93
Zirconium-95*

HEAVY METALS

Aluminum
Arsenic
Barium
Beryllium
Bismuth
Cadmium
Cerium
Chromium
Copper
Gold
Iron
Lanthanum
Lead
Manganese
Mercury
Nickel
Selenium
Silver
Strontium
Tin
Uranium
Vanadium
Zinc

OTHER INORGANICS

Aluminum nitrate
Ammonium carbonate
Ammonium fluoride
Ammonium nitrate
Bismuth phosphate
Boron
Cadmium nitrate
Calcium
Carbonate
Chloride
Cyanide
Ferric cyanide
Ferric nitrate
Ferrous sulfamate
Fluoride
Hydrazine
Hydrogen peroxide
Hydroxide
Hydroxylamine nitrate

Table 4-30. Candidate Contaminants of Potential Concern for the PUREX Aggregate Area.

OTHER INORGANICS (Cont.)	SEMIVOLATILE ORGANICS
Magnesium	Ethylene diamine tetraacetate (EDTA)
Nitrate	Gylcolate
Nitric acid	N-(2-hydroxyethyl) ethylenediaminetriacetate (HEDTA)
Nitrite	Oxalate
Phosphate	Oxalic Acid
Potassium	Paraffin hydrocarbons
Potassium fluoride	Sugar (sucrose)
Potassium hydroxide	Tartaric acid
Potassium permanganate	Tributyl phosphate
Selenium tetroxide (SeO_4)	
Silicon trioxide (SiO_3)	
Silver nitrate	
Sodium	
Sodium carbonate	
Sodium dichromate	
Sodium nitrate	
Sodium nitrite	
Sodium thiosulfate	
Sulfamic acid	
Sulfate	
Sulfuric acid	
Tungsten tetroxide (WO_4)	
Zirconium oxide	
VOLATILE ORGANICS	
Acetone	
Chloroform	
Methylene chloride	
Toluene	

* The radionuclide has a half-life of <1 year and if it is a daughter product, the parent has a half-life of <1 year, or the buildup of the short-lived daughter would result in an activity of <1% of the parent radionuclide's initial activity.

Table 4-31. Summary of Known and Suspected Contamination at Each Waste Management Unit and Unplanned Release Site.

Waste Management Unit		TRU	Fission Products	Uranium	Heavy Metals	Other Inorganics	Volatiles	Semi-Volatiles
Plants, Buildings, and Storage Areas								
204-AR Waste Unloading Station								
241-A-431 Ventilation Building								
241-C-801 Support Facility								
242-A Evaporator								
Grout Treatment Facility								
244-AR Lift Station		K	K	S	S	S	S	S
Tanks and Vaults								
241-A-101	Single-Shell Tank	K	K	K	K	K	K	K
241-A-102	Single-Shell Tank	K	K	K	K	K	K	K
241-A-103	Single-Shell Tank	K	K	K	K	K	K	K
241-A-104	Single-Shell Tank	K	K	K	K	K	K	K
241-A-105	Single-Shell Tank	K	K	K	K	K	K	K
241-A-106	Single-Shell Tank	K	K	K	K	K	K	K
241-AN-101	Double-Shell Tank	K	K	K	K	K	K	K
241-AN-102	Double-Shell Tank	K	K	K	K	K	K	K
241-AN-103	Double-Shell Tank	K	K	K	K	K	K	K
241-AN-104	Double-Shell Tank	K	K	K	K	K	K	K
241-AN-105	Double-Shell Tank	K	K	K	K	K	K	K
241-AN-106	Double-Shell Tank	K	K	K	K	K	K	K
241-AN-107	Double-Shell Tank	K	K	K	K	K	K	K
241-AP-101	Double-Shell Tank	K	K	K	K	K	K	K
241-AP-102	Double-Shell Tank	K	K	K	K	K	K	K
241-AP-103	Double-Shell Tank	K	K	K	K	K	K	K
241-AP-104	Double-Shell Tank	K	K	K	K	K	K	K
241-AP-105	Double-Shell Tank	K	K	K	K	K	K	K
241-AP-106	Double-Shell Tank	K	K	K	K	K	K	K
241-AP-107	Double-Shell Tank	K	K	K	K	K	K	K
241-AP-108	Double-Shell Tank	K	K	K	K	K	K	K
241-AW-101	Double-Shell Tank	K	K	K	K	K	K	K
241-AW-102	Double-Shell Tank	K	K	K	K	K	K	K

Table 4-31. Summary of Known and Suspected Contamination at Each Waste Management Unit and Unplanned Release Site.

Waste Management Unit		TRU	Fission Products	Uranium	Heavy Metals	Other Inorganics	Volatiles	Semi-Volatiles
241-AW-103	Double-Shell Tank	K	K	K	K	K	K	K
241-AW-104	Double-Shell Tank	K	K	K	K	K	K	K
241-AW-105	Double-Shell Tank	K	K	K	K	K	K	K
241-AW-106	Double-Shell Tank	K	K	K	K	K	K	K
241-AX-101	Single-Shell Tank	K	K	K	K	K	K	K
241-AX-102	Single-Shell Tank	K	K	K	K	K	K	K
241-AX-103	Single-Shell Tank	K	K	K	K	K	K	K
241-AX-104	Single-Shell Tank	K	K	K	K	K	K	K
241-AY-102	Double-Shell Tank	K	K	K	K	K	K	K
241-AY-103	Double-Shell Tank	K	K	K	K	K	K	K
241-AZ-102	Double-Shell Tank	K	K	K	K	K	K	K
241-AZ-103	Double-Shell Tank	K	K	K	K	K	K	K
241-C-101	Single-Shell Tank	K	K	K	K	K	K	K
241-C-102	Single-Shell Tank	K	K	K	K	K	K	K
241-C-103	Single-Shell Tank	K	K	K	K	K	K	K
241-C-104	Single-Shell Tank	K	K	K	K	K	K	K
241-C-105	Single-Shell Tank	K	K	K	K	K	K	K
241-C-106	Single-Shell Tank	K	K	K	K	K	K	K
241-C-107	Single-Shell Tank	K	K	K	K	K	K	K
241-C-108	Single-Shell Tank	K	K	K	K	K	K	K
241-C-109	Single-Shell Tank	K	K	K	K	K	K	K
241-C-110	Single-Shell Tank	K	K	K	K	K	K	K
241-C-111	Single-Shell Tank	K	K	K	K	K	K	K
241-C-112	Single-Shell Tank	K	K	K	K	K	K	K
241-C-201	Single-Shell Tank	K	K	K	K	K	K	K
241-C-202	Single-Shell Tank	K	K	K	K	K	K	K
241-C-203	Single-Shell Tank	K	K	K	K	K	K	K
241-C-204	Single-Shell Tank	K	K	K	K	K	K	K
241-A-302A	Catch Tank	S	S	S	S	S	S	S
241-A-302B	Catch Tank	S	S	S	S	S	S	S
241-A-350	Catch Tank	S	S	S	S	S	S	S

Table 4-31. Summary of Known and Suspected Contamination at Each Waste Management Unit and Unplanned Release Site.

Waste Management Unit		TRU	Fission Products	Uranium	Heavy Metals	Other Inorganics	Volatiles	Semi-Volatiles
241-A-417	Catch Tank	S	S	S	S	S	S	S
241-AX-152CT	Catch Tank	S	S	S	S	S	S	S
241-C-301C	Catch Tank	S	S	S	S	S	S	S
244-A	Receiving Vault	S	S	S	S	S	S	S
244-AR	Vault	S	S	S	S	S	S	S
244-CR	Vault	S	S	S	S	S	S	S
Cribs and Drains								
216-A-1	Crib	K	K	K	K	S	S	S
216-A-2	Crib	K	K	K	S	S	K	K
216-A-3	Crib	K	K	K	S	S	S	S
216-A-4	Crib	K	K	K	K	K	S	S
216-A-5	Crib	K	K	K	S	K	S	S
216-A-6	Crib	K	K	K	S	K	S	S
216-A-7	Crib	K	K	K	S	S	K	K
216-A-8	Crib	K	K	K	S	S	K	K
216-A-9	Crib	K	K	K	S	K	S	S
216-A-10	Crib	K	K	K	S	S	S	S
216-A-21	Crib	K	K	K	K	K	S	S
216-A-24	Crib	K	K	K	S	K	K	K
216-A-26	Crib	S	S	S	S	S	S	S
216-A-27	Crib	K	K	K	K	K	S	S
216-A-30	Crib	K	K	K	S	K	S	S
216-A-31	Crib	K	K	K	S	S	K	K
216-A-32	Crib	S	S	S	S	S	S	S
216-A-36A	Crib	S	S	S	S	S	S	S
216-A-36B	Crib	S	S	S	S	S	S	S
216-A-37-1	Crib	K	K	K	S	K	S	S
216-A-37-2	Crib	K	K	K	S	S	S	S
216-A-38-1	Crib	S	S	S	S	S	S	S
216-A-39	Crib	S	S	S	S	K	S	S
216-A-41	Crib	S	S	S	S	K	S	S

Table 4-31. Summary of Known and Suspected Contamination at Each Waste Management Unit and Unplanned Release Site. Page 4 of 8

Waste Management Unit		TRU	Fission Products	Uranium	Heavy Metals	Other Inorganics	Volatiles	Semi-Volatiles
216-A-45	Crib	K	K	K	S	S	S	S
216-A-11	French Drain	S	S	S	S	K	S	S
216-A-12	French Drain	S	S	S	S	K	S	S
216-A-13	French Drain	S	S	S	S	K	S	S
216-A-14	French Drain	S	S	S	S	K	S	S
216-A-15	French Drain	S	S	S	S	K	S	S
216-A-16	French Drain	S	S	S	S	K	S	S
216-A-17	French Drain	S	S	S	S	K	S	S
216-A-22	French Drain	S	S	S	S	K	S	S
216-A-23A	French Drain	S	S	S	S	K	S	S
216-A-23B	French Drain	S	S	S	S	K	S	S
216-A-26A	French Drain	S	S	S	S	K	S	S
216-A-28	French Drain	S	S	S	S	K	S	S
216-A-33	French Drain	S	S	S	S	S	S	S
216-A-35	French Drain	S	S	S	S	K	S	S
216-C-8	French Drain	S	S	S	S	K	S	S
Reverse Wells								
299-E24-111	Injection Well							
Ponds, Ditches, and Trenches								
216-A-29	Ditch	S	S	S	S	S	S	S
216-A-34	Ditch	S	S	S	S	S	S	S
216-A-18	Trench	K	K	K	S	K	S	S
216-A-19	Trench	K	K	K	S	K	S	S
216-A-20	Trench	K	K	K	S	K	S	S
216-A-40	Trench	S	S	S	S	K	S	S
Septic Tanks and Associated Drain Fields								
2607-EA	Septic Tank							
2607-EC	Septic Tank							
2607-ED	Septic Tank							
2607-EG	Septic Tank							
2607-EJ	Septic Tank							

Table 4-31. Summary of Known and Suspected Contamination at Each Waste Management Unit and Unplanned Release Site.

Waste Management Unit		TRU	Fission Products	Uranium	Heavy Metals	Other Inorganics	Volatiles	Semi-Volatiles
2607-EL	Septic Tank							
2607-E6	Septic Tank							
Transfer Facilities, Diversion Boxes, and Pipelines								
216-A-524	Control Structure	S	S	S	S			
241-AX-501	Valve Pit	S	S	S	S	S	S	S
241-A-A	Diversion Box	S	S	S	S	S	S	S
241-A-B	Diversion Box	S	S	S	S	S	S	S
241-A-151	Diversion Box	S	S	S	S	S	S	S
241-A-152	Diversion Box	S	S	S	S	S	S	S
241-A-153	Diversion Box	S	S	S	S	S	S	S
241-AN-A	Diversion Box	S	S	S	S	S	S	S
241-AN-B	Diversion Box	S	S	S	S	S	S	S
241-AR-151	Diversion Box	S	S	S	S	S	S	S
241-AW-A	Diversion Box	S	S	S	S	S	S	S
241-AW-B	Diversion Box	S	S	S	S	S	S	S
241-AX-A	Diversion Box	S	S	S	S	S	S	S
241-AX-B	Diversion Box	S	S	S	S	S	S	S
241-AX-151	Diversion Box	S	S	S	S	S	S	S
241-AX-152DS	Diversion Box	S	S	S	S	S	S	S
241-AX-155	Diversion Box	S	S	S	S	S	S	S
241-AY-151	Diversion Box	S	S	S	S	S	S	S
241-AY-152	Diversion Box	S	S	S	S	S	S	S
241-AZ-151DS	Diversion Box	S	S	S	S	S	S	S
241-AZ-152	Diversion Box	S	S	S	S	S	S	S
241-C-151	Diversion Box	S	S	S	S	S	S	S
241-C-152	Diversion Box	S	S	S	S	S	S	S
241-C-153	Diversion Box	S	S	S	S	S	S	S
241-C-252	Diversion Box	S	S	S	S	S	S	S
241-CR-151	Diversion Box	S	S	S	S	S	S	S
241-CR-152	Diversion Box	S	S	S	S	S	S	S
241-CR-153	Diversion Box	S	S	S	S	S	S	S

Table 4-31. Summary of Known and Suspected Contamination at Each Waste Management Unit and Unplanned Release Site.

Waste Management Unit		TRU	Fission Products	Uranium	Heavy Metals	Other Inorganics	Volatiles	Semi-Volatiles
241-ER-153	Diversion Box	S	S	S	S	S	S	S
241-AP-501	Valve Pit	S	S	S	S	S	S	S
Retention Basins								
207-A	Retention Basins	S	S	S	S	S	S	S
216-A-42	Retention Basin	S	S	S	S	S	S	S
Burial Sites								
218-E-1	Burial Ground	K	K	K				
218-E-8	Burial Ground	K	K	K				
218-E-12A	Burial Ground	K	K	K				
218-E-12B	Burial Ground	S	K	S				
218-E-13	Burial Ground	S	S	S				
200-E	Burning Pit	S	S	S	K	K	K	K
Unplanned Releases								
UN-200-E-10	Unplanned Release	S	S	S	S			
UN-200-E-11	Unplanned Release		S					
UN-200-E-12	Unplanned Release	S	S	S	S			
UN-200-E-13	Unplanned Release	S	S	S	S	S	S	S
UN-200-E-15	Unplanned Release	S	S	S	S			
UN-200-E-16	Unplanned Release	S	S	S	S			
UN-200-E-18	Unplanned Release	S	S	S	S	S	S	S
UN-200-E-19	Unplanned Release	S	S	S	S	S	S	S
UN-200-E-20	Unplanned Release	S	S	S	S			
UN-200-E-22	Unplanned Release		S					
UN-200-E-25	Unplanned Release	S	S	S	S			
UN-200-E-26	Unplanned Release	S	S	S	S			
UN-200-E-27	Unplanned Release	S	S	S	S			
UN-200-E-28	Unplanned Release		S					
UN-200-E-31	Unplanned Release	S	S	S	S			
UN-200-E-33	Unplanned Release	S	S	S	S			
UN-200-E-35	Unplanned Release		S					
UN-200-E-39	Unplanned Release		S			S	S	S

Table 4-31. Summary of Known and Suspected Contamination at Each Waste Management Unit and Unplanned Release Site.

Waste Management Unit		TRU	Fission Products	Uranium	Heavy Metals	Other Inorganics	Volatiles	Semi-Volatiles
UN-200-E-40	Unplanned Release	S	S	S	S			
UN-200-E-42	Unplanned Release	S	S	S	S			
UN-200-E-47	Unplanned Release	S	S	S	S			
UN-200-E-48	Unplanned Release	S	S	S	S			
UN-200-E-49	Unplanned Release	S	S	S	S			
UN-200-E-56	Unplanned Release	S	S	S	S			
UN-200-E-58	Unplanned Release	S	S	S	S			
UN-200-E-60	Unplanned Release	S	S	S	S			
UN-200-E-62	Unplanned Release	S	S	S	S			
UN-200-E-65	Unplanned Release	S	S	S	S			
UN-200-E-67	Unplanned Release	S	S	S	S			
UN-200-E-68	Unplanned Release	S	S	S	S			
UN-200-E-72	Unplanned Release	S	S	S	S			
UN-200-E-81	Unplanned Release	S	K	S	S			
UN-200-E-82	Unplanned Release	S	K	S	S			
UN-200-E-86	Unplanned Release	K	K	S	S			
UN-200-E-88	Unplanned Release	S	S	S	S			
UN-200-E-91	Unplanned Release	S	S	S	S			
UN-200-E-94	Unplanned Release	S	S	S	S			
UN-200-E-96	Unplanned Release	S	S	S	S			
UN-200-E-97	Unplanned Release							
UN-200-E-99	Unplanned Release	S	S	S	S	S	S	S
UN-200-E-100	Unplanned Release	S	S	S	S			
UN-200-E-107	Unplanned Release	S	S	S	S		K	K
UN-200-E-114	Unplanned Release	S	S	S	S			
UN-200-E-117	Unplanned Release	S	S	S	S			
UN-200-E-118	Unplanned Release	S	S	S	S			
UN-200-E-142	Unplanned Release						K	K
UPR-200-E-17	Unplanned Release			K				
UPR-200-E-21	Unplanned Release	S	S	S	S			
UPR-200-E-24	Unplanned Release	S	S	S	S			

Table 4-31. Summary of Known and Suspected Contamination at Each Waste Management Unit and Unplanned Release Site.

Waste Management Unit		TRU	Fission Products	Uranium	Heavy Metals	Other Inorganics	Volatiles	Semi-Volatiles
UPR-200-E-29	Unplanned Release	S	S	S	S			
UPR-200-E-30	Unplanned Release	S	S	S	S			
UPR-200-E-50	Unplanned Release	S	S	S	S			
UPR-200-E-53	Unplanned Release	S	S	S	S			
UPR-200-E-59	Unplanned Release		K					
UPR-200-E-66	Unplanned Release	S	S	S	S			
UPR-200-E-70	Unplanned Release	S	S	S	S			
UPR-200-E-106	Unplanned Release	S	S	S	S			
UPR-200-E-115	Unplanned Release	S	S	S	S			
UPR-200-E-119	Unplanned Release	S	S	S	S	S	S	S
UPR-200-E-125	Unplanned Release	S	S	S	S	S	S	S
UPR-200-E-126	Unplanned Release	S	S	S	S	S	S	S
UPR-200-E-136	Unplanned Release	S	S	S	S	S	S	S
UPR-200-E-137	Unplanned Release	S	S	S	S	S	S	S

K = Known contanimation (contaminants identified from inventory or sampling data).

S = Suspected contamination (contaminants that could occur at site). Evidence includes process data, historical records and chemical associations.

Table 4-32. Contaminants of Potential Concern for the PUREX Plant Aggregate Area.

RADIONUCLIDES	FISSION PRODUCTS (continued)	OTHER INORGANICS
Gross alpha		Beryllium
Gross beta	Lead-210	Boron
	Lead-211	Cyanide
TRANSURANICS	Lead-212	Fluoride
	Lead-214	Hydrazine
Americium-241	Nickel-59	Nitrate
Americium-242	Nickel-63	
Americium-242m	Niobium-93m	VOLATILE ORGANICS
Americium-243	Polonium-214	
Curium-242	Polonium-215	Acetone
Curium-244	Polonium-218	Chloroform
Curium-245	Potassium-40	Methylene chloride
Neptunium-237	Protactinium-231	Toluene
Neptunium-239	Protactinium-234m	1,1,1-Trichloroethane
Plutonium-238	Radium-225	
Plutonium-239/240	Radium-226	SEMIVOLATILE ORGANICS
Plutonium-241	Ruthenium-106	
	Samarium-151	Tributyl phosphate
URANIUM	Selenium-79	
	Strontium-90	
Uranium-233	Technetium-99	
Uranium-234	Thallium-207	
Uranium-235	Thorium-227	
Uranium-238	Thorium-229	
	Thorium-230	
FISSION PRODUCTS	Thorium-231	
	Tritium	
Actinium-225	Yttrium-90	
Actinium-227	Zirconium-93	
Antimony-126		
Antimony-126m	HEAVY METALS	
Barium-137m		
Bismuth-210	Arsenic	
Bismuth-211	Barium	
Bismuth-213	Cadmium	
Bismuth-214	Chromium	
Carbon-14	Copper	
Cesium-134	Iron	
Cesium-135	Lead	
Cesium-137	Manganese	
Cobalt-60	Mercury	
Europium-152	Nickel	
Europium-154	Silver	
Europium-155	Vanadium	
Francium-221	Zinc	
Iodine-129		
Lead-209		

Table 4-33. Soil-Water Distribution Coefficient K_d for Radionuclides and Inorganics of Concern at PUREX Plant Waste Management Units. Page 1 of 2

Element or Chemical	Recommended K_d for Hanford Site (Serne and Wood 1990) in mL/g	Conservative Default K_d[a/] (Serne and Wood 1990) in mL/g	MEPAS Default K_d pH 6-9[b/] (Strenge and Peterson 1989) in mL/g
Actinium	--	--	228
Americium	2 100 - 1000 (<1 @ pH 1-3)	100	82
Antimony	--	--	2
Arsenic	--	0	5.86
Barium	--	50	530
Beryllium	--	--	70
Bismuth	--	20	--
Boron	--	--	0.19
Cadmium	--	15	14.9
Carbon (^{14}C)	--	--	0
Cesium	200 - 1,000 1 - 200 (acidic waste)	50	51
Chromium	--	0	16.8
Cobalt	500 - 2000	10	1.9
Copper	--	15	41.9
Curium	100 - >2,000	100	82
Cyanide	--	--	--
Europium	--	--	228
Fluoride	--	--	0
Francium	--	--	--
Hyrdazine	--	--	0
Iodine	<1	0	0
Iron	--	20	15
Lead	--	30	234
Manganese	--	20	16.5
Mercury	--	--	322
Neptunium	<1-5	3	3
Nickel	--	15	12.2

WHC.23B/5-19-92/02724T

Table 4-33. Soil-Water Distribution Coefficient K_d for Radionuclides and Inorganics of Concern at PUREX Plant Waste Management Units. Page 2 of 2

Element or Chemical	Recommended K_d for Hanford Site (Serne and Wood 1990) in mL/g	Conservative Default K_d[a/] (Serne and Wood 1990) in mL/g	MEPAS Default K_d pH 6-9[b/] (Strenge and Peterson 1989) in mL/g
Niobium	--	--	50
Nitrate/nitric acid	--	--	0
Plutonium	100 - 1,000 < 1 at pH 1 - 3	100	10
Polonium	--	--	5.9
Potassium	--	--	--
Protactinium	--	--	0
Radium	--	20	24.3
Ruthenium	20 - 700 (<2 at >1 M nitrate)	--	274
Samarium	--	--	228
Silver	--	20	0.4
Strontium	5 - 100 3 - 5 (acidic conditions) 200 - 500 (w/phosphate or oxalate)	10	24.3
Technetium	0 - 1	0	3
Thallium	--	--	0
Thorium	--	50	100
Tritium	0	0	0
Uranium	--	0	0
Vanadium	--	--	50
Yttrium	--	--	278
Zinc	--	15	12.7
Zirconium	--	30	50

a/ Average K_Ds for low salt and organic solutions with neutral pH.
b/ Default values for pH 6-9 and soil content of [clay + organic matter + metal oxyhydroxides] < 10% (Strenge and Peterson 1989).

Table 4-34. Mobility of Inorganic Species in Soil.

Highly mobile ($K_d < 5$)	
Antimony	Potassium
Boron	Protactinium
Carbon (as $^{14}CO_2$)	Silver
Fluoride	Technetium
Iodine	Thallium
Neptunium	Tritium
Nitrate	Uranium
Moderately mobile ($5 < K_d < 100$)	
Arsenic	Manganese
Barium	Nickel
Beryllium	Niobium
Bismuth	Polonium
Cadmium	Radium
Cesium	Strontium
Chromium	Thorium
Copper	Vanadium
Iron	Zinc
Lead	Zirconium
Low mobility ($K_d > 100$)	
Actinium	
Americium	
Cesium	
Cobalt	
Curium	
Europium	
Mercury	
Plutonium	
Ruthenium	
Samarium	
Yttrium	

Table 4-35. Physical/Chemical Properties of Organic Contaminants of Concern for PUREX Plant Waste Management Units.

Compound	Molecular Weight in g/mole	Water Solubility in mg/L	Vapor Pressure in mm Hg	Henry's Law Constant in atm-m^3/mo	Soil/Organic Matter Partition Coef. K_{oc} in mL/g
Acetone	58.0	miscible	270	2.1×10^{-5}	2.2
Chloroform (trichloromethane)	119	8,200	150	2.9×10^{-3}	31
Methylene chloride	84.9	20,000	360	2×10^{-3}	8.8
Toluene	92.15	540	28	6.4×10^{-3}	300
Tributyl phosphate	266.3	280	15	1.9×10^{-2}	6,000
1,1,1-Trichloroethane	133.41	1,500	120	1.4×10^{-2}	150

Source: Strenge and Peterson (1989).

Table 4-36. Radiological Properties of Potential Radionuclides of Concern in PUREX Plant Waste Management Units. Page 1 of 2

Radionuclide	Half-Life	Specific Activity[a/] in Ci/g	Principal Radiation of Concern[b/]
^{225}Ac	10 d	5.8×10^{4}	α
^{227}Ac	21.8 yr	7.2×10^{1}	β, α
^{241}Am	432 yr	3.4×10^{0}	α
^{242}Am	16 hr	8.1×10^{5}	β
^{242m}Am	152 yr	9.7×10^{0}	α
^{243}Am	7,380 yr	2.0×10^{-1}	α
^{137m}Ba	2.6 min	5.3×10^{8}	γ
^{210}Bi	5.01 d	1.2×10^{5}	β
^{211}Bi	2.13 min	4.2×10^{8}	α, β
^{213}Bi	45.6 min	1.9×10^{7}	β, α
^{214}Bi	19.9 min	4.4×10^{7}	β, γ
^{14}C	5,730 yr	4.5×10^{0}	β
^{242}Cm	163.2 d	3.3×10^{3}	α
^{244}Cm	18.1 yr	8.1×10^{1}	α
^{245}Cm	8,500 yr	1.7×10^{-1}	α, γ
^{60}Co	5.3 yr	1.1×10^{3}	γ
^{134}Cs	2.06 yr	1.3×10^{3}	γ
^{135}Cs	3×10^{6} yr	8.8×10^{-4}	β
^{137}Cs	30 yr	8.7×10^{1}	γ
^{152}Eu	13.3 yr	7.7×10^{2}	β, γ[c/]
^{154}Eu	8.8 yr	2.7×10^{2}	β, γ[c/]
^{155}Eu	4.96 yr	4.6×10^{2}	β, γ
^{221}Fr	4.8 min	1.8×10^{8}	α, γ
^{3}H	12.3 yr	9.7×10^{3}	β
^{129}I	1.6×10^{7} yr	1.7×10^{-4}	β
^{40}K	1.3×10^{9} yr	6.7×10^{-6}	β, γ[c/]
^{93m}Nb	14.6 yr	2.8×10^{2}	γ[c/]
^{95}Nb	34.97 d	3.9×10^{4}	β, γ
^{59}Ni	8×10^{4} yr	7.6×10^{-2}	γ
^{63}Ni	92 yr	6.2×10^{2}	β
^{237}Np	2.14×10^{6} yr	7.0×10^{-4}	α, γ
^{239}Np	2.35 d	2.3×10^{5}	β
^{231}Pa	32,800 yr	4.7×10^{-2}	α
^{234m}Pa	1.2 min	6.7×10^{8}	β, γ
^{209}Pb	3.25 hr	4.5×10^{6}	β

WHC.23B/5-19-92/02724T

Table 4-36. Radiological Properties of Potential Radionuclides of Concern in PUREX Plant Waste Management Units. Page 2 of 2

Radionuclide	Half-Life	Specific Activity[a/] in Ci/g	Principal Radiation of Concern[b/]
^{210}Pb	22.3 yr	7.6×10^{1}	β
^{211}Pb	36.1 min	2.5×10^{7}	β
^{212}Pb	10.6 hr	1.4×10^{6}	β, γ[c/]
^{214}Pb	26.8 min	3.3×10^{7}	β, γ[c/]
^{214}Po	6×10^{-5} sec	8.8×10^{14}	α
^{215}Po	7.8×10^{-4} sec	2.9×10^{13}	α
^{218}Po	3.05 min	2.8×10^{8}	α
^{238}Pu	87.7 yr	1.7×10^{1}	α
^{239}Pu	24,400 yr	6.2×10^{-2}	α
^{240}Pu	6,560 yr	2.3×10^{-1}	α
^{241}Pu	14.4 yr	1.0×10^{2}	β
^{225}Ra	14.8 d	3.9×10^{4}	β
^{226}Ra	1,600 yr	9.9×10^{-1}	α
^{106}Ru	1.0 yr	3.4×10^{3}	β, γ[c/]
^{126}Sb	12.5 d	4.1×10^{5}	β, γ
^{126m}Sb	19 min	7.9×10^{7}	β, γ
^{79}Se	<65,000 yr	7.0×10^{-2}	β
^{151}Sm	90 yr	2.6×10^{1}	β
^{90}Sr	28.5 yr	1.4×10^{2}	β
^{99}Tc	213,000 yr	1.7×10^{-2}	β
^{227}Th	18.7 d	3.1×10^{4}	α
^{229}Th	7,340 yr	2.1×10^{-1}	α
^{230}Th	77,000 yr	2.1×10^{-2}	α
^{231}Th	25.5 hr	5.3×10^{5}	β
^{207}Tl	4.8 min	1.9×10^{8}	β, γ
^{233}U	159,000 yr	9.7×10^{-3}	α
^{234}U	244,500 yr	6.2×10^{-3}	α
^{235}U	7.0×10^{8} yr	2.2×10^{-6}	α, γ
^{238}U	4.5×10^{9} yr	3.4×10^{-7}	α
^{90}Y	6.41 hr	5.4×10^{5}	β
^{93}Zr	1.5×10^{6} yr	2.6×10^{-3}	β

a/ Calculated from half-life and atomic weight.
b/ α - alpha decay; β - negative beta decay; γ - release of gamma rays.
c/ Daughter radiation.

WHC.23B/5-19-92/02724T

Table 4-37. Comparison of Radionuclide Relative Risks for Radionuclides of Concern at the PUREX Plant Aggregate Area. Page 1 of 3

Radionuclide	Air Unit Risk[a/] in $(pCi/m^3)^{-1}$	Drinking Water Unit Risk[b/] in $(pCi/L)^{-1}$	Soil Ingestion Unit Risk[c/] in $(pCi/g)^{-1}$	External Exposure Unit Risk[d/] in $(pCi/g)^{-1}$
^{225}Ac	1.2×10^{-3}	8.7×10^{-7}	4.6×10^{-8}	9.4×10^{-6}
^{227}Ac	4.2×10^{-2}	1.8×10^{-5}	9.5×10^{-7}	1.3×10^{-7}
^{241}Am	2.1×10^{-2}	1.6×10^{-5}	8.4×10^{-7}	1.6×10^{-5}
^{242}Am	na	na	na	na
^{242m}Am	na	na	na	na
^{243}Am	2.1×10^{-2}	1.5×10^{-5}	8.1×10^{-7}	3.6×10^{-5}
^{210}Bi	4.1×10^{-5}	9.7×10^{-8}	5.1×10^{-9}	0
^{211}Bi	9.7×10^{-8}	6.1×10^{-10}	3.2×10^{-11}	2.8×10^{-5}
^{213}Bi	1.6×10^{-7}	1.2×10^{-8}	6.2×10^{-10}	8.1×10^{-5}
^{214}Bi	1.1×10^{-6}	7.2×10^{-9}	3.8×10^{-10}	8.0×10^{-4}
^{14}C	3.2×10^{-9}	4.7×10^{-8}	2.5×10^{-9}	0
^{242}Cm	na	na	na	na
^{244}Cm	1.4×10^{-2}	1.0×10^{-5}	5.4×10^{-7}	5.9×10^{-7}
^{245}Cm	na	na	na	na
^{60}Co	8.1×10^{-5}	7.8×10^{-7}	4.1×10^{-8}	1.3×10^{-3}
^{134}Cs	1.4×10^{-5}	2.1×10^{-6}	1.1×10^{-7}	8.9×10^{-4}
^{135}Cs	1.4×10^{-6}	2.1×10^{-7}	1.1×10^{-8}	0
^{137}Cs	9.6×10^{-6}	1.4×10^{-6}	7.6×10^{-8}	0 (3.4×10^{-4})[e/]
^{152}Eu	6.1×10^{-3}	1.1×10^{-7}	5.7×10^{-9}	6.3×10^{-4}
^{154}Eu	7.2×10^{-5}	1.5×10^{-7}	8.1×10^{-9}	6.8×10^{-4}
^{155}Eu	na	na	na	
^{221}Fr	4.7×10^{-7}	3.0×10^{-9}	1.6×10^{-10}	1.9×10^{-5}
^{3}H	4.0×10^{-8}	2.8×10^{-9}	1.5×10^{-10}	0
^{129}I	6.1×10^{-5}	9.6×10^{-6}	5.1×10^{-7}	1.5×10^{-5}
^{40}K	4.0×10^{-6}	5.7×10^{-7}	3.0×10^{-8}	7.8×10^{-5}
^{93m}Nb	na	na	na	na
^{59}Ni	3.5×10^{-7}	4.4×10^{-9}	2.3×10^{-10}	3.4×10^{-7}
^{63}Ni	8.7×10^{-7}	1.2×10^{-8}	6.2×10^{-10}	0

WHC.23B/5-19-92/02724T

Table 4-37. Comparison of Radionuclide Relative Risks for Radionuclides of Concern at the PUREX Plant Aggregate Area. Page 2 of 3

Radionuclide	Air Unit Risk[a/] in $(pCi/m^3)^{-1}$	Drinking Water Unit Risk[b/] in $(pCi/L)^{-1}$	Soil Ingestion Unit Risk[c/] in $(pCi/g)^{-1}$	External Exposure Unit Risk[d/] in $(pCi/g)^{-1}$
^{237}Np	1.8×10^{-2}	1.4×10^{-5}	7.3×10^{-7}	1.8×10^{-5}
^{239}Np	7.7×10^{-7}	4.8×10^{-8}	2.5×10^{-9}	1.1×10^{-4}
^{231}Pa	2.0×10^{-2}	9.7×10^{-6}	5.1×10^{-7}	2.0×10^{-5}
^{234m}Pa	8.2×10^{-10}	3.0×10^{-10}	1.6×10^{-11}	6.4×10^{-6}
^{209}Pb	3.6×10^{-8}	4.3×10^{-9}	2.3×10^{-10}	0
^{210}Pb	8.7×10^{-4}	3.4×10^{-5}	1.8×10^{-6}	1.8×10^{-6}
^{211}Pb	1.5×10^{-6}	9.2×10^{-9}	4.9×10^{-10}	2.9×10^{-5}
^{212}Pb	2.4×10^{-5}	3.7×10^{-7}	1.9×10^{-8}	9.2×10^{-5}
^{214}Pb	1.5×10^{-6}	9.2×10^{-9}	4.9×10^{-10}	1.5×10^{-4}
^{214}Po	1.4×10^{-13}	5.1×10^{-16}	2.7×10^{-17}	4.7×10^{-8}
^{215}Po	2.9×10^{-12}	1.4×10^{-14}	7.6×10^{-16}	8.7×10^{-8}
^{218}Po	3.0×10^{-7}	1.4×10^{-9}	7.6×10^{-11}	0
^{238}Pu	2.1×10^{-2}	1.4×10^{-5}	7.6×10^{-7}	5.9×10^{-7}
^{239}Pu	2.6×10^{-2}	1.6×10^{-5}	8.4×10^{-8}	2.6×10^{-7}
^{240}Pu	2.1×10^{-2}	1.6×10^{-5}	8.4×10^{-8}	5.9×10^{-7}
^{241}Pu	1.5×10^{-4}	2.5×10^{-7}	1.3×10^{-8}	0
^{225}Ra	8.2×10^{-4}	3.4×10^{-6}	1.8×10^{-7}	8.0×10^{-6}
^{226}Ra	1.5×10^{-3}	6.1×10^{-6}	3.2×10^{-7}	4.1×10^{-6}
^{106}Ru	2.3×10^{-4}	4.9×10^{-7}	2.6×10^{-8}	0
^{126}Sb	na	na	na	na
^{126m}Sb	na	na	na	na
^{79}Se	na	na	na	na
^{151}Sm	na	na	na	na
^{90}Sr	2.8×10^{-5}	1.7×10^{-6}	8.9×10^{-8}	0
^{99}Tc	4.2×10^{-6}	6.6×10^{-8}	3.5×10^{-9}	3.4×10^{-10}
^{227}Th	2.5×10^{-3}	2.5×10^{-7}	1.3×10^{-8}	6.6×10^{-6}
^{229}Th	3.9×10^{-2}	2.0×10^{-6}	1.1×10^{-7}	5.8×10^{-5}
^{230}Th	1.6×10^{-2}	1.2×10^{-6}	6.5×10^{-8}	5.9×10^{-7}
^{231}Th	2.5×10^{-7}	2.0×10^{-8}	1.1×10^{-9}	1.1×10^{-5}

WHC.23B/5-19-92/02724T

Table 4-37. Comparison of Radionuclide Relative Risks for Radionuclides of Concern at the PUREX Plant Aggregate Area. Page 3 of 3

Radionuclide	Air Unit Risk[a/] in $(pCi/m^3)^{-1}$	Drinking Water Unit Risk[b/] in $(pCi/L)^{-1}$	Soil Ingestion Unit Risk[c/] in $(pCi/g)^{-1}$	External Exposure Unit Risk[d/] in $(pCi/g)^{-1}$
^{207}Tl	2.3×10^{-9}	6.6×10^{-10}	3.5×10^{-11}	1.2×10^{-6}
^{233}U	1.4×10^{-2}	7.2×10^{-6}	3.8×10^{-7}	3.2×10^{-7}
^{234}U	1.4×10^{-2}	7.2×10^{-6}	3.8×10^{-7}	5.6×10^{-7}
^{235}U	1.3×10^{-2}	6.6×10^{-6}	3.5×10^{-7}	9.7×10^{-5}
^{238}U	1.2×10^{-2}	6.6×10^{-6}	3.5×10^{-7}	4.5×10^{-7}
^{90}Y	2.8×10^{-6}	1.6×10^{-7}	8.6×10^{-9}	0
^{93}Zr	na	na	na	na

a/ Excess cancer risk associated with lifetime exposure to 1 pCi/m^3 (10^{-12} curies) per day in air (EPA 1991).
b/ Excess cancer risk associated with lifetime exposure to 1 pCi (10^{-12} curies) per day in drinking water (EPA 1991).
c/ Excess cancer risk associated with lifetime exposure to 1 pCi/g (10^{-12} curies/g) per day in soil (EPA 1991).
d/ Excess cancer risk associated with lifetime exposure to surface soils containing 1 pCi/g of gamma-emitting radionuclides (EPA 1991).
e/ External radiation risk from ^{137m}Ba, a short-lived decay product of ^{137}Cs.

na No information available.

Table 4-38. Potential Chronic Health Effects of Chemicals Detected or Disposed of at PUREX Plant Aggregate Area. Page 1 of 2

Chemical	Tumor Site Inhalation Route; Oral Route [Weight of Evidence Group[a/]]	Non-carcinogenic Chronic Health Effects Inhalation Route; Oral Route
INORGANIC CHEMICALS		
Arsenic	respiratory tract [A]; skin [A]	NA; keratosis and hyperpigmentation
Barium	--	fetotoxicity; increased blood pressure
Beryllium	Lung; NA	--
Boron	--	NA; testicular lesions
Cadmium	respiratory tract [B1]; NA	cancer; renal damage
Chromium	lung [A] - Cr(VI) only; NA	nasal mucosa atrophy; hepatotoxicity
Copper	--	NA; gastrointestinal irritation
Cyanide	--	NA; weight loss, thyroid effects, and myelin degeneration
Fluoride	--	NA; dental flurosis at high levels
Hydrazine	Nasal cavity [B2]; liver [B2]	--
Iron	--	--
Lead	[B2][c/]; [B2]	central nervous system (CNS) effects[c/]; CNS effects
Manganese	--	respiratory symptoms and psychomotor disturbances; no effect
Mercury	--	neurotoxicity; kidney effects
Nickel	respiratory tract [A]; NA	cancer; reduced weight gain
Nitrate/Nitrite	--	NA; methemoglobinemia in infants[d/]
Silver	--	NA; argyria
Vanadium	--	NA; none observed
Zinc	--	NA; anemia
ORGANIC CHEMICALS		
Acetone	--	NA; kidney and liver effects
Chloroform	liver; kidney [B2]	NA; liver lesions
Methylene chloride	lung, liver [B2]; liver [B2]	NA; liver toxicity
Toluene	--	CNS effects, eye irritation; change in liver and kidney weights

WHC.23B/5-19-92/02724T

Table 4-38. Potential Chronic Health Effects of Chemicals Detected or Disposed of at PUREX Plant Aggregate Area. Page 2 of 2

Chemical	Tumor Site Inhalation Route; Oral Route [Weight of Evidence Group[a/]]	Non-carcinogenic Chronic Health Effects Inhalation Route; Oral Route
Tributyl phosphate	--	respiratory irritant; kidney damage[b/]
1,1,1-Trichloroethane	--	heptotoxicity; heptotoxicity

a/ Weight of Evidence Groups for carcinogens: A - Human carcinogen (sufficient evidence of carcinogenicity in humans); B - Probable human carcinogen (B1 - Limited evidence of carcinogenicity in humans; B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of data in humans); C - Possible human carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data); D - Not classifiable as to human carcinogenicity (inadequate or no evidence).

b/ Verified toxicity information was not available from EPA 1991. Toxicity information was obtained from EPA Registry of Toxic Effects of Chemical Systems (RTECS). A blank space means that no information was available from the above sources.

c/ Lead is considered by EPA to have both neurotoxic and carcinogenic effects; however, no toxicity criteria are available for lead at the present time.

d/ Toxic effect is considered to occur from exposure to nitrite; nitrate can be converted to nitrite in the body by intestinal bacteria.

NA Information not available.

5.0 HEALTH AND ENVIRONMENTAL CONCERNS

This preliminary qualitative evaluation of potential human health concerns is intended to provide input to the PUREX Plant Aggregate Area waste management unit recommendation process (Section 9.0). This process requires consideration of immediate and long-term impacts to human health and the environment. The approach that has been taken to identify potential health concerns related to individual waste management units and unplanned releases is as follows:

- Contaminants of potential concern are identified for each exposure pathway that is likely to occur within the PUREX Plant Aggregate Area. Selection of contaminants was discussed in Section 4.2. Contaminants of potential concern were selected from the list of candidate contaminants of potential concern presented in Table 4-26. This table includes contaminants that are likely to be present in the environment based on occurrence in the liquid process wastes that were discharged to soils, and also contaminants that have been detected in environmental samples within the aggregate area but have not been identified as components of PUREX waste streams.

- Exposure pathways potentially applicable to individual waste management units are identified based on the presence of the above contaminants of potential concern in wastes in the waste management units, consideration of known or suspected releases from those waste management units, and the physical and institutional controls affecting waste management unit access and use over the period of interest. The relationships between waste management units and exposure pathways are summarized in the conceptual model (Section 4.2).

- Estimates of relative hazard derived for the PUREX waste management units are identified using the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Hazard Ranking System (HRS) (40 CFR 300), modified Hazard Ranking System (mHRS) (Huckfeldt 1991), surface radiation survey data, and by the Westinghouse Hanford Environmental Protection Group scoring. Other indicators of relative hazard, such as rate of release of contaminants, irreversible results of continuing residence of contaminants, etc., were not used because they generally require unit-specific data that are not available for most units.

The human health concerns and various hazard ranking scores listed above are used to establish whether or not a waste management unit is considered a "high" priority. In the data evaluation process presented in Section 9.0, "high" priority units are evaluated for the potential implementation of an interim remedial measure (IRM). "Low" priority units are

evaluated to determine what type of additional investigation is necessary to establish a final remedy. Further detail is presented in Section 9.0.

The data used for this human health evaluation are presented in the earlier sections of this report. The types of data that have been assessed include waste management units histories and physical descriptions (Section 2.0), descriptions of the physical environment of the study area (Section 3.0) and a summary of the available chemical and radiological data for each waste management unit (Section 4.0).

The quality and sufficiency of these data are assessed in Section 8.0. This information is also used to identify applicable or relevant and appropriate requirements (ARARs) (Section 6.0).

5.1 CONCEPTUAL FRAMEWORK FOR RISK-BASED SCREENING

The range of potential human health exposure pathways at the PUREX Plant Aggregate Area was summarized in Section 4.2. The U.S. Environmental Protection Agency (EPA 1989a) considers a human exposure pathway to consist of four elements: 1) a source and mechanism for contaminant release, 2) a retention or transport medium (or media), 3) a point of potential human contact, and 4) an exposure route (e.g., ingestion) at the contact point. The probability of the existence of a particular pathway is dependent upon the physical and institutional controls affecting waste management unit access and use. In the absence of unit access controls and other land use restrictions, the identified potential exposure pathways could all occur. For example, it could be hypothesized that an individual establish a residence within the boundaries of the PUREX Plant Aggregate Area, disrupt the soil surface and contact buried contamination, and drill a well and withdraw contaminated groundwater for drinking water and crop irrigation. However, within the 5- to 10-year period of interest associated with identification and prioritization of remedial actions within the PUREX Plant Aggregate Area, unrestricted access and uncontrolled disruption of buried contaminants have a negligible probability of occurrence.

For the purpose of identifying health hazards associated with PUREX Plant Aggregate Area waste management units, and prioritizing remediation actions for those units, an occupational exposure scenario was determined to be the most appropriate. While work activities are assumed to include occasional contact with surface soils, it is assumed that no contact with buried contaminants will take place without proper protective measures.

Workers may be exposed via the following routes at the PUREX Plant Aggregate Area:

- Ingestion of surface soils

- Inhalation of volatilized contaminants and resuspended particles
- Direct dermal contact with surface soils
- Direct exposure to radiation from surface soils and airborne resuspended particles

Since evaluation of migration in the saturated zone is not within the scope of a source area aggregate area management study (AAMS), ingestion of or contact with groundwater were not evaluated as exposure pathways. However, since migration of waste constituents within the saturated zone will be addressed in the 200 East Groundwater Aggregate Area Management Study Report (AAMSR), contaminants likely to migrate to the water table and waste management units that have a high potential to impact groundwater will be identified.

5.2 POTENTIAL EXPOSURE SCENARIOS AND HUMAN HEALTH CONCERNS

The routes by which a Hanford Site worker could potentially be exposed to contamination at the waste management units include ingestion, inhalation, direct contact with soils, and direct exposure to radiation. To evaluate the potential for exposure at individual waste management units, it is necessary to have data available for surface soils, air, and radiation levels. Although samples have been collected from each of these media, only the surface radiation survey data (contamination levels and dose rate) are specific to individual waste management units. Therefore, only pathways associated with the surface radiological contamination and external dose rates can be evaluated with confidence at this time. Exposures by other pathways were evaluated based on available knowledge about contaminants disposed of to the waste management unit and the engineered barriers to releases.

5.2.1 External Exposure

External dose rate surveys, which are performed on a waste management unit basis, were used as the measure of a unit's potential for impacting human health through direct external radiation exposure. The contaminants of potential concern for this pathway are the radionuclides that emit moderate to high energy penetrating gamma radiation. The measured dose rates at PUREX Plant Aggregate Area waste management units are presented in Table 5-1 from the available survey data. At certain waste management units, the dose was measured over a year's time using a thermoluminescent dosimeter (TLD). In those instances, the measured value in units of mrem/yr was converted to units of mrem/h on the basis of 8,760 h/yr.

For 53 of the 103 PUREX Plant Aggregate Area waste management units, no radiation survey data are available. For those units that do have radiation survey data of some type, 29 were reported as having no contamination detected.

Westinghouse Hanford manual WHC-CM-4-10, Section 7 (WHC 1988c) was used as the basis for setting one of the criteria that are used to identify waste management units that can be considered high priority sites. The manual indicates that posting ("Radiation Area") and access controls are to be implemented at a level of 2 mrem/h for the purpose of personnel protection. With the same objective in mind, the level of 2 mrem/h is recommended as one of the criteria for distinguishing high priority from lower priority waste management units. The only PUREX Plant Aggregate Area waste management units that exceeded 2 mrem/h were 216-A-40 Trench, and UN-200-E-100 Unplanned Release.

High levels of radiation were reportedly associated with some of the unplanned releases that are listed in Table 5-1. Some of the releases were reportedly remediated by removing contaminated soil for disposal in burial grounds, paving or covering the area with soil, or flushing the soil with water. Unplanned releases located within engineered waste units are routinely surveyed and information on the current radiological status of the remediated unplanned releases are available. However, many of these releases occurred outside routinely surveyed areas in the early years of the Hanford Site, and more recent survey data are not available. The effectiveness of the various remediation measures is not known, and documented confirmatory survey measurements are not presently available. Access is controlled on the basis of surface contamination level and/or radiation dose rate at those unplanned release sites not remediated to uncontrolled levels. Access restrictions are not applied at sites with residual contamination levels less than the control levels. While the current absence of radiological survey data at certain sites implies the absence of contamination levels or dose rates requiring access controls, this is identified as a data gap in Section 8.0.

5.2.2 Ingestion of Soil or Inhalation of Fugitive Dust

Radionuclides and nonradioactive chemicals of concern for the soil ingestion and fugitive dust inhalation pathways are those that are nonvolatile, persistent in surface soils, and have appreciable carcinogenic or toxic affects by ingestion or inhalation. However, little information is available to evaluate the presence of specific radionuclides or nonradioactive chemicals in surface soils. Available gross activity survey data, which provide a measure of surface soil contamination at the PUREX Plant Aggregate Area waste management units, are provided in Table 5-1.

The Westinghouse Hanford Environmental Protection group policies state that the presence of any smearable alpha constitutes a potential threat to human health and qualifies a

waste management unit for a high remediation priority. Waste management units that exhibit elevated alpha readings in radiological surveys can be presumed to have surface contamination, since alpha radiation cannot penetrate solids.

Westinghouse Hanford manual WHC-CM-4-10 (WHC 1988c) was also used to set criteria for identifying waste management units that can be considered high remediation priority sites. The manual indicates that posting ("Surface Contamination Area") and access controls are to be implemented at a level of 100 ct/min above background beta/gamma, and/or 20 ct/min alpha, for the purpose of personnel protection. With the same objective in mind, the levels of 100 ct/min above background beta/gamma and 20 ct/min alpha are recommended as two of the criteria for identification of high priority waste management units. For those survey readings that are in units of dis/min, a conversion will be made to ct/min assuming a survey detector efficiency of 10%.

It should be noted that these radiation readings may indicate transient conditions (e.g., presence of contaminated vegetation) and that routine stabilization of surface contamination is carried out under the auspices of the Westinghouse Hanford Radiation Area Remedial Action (RARA) program.

5.2.3 Inhalation of Volatiles

As summarized in Section 4.1, the distribution of volatile organics in soils is not well-defined in the PUREX Plant Aggregate Area. Although several semivolatile compounds, such as tributyl phosphate and parafin hydrocarbons, have been disposed of in the cribs, no information is available on whether these compounds are still available in the near surface soil column for transport to the soil surface.

The primary volatile radionuclide of concern is ^{3}H. Exposure to ^{3}H (as tritiated water vapor) and the potential for ^{3}H release via radiolytic production of hydrogen from aqueous radioactive wastes is of concern. The mode of disposal of this material can not be determined from available information.

5.2.4 Migration to Groundwater

Risks that could potentially occur due to migration of contaminants in groundwater to existing or potential receptors will be addressed in the 200 East Groundwater AAMSR and thus, will not be discussed in the PUREX Plant AAMSR. However, the potential for individual units to impact groundwater has been discussed in Section 4.1.

5.3 ADDITIONAL SCREENING CRITERIA

In addition to determining human health concerns for a worker at each of the waste management units, previously developed site ranking criteria were investigated for the purpose of setting priorities for waste management units and unplanned releases. These criteria are the CERCLA HRS scores assigned during preliminary assessment/site inspection (PA/SI) activities performed for the Hanford Site (DOE 1988b), and the rankings assigned by the Westinghouse Hanford Environmental Protection Group to prioritize units needing remedial actions for radiological control.

Both of these ranking systems take into account some measure of hazard and environmental mobility, and are thus appropriate to consider for waste management unit prioritization. The HRS ranking system evaluates sites based on their relative risk, taking into account the population at risk, the hazard potential of the substances at the facility, the potential for contamination of the environment, the potential risk of fire and explosion, and the potential for injury associated with humans or animals that come into contact with the waste management unit inventory. The HRS is thus appropriate to consider for screening waste management units.

The PA/SI screening was performed using the U.S. Environmental Protection Agency's (EPA's) HRS and mHRS. The HRS is a site ranking methodology which was designed to determine whether sites should be placed on the CERCLA National Priorities List (NPL) based on chemical contamination history. The EPA has established the criteria for placement on the NPL to be a score of 28.5 or greater. The mHRS is a ranking system developed by the Pacific Northwest Laboratory (PNL) for the U.S. Department of Energy (DOE) that uses the basic methodology of the HRS; however, it more accurately predicts the impacts from radionuclides. The mHRS takes into account concentration, half-life, and other chemical-specific parameters that are not considered by the HRS. The mHRS has not been accepted by EPA as a ranking system.

Many of the PUREX Plant Aggregate Area waste management units were ranked in the PA/SI using both the HRS and mHRS. For those waste management units that were not ranked in the PA/SI, unit type and discharge history were evaluated in comparison with ranked units for the purpose of setting priorities. If a waste management unit that has been ranked exhibits similar characteristics (e.g., construction, waste type, and volume), the value for the ranked unit was applied to the unit without an HRS or mHRS score. If no ranked waste management units exhibit similar characteristics, then the unit was not ranked; however, a high or low score was determined qualitatively through evaluation of unit configuration and contamination history.

Table 5-1 lists the HRS and mHRS rankings, as well as scores that were assigned for unranked waste management units, based on their similarity to ranked units in terms of type,

construction, and quantity of waste disposed of. If no similar waste management units were available for comparison, the units were not ranked but were assigned a qualitative indicator of migration potential.

For the HRS ranking, 11 units of the 103 PUREX Plant Aggregate Area waste management units were given a score of 28.5 or greater. For the mHRS ranking, 11 units were given a score of 28.5 or greater (all of which had HRS scores greater than 28.5). Three units received a qualitative "high" score and 51 units received a qualitative "low" score. Each of the units that received a qualitative "high" HRS and mHRS score was given such a rating based on their discharge history of large quantities of hazardous materials, which could potentially have been transported to the groundwater. The units that received "low" scores were given such a ranking because there is no known history of liquid hazardous material disposal that could affect groundwater beneath the PUREX Plant Aggregate Area.

Five of the 103 units were assigned Westinghouse Environmental Protection Group scores of 7 or greater, indicating the need for remedial action.

5.4 SUMMARY OF SCREENING RESULTS

The screening process was used to sort sites as either high priority or low priority. Table 5-1 lists the PUREX Plant Aggregate Area waste management units that exceeded one or more of the screening criteria identified in the preceding Sections. In total, 26 units were identified as high priority.

Radiation survey results (dose rate and/or contamination) were available for 50 of the 103 waste management units. Twenty-nine were reported as having no detectable results. Of the remaining 21 units, 17 had survey results that exceeded one or more of the criteria (2 mrem/h, 100 ct/min beta/gamma, and 20 ct/min alpha).

For the HRS scores, 11 waste management units were given scores of 28.5 or greater. For the mHRS, the same 11 units received a score of 28.5 or greater. Three units received qualitative "high" scores. Five of the 103 units were assigned Westinghouse Environmental Protection Group scores of 7 or greater, indicating the need for remedial action. Some of the sites were designated as high priority for 2 or more of the criteria, hence only 26 total sites are designated high priority.

Table 5-1. Hazard Ranking Scores for PUREX Plant Aggregate Area.

Site Name	Site Type	HRS Rating	mHRS Rating	Radiation Surveys ct/min	dis/min	mrem/h	Environmental Protection Score	Priority
Cribs and Drains								
216-A-1	Crib	1.03	0.71	NC	NC	NC	--	No
216-A-2	Crib	4.39	3.19	NC	NC	NC	--	No
216-A-3	Crib	Low	Low	NC	NC	NC	--	No
216-A-4	Crib	47.81	47.81	NC	NC	NC	--	Yes
216-A-5	Crib	60.40	50.42	NC	NC	NC	--	Yes
216-A-6	Crib	47.81	42.14	--	5,000	--	--	Yes
216-A-7	Crib	57.88	42.79	--	30,000	--	7	Yes
216-A-8	Crib	High	High	NC	NC	0.01	8	Yes
216-A-9	Crib	57.88	42.79	--	30,000	--	--	Yes
216-A-10	Crib	Low	Low	NC	NC	NC	--	No
216-A-21	Crib	57.88	57.88	--	15,000	--	--	Yes
216-A-24	Crib	57.88	48.67	NC	NC	NC	--	Yes
216-A-27	Crib	57.88	59.63	NC	NC	NC	--	Yes
216-A-30	Crib			NC	NC	0.01	--	Yes
216-A-31	Crib	1.03	1.42	NC	NC	NC	--	No
216-A-32	Crib	0.00	0.00	NC	NC	NC	--	No
216-A-36A	Crib	50.33	32.62	NC	NC	NC	--	Yes
216-A-36B	Crib	Low	Low	NC	NC	NC	--	No
216-A-37-1	Crib	Low	Low	NC	NC	NC	--	No

Table 5-1. Hazard Ranking Scores for PUREX Plant Aggregate Area.

Site Name	Site Type	HRS Rating	mHRS Rating	Radiation Surveys ct/min	dis/min	mrem/h	Environmental Protection Score	Priority
216-A-37-2	Crib	Low	Low	--	500	--	--	Yes
				--	200	--	--	--
216-A-38-1	Crib	Low	Low	NC	NC	NC	--	No
216-A-41	Crib	1.03	0.71	NA	NA	NA	--	No
216-A-45	Crib	Low	Low	NC	NC	NC	--	No
216-A-11	French Drain	1.03	0.71	NC	NC	NC	--	No
216-A-12	French Drain	1.03	0.71	NC	NC	NC	--	No
216-A-13	French Drain	0.71	0.71	NC	NC	NC	--	No
216-A-14	French Drain	1.03	0.71	--	56,000	--	--	Yes
				--	20,000	--	--	--
216-A-15	French Drain	1.03	0.55	NC	NC	NC	--	No
216-A-22	French Drain	1.96	1.31	NC	NC	NC	--	No
216-A-26	French Drain	Low	Low	NC	NC	NC	--	No
216-A-26A	French Drain	2.07	1.42	NC	NC	NC	--	No
216-A-28	French Drain	47.81	32.72	--	10,000	--	--	Yes
216-A-33	French Drain	0.00	0.00	NC	NC	NC	--	No
216-A-35	French Drain	1.03	0.71	NC	NC	NC	--	No
216-C-8	French Drain	0.71	0.71	2,000	--	--	--	Yes
Reverse Wells								
299-E24-111	Injection Well	Low	Low	NA	NA	NA	NA	No

Table 5-1. Hazard Ranking Scores for PUREX Plant Aggregate Area.

Site Name	Site Type	HRS Rating	mHRS Rating	Radiation Surveys ct/min	Radiation Surveys dis/min	Radiation Surveys mrem/h	Environmental Protection Score	Priority
Ponds, Ditches and Trenches								
216-A-29	Ditch	High	High	2,000	--	--	--	Yes
216-A-34	Ditch	1.09	0.76	NC	NC	NC	--	No
216-A-18	Trench	1.03	0.71	NC	NC	NC	--	No
216-A-19	Trench	2.18	1.63	NC	NC	NC	--	No
216-A-20	Trench	2.07	1.42	NC	NC	NC	--	No
216-A-40	Trench	32.71	32.71	--	--	4	11	Yes
Septic Tanks and Associated Drain Fields								
2607-EA	Septic Tank/Drain Field	Low	Low	NA	NA	NA	--	No
2607-EC	Septic Tank/Drain Field	Low	Low	NA	NA	NA	--	No
2607-ED	Septic Tank/Drain Field	Low	Low	NA	NA	NA	--	No
2607-EG	Septic Tank	Low	Low	NA	NA	NA	--	No
2607-EJ	Septic Tank	Low	Low	NA	NA	NA	--	No
2607-EL	Septic Tank	Low	Low	NA	NA	NA	--	No
2607-E6	Septic Tank/Drain Field	Low	Low	NA	NA	NA	--	No
Basins								
207-A	Retention Basins	Low	Low	1,500	--	--	--	Yes
216-A-42	Retention Basin	High	High	--	200,000	--	--	Yes

Table 5-1. Hazard Ranking Scores for PUREX Plant Aggregate Area.

Site Name	Site Type	HRS Rating	mHRS Rating	Radiation Surveys ct/min	dis/min	mrem/h	Environmental Protection Score	Priority
Burial Sites								
200-E	Burning Pit	Low	Low	--	--	0.01	--	Yes
218-E-1	Burial Ground	0.70	0.50	5,000	--	--	--	Yes
218-E-8	Burial Ground	0.70	0.80	NA	NA	NA	--	No
218-E-12A	Burial Ground	0.70	0.80	--	20,000	--	--	Yes
218-E-12B	Burial Ground	Low	Low	--	--	0.01	--	Yes
218-E-13	Burial Ground	0.00	0.00	NA	NA	NA	--	No
Unplanned Releases								
UN-200-E-10	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-11	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-12	Unplanned Release	1.00	--	NA	NA	NA	--	No
UN-200-E-13	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-15	Unplanned Release	1.10	--	NA	NA	NA	--	No
UN-200-E-19	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-20	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-22	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-25	Unplanned Release	1.10	--	NA	NA	NA	--	No
UN-200-E-26	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-28	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-31	Unplanned Release	1.03	--	NC	NC	NC	--	No

Table 5-1. Hazard Ranking Scores for PUREX Plant Aggregate Area.

Site Name	Site Type	HRS Rating	mHRS Rating	Radiation Surveys ct/min	dis/min	mrem/h	Environmental Protection Score	Priority
UN-200-E-33	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-35	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-39	Unplanned Release	1.00	--	NA	NA	NA	--	No
UN-200-E-40	Unplanned Release	1.00	--	NA	NA	NA	--	No
UN-200-E-42	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-47	Unplanned Release	1.10	--	NA	NA	NA	--	No
UN-200-E-49	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-56	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-58	Unplanned Release	0.80	--	NA	NA	NA	--	No
UN-200-E-60	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-62	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-65	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-67	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-68	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-72	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-86	Unplanned Release	1.00	--	NC	NC	NC	--	No
UN-200-E-88	Unplanned Release	Low	--	--	60,000	--	--	Yes
UN-200-E-91	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-94	Unplanned Release	1.00	--	NA	NA	NA	--	No
UN-200-E-96	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-97	Unplanned Release	Low	--	NA	NA	NA	--	No

Table 5-1. Hazard Ranking Scores for PUREX Plant Aggregate Area.

Site Name	Site Type	HRS Rating	mHRS Rating	Radiation Surveys ct/min	dis/min	mrem/h	Environmental Protection Score	Priority
UN-200-E-99	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-100	Unplanned Release	Low	--	--	--	5	--	Yes
UN-200-E-114	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-117	Unplanned Release	1.00	--	NA	NA	NA	--	No
UN-200-E-142	Unplanned Release	Low	--	NA	NA	NA	--	No
UPR-200-E-17	Unplanned Release	Low	--	NA	NA	NA	--	No
UPR-200-E-21	Unplanned Release	Low	--	NA	NA	NA	--	No
UPR-200-E-24	Unplanned Release	Low	--	NA	NA	NA	--	No
UPR-200-E-29	Unplanned Release	Low	--	NA	NA	NA	--	No
UPR-200-E-30	Unplanned Release	Low	--	NA	NA	NA	--	No
UPR-200-E-50	Unplanned Release	1.10	--	NA	NA	NA	--	No
UPR-200-E-53	Unplanned Release	0.80	--	NA	NA	NA	--	No
UPR-200-E-106	Unplanned Release	Low	--	NA	NA	NA	--	No

NA = No data available.
NC = No contamination.

THIS PAGE INTENTIONALLY
LEFT BLANK

6.0 IDENTIFICATION OF POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR THE PUREX PLANT AGGREGATE AREA

6.1 INTRODUCTION

The Superfund Amendments and Reauthorization Act (SARA) of 1986 amended Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to require that all applicable or relevant and appropriate requirements (ARARs) be employed during implementation of a hazardous waste site cleanup. "Applicable" requirements are defined by the Environmental Protection Agency (EPA) in "CERCLA Compliance with Other Laws Manual" (OSWER Directive 9234.1-01, August 8, 1988) as:

> cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

A separate set of "relevant and appropriate" requirements that must be evaluated include:

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

"To-be-Considered Materials" (TBCs) are nonpromulgated advisories or guidance issued by federal or state governments that are not legally binding and do not have the status of potential ARARs. However, in many circumstances, TBCs will be considered along with potential ARARs and may be used in determining the necessary level of cleanup for protection of health or the environment.

The following sections identify potential ARARs to be used in developing and assessing various remedial action alternatives at the PUREX Plant Aggregate Area. Specific requirements pertaining to hazardous and radiological waste management, remediation of contaminated soils, surface water protection, and air quality will be discussed.

The potential ARARs focus on federal or state statutes, regulations, criteria, and guidelines. The specific types of potential ARARs evaluated include:

- Contaminant-specific
- Location-specific
- Action-specific.

Contaminant-specific potential ARARs are usually health or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical contaminant values that are generally recognized by the regulatory agencies as allowable to protect human health and the environment. In the case of the PUREX Plant Aggregate Area, contaminant-specific potential ARARs address chemical constituents and/or radionuclides. The potential contaminant-specific ARARs that were evaluated for the PUREX Plant Aggregate Area are discussed in Section 6.2.

Location-specific potential ARARs are restrictions placed on the concentration of hazardous substances, or the conduct of activities, solely because they occur in specific locations. The location-specific potential ARARs that were evaluated for the PUREX Plant Aggregate Area are discussed in Section 6.3.

Action-specific potential ARARs apply to particular remediation methods and technologies, and are evaluated during the detailed screening and evaluation of remediation alternatives. The potential action-specific ARARs that were evaluated for the PUREX Plant Aggregate Area are discussed in Section 6.4.

The TBC requirements are other federal and state criteria, advisories, and regulatory guidance that are not promulgated regulations, but are to be considered in evaluating alternatives. Potential TBCs include U.S. Department of Energy (DOE) Orders that carry out authority granted under the Atomic Energy Act. All DOE Orders are potentially applicable to operations at the PUREX Plant Aggregate Area. Specific TBC requirements are discussed in Section 6.5.

Potential contaminant- and location-specific ARARs will be refined during the AAMS process. Potential action-specific ARARs are briefly discussed in this section, and will be further evaluated upon final selection of remedial alternatives. The points at which these potential ARARs must be achieved and the timing of the ARARs evaluations are discussed in Sections 6.6 and 6.7, respectively.

6.2 CONTAMINANT-SPECIFIC REQUIREMENTS

A contaminant-specific requirement sets concentration limits in various environmental media for specific hazardous substances, pollutants, or contaminants. Based on available information, some of the currently known or suspected contaminants that may be present in the PUREX Plant Aggregate Area are outlined in Table 4-31. The currently identified potential federal and state contaminant-specific ARARs are summarized below.

6.2.1 Federal Requirements

Federal contaminant-specific requirements are specified in several statutes, codified in the U.S. Code (USC), and promulgated in the Code of Federal Regulations (CFR), as follows:

6.2.1.1 Clean Water Act. Federal Water Quality Criteria (FWQC) are developed under the authority of the Clean Water Act to serve as guidelines to the states for determining receiving water quality standards. Different FWQC are derived for protection of human health and protection of aquatic life. The human health FWQC are further subdivided according to how people are expected to use the water (e.g., drinking the water versus consuming fish caught from the water). The SARA 121(d)(2) states that remedial actions shall attain FWQC where they are relevant and appropriate, taking into account the designated or potential use of the water, the media affected, the purpose of the criteria, and current information. Many more substances have FWQC than maximum contaminant levels (MCLs) issued under the Safe Drinking Water Act (see discussion below); consequently, EPA and other state agencies rely on these criteria more than MCLs, even though these criteria can only be considered relevant and appropriate and not applicable.

The FWQC would not be considered at PUREX Plant Aggregate Area, as no natural surface water bodies exist. The only existing man-made surface water bodies at PUREX Plant Aggregate Area are waste management units: the 207-A Retention Basins and open stretches of the 216-A-29 Ditch.

6.2.1.2 Safe Drinking Water Act. Under the authority of the Safe Drinking Water Act, MCLs apply when the water may be used for drinking. At present, EPA and the State of Washington apply MCLs as the standards for groundwater contaminants at CERCLA sites that could be used as drinking water sources. Groundwater contamination and application of MCLs as potential ARARs are addressed under a separate Aggregate Area Management Study (AAMS) specific to groundwater.

6.2.1.3 Resource Conservation and Recovery Act. The Resource Conservation and Recovery Act (RCRA) addresses the generation and transportation of hazardous waste, and waste management activities at facilities that treat, store, or dispose of hazardous wastes. Subtitle C (Hazardous Waste Management) mandates the creation of a cradle-to-grave management and permitting system for hazardous wastes. The RCRA defines hazardous wastes as "solid wastes" (even though the waste is often liquid in physical form) that may cause or significantly contribute to an increase in mortality or serious illness, or that poses a substantial hazard to human health or the environment when improperly managed. In Washington State, RCRA is implemented by EPA and the authorized state agency, the Washington State Department of Ecology (Ecology).

The RCRA is potentially applicable or relevant and appropriate to the PUREX Plant Aggregate Area. The extensive permitting requirements under RCRA would only apply to a waste management unit that is an identified hazardous waste treatment, storage or disposal (TSD) facility, and to hazardous waste management activities that occurred outside an area of contamination. If a waste management unit is not a RCRA TSD facility and if remediation occurs on site, then the RCRA permitting requirements would not have to be satisfied. However, other substantive requirements necessary to protect human health and the environment would constitute potential ARARs.

Two key contaminant-specific potential ARARs have been adopted under the federal hazardous waste regulations: the Toxicity Characteristic Leaching Procedure (TCLP) designation limits promulgated under 40 CFR Part 261; and the hazardous waste land disposal restrictions for constituent concentrations promulgated under 40 CFR Part 268.

The TCLP designation limits define when a waste is hazardous, and are used to determine when more stringent management standards apply than would be applied to typical solid wastes. Thus, the TCLP contaminant-specific potential ARARs can be used to determine when RCRA waste management standards may be required. The TCLP limits are presented in Table 6-1.

The land disposal restrictions are numerical limits derived by EPA by reviewing available technologies for treating hazardous wastes. Until a prohibited waste can meet the numerical limits, it can be prohibited from land disposal. Two sets of limits have been promulgated: limits for constituent concentrations in waste extract, which uses the TCLP test to obtain a leached sample of the waste; and limits for constituent concentrations in waste, which addresses the total contaminant concentration in the waste. The land disposal restrictions limits are presented in Table 6-1 (see Section 6.4.1.2 for a further discussion on applying the land disposal restriction limits).

6.2.1.4 Clean Air Act. The Clean Air Act establishes National Primary and Secondary Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), National Emission Standards for Hazardous Air Pollutants (NESHAP)(40 CFR Part 61), and New Source Performance Standards (NSPS)(40 CFR Part 60).

In general, new and modified stationary sources of air emissions must undergo a pre-construction review to determine whether the construction or modification of any source, such as a CERCLA remedial program, will interfere with attainment or maintenance of NAAQS or fail to meet other new source review requirements including NESHAP and NSPS. However, the process applies only to "major" sources of air emissions (defined as emissions of 250 tons per year). The PUREX Plant Aggregate Area would not constitute a major source.

Section 112 of the Clean Air Act directs EPA to establish standards at the level that provides an ample margin of safety to protect the public health from hazardous air pollutants. The NESHAP standards for radionuclides are directly applicable to DOE facilities under Subpart H of Section 112 that establishes a 10 mrem/year facility-wide standard during cleanup of the site. Further, if the maximum individual dose added by a new construction or modification during remediation exceeds 1 percent of the NESHAP standard (0.1 mrem/yr), a report meeting the substantive requirements of an application for approval of construction must be prepared.

6.2.2 State of Washington Requirements

Potential state contaminant-specific requirements are specified in several statutes, codified in the Revised Code of Washington (RCW) and promulgated in the Washington Administrative Code (WAC).

6.2.2.1 Model Toxics Control Act. The Model Toxics Control Act (MTCA) (Ecology 1991) authorized Ecology to adopt cleanup standards for remedial actions at hazardous waste sites. These regulations are considered potential ARARs for soil, groundwater, and surface water cleanup actions. The processes for identifying, investigating, and cleaning up hazardous waste sites are defined and cleanup standards are set for groundwater, soil, surface water, and air in Chapter 173-340 WAC.

Under the MTCA regulations, cleanup standards may be established by one of three methods.

- Method A may be used if a routine cleanup action, as defined in WAC 173-340-200, is being conducted at the site or relatively few hazardous substances

are involved for which cleanup standards have been specified by Tables 1, 2, or 3 of WAC 173-340-720 through -745.

- Under Method B, a risk level of 10^{-6} is established and a risk calculation based on contaminants present is determined.

- Method C cleanup standards represent concentrations that are protective of human health and the environment for specified site uses. Method C cleanup standards may be established where it can be demonstrated that such standards comply with applicable state and federal laws, that all practical methods of treatment are used, that institutional controls are implemented, and that one of the following conditions exist: (1) Method A or B standards are below background concentrations; (2) Method A or Method B results in a significantly greater threat to human health or the environment; (3) Method A or Method B standards are below technically possible concentrations, or (4) the site is defined as an industrial site for purposes of soil remediation.

Table 1 of Method A addresses groundwater, so it is not considered to be an ARAR for PUREX Plant Aggregate Area (groundwater will be addressed in the 200 East Groundwater Aggregate Area Management Study Report, AAMSR). Table 2 of Method A is intended for non-industrial site soil cleanups, and Table 3 of Method A is intended for industrial site soil cleanups. Method A industrial soil cleanup standards for preliminary contaminants of concern are provided as potential ARARs in Table 6-1.

In addition to Method A, Method B and Method C cleanup standards may also be considered potential ARARs for the PUREX Plant Aggregate Area. Method B and Method C cleanup standards can be calculated on a case-by-case basis in concert with Ecology. Method B and Method C should be used where Method A standards do not exist or cannot be met, or where routine cleanup actions cannot be implemented at a specific waste management unit.

6.2.2.2 State Hazardous Waste Management Act and Dangerous Waste Regulations. The State of Washington is a RCRA-authorized state for hazardous waste management, and has developed state-specific hazardous waste regulations under the authority of the State Hazardous Waste Management Act. Generally, state hazardous waste regulations parallel the federal regulations. The state definition of a hazardous waste incorporates the EPA designation of hazardous waste that is based on the compound being specifically listed as hazardous, or on the waste exhibiting the properties of reactivity, ignitability, corrosivity, or toxicity as determined by the TCLP.

In addition, Washington State identifies other waste as hazardous. Three unique criteria are established: toxic dangerous waste; persistent dangerous waste; and carcinogenic dangerous waste. These additional designation criteria may be imposed by Ecology as potential ARARs, for purposes of determining acceptable cleanup standards and appropriate waste management standards.

6.2.2.3 Ambient Air Quality Standards and Emission Limits for Radionuclides (Chapter 173-480 WAC). These Ecology ambient air quality standards specify maximum accumulated dose limits to members of the public.

6.2.2.4 Monitoring and Enforcement of Air Quality and Emission Standards for Radionuclides (WAC 246-247). These permitting requirements by the Washington State Department of Health adopt the Ecology standards for maximum accumulated dose limits to members of the public.

6.2.2.5 Controls for New Sources of Toxic Air Pollutants (Chapter 173-460 WAC). In accordance with regulations recently promulgated by Ecology in Chapter 173-460 WAC, any new emission source will be subject to Toxic Air Pollutant (TAP) emission standards. The regulations establish allowable ambient source impact levels (ASILs) for hundreds of organic and inorganic compounds. Ecology's ASILs may constitute potential ARARs for cleanup activities that have a potential to affect air. ASILs for preliminary contaminants of concern are provided in Table 6-1.

6.2.2.6 Water Quality Standards. Washington State has promulgated various numerical standards related to surface water and groundwater contaminants. These are included principally in the following regulations:

- **Public Water Supplies (Chapter 248-54 WAC).** This regulation establishes drinking water standards for public water supplies. The standards essentially parallel the federal drinking water standards (40 CFR Parts 141 and 143).

- **Water Quality Standards for Ground Waters of the State of Washington (Chapter 173-200 WAC).** This regulation establishes contaminant standards for protecting existing and future beneficial uses of groundwater through the reduction or elimination of the discharge of contaminants to the state's groundwater.

- **Water Quality Standards for Surface Waters of the State of Washington (Chapter 173-201 WAC and Proposed Chapter 173-203/173-201A WAC).** Ecology has adopted numerical ambient water quality criteria for six conventional pollutant parameters for various surface water classes (WAC 173-201-045): (1) fecal coliform bacteria; (2) dissolved oxygen; (3) total dissolved gas; (4) temperature; (5) pH; and (6) turbidity. In addition, toxic, radioactive, or deleterious material concentrations shall be below those of public health significance or which may cause acute or chronic toxic conditions to the aquatic environment or which may adversely affect any water use. Numerical criteria currently exist for a limited number of toxic substances (WAC 173-201-047). Ecology has initiated rulemaking to modify and incorporate additional numerical criteria for toxic substances and for radioactive substances, and to reclassify certain waters of the state.

  Under the state Water Quality Standards, the criteria and classifications do not apply inside an authorized mixing zone surrounding a wastewater discharge. In defining mixing zones, Ecology generally follows guidelines contained in "Criteria for Sewage Works Design." Although water quality standards can be exceeded inside the mixing zone, state regulations will not permit discharges that cause mortalities of fish or shellfish within the zone or that diminish aesthetic values.

These water quality standards do not constitute ARARs for purposes of establishing cleanup standards for the PUREX Plant Aggregate Area. Because no surface water bodies exist within the PUREX Plant Aggregate Area, there will be no need to achieve ambient water quality standards during remediation activities. Groundwater is being addressed under a separate study in which pertinent groundwater-related potential ARARs will be covered.

The numerical water quality standards cited above may become potential ARARs if selected remedial actions could result in discharges to groundwater or surface water (e.g., if treated wastewaters are discharged to the soil column or the Columbia River). Determining appropriate standards for such discharges will depend on the type of remediation performed and will have to be established on a case-by-case basis as remedial actions are defined.

6.2.3 National Pollutant Discharge Elimination System (Chapter 173-220 WAC and 40 CFR Part 122) and Water Quality Standards.

National Pollutant Discharge Elimination System (NPDES) regulations govern point source discharges into navigable waters. Limits on the concentrations of contaminants and volumetric flowrates that may be discharged are determined on a case-by-case basis and

permitted under this program. No point source discharges have been identified. The EPA implements this program in Washington State for federal facilities; however, assumption of the NPDES program by the state is likely within five years.

6.3 LOCATION-SPECIFIC REQUIREMENTS

Location-specific potential ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in specific locations. Some examples of special locations include floodplains, wetlands, historic places, and sensitive ecosystems or habitats.

Table 6-2 lists various location-specific standards and indicates which of these may be potential ARARs. Potential ARARs have been identified as follows:

- **Floodplains.** Requirements for protecting floodplains are not ARARs for activities conducted within the PUREX Plant Aggregate Area. However, remedial actions selected for cleanup may require projects in or near floodplains (e.g., construction of a treatment facility outfall at the Columbia River). In such cases, location-specific floodplain requirements may be potential ARARs.

- **Wetlands, Shorelines, and Rivers and Streams.** Requirements related to wetlands, shorelines, and rivers and streams are not ARARs for activities conducted within the PUREX Plant Aggregate Area. However, remedial actions selected for cleanup may require projects on a shoreline or wetland, or discharges to wetlands (e.g., construction of a treatment facility outfall at the Columbia River). In such cases, location-specific shoreline and wetlands requirements may be potential ARARs.

- **Threatened and Endangered Species Habitats.** As discussed in Section 3.6, various threatened and endangered species inhabit portions of the Hanford Site and may occur in the PUREX Plant Aggregate Area (American peregrine falcon, bald eagle, white pelican, and sandhill crane). Therefore, critical habitat protection for these species would constitute a potential ARAR.

- **Wild and Scenic Rivers.** The Columbia River Hanford Reach is currently undergoing study pursuant to the federal Wild and Scenic Rivers Act. Pending results of this study, actions that may impact the Hanford Reach may be restricted. This requirement would not be an ARAR for remedial activities within the PUREX Plant Aggregate Area. However, Wild and Scenic Rivers Act

requirements may be potential ARARs for actions taken as a result of PUREX Plant cleanup efforts that could affect the Hanford Reach.

6.4 ACTION-SPECIFIC REQUIREMENTS

Action-specific potential ARARs are requirements that are triggered by specific remedial actions at the site. These remedial actions will not be fully defined until a remedial approach has been selected. However, the universe of action-specific ARARs defined by a preliminary screening of potential remedial action alternatives will help focus the selection process. Potential action-specific ARARs are outlined below. (Note that contaminant- and location-specific potential ARARs discussed above will also include provisions for action-specific potential ARARs to be applied once the remedial action is selected.)

6.4.1 Federal Requirements

6.4.1.1 Comprehensive Environmental Response, Compensation, and Liability Act. CERCLA, and regulations adopted pursuant to CERCLA contained in the National Contingency Plan (40 CFR Part 300), include selection criteria for remedial actions. Under the criteria, excavation and off-site land disposal options are least favored when on-site treatment options are available. Emphasis is placed on alternatives that permanently treat or immobilize contamination. Selected alternatives must be protective of human health and the environment, which implies that federal and state ARARs be met. However, a remedy may be selected that does not meet all potential ARARs if the requirement is technically impractical, if its implementation would produce a greater risk to human health or the environment, if an equivalent level of protection can otherwise be provided, if state standards are inconsistently applied, or if the remedy is only part of a complete remedial action which attains potential ARARs.

The CERCLA gives state cleanup standards essentially equal importance as federal standards in guiding cleanup measures in cases where state standards are more stringent. State standards pertain only if they are generally applicable, were passed through formal means, were adopted on the basis of hydrologic, geologic, or other pertinent considerations, and do not preclude the option of land disposal by a state-wide ban. Most importantly, CERCLA provides that cleanup of a site must ensure that public health and the environment are protected. Selected remedies should meet all potential ARARs, but issues such as cost-effectiveness must be weighed in the selection process.

6.4.1.2 Resource Conservation and Recovery Act. The RCRA, and regulations adopted pursuant to RCRA, describe numerous action-specific requirements that may be potential

ARARs for cleanup activities. The primary regulations are promulgated under 40 CFR Parts 262, 264, and 265, and include such action-specific requirements as:

- Packaging, labeling, placarding, and manifesting of off-site waste shipments;
- Inspecting waste management areas to ensure proper performance and safe conditions;
- Preparation of plans and procedures to train personnel and respond to emergencies;
- Management standards for containers, tanks, incinerators, and treatment units;
- Design and performance standards for land disposal facilities; and
- Groundwater monitoring system design and performance.

Many of these requirements will depend on the particular remediation activity undertaken, and will have to be identified as remediation proceeds.

One key potential area of action-specific RCRA ARARs are the 40 CFR Part 268 land disposal restrictions. In addition to the contaminant-specific constituent concentration limits established in the land disposal restrictions (as previously discussed in Section 6.2.1.3), EPA has identified best demonstrated available treatment technologies (BDATs) for various waste streams. The EPA could require the use of BDATs prior to allowing land disposal of wastes generated during remediation. The EPA's imposition of the land disposal restrictions and BDAT requirements will depend on various factors.

Applicability to CERCLA actions is based on determinations of waste "placement/disposal" during a remediation action. According to OSWER Directive 9347.3-05FS, EPA concludes that Congress did not intend in situ consolidation, remediations, or improvement of structural stability to constitute placement or disposal. Placement or disposal would be considered to occur if:

- Wastes from different units are consolidated into one unit (other than a land disposal unit within an area of contamination);
- Waste is removed and treated outside a unit and redeposited into the same or another unit (other than a land disposal unit within an area of contamination); or

- Waste is picked up from a unit and treated within the area of contamination in an incinerator, surface impoundment, or tank and then redeposited into the unit (except for in situ treatment).

Consequently, the requirement to use BDAT would not apply under the land disposal restrictions standards unless placement or disposal had occurred. However, remediation actions involving excavation and treatment could trigger the requirements to use BDAT for wastes subject to the land disposal restrictions standards. In addition, the agencies could consider BDAT technologies to be relevant and appropriate when developing and evaluating potential remediation technologies.

Two additional components of the land disposal restrictions program should be considered with regard to an excavate and treat remedial action. First, a national capacity variance was issued by EPA for contaminated soil and debris for a two-year period ending May 8, 1992 (54 FR 26640). Second, a series of variances and exemptions may be applied under an excavate and treat scenario. These include:

- A no-migration petition;
- A case-by-case extension to an effective date;
- A treatability variance; and
- Mixed waste provisions of a federal Facilities Compliance Act (when enacted).

The applicability and relevance of each of these options will vary based on the specific details of a PUREX Plant Aggregate Area excavate and treat option. An analysis of these variances can be developed once engineering data on the option becomes available.

The effect of the land disposal restrictions program on mixed waste management is significant. Currently, limited technologies are available for effective treatment of these waste streams and no commercially available treatment facilities exist except for liquid scintillation counting fluids used for laboratory analysis and testing. The EPA recognized that inadequate capacity exists and issued a national capacity variance until May 8, 1992, to allow for the development of such treatment capacity.

Lack of treatment and disposal capacity also presents implications for storage of these materials. Under 40 CFR 268.50, mixed wastes subject to land disposal restrictions may be stored for up to one year. Beyond one year, the owner/operator has the burden of proving such storage is for accumulating sufficient quantities for treatment. On August 29, 1991, EPA issued a mixed waste storage enforcement policy providing some relief from this

provision for generators of small volumes of mixed wastes. However, the policy was limited to facilities generating less than 28 m^3 (1,000 ft^3) of land disposal-prohibited waste per year. Congress is considering amendments to RCRA postponing the storage prohibition for another five years; however, final action on these amendments has not occurred.

6.4.1.3 Clean Water Act. Regulations adopted pursuant to the Clean Water Act under the NPDES mandate use of best available treatment technologies prior to discharging contaminants to surface waters. The NPDES requirements would not be ARARs for actions conducted only within the PUREX Plant Aggregate Area. However, NPDES requirements could constitute potential ARARs for cleanup actions which would result in discharge of treated wastewaters to the Columbia River, and associated treatment systems could be required to utilize best available treatment technologies.

6.4.2 State of Washington Requirements

6.4.2.1 Hazardous Waste Management. As discussed in Section 6.4.1.2, there are various requirements addressing the management of hazardous wastes that may be potential action-specific ARARs. Pertinent Washington regulations appear in Chapter 173-303 WAC and generally parallel federal management standards. Determination of potential ARARs will be on a case-by-case basis as cleanup actions proceed.

6.4.2.2 Solid Waste Management. Washington State regulations describe management standards for solid waste in Chapter 173-304 WAC. Some of these management standards may be potential ARARs for disposal of cleanup wastes within the PUREX Plant Aggregate Area. Solid waste standards include such requirements as:

- Inspecting waste management areas to ensure proper performance and safe conditions;
- Management standards for incinerators and treatment units;
- Design and performance standards for landfills; and
- Groundwater monitoring system design and performance.

Many of these requirements will depend on the particular remediation activity undertaken, and will have to be identified as remediation proceeds.

6.4.2.3 Water Quality Management. Chapter 90.48 RCW, the Washington State Water Pollution Control Act, requires use of all known, available, and reasonable treatment

technologies for treating contaminants prior to discharge to waters of the state. Implementing regulations appear principally at Chapters 173-216, 173-220, and 173-240 WAC.

The Water Pollution Control Act requirements for groundwater could be potential ARARs for actions conducted within the PUREX Plant Aggregate Area if such actions would result in discharge of liquid contaminants to the soil column. In this event, Ecology may require use of all known, available, and reasonable treatment technologies to treat the liquid discharges prior to soil disposal.

The Water Pollution Control Act requirements for surface water would not be ARARs for actions conducted only within the PUREX Plant Aggregate Area. However, these requirements could constitute potential ARARs for cleanup actions which would result in discharge of treated wastewaters to the Columbia River and associated treatment systems could be required to demonstrate they meet all known, available, and reasonable treatment technologies.

6.4.2.4 Air Quality Management. The Toxic Air Pollutant regulations for new air emission sources, promulgated in Chapter 173-460 WAC, require use of best available control technology for air toxics. The Toxic Air Pollutant regulations may be potential ARARs for cleanup actions at the PUREX Plant Aggregate Area that could result in emissions of toxic contaminants to the air. Ecology may require the use of best available control technology for air toxics, to treat such air emissions.

6.5 OTHER CRITERIA AND GUIDANCE TO BE CONSIDERED

In addition to the potential ARARs presented, other federal and state criteria, advisories, guidance, and similar materials are TBC in determining the appropriate degree of remediation for the PUREX Plant Aggregate Area. A myriad of resources may be potentially evaluated. The following represents an initial assessment of pertinent TBC provisions.

6.5.1 Health Advisories

The EPA Office of Drinking Water publishes advisories identifying contaminants for which health advisories have been issued.

6.5.2 International Commission of Radiation Protection/National Council on Radiation Protection

The International Commission of Radiation Protection (ICRP) and the National Council on Radiation Protection (NCRP) have a guidance standard of 100 mrem/yr whole body dose of gamma radiation. These organizations also issue recommendations on other areas of interest regarding radiation protection.

6.5.3 EPA Proposed Corrective Actions for Solid Waste Management Units

In the July 27, 1990, federal register (55 FR 30798), EPA published proposed regulations for performing corrective actions (cleanup activities) at solid waste management units associated with RCRA facilities. The proposed 40 CFR Part 264 Subpart S include requirements that would be TBCs for determining an appropriate level of cleanup at the PUREX Plant Aggregate Area. In particular, EPA included an appendix, "Appendix A - Examples of Concentrations Meeting Criteria for Action Levels", which presented recommended contaminant concentrations warranting corrective action. These contaminant-specific TBCs are included in Table 6-1 for the preliminary contaminants of concern.

6.5.4 DOE Standards for Radiation Protection

A number of DOE Orders exist which could be TBCs. The DOE Orders that establish potential contaminant-specific or action-specific standards for the remediation of radioactive wastes and materials are discussed below.

6.5.4.1 DOE Order 5400.5 - DOE Standards for Radiation Protection of the Public and Environment. The DOE Order 5400.5 establishes the requirements for DOE facilities to protect the environment and human health from radiation including soil and air contamination. The purpose of the Order is to establish standards and requirements for operations of the DOE and DOE contractors with respect to protection of members of the public and the environment against undue risk from radiation.

The Order mandates that the exposure to members of the public from a radiation source as a consequence of routine activities shall not exceed 100 mrem/yr from all exposure sources due to routine DOE activities. In accordance with the Clean Air Act, exposures resulting from airborne emissions shall not exceed 10 mrem/yr to the maximally exposed individual at the facility boundary. The DOE Order 5400.5 provides Derived Concentration Guide (DCG) values for releases of radionuclides into the air or water. The DCG values are calculated so that, under conditions of continuous exposure, an individual would receive an

effective dose equivalent of 100 mrem/year. Because dispersion in air or water is not accounted for in the DCG, actual exposures of maximally exposed individuals in unrestricted areas are considerably below the 100 mrem/year level.

The DOE Order 5400.5 also provides for establishment of soil cleanup levels through a site-specific pathway analysis such as the allowable residual contamination level method. The calculation of allowable residual contamination level values for radionuclides is dependent on the physical characteristics of the site, the radiation dose limit determined to be acceptable, and the scenarios of human exposure judged to be possible and to result in the upper-bound exposure.

6.5.4.2 DOE Order 5820.2A - Radioactive Waste Management. The DOE Order 5820.2A applies to all DOE contractors and subcontractors performing work that involves management of waste containing radioactivity. This Order requires that wastes be managed in a manner that assures protection of the health and safety of the public, operating personnel, and the environment. The DOE Order 5820.2A establishes requirements for management of high-level, transuranic, and low-level wastes as well as wastes containing naturally occurring or accelerator produced radioactive material, and for decommissioning of facilities. The requirements applicable to the PUREX Plant Aggregate Area remediation activities include those related to transuranic waste and low-level radioactive waste. These are summarized below.

6.5.4.2.1 Management of Transuranic Waste. Transuranic waste resulting from the PUREX Plant Aggregate Area remedial action must be managed to protect the public and worker health and safety, and the environment, and performed in compliance with applicable radiation protection standards and environmental regulations. Practical and cost-effective methods must be used to reduce the volume and toxicity of transuranic (TRU) waste.

Transuranic waste must be certified in compliance with the Waste Isolation Pilot Plant (WIPP) Acceptance Criteria, placed in interim storage, if required, and sent to the WIPP. Any transuranic waste that the DOE has determined, with the concurrence of the EPA Administrator, does not need the degree of isolation provided by a geologic repository or transuranic waste that cannot be certified or otherwise approved for acceptance at the WIPP must be disposed of by alternative methods. Alternative disposal methods must be approved by DOE Headquarters and comply with NEPA requirements and EPA/state regulations.

6.5.4.2.2 Management of Low-Level Radioactive Waste. The requirements for management of low-level radioactive waste presented in DOE Order 5820.2A are relevant to the remedial alternative of removal and disposal of PUREX Plant Aggregate Area wastes. Performance objectives for this option shall ensure that external exposure to the radioactive material released into surface water, groundwater, soil, plants, and animals does not result in

an effective dose greater than 25 mrem/yr to the public. Releases to the environment shall be at levels as low as reasonably achievable. An inadvertent intruder after the institutional control period of 100 years is not to exceed 100 mrem/yr for continuous exposure or 500 mrem for a single acute exposure. A performance assessment is to be prepared to demonstrate compliance with the above performance objectives.

Other requirements under DOE Order 5820.2A which may affect remediation of the PUREX Plant Aggregate Area include waste volume minimization, waste characterization, waste acceptance criteria, waste treatment, and shipment. The low-level radioactive waste may be stored by appropriate methods prior to disposal to achieve the performance objectives discussed above. Disposal site selection, closure/post-closure, and monitoring requirements are also discussed in this Order.

6.6 POINT OF APPLICABILITY

A significant factor in the evaluation of remedial alternatives for the PUREX Plant Aggregate Area will be the determination of the point at which compliance with identified ARARs must be achieved (i.e., the point of a specific ARAR's applicability). These points of applicability are the boundaries at which the effectiveness of a particular remedial alternative will be assessed.

For most individual radioactive species transported by either water or air, Ecology and Health standards generally require compliance at the boundaries of the Hanford Site. The assumed point of compliance for radioactive species is the point where a member of the public would have unrestricted access to live and conduct business, and, consequently, to be maximally exposed. Although Health is responsible for monitoring and enforcing the air standards promulgated by Ecology, and generally recognizes the site boundary as the point of applicability, Ecology has recently indicated that compliance may be required at the point of emission.

The point at which compliance with identified ARARs must be achieved will be a significant factor in evaluating appropriate remedial alternatives in the PUREX Plant Aggregate Area. Applicability of ARARs at the point of discharge, at the boundary of the disposal unit, at the boundary of the AAMS, at the boundary of the Hanford Site, and/or at the point of maximum exposure will need to be determined.

6.7 ARARs EVALUATION

Evaluation of ARARs is an iterative process that will be conducted at multiple points throughout the remedial process:

- When the public health evaluation is conducted to assess risks at the PUREX Plant Aggregate Area, the contaminant-specific ARARs and advisories and location-specific ARARs will be identified more comprehensively and used to help determine the cleanup goals; and

- During detailed analysis of alternatives, all the ARARs and advisories for each alternative will be examined to determine what is needed to comply with other laws and to be protective of public health and the environment.

Following completion of the investigation, the remedial alternative selected must be able to attain all ARARs unless one of the six statutory waivers provided in Section 121 (d)(4)(A) through (f) of CERCLA is invoked. Finally, during remedial design, the technical specifications of construction must ensure attainment of ARARs. The six reasons ARARs can be waived are as follows:

- The remedial action is an interim measure, where the final remedy will attain ARARs upon completion.

- Compliance will result in greater risk to human health and the environment than will other options.

- Compliance is technically impracticable.

- An alternative remedial action will attain the equivalent performance of the ARAR.

- For state ARARs, the state has not consistently applied (or demonstrated the intention to consistently apply) the requirements in similar circumstances.

- For CERCLA-financed actions under Section 104, compliance with the ARAR will not provide a balance between the need for protecting public health, welfare, and the environment at the facility, and the need for fund money to respond to other sites (this waiver is not applicable at the Hanford Site).

Table 6-1. Potential Contaminant-Specific ARARs and TBCs for Preliminary Inorganic and Organic Contaminants of Concern.

	RCRA TCLP Designation Limits	RCRA Land Ban Limits Nonwastewater		MTCA Method A Cleanup Levels Industrial Soil	WCAA Toxic Air Pollutants ASIL	RCRA Corrective Action Levels (Proposed) (1)	
INORGANIC CHEMICALS	in mg/L	CCWE in mg/L	CCW in mg/kg	in mg/kg	in $\mu g/m^3$	Air in $\mu g/m^3$	Soil in mg/kg
Arsenic	5	5.0	—	200	.00023[b/]	0.00007	80
Barium	100	100	—	—	1.7 [a/]	—	—
Boron	—	—	—	—	—	—	—
Cadmium	1.0	1.0	—	10	0.00056[b/]	0.0006	40
Chromium	5.0	5.0	—	500	0.000083[b/]	0.00009	400
Copper	—	—	—	—	3.3[a/]	—	—
Cyanide (total)	—	—	590	—	16.7	—	—
Fluoride	—	—	—	—	8.3[a/]	—	—
Lead	5	5.0	—	1,000	—	—	—
Manganese	—	—	—	—	16.7	—	—
Mercury	.2	0.20 (low-level)	—	1.0	.3[a/]	—	20
Nickel	—	134	—	—	3.3[a/]	—	2000
Nitrite	—	—	—	—	—	—	—
Vanadium	—	—	—	—	—	—	—
Zinc	—	—	—	—	—	—	—
ORGANIC CHEMICALS							
Acetone	—	—	0.59	—	5927.4 [a/]	—	8000
Chloroform	6	5.6	—	—	0.043[b/]	0.04	100
Methylene chloride	—	.96	.33	0.5	2.0	0.3	90
Toluene	—	.33	28	40.6	1248.8	—	20,000

ASIL = Acceptable Source Impact Level
CCWE = Constituent Concentration in Waste Extract
CCW = Constituent Concentration in Waste
MTCA = Washington State Model Toxics Control Act
RCRA = Federal Resource Conservation and Recovery Act
TCLP = Toxicity Characteristic Leaching Procedure
WCAA = Washington State Clean Air Act
a/ 24-hour average
b/ annual average

mg/L = milligrams per liter
mg/kg = milligrams per kilogram
$\mu g/m^3$ = micrograms per cubic meter

(1) RCRA Corrective Action Levels are only proposed at this time (40 CFR Part 264 Subpart S), so are not ARARs yet; they are "To Be Considered."

Table 6-2. Potential Location-Specific ARARs.

Location	Requirement	Prerequisite	Citation	ARAR
GEOLOGICAL:				
Within 61 m (200 ft) of a fault displaced in Holocene time.	New treatment, storage or disposal of hazardous waste prohibited.	Hazardous waste management near Holocene fault.	40 CFR 264.18; WAC 173-303-420	Not ARAR. No Holocene fault.
Holocene faults and subsidence areas.	New solid waste disposal facilities prohibited over faults with displacement in Holocene time, and in subsidence areas.	New solid waste management activities near Holocene fault.	WAC 173-304-130	Not ARAR. No Holocene fault.
Unstable slopes.	New solid waste disposal areas prohibited from hills with unstable slopes.	New solid waste disposal on an unstable slope.	WAC 173-304-130	Not ARAR. No unstable slope.
100-year floodplains.	Solid and hazardous waste disposal facilities must be designed, built, operated, and maintained to prevent washout.	Solid or hazardous waste disposal in a 100-year floodplain.	40 CFR 264.18; WAC 173-303-420; WAC 173-304-460	Potential ARAR.
	Avoid adverse effects, minimize potential harm, restore/preserve natural and beneficial values in floodplains.	Actions occurring in a floodplain.	40 CFR Part 6 Subpart A; 16 USC 661 et seq; 40 CFR 6.302	Potential ARAR.
Salt dome and salt bed formations, underground mines, and caves.	Placement of non-containerized or bulk liquid hazardous wastes is prohibited.	Hazardous waste placement in salt dome, salt bed, mine, or cave.	40 CFR 264.18	Not ARAR. None of these units.

Table 6-2. Potential Location-Specific ARARs.

Location	Requirement	Prerequisite	Citation	ARAR
SURFACE WATER:				
Wetlands.	New hazardous waste disposal facilities prohibited in wetlands (including within 61 m (200 ft) of shoreline).	Hazardous waste disposal within 61 m (200 ft) of surface water.	WAC 173-303-420	Potential ARAR.
	New solid waste disposal facilities prohibited within 61 m (200 ft) of surface water (stream, lake, pond, river, salt water body).	Solid waste disposal within 61 m (200 ft) of surface water.	WAC 173-304-130	Potential ARAR.
	New solid waste disposal facilities prohibited in wetlands (swamps, marshes, bogs, estuaries, and similar areas).	Solid waste disposal in a wetland (swamp, marsh, bog, estuary, etc.).	WAC 173-304-130	Not ARAR. No wetlands present.
	Discharge of dredged or fill materials into wetlands prohibited without a permit.	Discharges to wetlands and navigable waters.	40 CFR Part 230; 33 CFR Parts 303, and 320 to 330	Potential ARAR.
	Minimize potential harm, avoid adverse effects, preserve and enhance wetlands.	Construction or management of property in wetlands.	40 CFR Part 6 Appendix A	Not ARAR. No wetlands present.
Shorelines.	Actions prohibited within 61 m (200 ft) of shorelines of statewide significance unless permitted.	Actions near shorelines.	Chapter 90.58 RCW; Chapter 173-14 WAC.	Potential ARAR.

Table 6-2. Potential Location-Specific ARARs.

Location	Requirement	Prerequisite	Citation	ARAR
Rivers and streams.	Avoid diversion, channeling or other actions that modify streams or rivers, or adversely affect fish or wildlife habitats and water resources.	Actions modifying a stream or river and affecting fish or wildlife.	40 CFR 6.302	Potential ARAR.
GROUNDWATER:				
Sole source aquifer.	New solid and hazardous waste land disposal facilities prohibited over a sole source aquifer.	Disposal over a sole source aquifer.	WAC 173-303-402; WAC 173-304-130	Not ARAR. No sole source aquifer.
Uppermost aquifer.	Bottom of lowest liner of new solid waste disposal facility must be at least 3 m (10 ft) above seasonal high water in uppermost aquifer 1.5 m (5 ft) if hydraulic gradient controls installed).	New solid waste disposal.	WAC 173-304-130	Not ARAR. Groundwater is deeper than 3 m (10 ft).
Aquifer Protection Areas.	Activities restricted within designated Aquifer Protection Areas.	Activities within an Aquifer Protection Area.	Chapter 36.36 RCW.	Not ARAR. Not an Aquifer Protection Area.
Groundwater Management Areas.	Activities restricted within Ground Water Management Areas.	Activities within a Groundwater Management Area.	Chapter 90.44 RCW; Chapter 173-100 WAC	Not ARAR. Not a Groundwater Management Area.

Table 6-2. Potential Location-Specific ARARs.

Location	Requirement	Prerequisite	Citation	ARAR
DRINKING WATER SUPPLY:				
Drinking water supply well.	New solid waste disposal areas prohibited within 305 m (1,000 ft) upgradient, or 90 days travel time, of drinking water supply well.	New solid waste disposal within 305 m (1,000 ft) of drinking water supply well.	WAC 173-304-130	Not ARAR. No drinking water supply wells.
Watershed.	New solid waste disposal areas prohibited within a watershed used by a public water supply system for municipal drinking water.	New solid waste disposal in a public watershed.	WAC 173-304-130	Not ARAR. Not a public watershed.
AIR:				
Non-attainment areas.	Restrictions on air emissions in areas designated as non-attainment areas under state and federal air quality programs.	Activities in a designated non-attainment area.	Chapter 70.94 RCW; Chapters 173-400 and 173-403 WAC.	Not ARAR. Not a non-attainment area.
SENSITIVE ENVIRONMENTS:				
Endangered/threatened species habitats.	New solid waste disposal prohibited from areas designated by US Fish and Wildlife Service as critical habitats for endangered/threatened species.	New solid waste disposal in critical habitats.	WAC 173-304-130	Not ARAR. Not a critical habitat.
	Actions within critical habitats must conserve endangered/threatened species.	Activities where endangered or threatened species exist.	50 CFR Parts 200 and 402.	Potential ARAR.

Table 6-2. Potential Location-Specific ARARs.

Location	Requirement	Prerequisite	Citation	ARAR
Parks.	No new solid waste disposal areas within 305 m (1,000 ft) of state or national park.	New solid waste disposal near state/national park.	WAC 173-304-130	Not ARAR. No state/national park.
	Restrictions on activities in areas that are designated state parks, or recreation/ conservation areas.	Activities in state parks or recreation/conservation areas.	Chapter 43.51 RCW; Chapter 352.32 WAC	Not ARAR. None of these state areas.
Wilderness areas.	Actions within designated wilderness areas must ensure area is preserved and not impaired.	Activities within designated wilderness areas.	16 USC 1131 et seq; 50 CFR 35.1 et seq	Not ARAR. Not a wilderness area.
Wildlife refuge.	Restrictions on actions in areas that are part of the National Wildlife Refuge System.	Activities within designated wildlife refuges.	16 USC 668dd et seq; 50 CFR Part 27	Not ARAR. Not a wildlife refuge.
Natural areas preserves.	Activities restricted in areas designated as having special habitat value (Natural Heritage Resources).	Activities within identified Natural Area Preserves.	Chapter 79.70 RCW; Chapter 332-650 WAC	Not ARAR. Not a Natural Area Preserve.
Wild, scenic, or recreational rivers.	Avoid actions that would have adverse effects on designated wild, scenic, or recreational rivers.	Activities near wild, scenic, and recreational rivers.	16 USC 1271 et seq; 40 CFR 6.302; Chapter 79.72 RCW	Potential ARAR.
Columbia River Gorge	Restrictions on activities that could affect resources in the Columbia River Gorge.	Activities within the Columbia River Gorge.	Chapter 43.97 RCW	Not ARAR. Not in Columbia River Gorge.

Table 6-2. Potential Location-Specific ARARs.

Location	Requirement	Prerequisite	Citation	ARAR
UNIQUE LANDS AND PROPERTIES:				
Natural resource conservation areas.	Restrictions on activities within designated Conservation Areas.	Activities within designated Conservation Areas.	Chapter 79.71 RCW	Not ARAR. Not a Conservation Area.
Forest lands.	Activities restricted within state forest lands to minimize fire hazards and other adverse impacts.	Activities within state forest lands.	Chapter 76.04 RCW; Chapter 332-24 WAC	Not ARAR. Not a forest land.
	Restrictions on activities in state and federal forest lands.	Activities within state and federal forest lands.	16 USC 1601; Chapter 76.09 RCW	Not ARAR. Not a forest land.
Public lands.	Activities on public lands are restricted, regulated, or proscribed.	Activities on state-owned lands	Chapter 79.01 RCW	Not ARAR. Not a state land.
Scenic vistas.	Restrictions on activities that can occur in designated scenic areas.	Activities in designated scenic vista areas.	Chapter 47.42 RCW	Not ARAR. Not a scenic area.
Historic areas.	Actions must be taken to preserve and recover significant artifacts, preserve historic and archaeologic properties and resources, and minimize harm to national landmarks.	Activities that could affect historic or archaeologic sites or artifacts.	16 UST 469, 470 et seq; 36 CFR Parts 65 and 800; Chapters 27.34, 27.53, and 27.58 RCW.	Not ARAR. No historic or archaeologic sites.

Table 6-2. Potential Location-Specific ARARs.

Location	Requirement	Prerequisite	Citation	ARAR
LAND USE:				
Neighboring properties.	No new solid waste disposal areas within 30.5 m (100 ft) of the facility's property line.	New solid waste disposal within 100 feet of facility property line.	WAC 173-304-130	Not ARAR. Not near facility boundary.
	No new solid waste disposal areas within 76 m (250 ft) of property line of residential zone properties.	New solid waste disposal within 250 feet of property line of residential property.	WAC 173-304-130	Not ARAR. No residential property near.
Proximity to airports.	Disposal of garbage that could attract birds prohibited within 3,048 m (10,000 ft) (turbojet aircraft)/1,524 m (5,000 ft) (piston-type aircraft) of airport runways.	Garbage disposal near airport.	WAC 173-304-130	Not ARAR. No airports near.

7.0 PRELIMINARY REMEDIAL ACTION TECHNOLOGIES

Previous sections identified contaminants of concern at the PUREX Plant Aggregate Area, potential routes of exposure, and applicable or relevant and appropriate requirements (ARARs). Section 7.0 identifies preliminary remedial action objectives (RAOs) and develops preliminary remedial action alternatives consistent with reducing the potential hazards of this contamination and satisfying ARARs. The overall objective of this section is to identify viable and innovative remedial action alternatives for media of concern at the PUREX Plant Aggregate Area.

The process of identifying viable remedial action alternatives consists of several steps. In Section 7.1, RAOs are first identified. Next, in Section 7.2, general response actions are determined along with specific treatment, resource recovery, and containment technologies within the general response categories. Specific process options belonging to each technology type are identified, and these process options are subsequently screened based on their effectiveness, implementability, and cost (Section 7.3). The combining of process options into alternatives occurs in Section 7.4. Here the alternatives are described and diagrammed. Criteria are then identified in Section 7.5 for preliminary screening of alternatives that may be applicable to the waste management units and unplanned release sites identified in the PUREX Plant Aggregate Area. Figure 7-1 is a matrix summarizing the development of the remedial action alternatives starting with media-specific RAOs.

Because of uncertainty regarding the nature and extent of contamination at the PUREX Plant Aggregate Area waste management units, recommendations for remedial alternatives are general and cover a broad range of actions. Remedial action alternatives will be considered and more fully developed in future focused feasibility studies (FFS). The *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) is used to focus the range of remedial action alternatives that will be evaluated in focused studies. In general, the *Hanford Site Past-Practice Strategy* remedial investigation (RI)/FS and the Resource Conservation and Recovery Act (RCRA)/Corrective Measures Studies (CMS) are defined as the combination of interim remedial measures (IRMs), limited field investigations (LFIs) for final remedy selection where interim actions are not clearly justified, and focused or aggregate area feasibility/treatability studies for further evaluation of treatment alternatives. After completion of an IRM, data will be evaluated including concurrent characterization and monitoring data to determine if a final remedy can be selected.

A secondary purpose of the evaluation of preliminary remedial action alternatives is the identification of additional information needed to complete the evaluation. This information may include field data needs and treatability tests of selected technologies. Additional data will be developed for most waste management units or waste groups during future data

gathering activities (e.g., LFIs, characterization supporting IRMs, or treatability studies). These data may be used to refine and supplement the RAOs and proposed alternatives identified in this initial study. Data needs are defined in Section 8.0. Alternatives involving technologies that are not well-demonstrated under the conditions of interest are identified in Sections 7.3 and 7.5. These technologies may require bench-scale and pilot-scale treatability studies. The intent is to conduct treatability studies for promising technologies early in the RI/FS process. Conclusions regarding the feasibility of some individual technologies may change after new data become available.

The bias-for-action philosophy of addressing contamination at the Hanford Site requires an expedited process for implementing remedial actions. Implementation of general response actions may be accomplished using an observational or "learn-as-you-go" approach. This observational approach is an iterative process of data acquisition and refinement of the conceptual model. Data needs are determined by the model, and data collected to fulfill these needs are used as additional input to the model. Use of the observational approach while conducting response actions in the 200 Areas will allow integrating these actions with longer range objectives of final remediation of similar areas and the entire 200 Areas. Site characterization and remediation data will be collected concurrently with the use of LFIs, IRMs, and treatability testing. The knowledge gained through these different activities will be applied to similar areas. The overall goal of this approach is convergence on an appropriate response action as early as possible while continuing to obtain valuable characterization information during remediation phases.

7.1 PRELIMINARY REMEDIAL ACTION OBJECTIVES

The RAOs are remediation goals for protection of human health and the environment that specify the contaminants and media of concern, exposure pathways, and allowable contaminant levels. The RAOs discussed in this section are considered to be preliminary and may change or be refined as new data are acquired and evaluated.

The fundamental objective of the corrective action process at the PUREX Plant Aggregate Area is to protect environmental resources and/or human receptors from the potential threats that may exist because of known or suspected contamination. Specific interim and final RAOs will depend in part on current and reasonable potential future land use in the PUREX Plant Aggregate Area and the 200 East Area.

Potential future land use will affect the risk-based cleanup objectives, potential ARARs, and point of compliance. The RAOs for protecting human health for residential or agricultural land use would be based on risk assessment exposure scenarios requiring cleanup to lower contaminant levels than for recreational or industrial land uses. It is important that

potential future land use and the RAOs be clearly defined and agreed upon by the U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and Washington State Department of Ecology (Ecology) before further and more detailed evaluation of remedial actions. The Hanford Site Remedial Action Environmental Impact Statement is intended to resolve the land use issues. A Record of Decision (ROD) for this environmental impact statement is expected in the spring of 1994.

To focus remedial actions with a bias for action through implementing IRMs, preliminary RAOs are identified for the 200 East Area and PUREX Plant Aggregate Area. The overall objective for the 200 East Area is as follows:

> Reduce the risk of harmful effects to the environment and human users of the area by reducing the toxicity, mobility, or volume of contaminants from the source areas to meet ARARs or risk-based levels that will allow industrial use of the area (this is a potential final RAO, and an interim action objective based on current use of the 200 Areas).

The RAOs are further developed in Table 7-1 for media of concern and applicable exposure pathways (see Sections 4.1 and 4.2) for the PUREX Plant Aggregate Area. The media of concern for the PUREX Plant Aggregate Area include:

- Radiation contaminated soils that could result in direct exposure or inhalation
- Contaminated soils that are or could contribute to groundwater contamination
- Vadose zone vapors that could cause ambient air impacts or contribute to the lateral and vertical migration of contaminants in the soil and to the groundwater
- Biota that could mobilize radionuclides or chemical contaminants directly or could degrade the integrity of other controls, such as caps thereby mobilizing contaminants.

Waste materials currently stored in single-shell tanks that contribute or may contribute contaminants to environmental media will not be addressed by this aggregate area management study (AAMS) program but rather by the single-shell tank program. In addition, groundwater as an exposure medium is not addressed in this source AAMS report but will be addressed in the 200 East Groundwater Aggregate Area Management Study Report (AAMSR).

7.2 PRELIMINARY GENERAL RESPONSE ACTIONS

General response actions represent broad classes of remedial measures that may be appropriate to achieve both interim and final RAOs at the PUREX Plant Aggregate Area, and are presented in Table 7-2. The following are the general response actions followed by a brief description for the PUREX Plant Aggregate Area:

- No action (applicable to specific facilities)
- Institutional controls
- Waste removal and treatment or disposal
- Waste containment
- In situ waste treatment
- Combinations of the above actions.

No action is included for evaluations as required by the National Environmental Policy Act (NEPA) and National Contingency Plan (NCP) [40 CFR 300.68 (f)(l)(v)] to provide a baseline for comparison with other response actions. The no action alternative may be appropriate for some facilities and sources of contamination if risk assessments determine acceptable natural resource or human health risks posed by those sources or facilities and no exceedances of contaminant-specific ARARs occur.

Institutional controls involve the use of physical barriers or access restrictions to reduce or eliminate public exposure to contamination. Considering the nature of the PUREX Plant Aggregate Area and the 200 Areas as a whole, institutional controls will likely be an integral component of all interim remedial alternatives. Many access and land use restrictions are currently in place at the Hanford Site and will remain in place during implementation of remedial actions. Institutional controls may also be important for final remedial measures alternatives. The decisions regarding future long-term land use at the 200 Area will be important in determining whether institutional controls will be a part of the remedial measures alternative, and the type of controls required.

Waste removal and treatment or disposal involves excavation of contamination sources for eventual treatment and/or disposal either on a small- or large-scale basis. One approach being considered for large-scale waste removal is macro-engineering, which is based on high volume excavation using conventional surface mining technologies. Waste removal on a macro-engineering scale would be used over large areas such as groups of waste management

units, operable units, or operational areas as a final remedial action. Waste removal on a small scale would be conducted for individual waste management units on a selective basis. Small-scale waste removal could be conducted as either an interim or final remedial action. One potential problem with off-site disposal is the lack of an alternate disposal location that will decrease the potential human exposure over the long time required for many of the contaminants. Waste removal actions may not be needed, or only be required on a small scale, to protect human health or the environment for industrial uses of the 200 Areas.

Waste treatment involves the use of biological, thermal, physical, or chemical technologies. Typical treatment options include biological land farming, thermal processing, soil washing, and fixation/solidification/stabilization. Some treatment technologies may be pilot tested at the highest priority facilities. Waste treatment could be conducted either as an interim or final action and may be appropriate in meeting RAOs for all potential future land uses.

Waste containment includes the use of capping technologies (i.e., capping and grouting) to minimize the driving force for downward or lateral migration of contaminants. Capping also provides a radiation exposure barrier and barrier to direct exposure. In addition, these barriers provide long-term stability with relatively low maintenance requirements. Containment actions may be appropriate for either interim or final remedial actions.

In situ waste treatment includes thermal, chemical, physical, and biological technology types, of which there are several specific process options including in situ vitrification, in situ grouting or stabilization, soil flushing, and in situ biotreatment. The distinguishing feature of in situ treatment technologies is the ability to attain RAOs without removing the wastes. The final waste form generally remains in place. This feature is advantageous when exposure during excavation would be significant or when excavation is technically impractical. In situ treatment can be difficult because the process conditions may not be easily controlled.

In the next section, specific process options within these technology groups are evaluated.

7.3 TECHNOLOGY SCREENING

In this section, potentially applicable technology types and process options are identified. These process options are then screened using effectiveness, implementability, and relative cost as criteria to eliminate those process options that would not be feasible at the site. The remaining applicable processes are then grouped into remedial alternatives in Section 7.4.

The effectiveness criteria focuses on: 1) the potential effectiveness of process options in handling the areas or volumes of media and meeting the remedial action objectives; 2) the potential impacts to human health and the environment during the construction and implementation phase; and 3) how proven and reliable the process is with respect to the contaminants and conditions at the site. This criteria also concentrates on the ability of a process option to treat a contaminant type (organics, inorganics, metals, radionuclides, etc.) rather than a specific contaminant (nitrate, cyanide, chromium, plutonium, etc.).

The implementability criteria places greater emphasis on the institutional aspects of implementability, such as the ability to obtain necessary permits for offsite actions, the availability of treatment, storage, and disposal services, and the availability of necessary equipment and skilled workers to implement the technology. It also focuses on the process option's developmental status, whether it is an experimental or established technology.

The relative cost criteria is an estimate of the overall cost of a process, including capital and operating costs. At this stage in the process, the cost analysis is made on the basis of engineering judgement, and each process is evaluated as to whether costs are high, medium, or low relative to other process options.

A process option is rated effective if it can handle the amount of area or media required, if it does not impact human health or the environment during the construction and implementation phases, and if it is a proven or reliable process with respect to the contaminants and conditions at the site. Also a process option is considered more effective if it treats a wide range of contaminants rather than a specific contaminant. An example of a very effective process option would be vitrification because it treats inorganics, metals, and radionuclides. On the other hand, chemical reduction may only treat chromium (VI), making it a less useful option.

An easily implemented process option is one that is an established technology, uses readily available equipment and skilled workers, uses treatment, storage, and disposal services that are readily available, and has few regulatory constraints. Preference is given to technologies that are easily implemented.

Preference is given to lower cost options, but cost is not an exclusionary criteria. A process option is not eliminated based on cost alone.

Results of the screening process are shown in Table 7-3. Brief descriptions are given of the process options, followed by comments regarding the evaluation criteria. The last column of the table indicates whether the process option is rejected or carried forward for possible alternative formation. The table first lists technologies that address soil RAOs.

Next, technologies pertaining to biota RAOs are presented. All the biota-specific technologies happen to be technologies that were listed for soil RAOs. Air RAOs are dealt with as soil remediation issues because the air contamination is a result of the contaminants in the soil: addressing and remediating the air pathways would be unnecessary and ineffective as long as there is soil contamination. If the soil is remediated, the source of the air contamination would be removed.

The conclusions column of Table 7-3 indicates that no action, monitoring, 3 institutional process options, and 16 other process options are retained for further development of alternatives. These options are carried forward into the development of preliminary alternatives.

7.4 PRELIMINARY REMEDIAL ACTION ALTERNATIVES

This section develops and describes several remedial alternatives considered applicable to disposal sites that contain hazardous chemicals, radionuclides, and volatile organic compounds (VOCs). These alternatives are not intended as recommended actions for any individual site, but are intended only to provide potential options applicable to most sites where multiple contaminants are present. Selection of actual remedial alternatives that should be applied to the individual sites would be partly based on future expedited or interim actions and LFIs, as recommended in Section 9.0 of this report. Selection of proper alternatives would be conducted within the framework of the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) and the strategy outlined in Section 9.4.

The remedial alternatives are developed in Section 7.4.1. Then, in Section 7.4.2 through Section 7.4.7, the remedial action alternatives are described. Detailed evaluations and costs are not provided because site-specific conditions must be further investigated before meaningful evaluations could be conducted.

7.4.1 Development of Remedial Alternatives

Potentially feasible remedial technologies were described and evaluated in Section 7.3. Some of those technologies have been proven to be effective and constructible at industrial waste management units, while other technologies are in the developmental stages. The EPA guidance on feasibility studies (FS) for uncontrolled waste management units recommends that a limited number of candidate technologies be grouped into "Remedial Alternatives." For this study, technologies were combined to develop remedial alternatives and provide at least one alternative for each of the following general strategies:

- No action
- Institutional controls
- Removal, above-ground treatment, and disposal
- Containment
- In situ treatment

The alternatives are intended to treat all or a major component of the PUREX Plant Aggregate Area contaminated waste management units or unplanned releases. Consistent with the development of RAOs and technologies, alternatives were developed based on treating classes of compounds (radionuclides, heavy metals, inorganics, and organics) rather than specific contaminants. At a minimum, the alternative must be a complete package. For example, disposal of radionuclide-contaminated soil must be combined with excavation and backfilling of the excavated site.

One important factor in the development of the preliminary remedial action alternatives is the fact that radionuclides, heavy metals, and some inorganic compounds cannot be destroyed. Rather, these compounds must be physically immobilized, contained, isolated, or chemically converted to less mobile forms to satisfy RAOs. Organic compounds can be destroyed, but may represent a smaller portion of the overall contamination at the PUREX Plant Aggregate Area. Both no action and institutional controls are required as part of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) RI/FS guidance. The purpose of including both of these alternatives is to provide decision makers with information on the entire range of available remedial actions.

For the containment alternative, an engineered multimedia cover, with or without vertical barriers (depending on the specifics of the remediation) was selected. Two alternatives were selected to represent the excavation and treatment strategy. One of these deals with disposal of transuranic (TRU) contaminated soils. Finally, three in situ alternatives were identified. One deals with vapor extraction for VOCs, one with stabilization of soils and the other with vitrification of soils.

It is recognized that this does not represent an exhaustive list of all applicable alternatives. However, these do provide a reasonable range of remedial actions that are likely to be evaluated in future FS. The remedial action alternatives are summarized as follows:

- No action
- Institutional controls
- Engineered multimedia cover with or without vertical barriers (containment)
- In situ grouting or stabilization of soil (in situ treatment)
- Excavation, above-ground treatment, and disposal of soil (removal, treatment and disposal)
- In situ vitrification of soil (in situ treatment)
- Excavation, treatment, and geologic disposal of soil with TRU radionuclides (removal, treatment and disposal)
- In situ soil vapor extraction of VOCs (in situ treatment).

These alternatives, with the exception of no action and institutional controls, were developed because they satisfy a number of RAOs simultaneously and use technologies that are appropriate for a wide range of contaminant types. For example, constructing an engineered multimedia cover can effectively contain radionuclides, heavy metals, inorganic compounds, and organic compounds simultaneously. It satisfies the RAOs of protecting human health and the environment from exposures from contaminated soil, bio-mobilization, and airborne contaminants. In situ soil vapor extraction is more specific than the other alternatives, but it addresses a contaminant class (VOCs) that is not readily treated using the other options, such as in situ stabilization. It is possible that some waste management units may require a combination of the identified alternatives to completely address all contaminants.

The use of contaminant-specific remedial technologies was avoided because there appear to be few, if any, waste management units where a single contaminant has been identified. It is possible to construct alternatives that include several contaminant-specific technologies, but the number of combinations of technologies would result in an unmanageable number of alternatives. Moreover, the possible presence of unidentified contaminants may render specific alternatives unusable. Alternatives may be refined as more contamination data are acquired. For now, the alternatives will be directed at remediating the major classes of compounds (radionuclides, heavy metals, inorganics, and organics).

In all alternatives except the no-action alternative, it is assumed that monitoring and institutional controls are required, although they may be temporary. These features are not

explicitly mentioned, and details are purposely omitted until a more detailed evaluation may be performed in subsequent studies.

In the next sections, the preliminary remedial action alternatives are described in more detail, with the exception of the no-action and institutional control options.

7.4.2 Alternative 1--Engineered Multimedia Cover with or without Vertical Barriers

Alternative 1 consists of an engineered multimedia cover. Vertical barriers such as grout curtains or slurry walls may be used in conjunction with the cover. Figure 7-2 shows a schematic diagram of an engineered multimedia cover without the vertical barriers. If the affected area includes either a naturally occurring or engineered depression, then imported backfill would be placed to control runoff and run-on water. The engineered cover itself may consist of clay, gravel, sand, asphalt, soil, and/or synthetic liners. A liquid collection layer could also be included. The specific design of the cover and vertical barriers would be the subject of a focused feasibility study which may be supported by performance testing. The barrier would be designed to minimize infiltration of surface water by enhancing the evapotranspiration mechanism. The covered area may be fenced, and warning signs may be posted.

Alternative 1 would provide a permanent cover over the affected area. The cover would accomplish the following: minimize or eliminate the migration of precipitation into the affected soil; reduce the migration of windblown dust that originated from contaminated surface soils; reduce the potential for direct exposure to contaminated soils; and reduce the volatilization of VOCs and tritium to the atmosphere. If vertical barriers are included, they would limit the amount of lateral migration of contaminants. However, capping does not eliminate vapor phase transport, and contaminants are not treated or reduced in volume.

7.4.3 Alternative 2--In Situ Grouting or Stabilization of Soil

Radioactive and hazardous soil would be grouted in this alternative using in situ injection methods to significantly reduce the leachability of hazardous contaminants, radionuclides and/or VOCs from the affected soil. Grouting may also be used to fill voids, such as in cribs, thereby reducing subsidence. Another variation of this alternative would be to stabilize the soil using in situ mixing of soil with stabilizing compounds such as pozzolanics or fly ash.

Figure 7-3 shows a schematic diagram of the in situ grout injection process. Grouting wells would be installed and screened throughout the affected vertical zones. Specially

formulated cement grout (determined by treatability studies) would be injected and allowed to cure. In situ stabilization would be conducted in a similar manner, except a cutting-head tool would be used to mix the contaminated soil with stabilizing compounds fed into the soil.

Alternative 2 would provide a combination of immobilization and containment of heavy metal, radionuclide, and inorganic contamination. Thus, this alternative would reduce migration of precipitation into the affected soil; reduce the migration of windblown dust that originated from contaminated surface soils; reduce the potential for direct exposure to contaminated soils; and reduce the volatilization of VOCs.

7.4.4 Alternative 3--Excavation, Soil Treatment, and Disposal

Under Alternative 3, radioactive and hazardous soil would be excavated using conventional techniques, with special precautions to minimize fugitive dust generation. The soil would be treated above ground. Several treatment options could be selected from the physical, chemical, and thermal treatment process options screened in Section 7.3. For example, thermal desorption with off-gas treatment could be used if organic compounds are present; soil washing could be used to remove contaminated silts and sands or specific compounds; and stabilization could be used to immobilize radionuclides and heavy metals. The specific treatment method would depend on site-specific conditions (determined in part through bench-scale testing). The treated soil would be backfilled into the original excavation or landfilled. Soil treatment by-products may require additional processing or treatment. Figure 7-4 shows a schematic diagram of this alternative.

Alternative 3 would be effective in treating a full range of contamination, depending on the type of treatment processes selected. Attainment of soil RAOs would depend on the depth to which the soil was excavated. If near surface soil was treated, airborne contamination, direct exposure to contaminated soil, and bio-mobilization of contamination would be minimized. Because of practical limits on deep excavation, deep contamination may not be removed and would be subject to migration into groundwater. Alternative 3 could be used in conjunction with Alternative 1 (multimedia cap) to reduce this possibility.

7.4.5 Alternative 4--In Situ Vitrification of Soil

In this alternative, the contaminated soil in a subject site would be immobilized by in situ vitrification. Figure 7-5 shows a schematic diagram of the alternative. Import fill would initially be placed over the affected area to reduce exposures to the remediation workers from surface contamination. High power electrodes would be used to vitrify the contaminated soil under the site to a depth below where contamination is present. A large fume hood would be

constructed over the site before the start of the vitrification process to collect and treat emissions. After completion of the vitrification, the site would be built back to original grade with imported backfill. Fences and warning signs may be placed around the vitrified monolith to minimize disturbance and potential exposure.

In situ vitrification would be effective in treating radionuclides, heavy metals, and inorganic contamination and may also destroy organic contaminants. This would reduce the potential for exposures by leaching to groundwater, windblown dust and direct dermal contact. However, this alternative would not reduce the mass or toxicity of the radionuclides present onsite. Also, in situ vitrification may be limited to depths of less than about 30 m (100 ft), which may not be adequate to immobilize deep contamination.

7.4.6 Alternative 5--Excavation, Above-Ground Treatment, and Geologic Disposal of Soil with TRU Radionuclides

Figure 7-6 shows a schematic diagram of Alternative 5. Special excavation procedures would have to be used to minimize fugitive dust. Non-TRU "overburden" may have to be removed, temporarily stored, and returned to the excavation after the TRU soil was removed. Imported backfill would be used to restore the site to original grade. The excavated TRU soil would be vitrified or stabilized by an above-ground treatment plant. The vitrified or stabilized soil would then be shipped to a TRU waste repository. Long-term storage may be required until a suitable facility could be sited and constructed. An engineered multimedia cover (Alternative 1) could be installed over the completed site to reduce exposure to any remaining contaminated, non-TRU soils.

For Alternative 5, soil containing TRU radionuclides at concentrations exceeding 100 nCi/g would be excavated, treated, and disposed. Thus, potential exposure to and migration of TRU-wastes would be minimized. Potential exposure to other contaminants would be determined by other remedial alternatives implemented. At sites containing TRU and non-TRU wastes, the use of Alternative 5 alone may not satisfy all RAOs.

7.4.7 Alternative 6--In Situ Soil Vapor Extraction for VOCs

Figure 7-7 shows a schematic diagram of a representative soil vapor extraction system. The soil vapor extraction system would consist of venting wells, manifold piping, condensed water collectors, high efficiency particulate air (HEPA) filters, and a catalytic oxidizer. The condensed water may contain VOCs and radionuclides, so it may have to be disposed of as radioactive mixed waste. The vented air may contain radionuclide-containing dust particles, so HEPA filters would be installed to remove the particulate radionuclides.

The vented vapors would be treated by the catalytic incinerator to provide at least 95% destruction. Because there are few sites in the PUREX Plant Aggregate Area, the potential use of soil vapor extraction in this aggregate area would be limited.

In situ soil vapor extraction is a proven technology for removal of VOC from the vadose zone soils. Soil vapor extraction would reduce downward migration of the VOC vapors through the vadose zone, and thereby minimize potential cross-media migration into the groundwater. Soil vapor extraction would reduce upward migration of VOC through the soil column into the atmosphere, and thereby minimize inhalation exposures to the contaminants. In some cases the radionuclides were discharged to the disposal sites with VOCs (e.g., hexone). Removal of the VOC by implementing soil vapor extraction could reduce the mobility of the radionuclides, and thereby reduce the potential for downward migration of the radionuclides. Finally, soil vapor extraction would enhance partitioning of the VOC off of the soil and into the vented air stream, resulting in the permanent removal and destruction of the VOC. Alternative 6 may be used in conjunction with other alternatives if contaminants other than VOCs are present. However, because of the limited number of PUREX Plant sites that contain VOCs, the use of soil vapor extraction will not be extensive.

7.5 PRELIMINARY REMEDIAL ACTION ALTERNATIVES APPLICABLE TO WASTE MANAGEMENT UNITS AND UNPLANNED RELEASE SITES

The purpose of this section is to discuss which preliminary remedial action alternatives could be used to remediate each PUREX Plant Aggregate Area waste management unit or unplanned release site. The criteria used for deciding this are as follows:

- Installing an engineered multimedia cover with or without vertical barriers (Alternative 1) could be used on any site where contaminants may be leached or mobilized by surface water infiltration or if surface/near-surface contamination exists.

- In situ grouting or stabilization (Alternative 2) could be used on any waste management unit or unplanned release site that contain heavy metals, radionuclides, and/or other inorganic compounds. In situ grouting could also be effective in filling voids for subsidence control.

- Excavation and soil treatment (Alternative 3) could be used at most waste management units or unplanned release sites that contain radionuclides, heavy metals, other inorganics compounds, and/or semi-volatile organic compounds.

- In situ vitrification (Alternative 4) could be used at most waste management unit or unplanned release sites, although vapor extraction may be needed when VOCs are present. Waste management units or unplanned release sites where in situ vitrification may not be effective include reverse wells and other sites where the contamination is present in a very narrow geometry. In situ vitrification is also not considered for surface spills.

- Excavation, treatment, and geologic disposal of TRU-containing soils (Alternative 5) could be used only on those sites that contain TRU radionuclides. Since a geologic repository is likely to accept only TRU radioactive soils, the non-TRU radioactive soils will not be remediated using this alternative.

- In situ soil vapor extraction (Alternative 6) could be used on any waste management unit or unplanned release sites that contains volatile organic compounds. Such sites are not common in the PUREX Plant Aggregate Area. Nonetheless, the 216-A-8 Crib, where butyle phosphate and/or paraffin hydrocarbons were disposed, is one site at which soil vapor extraction would be an effective remedy.

Using these criteria, Table 7-4 was created showing possible preliminary remedial action alternatives that could be used to remediate each of the waste management units and unplanned release sites. Table 7-4 excludes sites that will be addressed by other programs. For example, single-shell tanks are excluded because they will be addressed by the single-shell tank program. Note that a single alternative may not be sufficient to remediate all contamination at a single site. For example, soil vapor extraction to remove organic contaminants could precede in situ vitrification. Also, different combinations of technologies are possible besides those presented in these preliminary alternatives.

Each waste management unit or unplanned release site may require just one alternative or a combination of many alternatives. Furthermore, similar sites may be remediated simultaneously. Also, more specific waste treatment alternatives could be identified and evaluated as more information is obtained.

Technology development studies will be needed for the in situ vitrification process, and treatability studies will be needed for the in situ grouting or stabilization process, and for soil treatment processes to make sure that they will effectively remediate the contaminants. Specifically, organic waste mobility may be a problem for in situ vitrification; grouting agents and the resulting reduction of contaminant leachability will need to be determined before in situ grouting can be performed; and appropriate treatment protocols and systems will need to be identified before soil washing can be used. Capping, soil vapor extraction,

and disposal options are all proven processes but may require site-specific performance assessment (treatability) studies.

A FFS will be required to evaluate alternative designs for all of the alternatives evaluated, as they relate to the specific waste management unit being remediated. A site-by-site economic evaluation is also required before making a decision. This evaluation will require site-specific information obtained in LFIs and FFS.

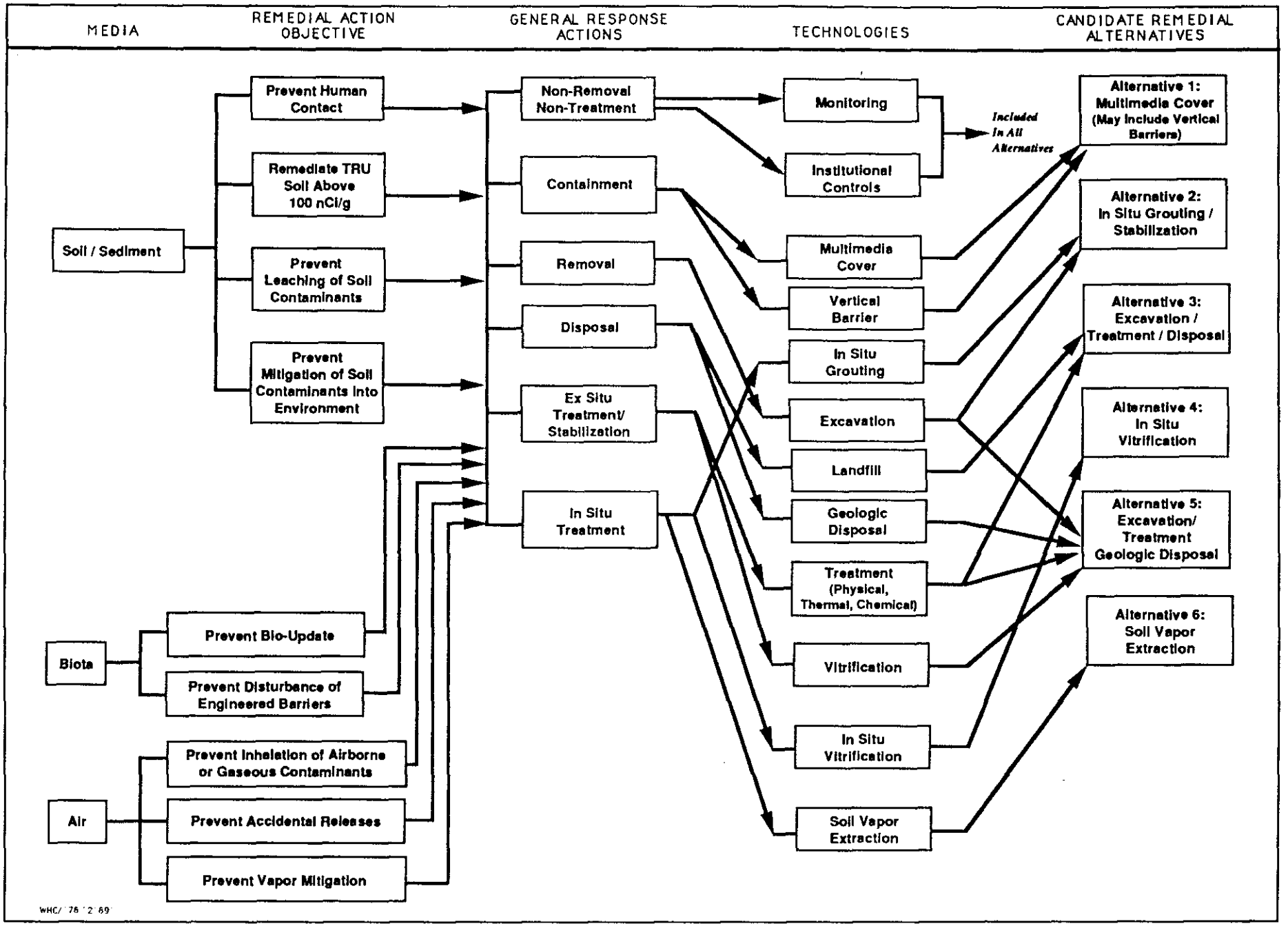


Figure 7-1. Development of Candidate Remedial Alternatives for PUREX Plant Aggregate Area.

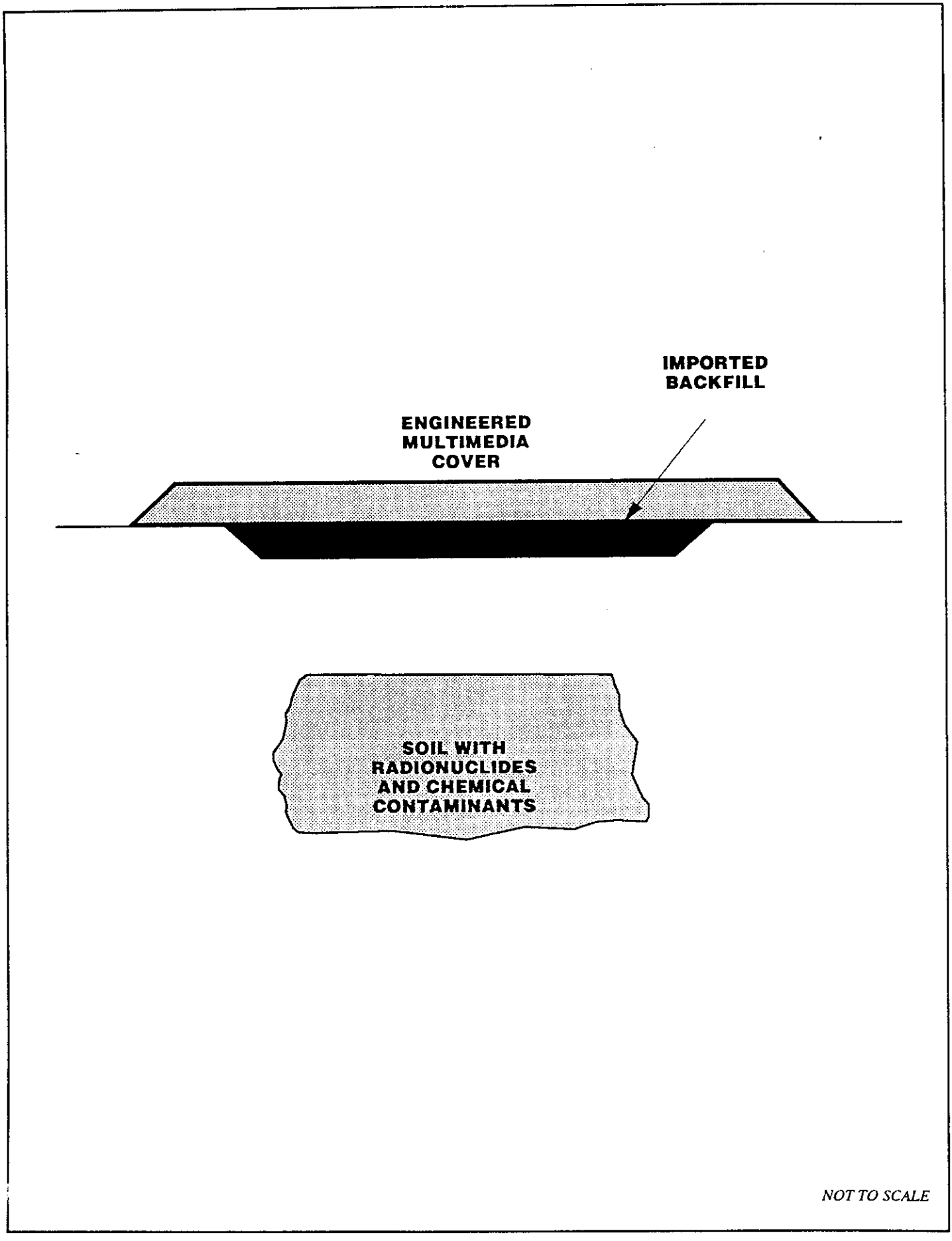
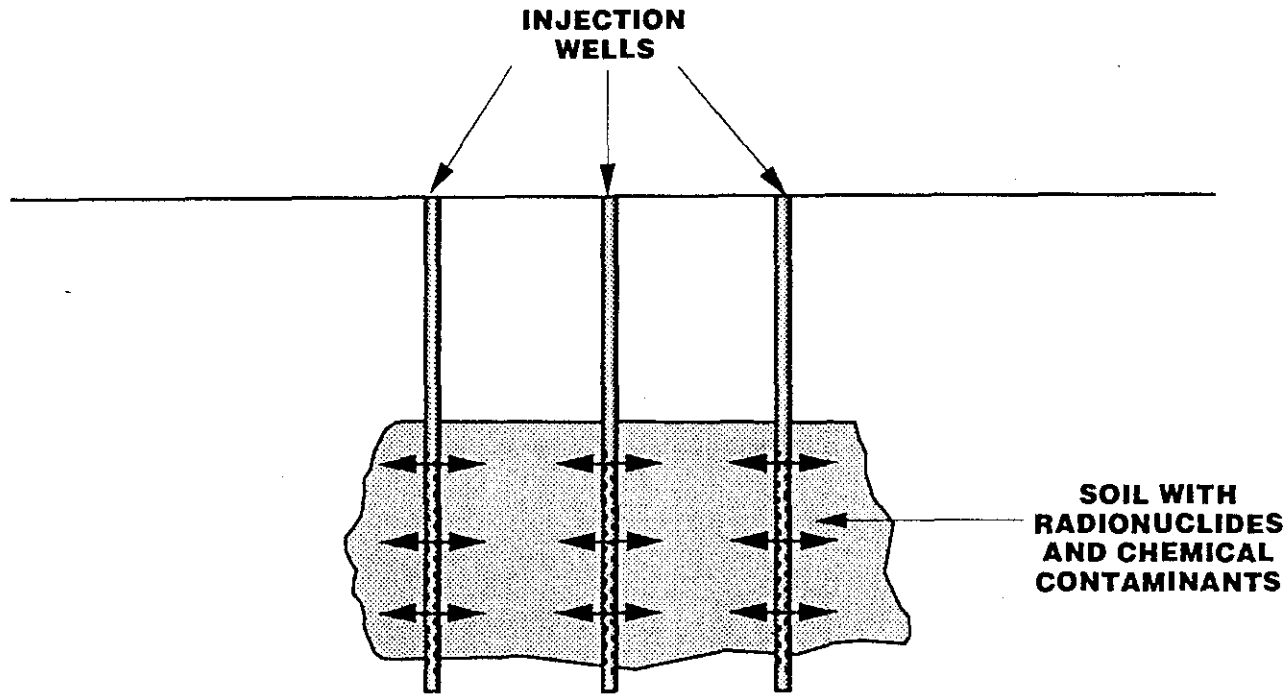


Figure 7-2. Alternative 1: Multimedia Cover.



NOT TO SCALE

Figure 7-3. Alternative 2: In Situ Grouting of Soil.

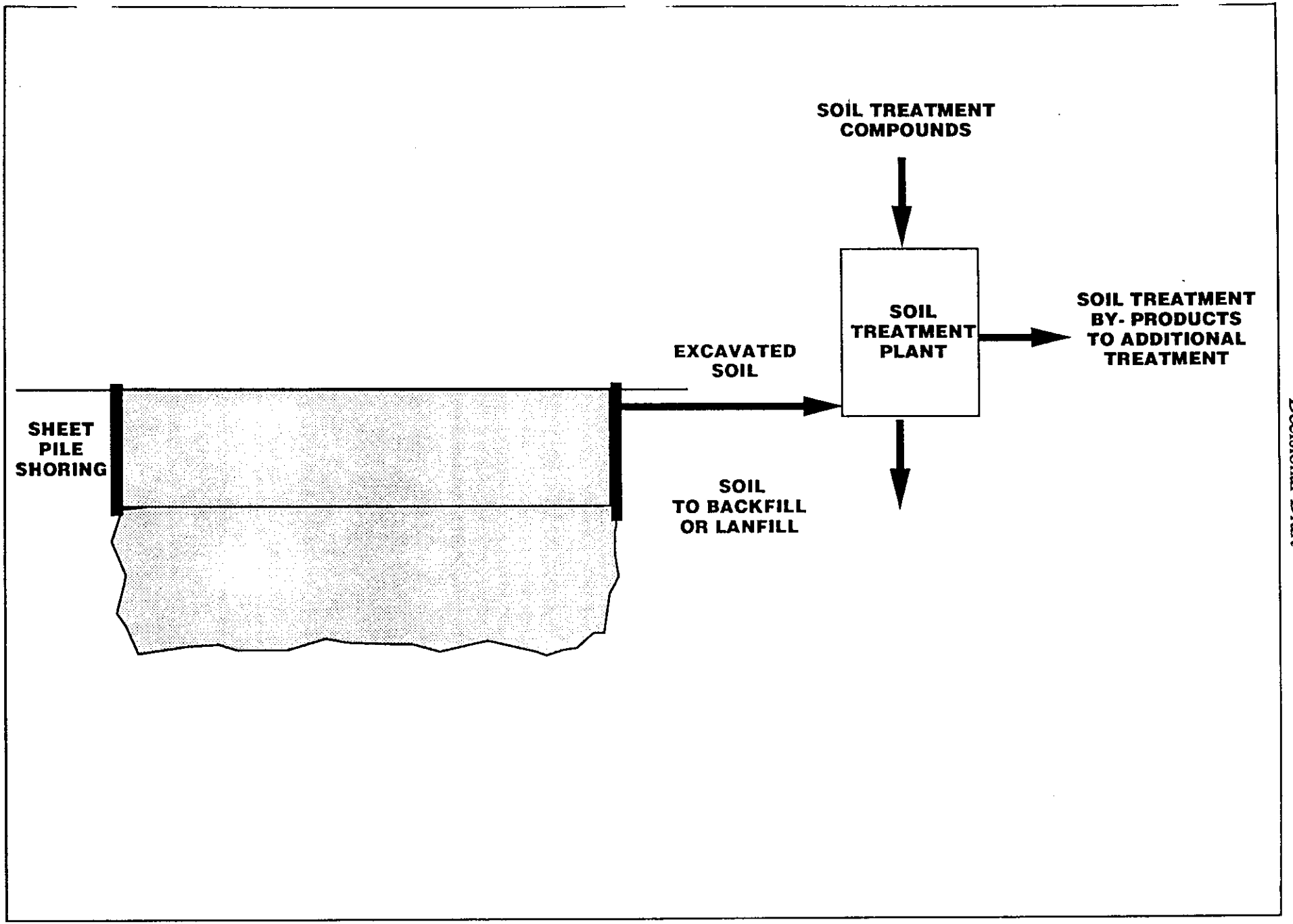


Figure 7-4. Alternative 3: Excavation, Treatment and Disposal.

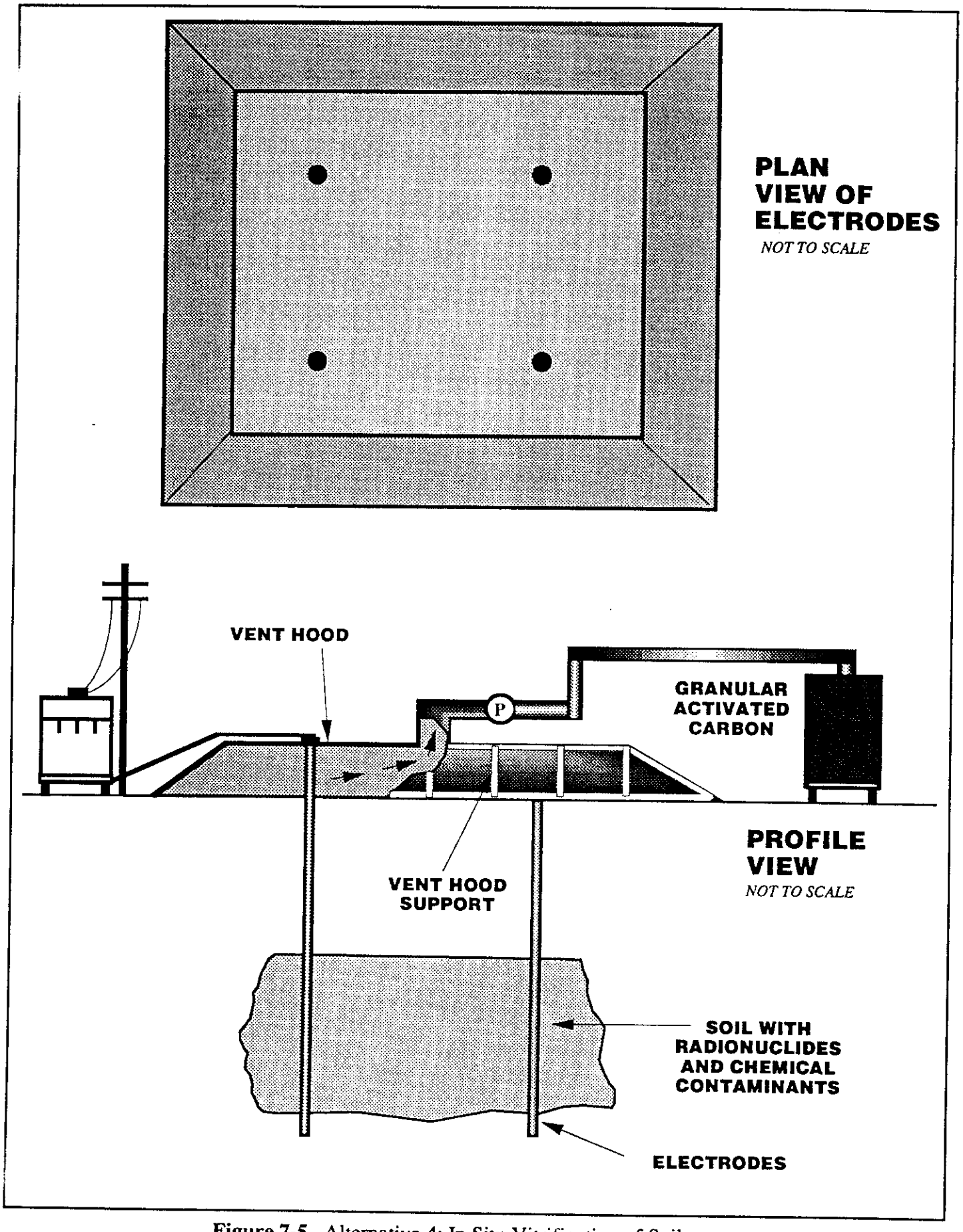


Figure 7-5. Alternative 4: In Situ Vitrification of Soil.

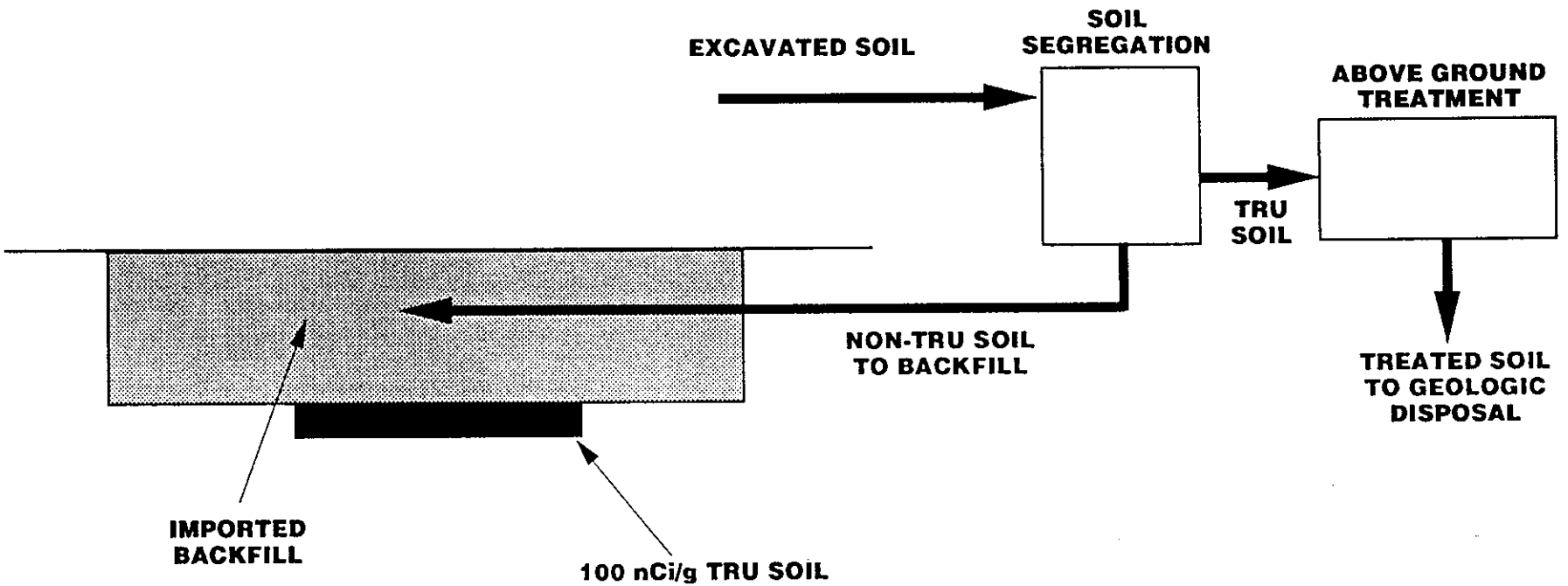


Figure 7-6. Alternative 5: Excavation, Treatment, and Geologic Disposal of Soil with TRU Radionuclides.

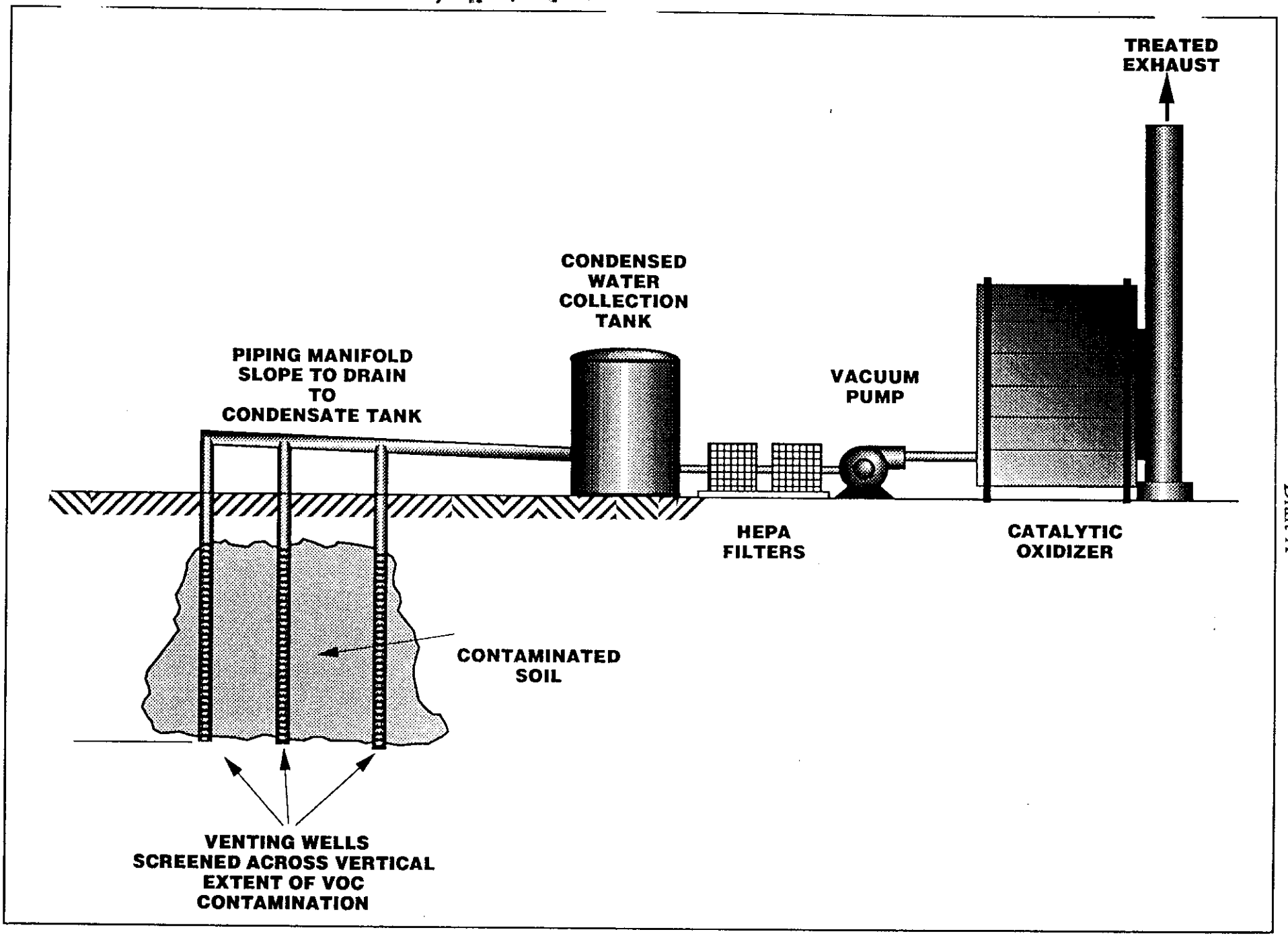


Figure 7-7. Alternative 6: Soil Vapor Extraction for Volatile Organic Compounds (VOCs).

Table 7-1. Preliminary Remedial Action Objectives and General Response Actions.

Environmental Media	Remedial Action Objectives: Human Health	Remedial Action Objectives: Environmental Protection	General Response Actions
Soils/ Sediments	• Prevent ingestion, inhalation, or direct contact with solids containing radioactive and/or hazardous constituents present at concentrations above MTCA and DOE standards for industrial sites (or subsequent risk-based standards). • Remediate soils containing TRU contamination above 100 nCi/g in accordance with 40 CFR 191 requirements. • Prevent leaching of contaminants from the soil into the groundwater that would cause groundwater concentrations to exceed MTCA and DOE standards at the compliance point location.	• Prevent migration of radionuclides and hazardous constituents that would result in groundwater, surface water, air, or biota contamination with constituents at concentrations exceeding ARARs.	• No Action • Institutional Controls • Containment • Excavation • Treatment • Disposal • In Situ Treatment
Biota	• Prevent bio uptake by plants. • Prevent disturbance of engineered barriers by biota.	• Prevent bio-uptake of radioactive contaminants.	• No Action • Institutional Controls • Excavation • Disposal • Containment
Air (1)	• Prevent inhalation of contaminated airborne particulates and/or volatile emissions exceeding MTCA and DOE limits from soils/sediments. • Prevent accidental release from collapse of containment structures.	• Prevent adverse environmental impacts on local biota.	

Note: (1) No General Response Actions are required for the air because soil remediation will eliminate the air contamination source.

Table 7-2. Preliminary Remedial Action Technologies.

Media	General Response Action	Technology Type	Process Option	Contaminants Treated
Soil	No Action	No Action	No Action	NA
	Institutional Controls	Land Use Restrictions	Deed Restrictions	NA
		Access Controls	Signs/Fences	NA
			Entry Control	NA
		Monitoring	Monitoring	NA
	Containment	Capping	Multimedia	I,M,R,O
		Vertical Barriers	Slurry Walls	I,M,R,O
			Grout Curtains	I,M,R,O
			Cryogenic Walls	I,M,R,O
		Dust & Vapor Suppression	Membranes/Sealants/ Wind Breaks/Wetting Agents	I,M,R,O
	Excavation	Excavation	Standard Construction Equipment	I,M,R,O
	Treatment	Thermal Treatment	Vitrification	I,M,R,O
			Incineration	O
			Thermal Desorption	O
			Calcination	I,M,R,O
		Chemical Treatment	Chemical Reduction	M
			Hydrolysis	I,O

Table 7-2. Preliminary Remedial Action Technologies.

Media	General Response Action	Technology Type	Process Option	Contaminants Treated
		Physical Treatment	Soil Washing	I,M,R,O
			Solvent Extraction	O
			Physical Separation	I,M,R,O
			Fixation/Solidification/ Stabilization	I,M,R,O
			Containerization	I,M,R,O
		Biological Treatment	Aerobic	O
			Anaerobic	O
	Disposal	Landfill Disposal	Landfill Disposal	I,M,R,O
		Geologic Repository	Geologic Repository	R (I,M,O if mixed with R)
	In Situ Treatment	Thermal Treatment	Vitrification	I,M,R,O
			Thermal Desorption	O
		Chemical Treatment	Reduction	M,O
		Physical Treatment	Soil Flushing	I,M,R,O
			Vapor Extraction	O
			Grouting	I,M,R
			Fixation/Solidification/ Stabilization	I,M,R,O

Table 7-2. Preliminary Remedial Action Technologies.

Media	General Response Action	Technology Type	Process Option	Contaminants Treated
		Biological Treatment	Aerobic	O
			Anaerobic	O
Biota	No Action	No Action	No Action	NA
	Institutional Controls	Land Use Restrictions	Deed Restrictions	NA
		Access Controls	Signs/Fences	NA
			Entry Control	NA
		Monitoring	Monitoring	NA
	Excavation	Excavation	Standard Construction Equipment	I,M,R,O
	Disposal	Landfill Disposal	Landfill Disposal	I,M,R,O
	Containment	Capping	Multimedia	I,M,R,O

I = Other Inorganics contaminants applicability
M = Heavy Metals contaminants applicability
R = Radionuclide contaminants applicability
O = Organic contaminants applicability
NA = Not Applicable

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
SOIL TECHNOLOGIES:						
No Action	No Action	Do nothing to cleanup the contamination or reduce the exposure pathways.	Not effective in reducing the contamination or exposure pathways.	Easily implemented, but might not be acceptable to regulatory agencies, local governments, and the public.	Low	Retained as a "baseline" case.
Land Use Restrictions	Deed Restrictions	Identify contaminated areas and prohibit certain land uses such as farming.	Depends on continued implementation. Does not reduce contamination.	Administrative decision is easily implemented.	Low	Retained to be used in conjunction with other process options.
Access Controls	Signs/Fences	Install a fence and signs around areas of soil contamination.	Effective if the fence and signs are maintained.	Easily implemented. Restrictions on future land use.	Low	Retained to be used in conjunction with other process options.
	Entry Control	Install a guard/monitoring system to prevent people from becoming exposed.	Very effective in keeping people out of the contaminated areas.	Equipment and personnel easily implemented and readily available.	Low	Retained to be used in conjunction with other process options.
Monitoring	Monitoring	Analyze soil and soil gas samples for contaminants and scan with radiation detectors.	Does not reduce the contamination, but is very effective in tracking the contaminant levels.	Easily implemented. Standard technology.	Low	Retained to be used in conjunction with other process options.
Capping	Multimedia	Fine soils over synthetic membrane or other layers and covered with soil; applied over contaminated areas.	Effective on all types of contaminants, not likely to crack. Likely to hold up over time.	Easily implemented. Restrictions on future land use will be necessary.	Medium	Retained because of potential effectiveness and implementability.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Vertical Barriers	Slurry Walls	Trench around areas of contamination is filled with a soil (or cement) bentonite slurry.	Effective in blocking lateral movement of all types of soil contamination. May not be effective for deep contamination.	Commonly used practice and easily implemented with standard earth moving equipment. May not be possible for deep contamination.	Medium	Retained for shallow contamination.
	Grout Curtains	Pressure injection of grout in a regular pattern of drilled holes.	Effective in blocking lateral movement of all types of soil contamination.	Commonly used practice and easily implementable, but depends on soil type. May be difficult to ensure continuous wall.	Medium	Retained because of potential effectiveness and implementability.
	Cryogenic Walls	Circulate refrigerant in pipes surrounding the contaminated site to create a frozen curtain with the pore water.	Effective in blocking lateral movement of all types of soil contamination.	Specialized engineering design required. Requires ongoing freezing.	Medium	Rejected because it is difficult to implement.
Dust and Vapor Suppression	Membranes/ Sealants/Wind Breaks/Wetting Agents	Using membranes, sealants, wind breaks, or wetting agents on top of the contaminated soil to keep the contaminants from becoming airborne.	Effective in blocking the airborne pathways of all the soil contaminants, but may require regular upkeep.	Commonly used practice and very easy to implement, but land restrictions will be necessary.	Low	Rejected because of limited duration of integrity and protection.
Excavation	Standard Excavating Equipment	Moving soil around the site and loading soil onto process system equipment.	Effective in moving and transporting soil to vehicles for transportation, and for grading the surface.	Equipment and workers are readily available.	Low	Retained because of potential effectiveness and implementability.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Thermal Treatment	Above-ground Vitrification	Convert soil to glassy materials by application of electric current.	Effective in destroying organics and immobilizing the inorganics and radionuclides. Off-gas treatment for volatiles may be required.	Commercial units are available. Laboratory testing required to determine additives, operating conditions, and off gas treatment. Must pre-treat soil to reduce size of large materials.	High	Retained because of potential ability to immobilize radionuclides and destroy organics.
	Incineration	Destroy organics by combustion in a fluidized bed, kiln, etc.	Effectively destroys the organic soil contaminants. Some heavy metals will volatilize. Radionuclides will not be treated.	Technology is well developed. Mobile units are currently available for relatively small soil quantities. Off-site treatment is available. Air emissions and wastewater generation should be addressed.	High	Rejected because of potential air emissions and wastewater generation.
	Thermal Desorption	Organic volatilization at 150 to 400°C (300 to 800°F) by heating contaminated soil followed by off gas treatment.	Effectively destroys the organic soil contaminants. Heavy metals less likely to volatilize than in high temperature treatments. Radionuclides will not be treated.	Successfully demonstrated on a pilot-scale level. Full-scale remediation yet to be demonstrated. Pilot testing essential.	Medium	Retained because of potential effectiveness and implementability.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
	Calcination	High temperature decomposition of solids into separate solid and gaseous components without air contact.	Effective in the decomposition of inorganics such as hydroxides, carbonates, nitrates, sulfates, and sulfites. Removes organic components but does not combust them because of the absence of air. Radionuclides will not be treated.	Commercially available. Most often used for concentration and volume reduction of liquid or aqueous waste. Off-gas treatment is required.	High	Rejected because of limited effectiveness on non-liquid or aqueous wastes.
Chemical Treatment	Chemical Reduction	Treat soils with a reducing agent to convert contaminants to a more stable or less toxic form.	May be effective in treating heavy metal soil contaminants. Radioactivity will not be reduced.	Virtually untested on treating soils. Competing reactions may reduce efficiency.	Medium	Rejected because of limited applicability and implementation problems.
	Hydrolysis	Acid- or base-catalyst reaction in water to break down contaminants to less toxic components.	Very effective on compounds generally classified as reactive. Limited effectiveness on stable compounds. Radioactivity will not be reduced.	Common industrial process. Use for treatment of soils not well demonstrated.	Medium	Rejected because of limited effectiveness and unproven on soils.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Physical Treatment	Soil Washing	Leaching of waste constituents from contaminated soil using a washing solution.	Effectiveness is contaminant specific. Generally more effective on contaminants that partition to the fine soil fraction. Radioactivity will not be reduced.	Treatability tests are necessary. Well developed technology and commercially available.	Medium	Retained because of potential effectiveness and implementability.
	Solvent Extraction	Contacting a solvent with contaminated soils to preferentially dissolve the contaminants into the solvent.	The selected solvent is often just as hazardous as the contaminants presented in the waste. May lead to further contamination. Radioactivity will not be reduced.	Laboratory testing necessary to determine appropriate solvent and operating conditions. Not fully demonstrated for hazardous waste applications.	Medium	Rejected because the solvent may lead to further contamination.
	Physical Separation	Separating soil into size fractions.	Effective as a concentration process for all contaminants that partition to a specific soil size fraction.	Most often used as a pretreatment to be combined with another technology. Equipment is readily available.	Low	Retained because of potential effectiveness and implementability.
	Fixation/ Solidification/ Stabilization	Form low permeability solid matrix by mixing soil with cement, asphalt, or polymeric materials.	Effective in reducing inorganic and radionuclide soil contaminant mobility. Effectiveness for organic stabilization is highly dependent on the binding agent.	Stabilization has been implemented for site remediations. Treatability studies are needed. Volume of waste is increased.	Medium	Retained because of potential effectiveness and implementability.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
	Containerization	Enclosing a volume of waste within an inert jacket or container.	Effective for difficult to stabilize, extremely hazardous, or reactive waste. Reduces the mobility of radionculides.	May be implemented for low concentration waste. Disposal or safe storage of containers required. Regulatory constraints may prevent disposal of containers of certain waste types.	Low	Retained because of potential effectiveness and implementability.
Biological Treatment	Aerobic	Microbial degradation in an oxygen-rich environment.	Effectiveness is very contaminant- and concentration-specific. Treatment has been demonstrated on a variety of organic compounds. Not effective on inorganics or radionuclides.	Various options are commercially available to produce contaminant degradation. Treatability tests are required to determine site-specific conditions.	Medium	Rejected because of limited applicability and difficult implementation.
	Anaerobic	Microbial degradation in an oxygen deficient environment.	Effectiveness is very contaminant and concentration specific. Treatment has been demonstrated on a variety of organic compounds. Not effective on inorganics or radionuclides.	Various options are commercially available to produce contaminant degradation. Treatability tests are required to determine site-specific conditions.	Medium	Rejected because of limited applicability and difficult implementation.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Disposal	Landfill Disposal	Place contaminated soil in an existing onsite landfill.	Does not reduce the soil contamination but moves all of the contamination to a more secure place.	Easily implemented if sufficient storage is available in an on-site landfill area.	Medium	Retained because of potential effectiveness and implementability.
	Geologic Repository	Put the contaminated soil in a safe geologic repository.	Does not reduce the soil contamination, but is a very effective and long-term way of storing radionuclides. Probably unnecessary for nonradioactive waste.	Not easy to implement because of limited site availability, and permits for transporting radioactive wastes are hard to get.	High	Retained because of effectiveness on TRU wastes.
In Situ Thermal Treatment	Vitrification	Electrodes are inserted into the soil and a carbon/glass frit is placed between the electrodes to act as a starter path for initial melt to take place.	Effective in immobilizing radionuclides and most inorganics. Effectively destroys some organics through pyrolysis. Some volatilization of organics and inorganics may occur.	Potentially implementable. Implementability depends on site configuration, e.g., lateral and vertical extent of contamination. Treatability studies required.	High	Retained because of potential ability to immobilize radionuclides and destroy organics.
	Thermal Desorption	Soil is heated in situ by radio-frequency electrodes or other means of heating to temperatures in the 80 to 400°C (200 to 750°F) range thereby causing desorption of volatile and semi-volatile organics from the soil.	Effective for removal of volatile and semi-volatile organics from soil. Ineffective for most inorganics and radionuclides. Contaminants are transferred from soil to air.	Implementable for shallow organics contamination. Not implementable for radionuclides and inorganics. Emission treatment and treatability studies required.	Medium	Rejected because of limited applicability.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
In Situ Chemical Treatment	Chemical Reduction	Reducing agent is added to the soil to change oxidation state of target contaminant.	Effective for certain inorganics, e.g., chromium. Ineffective for organics. Limited applicability.	Difficult to implement in situ because of distribution requirements for reducing agent.	Low	Rejected because of limited applicability and implementation problems.
In Situ Physical Treatment	Soil Flushing	Solutions are injected through injection system to flush and extract contaminants.	Potentially effective for all contaminants. Effectiveness depends on chemical additives and hydrology. Flushing solutions posing environmental threat likely to be needed. Difficult recovery of flushing solution.	Difficult to implement. Not implementable for complex solvents of contaminants. Flushing solution difficult to recover. Chemical additives likely to pose environmental threat.	Medium	Rejected because of implementation problem.
	Vapor Extraction	Vacuum is applied by use of wells inducing a pressure gradient that causes volatiles to flow through air spaces between soil particles to the extraction wells.	Effective for volatile organics. Ineffective for inorganics and radionuclides. Emission treatment required.	Easily implementable for proper site conditions. Requires emission treatment for organics and capture system for radionuclides and volatilized metals.	Medium	Retained for potential application to volatile organics.
	Grouting	Involves drilling and injection of grout to form barrier or injection to fill voids.	Effective in limiting migration of leachate, but difficult to maintain barrier integrity. Potentially effective in filling voids.	Implementable as barrier and for filling voids. Implementability depends on site conditions.	Medium	Retained because of ability to limit contaminant migration and potential use for filling void spaces.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
	Fixation/ Solidification/ Stabilization	Solidification agent is applied to soil by mixing in place.	Effective for inorganics and radionuclides. Potentially effective for organics. Effectiveness depends on site conditions and additives used.	Implementable. Treatability studies required to select proper additives. Thorough characterization of subsurface conditions and continuous monitoring required.	Medium	Retained because of potential effectiveness and implementability.
In Situ Biological Treatment	Aerobic	Microbial growth utilizing organic contaminants as substrate is enhanced by injection of or spraying with oxygen source and nutrients.	Effective for most organics at proper conditions. Ineffective for inorganics and radionuclides.	Difficult to implement. Treatability studies and thorough subsurface characterization required.	Low	Rejected because of limited applicability and difficult implementation.
	Anaerobic	Microbial growth utilizing organic contaminants as substrate is enhanced by addition of nutrients.	Effective for volatile and complex organics. Not effective for inorganics and radionuclides.	Difficult to implement. Anoxic ground conditions required. Treatability studies and thorough subsurface characterization necessary.	Low	Rejected because of limited applicability and difficult implementation.
BIOTA TECHNOLOGIES:						
No Action	No Action	Do nothing to clean-up the contamination or reduce the exposure pathways.	Not effective in reducing the contamination or exposure pathways.	Easily implemented, but might not be acceptable to regulatory agencies, local governments, and the public.	Low	Retained as a "baseline" case.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Land Use Restrictions	Deed Restrictions	Identify contaminated areas and prohibit certain land uses such as agriculture.	Effective if implementation is continued. Does not reduce contamination.	Administrative decision is easily implemented.	Low	Retained to be used in conjunction with other process options.
Access Controls	Signs/Fences	Install a fence and signs around areas of contamination to keep people out and the biota in.	Effective if fencing is maintained.	Easily implemented. Restrictions on future land use.	Low	Retained to be used in conjunction with other process options.
	Entry Control	Install a guard/monitoring system to eliminate people from coming in contact with the contamination.	Very effective in keeping people out of the contaminated areas.	Equipment and personnel are easily implemented and readily available.	Low	Retained to be used in conjunction with other process options.
Monitoring	Monitoring	Take biota samples and test them for contaminants.	Does not reduce the contamination, but is very effective tracking the contaminant levels.	Easily implemented. Standard Technology.	Low	Retained to be used in conjunction with other process options.
Capping	Multimedia	Fine soils over synthetic membrane or other layers and covered with soil; applied over contaminated areas.	Effective in reducing the uptake of contaminants, not likely to crack. Likely to hold up over time.	Easily implemented. Restrictions on future land use will also be necessary.	Medium	Retained because of potential effectiveness and implementability.
Excavation	Standard Excavating Equipment	Remove affected biota and load it onto process system equipment.	Effective in moving and transporting biota to vehicles for transportation.	Equipment and workers are readily available.	Low	Retained because of potential effectiveness and implementability.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Disposal	Landfill Disposal	Place contaminated biota in an existing landfill.	Does not reduce the biota contamination but moves all of the contamination to a more secure place.	Easily implemented if sufficient storage is available in an offsite landfill area.	Medium	Retained because of potential effectiveness and implementability.

Table 7-4. Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites.

Waste Management Unit		Alt. 1 Multimedia Cover With or Without Vertical Barriers	Alt. 2 in Situ Grouting or Stabilization	Alt. 3 Excavation and Treatment	Alt. 4 In Situ Vitrification	Alt. 5 Excavation, Treatment, and Geologic Disp. of TRU Soil	Alt. 6 In Situ Soil Vapor Extration for VOCs
Cribs and Drains							
216-A-1	Crib	X	X	X	X	X	
216-A-2	Crib	X	X	X	X	X	X
216-A-3	Crib	X	X	X	X	X	
216-A-4	Crib	X	X	X	X	X	
216-A-5	Crib	X	X	X	X	X	
216-A-6	Crib	X	X	X	X	X	
216-A-7	Crib	X	X	X	X	X	
216-A-8	Crib	X	X	X	X	X	X
216-A-9	Crib	X	X	X	X	X	
216-A-10	Crib	X	X	X	X	X	
216-A-21	Crib	X	X	X	X	X	
216-A-24	Crib	X	X	X	X	X	X
216-A-27	Crib	X	X	X	X	X	
216-A-30	Crib	X	X	X	X	X	
216-A-31	Crib	X	X	X	X	X	
216-A-32	Crib	X	X	X	X	X	
216-A-36A	Crib	X	X	X	X	X	
216-A-36B	Crib	X	X	X	X	X	
216-A-37-1	Crib	X	X	X	X	X	
216-A-37-2	Crib	X	X	X	X	X	
216-A-38-1	Crib	X	X	X	X	X	
216-A-41	Crib	X	X	X	X	X	
216-A-45	Crib	X	X	X	X	X	
216-A-11	French Drain	X	X	X	X	X	
216-A-12	French Drain	X	X	X	X	X	
216-A-13	French Drain	X	X	X	X	X	
216-A-14	French Drain	X	X	X	X	X	

Table 7-4. Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites.

Waste Management Unit		Alt. 1 Multimedia Cover With or Without Vertical Barriers	Alt. 2 in Situ Grouting or Stabilization	Alt. 3 Excavation and Treatment	Alt. 4 In Situ Vitrification	Alt. 5 Excavation, Treatment, and Geologic Disp. of TRU Soil	Alt. 6 In Situ Soil Vapor Extration for VOCs
216-A-15	French Drain	X	X	X	X	X	
216-A-22	French Drain	X	X	X	X	X	
216-A-26	French Drain	X	X	X	X	X	
216-A-26A	French Drain	X	X	X	X	X	
216-A-28	French Drain	X	X	X	X	X	
216-A-33	French Drain	X	X	X	X	X	
216-A-35	French Drain	X	X	X	X	X	
216-C-8	French Drain	X	X	X	X	X	
Reverse Wells							
299-E24-111	Injection Well	X	X				
Ponds, Ditches and Trenches							
216-A-29	Ditch	X	X	X	X	X	
216-A-34	Ditch	X	X	X	X	X	
216-A-18	Trench	X	X	X	X	X	
216-A-19	Trench	X	X	X	X	X	
216-A-20	Trench	X	X	X	X	X	
216-A-40	Trench	X	X	X	X	X	
Septic Tanks and Associated Drain Fields							
2607-EA	Septic Tank/Drain Field	X	X	X			
2607-EC	Septic Tank/Drain Field	X	X	X			
2607-ED	Septic Tank/Drain Field	X	X	X			
2607-EG	Septic Tank	X	X	X			
2607-EJ	Septic Tank	X	X	X			
2607-EL	Septic Tank	X	X	X			
2607-E6	Septic Tank/Drain Field	X	X	X			
Basins							
207-A	Retention Basins	X	X	X		X	
216-A-42	Retention Basin	X	X	X		X	

Table 7-4. Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites.

Waste Management Unit		Alt. 1 Multimedia Cover With or Without Vertical Barriers	Alt. 2 in Situ Grouting or Stabilization	Alt. 3 Excavation and Treatment	Alt. 4 In Situ Vitrification	Alt. 5 Excavation, Treatment, and Geologic Disp. of TRU Soil	Alt. 6 In Situ Soil Vapor Extration for VOCs
Burial Sites							
200-E	Burning Pit	X	X	X			
218-E-1	Burial Ground	X	X	X			
218-E-8	Burial Ground	X	X	X			
218-E-12A	Burial Ground	X	X	X			
218-E-12B	Burial Ground	X	X	X			
218-E-13	Burial Ground	X	X	X			
Unplanned Releases							
UN-200-E-10	Unplanned Release	X	X	X			
UN-200-E-11	Unplanned Release	X	X	X			
UN-200-E-12	Unplanned Release	X	X	X			
UN-200-E-13	Unplanned Release	X	X	X			
UN-200-E-15	Unplanned Release	X	X	X			
UN-200-E-19	Unplanned Release	X	X	X			
UN-200-E-20	Unplanned Release	X	X	X			
UN-200-E-22	Unplanned Release	X	X	X			
UN-200-E-25	Unplanned Release	X	X	X			
UN-200-E-26	Unplanned Release	X	X	X			
UN-200-E-28	Unplanned Release	X	X	X			
UN-200-E-31	Unplanned Release	X	X	X			
UN-200-E-33	Unplanned Release	X	X	X			
UN-200-E-35	Unplanned Release	X	X	X			
UN-200-E-39	Unplanned Release	X	X	X			
UN-200-E-40	Unplanned Release		X	X			
UN-200-E-42	Unplanned Release	X	X	X			
UN-200-E-47	Unplanned Release	X	X	X			
UN-200-E-49	Unplanned Release	X	X	X			
UN-200-E-56	Unplanned Release	X	X	X			

Table 7-4. Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites.

Waste Management Unit		Alt. 1 Multimedia Cover With or Without Vertical Barriers	Alt. 2 in Situ Grouting or Stabilization	Alt. 3 Excavation and Treatment	Alt. 4 In Situ Vitrification	Alt. 5 Excavation, Treatment, and Geologic Disp. of TRU Soil	Alt. 6 In Situ Soil Vapor Extration for VOCs
UN-200-E-58	Unplanned Release			X			
UN-200-E-60	Unplanned Release			X			
UN-200-E-62	Unplanned Release	X	X	X			
UN-200-E-65	Unplanned Release	X	X	X			
UN-200-E-67	Unplanned Release		X	X			
UN-200-E-68	Unplanned Release	X	X	X			
UN-200-E-72	Unplanned Release	X	X	X			
UN-200-E-86	Unplanned Release			X		X	
UN-200-E-88	Unplanned Release		X	X			
UN-200-E-91	Unplanned Release	X	X	X			
UN-200-E-94	Unplanned Release	X	X	X			
UN-200-E-96	Unplanned Release	X	X	X			
UN-200-E-97	Unplanned Release	X	X	X			
UN-200-E-99	Unplanned Release	X	X	X			
UN-200-E-100	Unplanned Release	X	X	X			
UN-200-E-114	Unplanned Release						
UN-200-E-117	Unplanned Release	X	X	X	X		
UN-200-E-142	Unplanned Release	X		X			
UPR-200-E-17	Unplanned Release	X	X	X	X		
UPR-200-E-21	Unplanned Release	X	X	X			
UPR-200-E-24	Unplanned Release	X	X	X			
UPR-200-E-29	Unplanned Release	X	X	X			
UPR-200-E-30	Unplanned Release	X	X	X			
UPR-200-E-50	Unplanned Release	X	X	X			
UPR-200-E-53	Unplanned Release	X	X	X			
UPR-200-E-106	Unplanned Release			X			

THIS PAGE INTENTIONALLY
LEFT BLANK

8.0 DATA QUALITY OBJECTIVES

As described in Section 1.2.2, this aggregate area management study (AAMS) process, as part of the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a), is designed to focus the remedial investigation (RI)/feasibility study (FS) process toward comprehensive cleanup or closure of all contaminated areas at the earliest possible date and in the most effective manner. The fundamental principle of the *Hanford Site Past-Practice Strategy* is a "bias for action" that emphasizes the maximum use of existing data to expedite the RI/FS process as well as allow decisions about work that can be done at the site early in the process, such as expedited response actions (ERAs), interim remedial measures (IRMs), limited field investigations (LFIs), and focused feasibility studies (FFS). The data have already been described in previous sections (2.0, 3.0, and 4.0). Remediation alternatives are described in Section 7.0. However, data, whether existing or newly acquired, can only be used for these purposes if it meets the requirements of data quality as defined by the data quality objective (DQO) process developed by the U.S. Environmental Protection Agency (EPA) for use at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites (EPA 1987). This section implements the DQO process for this, the scoping phase in the PUREX Plant Aggregate Area.

In the guidance document for DQO development (EPA 1987), the process is described as involving three stages which have been used in the organization of the following sections:

- Stage 1--Identify decision types (Section 8.1)
- Stage 2--Identify data uses and needs (Section 8.2)
- Stage 3--Design a data collection program (Section 8.3).

8.1 DECISION TYPES (STAGE 1 OF THE DQO PROCESS)

Stage 1 of the DQO process is undertaken to identify:

- The decision makers (thus data users) relying on the data to be developed (Section 8.1.1),
- The data available to make these decisions (Section 8.1.2),
- The quality of these available data (Section 8.1.3),

- The conceptual model into which these data must be incorporated (Section 8.1.4), and

- The objectives and decisions that must evolve from the data (Section 8.1.5).

These issues serve to define, from various sides, the types of decisions that will be made on the basis of the PUREX Plant AAMS.

8.1.1 Data Users

The data users for the PUREX Plant AAMS [and subsequent investigations such as LFIs, RI/FSs, and Resource Conservation and Recovery Act (RCRA) Facility Investigations (RFI)/Corrective Measures Studies (CMSs)] are the following:

- The decision makers for policies and strategies on remedial action at the Hanford Site. These are the signatories of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1990) including the U.S. Department of Energy (DOE), EPA, and the Washington State Department of Ecology (Ecology).

Nominally these responsibilities are assigned to the managers of these agencies (the Secretary of Energy for DOE, the Administrator of EPA, and the Director of Ecology), although the political process requires that more local policy-makers (such as the Regional Administrator of EPA and the head of the U.S. Department of Energy, Richland Operations Office (DOE/RL) and, to a great extent, technical and policy-assessment staff of these agencies will have a major say in the decisions to be evolved through this process.

- Unit managers of Westinghouse Hanford and potentially other Hanford Site contractors who will be tasked with implementing remedial activities at the PUREX Plant Aggregate Area. Staff of these contractors will have to make the lower level (tactical) decisions about appropriate scheduling of activities and allocation of resources (funding, personnel, and equipment) to accomplish the recommendations of the AAMS.

- Concerned members of the wide community involved with the Hanford Site. These may include:

  - Other states (Washington, Oregon, and other states) and federal agencies,
  - Affected Indian tribes,

- Special interest groups, and
- The general public.

These groups will be involved in the decision process through the implementation of the Community Relations Plan (CRP) (Ecology et al. 1989), and will apply their concerns through the "primary" data users, the signatories of the Tri-Party Agreement.

The needs of these users will have a pivotal role in issues of data quality. Some of this influence is already imposed by the guidance of the Tri-Party Agreement.

8.1.2 Available Information

The *Hanford Site Past-Practice Strategy* specifies a "bias for action" that intends to make the maximal use of existing data on an initial basis for decisions about remediation. This emphasis can only be implemented if the existing data are adequate for the purpose.

Available data for the PUREX Plant Aggregate Area are presented in Sections 2.0, 3.0, and 4.0 and in topical reports prepared for this study. As described in Section 1.2.2, these data should address several issues:

- Issue 1: Facility and process descriptions and operational histories for waste sources (Sections 2.2, 2.3, and 2.4)

- Issue 2: Waste disposal records defining dates of disposal, waste types and waste quantities (Section 2.3)

- Issue 3: Sampling events of waste effluents and affected media (Section 4.1)

- Issue 4: Site conditions including the site physiography, topography, geology, hydrology, meteorology, ecology, demography, and archaeology (Section 3.0)

- Issue 5: Environmental monitoring data for affected media including air, surface water, sediment, soil, groundwater and biota (Section 4.1, except that groundwater data will be presented in the separate 200 East Groundwater Aggregate Area Management Study Report, AAMSR).

A major requirement for adequate characterization of many of these issues is identification of chemical and radiological constituents associated with the sites, with a view to determine the contaminants of concern there and the extent of their distribution in the soils beneath each of the waste management units in the PUREX Plant Aggregate Area. There

was found to be a limited amount of data in this regard. The data reported for the various waste management units in the PUREX Plant Aggregate Area (see Section 4.1 and Tables 4-1, 4-2, and 4-3) have been found to describe:

- Inventory--generally estimated from chemical process data and emphasizing radionuclides (Issues 1 and 2). These data are especially limited regarding reconstruction of early activities, and even the most recent data are based on very few sampling events, possibly non-representative of the long-term activity of the waste management units. In some cases (2607-EL Septic Tank) even the location of the facility is not adequately understood.

- Surface radiological surveys--undifferentiated radiation levels, without identification of radionuclides present, presented in terms of extent of radiation and maximal levels (Issue 5). These historical data are extremely difficult to relate to the present-day distribution and nature of the radioactive contamination they purport to measure because of the lack of radionuclide identification and the likelihood that changes have occurred (at least to surface soils) since the time of these surveys.

- External radiation monitoring--similar to the surface radiological surveys but provide even less information because with a fixed-point thermoluminescent dosimeter (TLD) no spatial distribution is provided. In addition, data are also available for some TLDs placed at points not associated with specific waste management units. The TLD data again do not differentiate radionuclide species.

- Waste, soil, or sediment sampling--these include waste sampling in single-shell tanks (in the 241-A, 241-AX and 241-C Tank Farms), and sediment sampling in the 216-A-29 Ditch (Issue 5). The quality of these data is apparently good, but changes at the release sites (e.g., cleanup activities) since the time of the sampling makes the data again generally inapplicable to determination of the present-day distribution of contamination.

  There are also some sets of data of soil sampling and analysis that were conducted for several years on a grid pattern that cannot be assigned to a particular waste management unit. These data would indicate impacts of historical operations at the Hanford Site, and in the vicinity of the grid points, but the impacts cannot be ascribed to a particular unit and so do not assist in decision making on a unit-by-unit basis.

- Aquatic Vegetation sampling--only in the 216-A-29 Ditch. These data could assist assessment of uptake and transfer pathways from this unit (Issue 5).

There are also analytical data for grid-point samples of vegetation which again cannot be assigned to a specific waste management unit.

- Biota Sampling--only in the 216-A-24 Crib. These data could assist assessment of bio-uptake and bio-transfer pathways from this unit (Issue 5).

- Borehole geophysics--these data, for a number of units which discharged to the soil column (cribs, french drains, and the 216-U-14 Ditch) and the single-shell tanks, were designed to detect the presence of radionuclides (by their gamma-ray radiation) in the subsurface and to indicate whether these materials are migrating vertically (Issue 5). A list of these surveys that have been conducted in the PUREX Plant Aggregate Area is included in the *PUREX Plant Geologic and Geophysics Data Package for the 200 Aggregate Area Management Study* prepared for this study (Chamness et al. 1992). These data are limited by the method's inability to identify specific radionuclides and thus to differentiate naturally occurring radioactive materials from possible releases. Variations in quality control further limit their comparability and possible use for estimation of concentrations.

  Besides these historic data, additional borehole geophysical data will be available through the Radionuclide Logging System (RLS), being carried out at the time of this report and in support of the AAMS process. Like the previous (gross gamma) logging conducted at waste management units in the PUREX Plant Aggregate Area, the RLS depends on gamma rays and so cannot detect some species of radionuclides. However, unlike the gross gamma surveys, the RLS is designed to identify individual radionuclide species through their characteristic gamma ray photon energy levels. It should thus be able to differentiate naturally-occurring radionuclides from those resulting from releases. It will also (like gross gamma logging) determine the vertical extent of the presence of the radionuclides. It will be conducted in about ten wells located in the PUREX Plant Aggregate Area and will be available with completion of the AAMS process.

Based on the above summary, the data are considered to be of varying quality. These data have not been validated, a process generally required for risk assessment or final Record of Decision (ROD) purposes. Most of the data are based on field methods, which are generally applicable only for screening purposes and can be used to focus future activities (e.g., sampling and analysis plans).

They are considered to be deficient in one or more of the following ways:

- The methods are unable to differentiate the various radionuclides that may have been present at the time of the survey.

- The release locations have been changed (especially by remediation activities) since the time of the survey or sampling, and it is likely that contaminant distributions have changed.

- The survey or sampling has been done at a location different from the waste management unit or release, and so would not be representative of the concentrations in the zone of release. This deficiency applies to horizontal and vertical differences in location: the borehole geophysics data may be at the correct depths, but the distance of the borehole from the waste management unit can severely attenuate the gamma-radiation that is used to indicate contamination; surface sampling and surveys similarly cannot establish subsurface contaminant concentrations or even disprove the possible presence of some radioactive constituents (particularly alpha-emitting transuranic, TRU, elements).

- There has been virtually no measurement of non-radioactive hazardous constituents in the sampling and analysis of media in the PUREX Plant Aggregate Area.

As a result of these deficiencies, the data are not considered to be usable for input to a quantitative risk assessment or for comparison to applicable or relevant and appropriate requirements (ARARs).

In addition to these data, there are also data regarding site conditions (Issue 2) which do not directly relate to the presence of environmental releases but which will assist in the assessment of its potential migration if present. These data are generally summarized in the Topical Reports prepared for this AAMS. Those include the following:

- *PUREX Plant Geologic and Geophysics Data Package for the 200 Aggregate Area Management Study* (Chamness et al. 1992), contains tables of wells in which borehole geophysics have been conducted, the types and dates of the tests, and a reference to indicate the physical location of the logs. The package also includes a list of the data available from the drilling of each well located in the PUREX Plant Aggregate Area, such as the logs available (driller's or geologist's; indication of their physical location; grain size, carbonate, moisture, and chemical/radiological analyses; lists of depths, dates, elevation, and coordinates for all wells; and copies of the boring logs and well completion (as-built) summaries for a selection of wells in the PUREX Plant Aggregate Area.

- *Geologic Setting of the 200 East Area: An Update* (Lindsey et al. 1992) includes descriptions of regional stratigraphy, structural geology, and local (200 East Area) stratigraphy,with revised structure and isopach maps of the various unconsolidated strata found beneath the 200 East Area.

The data in these topical reports was obtained for the AAMS study based on a review of driller's and geologist's logs for wells drilled in the PUREX Plant Aggregate Area. A selection of 15 of those logs was made which best represented the geologic structures below the aggregate area and are presented in Chamness et al. (1992). Lindsey et al. (1992) then used these wells (and others from other Aggregate Areas in the 200 East Area) to develop cross-sections, structure maps, and isopach maps, which were in turn adapted to the specific needs of this report and presented in Section 3.0. Only existing logs were used; no new wells were drilled as part of this study. The quality of the data varies among the logs according to the time they were drilled and the scope of the study they were supporting, but generally these data are sufficient for the general geological characterization of the site. Issues involving the potential of contaminant migration at specific sites, based on stratigraphic concerns, may not be fully addressed through any existing borings or wells because appropriate borings may not be located in close proximity; these issues should be addressed during subsequent field investigations at locations where contaminant migration is considered likely.

Another class of data that was gathered in the general area of the 200 West Area, and thus potentially appropriate to the PUREX Plant Aggregate Area, is the result of a set of studies which were performed for the Basalt Waste Isolation Project (BWIP) (DOE 1988b), in the attempt to site a high-level radioactive waste geologic repository in the basalt beneath and in the vicinity of the Hanford Site. The proposed Reference Repository Site included the 200 West Area and some distance beyond it, mainly to the west. For this siting project, a number of geologic techniques were used, and some of the data generated by the drilling program has been used for the stratigraphic interpretation presented in Section 3.4 (all the wells denoted with an alias "BH-.." were drilled for the BWIP project) and a number of the figures used in this and other sections of Section 3.0. The program also included a number of geophysical studies, using the following techniques:

- Gravity
- Magnetics
- Seismic reflection
- Seismic refraction

- Magnetotellurics.

These data, as presented in Section 1.3.2.2.3 of DOE (1988b), were reviewed for their relevance to the present PUREX Plant (source area) AAMS. The limitations of these studies include the following aspects:

- Most of the studies covered a regional scale with lines or coverages that may have crossed the PUREX Plant Aggregate Area (or even the 200 West Area) only in passing. Some of the surveys (e.g., the grid of gravity stations) specifically avoided the 200 West Area ("due to restricted access").

- Many of the techniques are more sensitive to the basalt than to the suprabasalt sediments of specific interest in the AAMS program, and even less sensitive to the features which are closer to the surface, as is applicable to the source area AAMS. Basalt is by nature much denser than the unconsolidated sediments (and thus also has a characteristic seismic signature) and has more consistent magnetic properties. In addition, the analysis of the data emphasized the basalt features that were apparent in the data. All this is appropriate to a study of the basalt, but does not make the studies applicable to the current study.

- Even when features potentially caused by shallow sediments are identified, they are interpreted either very generally (e.g., "erosional features in the Hanford and (or) Ringold Formations") or as complications (e.g., "shallow sediment velocity variations causing stacking velocity correction errors"). There are only a very few features (and none in the PUREX Plant Aggregate Area) which are interpreted as descriptive of the structure of the suprabasalt sediments.

- Lastly, some of the anomalies which are interpreted in terms of a sedimentary stratigraphic cause (e.g., "erosion of Middle Ringold") do not bear up under the more detailed stratigraphic interpretation carried out under the topical reports for the AAMS (Lindsey et al. 1992; Chamness et al. 1992).

However, these data will be reviewed in more detail for the purposes of the 200 East Groundwater AAMSR, since deeper features (including in the basalt) are of more concern for that study.

Other data, presented in Sections 2.0, 3.0, and 4.0, are broader-scale rather than site-specific like the contaminant concentrations are. These include: topography, meteorology, surface hydrology, environmental resources, and human resources, and contaminant characteristics. These data are generally of acceptable quality for the purposes of planning remedial actions in the PUREX Plant Aggregate Area.

8.1.3 Evaluation of Available Data

EPA (1987) has specified indicators of data quality, the five "PARCC" parameters (precision, accuracy, representativeness, completeness, and comparability), which can be used to evaluate the existing data and to specify requirements for future data collection.

- Precision--the reproducibility of the data

- Accuracy--the lack of a bias in the data

  Much of the existing data are of limited precision and accuracy due to the analytical methods which have been used historically. The gross gamma borehole geophysical logging in particular is limited by methodological problems although reproducibility has been generally observed in the data. Conditions that have contributed to lack of precision and/or accuracy include: improvements in analytical instrumentation and methodology making older data incompatible; effects of background levels (particularly regarding radioactivity and inorganics); and lack of quality control on data acquisition.

  The limitations in precision and accuracy in existing data are mainly due to the progress of analytical methodologies and quality assurance (QA) procedures since the time they were collected. The *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) recommends that existing data be used to the maximum extent possible, at two levels: first to formulate the conceptual model, conduct a qualitative risk assessment, and prepare work plans, but also as an initial data set that can be the basis for a fully qualified data set through a process of review, evaluation, and confirmation.

- Representativeness--the degree to which the appropriate environmental parameters or media have been sampled

  This parameter highlights a shortcoming of most of the historical data. Limitations include the observation only of gross gamma radiation rather than differentiating it by radionuclide (e.g., through spectral surveying methods as are being used by the RLS program), the analysis of samples only for radionuclides rather than for chemicals and radionuclides, and the failure to sample (especially in the subsurface) for the full potential extent of contaminant migration.

  The data are incomplete primarily because of the lack of subsurface sampling for extent of contamination. This is because no subsurface investigation has been

initiated on the waste management units in the PUREX Plant Aggregate Area yet. The lack of these data is also caused by concerns to limit the potential exposure to radioactivity of workers who would have to drill in contaminated areas and the possible release or spread of contamination through these intrusive procedures. The result of this data gap is that none of the sites can be demonstrated to have contamination either above or below levels of regulatory concern, and a full quantitative risk assessment cannot be conducted.

In addition, in many cases it has been necessary to use general data (i.e., from elsewhere in the 200 East Area or even from the vicinity of the 200 Areas) rather than data specific to a particular waste management unit. For most purposes of characterization for transport mechanisms, this procedure is acceptable given the screening level of the present study. For example, while it is appropriate to use a limited number of boring logs to characterize the stratigraphy in the Aggregate Area (Chamness et al. 1992, Lindsey et al. 1991), the later, waste management unit specific, field sampling plans will require detailed consideration of more of the logs of wells drilled in the immediate vicinity, whatever their quality, as a starting point to conceptually model the geology specifically beneath that unit.

- Completeness--the fraction of samples which are considered "valid"

  None of the data that have been previously gathered in the PUREX Plant Aggregate Area has been "validated" in the EPA Contract Laboratory Program (CLP) sense, although varying levels of quality control have been applied to the sampling and analysis procedures. The best indication of the validity of the data is the reproducibility of the results, at least as far as precision is concerned (accuracy requires proof of a lack of bias). This indicates that validity (completeness) is one of the less significant problems with the data.

- Comparability--the confidence that can be placed in the comparison to two data sets (e.g., separate samplings)

  With varying levels of quality control and varying procedures for sample acquisition and analysis, this parameter is also generally poorly met. Much of this is due to the more recent development of QA procedures.

While these limitations cannot in most cases be quantified (and some such as representativeness are specifically only qualitative), most of the data gathered in the PUREX Plant Aggregate Area can be cited as failing one or more of the PARCC parameters. As discussed in Section 8.1.2, the data are considered to be deficient in completeness, (the appropriate media, constituents, or locations were generally not sampled or analyzed). These

data should, however, be used to the maximum extent in the development of work plans for site field investigations, prioritization of the various units, and to determine, to the extent possible, where contamination is or is not present.

In addition to these site-specific data, there are also a limited number of non site-specific sampling events that are being developed to determine background levels of naturally occurring constituents (Hoover and LeGore 1991). These data can be used to differentiate the effect of the environmental releases from naturally occurring background levels.

8.1.4 Conceptual Model

The initial conceptual model of the waste management units in the PUREX Plant Aggregate Area is presented and described in Section 4.2 (Figure 4-3). The model is based on best estimates of where contaminants were discharged and their potential for migration from release points. The conceptual model is designed to be conservatively inclusive in the face of a lack of data. This means that a migration pathway was included if there is any possibility of contamination travelling on it, historically or at present. In most cases there may not be a significant flux of such contamination migration for many of the pathways shown on the figure.

The pathway from the cribs leading to adsorption of transuranic elements on vadose-zone soils is possibly the most significant. These and other pathways can be traced on the conceptual model. All are possible; only a few are likely because of the conservatism inherent in including all conceivable pathways. More importantly, even if a pathway carries significant levels of a contaminant, it still may not have carried contamination to the ultimate receptors, human or ecological. This can only be assessed by sampling at the exposure point on this pathway, or sampling at some other point and extrapolation to the exposure point, to indicate the dosage to the receptors.

There are significant uncertainties in the contaminant levels in the contaminant migration pathways shown on the conceptual model, yet almost none of these pathways has been sampled to determine whether any contamination still exists in any of the locations implicated from the conceptual model, and if so which constituents, how much, and to what extent.

8.1.5 Aggregate Area Management Study Objectives and Decisions

The specific objectives of the PUREX Plant AAMS are listed in Section 1.3. They include (in part) the following:

- Assemble site data (as described in Section 8.1.2)
- Develop a site conceptual model (see Section 8.1.3)
- Identify contaminants of concern and their distribution (Section 5.0)
- Identify preliminary applicable, or relevant and appropriate, regulations (ARARs, Section 6.0)
- Define preliminary remedial action objectives and screen potential remedial technologies to prepare preliminary remedial action alternatives (Section 7.0)
- Recommend expedited, interim, or limited actions (Section 9.0), and
- Define and prioritize workplan activities with emphasis on supporting early cleanup actions and records of decision.

The decisions that will have to be made on the basis of this AAMS can best be described according to the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) flow chart (Figure 1-2 in Section 1.0) that must be conducted on a site-by-site basis. Decisions are shown on the flow chart as diamond-shaped boxes, and include:

- Is an ERA justified?
- Is less than five months' response needed (is the ERA time critical)?
- Are data sufficient to formulate the conceptual model and perform a qualitative risk assessment?
- Is an IRM justified?
- Can the remedy be selected?
- Can additional required data be obtained by LFI?
- Are data (from field investigations) sufficient to perform risk assessment?

(The last question will only be asked after additional data are obtained through field investigations, and so are DQO issues only in assessing scoping for those investigations.)

Most of these decisions are actually a complicated mixture of many smaller questions, and will be addressed in Section 9.0 in a more detailed flowchart for assessing the need for remediation or investigation.

Similarly, the tasks that will need to be performed after the AAMS that drive the data needs for the study are found in the rectangular boxes on the flow chart. These include:

- ERA (if justified)
- Determination of minimum data requirements for IRM path
- Negotiation of Scope of Work, relative priority, and incorporation into integrated schedule, performance of LFI
- Determination of minimum data needs for risk assessment and final Remedy Selection (preparation of RI/FS pathway).

These stages of the investigation must be considered in assessing data needs (Section 8.2.1).

8.2 DATA USES AND NEEDS (STAGE 2 OF THE DQO PROCESS)

Stage 2 of the DQO development process (EPA 1987) defines data uses and specifies the types of data needed to meet the project objectives. These data uses and needs are based on the Stage 1 results, but must be more specific. The elements of this stage of the DQO process include:

- Identifying data uses (Section 8.2.1)
- Identifying data types (Section 8.2.2.1)
- Identifying data quality needs (Section 8.2.2.2)
- Identifying data quantity needs (Section 8.2.2.3)
- Evaluating sampling/analysis options (Section 8.2.2.4)
- Reviewing data quality parameters (Section 8.2.2.5)
- Summarizing data gaps (Section 8.2.3).

Stage 2 is developed on the basis of the conceptual model and the project objectives. These following sections discuss these issues in greater detail.

8.2.1 Data Uses

For the purposes of the remediation in the PUREX Plant Aggregate Area, most data uses fall into one or more of four general categories:

- Site characterization
- Public health evaluation and human health and ecological risk assessments
- Evaluation of remedial action alternatives
- Worker health and safety.

Site characterization refers to a process that includes determination and evaluation of the physical and chemical properties of any wastes and contaminated media present at a site, and an evaluation of the nature and extent of contamination. This process normally involves the collection of basic geologic, hydrologic, and meteorologic data but more importantly for the PUREX Plant Aggregate Area waste management units, data on specific contaminants and sources that can be incorporated into the conceptual model to indicate the relative significance of the various pathways. Site characterization is not an end in itself, as stressed in the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a), but rather the data must work toward the ultimate objectives of assessing the need for remediation (according to risk assessment methods, either qualitative or quantitative) and providing appropriate means of remediation (through an FFS, FS, or CMS). The understanding of the site characterization, based on existing data, is presented in Sections 2.0, 3.0, and 4.0, and summarized in the conceptual model (Section 4.2).

Data required to conduct a public health evaluation, and human health and ecological risk assessments at the sites in the PUREX Plant Aggregate Area include the following: input parameters for various performance assessment models (e.g., the Multimedia Environmental Pollutant Assessment System); site characteristics; and contaminant data required to evaluate the threat to public and environmental health and welfare through exposure to the various media. These needs usually overlap with site characterization needs. An extensive discussion of risk assessment data uses and needs is presented in the *Risk Assessment Guidance for Superfund* (EPA 1989a). The main deficiency in the data available for waste management units in the PUREX Plant Aggregate Area is that a quantitative

assessment of contaminant concentrations for the purposes of risk assessment cannot be performed. The present understanding of site risks is presented in the selection of constituents of concern (Section 5.0). Quantitative risk assessments will be conducted at the Hanford Site with a methodology under development, and the data needs for this methodology will be considered in developing site specific sampling and analysis plans.

Data collected to support evaluation of remedial action alternatives for ERAs, IRMs, FFSs, or the full RI/FS, include site screening of alternatives, feasibility-level design, and preliminary cost estimates. Once an alternative is selected for implementation, much of the data collected during site investigations (LFI or RI) can also be used for the final engineering design. Generally, collection of information during the investigations specifically for use in the final design is not cost effective because many issues must be decided about appropriate technologies before effective data gathering can be undertaken. It is preferable to gather such specific information during a separate predesign investigation or at the time of remediation (i.e., the "observational approach" of the *Hanford SitePast-Practice Strategy* [DOE/RL 1992a]). Based on the existing data, broad remedial action technologies and objectives have been identified in Section 7.0.

The worker health and safety category includes data collected to establish the required level of protection for workers during various investigation activities. These data are used to determine if there is concern for the personnel working in the vicinity of the aggregate area. The results of these assessments are also used in the development of the various safety documents required for field work (see Health and Safety Plan, Appendix B).

It should be noted that each of these data use categories (site characterization, risk assessment needs, remedial actions, and health and safety) will be required at each decision point on the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) flow chart, as discussed at the end of Section 8.1.5. To the extent possible, however, not all sites will be investigated to the same degree but only those with the highest priority. These results will then be extended to the other, analogous sites which have similar geology and disposal histories (see Section 9.2.3).

he existing data can presently be used for two main purposes:

- Development of site-specific sampling plans (site characterization use)
- Screening for health and safety (worker health and safety use).

Table 8-1 presents a summary of the availability of existing data for these two uses.

For the purposes of developing sampling plans, existing information is available for:

- The location of waste management units and unplanned releases--many of the units or releases have surface expressions, markers, or have been surveyed in the past. The unplanned releases in particular are lacking in this information, as well as for the 2607-EL Septic Tank and Drain Field. Many of the unplanned releases are located by coordinates only and can be found on various site maps by a number of different names.

- Possible contamination found at the waste management units--these data are derivable from the inventories for the units (mainly for the cribs and other disposal facilities) as well as from the limited sampling that has been done at the 216-A-29 Ditch.

- The likely depth of contaminants--this information is mainly obtained from the gross gamma borehole logging for many of the units.

Two types of information are available for the purposes of worker health and safety, and will be used for the development of health and safety documents:

- Levels of surface radiation--derived from the on-going periodic radiological surveys done under the Environmental Surveillance program (Schmidt et al. 1991). Table 8-1 shows where surveys have indicated no detectable levels of surface radiation and so no additional survey is required before surface activities can be conducted.

- Expected maximum contaminant levels--these data can be used mainly on the results of subsurface soil sampling. Extensive sampling of this type has generally not been conducted at the PUREX Plant Aggregate Area waste management units.

Table 8-1 also presents a first expression of the data needs for the individual waste management units in the PUREX Plant Aggregate Area, which must be addressed for remediation approaches to be developed.

8.2.2 Data Needs

The data needs for the PUREX Plant Aggregate Area are discussed in the following sections according to the categories of types of data (Section 8.2.2.1), quality (8.2.2.2), quantity (8.2.2.3), options for acquiring the data (8.2.2.4), and appropriate DQO (PARCC) parameters (8.2.2.5). These considerations are summarized for each category of waste management unit site in the PUREX Plant Aggregate Area (Section 8.2.3).

8.2.2.1 Data Types. Data use categories described in Section 8.2.1 define the general purpose of collecting additional data. Based on the intended uses, a concise statement regarding the data types needed can be developed. Data types specified at this stage should not be limited to chemical parameters, but should also include necessary physical parameters such as bulk density and moisture. Since environmental media and source materials are interrelated, data types used to evaluate one media may also be useful to characterize another media.

Identifying data types by media indicates that there are overlapping data needs. Data objectives proposed for collection in the site investigations at sites in the PUREX Plant Aggregate Area are discussed in Section 8.3 to provide focus to investigatory methods that may be employed. The data type requirements for the preliminary remedial action alternatives developed in Section 7.4 are summarized in Table 8-2.

8.2.2.2 Data Quality Needs. The various tasks and phases of a CERCLA investigation may require different levels of data quality. Important factors in defining data quality include selecting appropriate analytical levels and validation and identifying contaminant levels of concern as described below. The Westinghouse Hanford document, *A Proposed Data Quality Strategy for Hanford Site Characterization,* will be used to help define these levels (McCain and Johnson 1990).

Chemical and radionuclide laboratory analysis will be one of the most important data types, and is required at virtually all the waste management units in the PUREX Plant Aggregate Area. In general, increasing accuracy, precision, and lower detection limits are obtained with increasing cost and time. Therefore, the analytical level used to obtain data should be commensurate with the intended use. Table 8-3 defines five analytical levels associated with different types of characterization efforts. While the bulk of the analysis during LFIs/RIs will be screening level (DQO Level I or II), these data will require confirmation sampling and analysis to allow final remedial decisions through quantitative risk assessment methods. Individual DQO analytical PARCC parameters for Level III or IV analytical data associated with each contaminant anticipated in the PUREX Plant Aggregate Area (as developed in Section 5) are given in Table 8-4. These parameters will be used for the development of site-specific sampling and analysis plans and quality assurance plans for investigations and remediations in the aggregate area.

Before laboratory or even field data can be used in the selection of the final remedial action, they must first be validated. Exceptions are made for initial evaluations of the sites using existing data, which may not be appropriate for validation but will be used on a screening basis based on the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a). Other screening data (e.g., estimates of contaminant concentration inferred from field analyses) may also be excepted. Validation involves determining the usability and quality of the data.

Once data are validated, they can be used to successfully complete the remedial action selection process. Activities involved in the data validation process include the following:

- Verification of chain-of-custody and sample holding times
- Confirmation that laboratory data meet Quality Assurance/Quality Control (QA/QC) criteria
- Confirmation of the usability and quality of field data, which includes geological logs, hydrologic data, and geophysical surveys
- Proper documentation and management of data so that they are usable.

Validation may be performed by qualified Westinghouse Hanford personnel from the Office of Sample Management (OSM), other Westinghouse Hanford organizations, or a qualified independent participant subcontractor. Data validation of laboratory analyses will be performed in accordance with *A Proposed Data Quality Strategy for Hanford Site Characterization* (McCain and Johnson 1990) and standards set forth by Westinghouse Hanford.

To accomplish the second point, all laboratory data must meet the requirements of the specific QA/QC parameters as set up in the Quality Assurance Project Plan (QAPP) for the project before it can be considered usable. The QA/QC parameters address laboratory precision and accuracy, method blanks, instrument calibration, and holding times.

The usability of field data must be assessed by a trained and qualified person. The project geohydrologist/geophysicists will review the geologic logs, hydrologic data, geophysical surveys, and results of physical testing, on a daily basis, and senior technical reviews will be conducted periodically throughout the project.

Data management procedures are also necessary for the validation. Data management includes proper documentation of field activities, sample management and tracking, and document and inventory control. Specific consistent procedures are discussed in the Data Management Plan (Appendix D).

8.2.2.3 Data Quantity Needs. The number of samples that need to be collected during an investigation can be determined by using several approaches. In instances where data are lacking or are limited (such as for contamination in the vadose zone soils), a phased sampling approach will be appropriate. In the absence of any available data, an approach or rationale will need to be developed to justify the sampling locations and the numbers of samples selected. Specific locations and numbers of samples will be determined based on data

collected during screening activities. For example, the number and location of beta/gamma spectrometer probe locations can be based on results of surface geophysical and radiation surveys. These may help locate some subsurface features, which may not be adequately documented. Details of any higher DQO level subsurface soil sampling scheme will depend on results of screening investigations such as geophysics surveys, surface radiation surveys, and beta/gamma spectrometer probe surveys. In situations where and when available data are more complete, statistical techniques may be useful in determining the additional data required.

8.2.2.4 Sampling and Analysis Options. Data collection activities are structured to obtain the needed data in a cost-effective manner. Developing a sampling and analysis approach that ensures that appropriate data quality and quantity are obtained with the resources available may be accomplished by using field screening techniques and focusing the higher DQO level analyses on a limited set of samples at each site. The investigations on waste management units in the PUREX Plant Aggregate Area should take advantage of this approach for a comprehensive characterization of the site in a cost-effective manner.

A combination of lower level (Levels I, II, and III) and higher level analytical data (Levels IV and V) should be collected. For instance, at least one of the samples collected from each source (including contaminated surface soil at unplanned release locations) should be analyzed at DQO Level IV or V and validated to provide high quality data to confirm the less expensive but more extensive lower level analyses. This approach would provide the certainty necessary to determine contaminants present near the sources. Samples collected from the other media (i.e., subsurface soils, sediments) will be analyzed by *Test Methods for Evaluating Solid Wastes*, (EPA 1986), CLP (EPA 1988a, EPA 1989b), *Methods for Chemical Analysis of Water and Wastes* (EPA 1983), or *Prescribed Procedures for Measurement of Radioactivity in Drinking Water* (EPA 1980).

8.2.2.5 Data Quality Parameters. The PARCC parameters are indicators of data quality. Ideally, the end use of the data collected should define the necessary PARCC parameters. Once the PARCC requirements have been identified, then appropriate analytical methods can be chosen to meet established goals and requirements. Definitions of the PARCC parameters are presented in Section 8.1.2.

In general the precision and accuracy objectives are governed by the capabilities of the available methodologies and in most cases these are more than adequate for the needs of the investigations. Chemical analyses can usually attain parts per billion detection range in soils and water, and this level is adequate to the needs of the risk assessment for most analytes. Radiological analyses reach similar levels. Some constituents (e.g., arsenic) would require analysis to much lower levels, but this is impossible because of the limitations of analytical methods and the effects of natural background levels. In addition, risk assessment is

conventionally computed only to a single digit of precision and uses conservative assumptions, which reduce the impact of measurements with lower accuracy.

For other measurements, such as physical parameters, the precision and accuracy capabilities of existing measurement technologies are sufficient for the evaluation methods used to produce characterization data, so the objectives are based on the limitations of the analysis methodologies.

Representativeness is maintained by fitting the sampling program to the governing aspects of the sources and transport processes of the site, as demonstrated in the site conceptual model (Section 4.2). Initial sampling should concentrate on sources, which are fairly well-understood, and on representative locations of anticipated transport mechanisms. If necessary, following activities can focus on aspects or locations that were not anticipated but were demonstrated by the more general results.

Completeness is generally attained by specifying redundancy on critical samples and maintaining quality control on their acquisition and analysis. As with representativeness, the initial sampling program may lead to modifications of which samples should be considered critical during subsequent sampling activities.

Comparability will be met through the use of Westinghouse Hanford standard procedures generally incorporated into the *Environmental Investigation and Site Characterization Manual* (WHC 1988d).

8.2.3 Data Gaps

Considering the data needs developed in Section 8.2.2, and the data available to meet these needs as presented in Section 8.1.2, it is apparent that a number of data gaps can be identified. These are summarized, on a waste management unit category basis, in Table 8-5, and should be the focus of LFIs on a waste management unit category basis, using the analogue sites approach. These contaminant concentration data are the highest priority because of the need to assess the need for remediation and appropriate remedial actions for each site.

In addition to these data needs specifically addressing contamination problems at sites included for consideration in this aggregate area, there are general data needs which will be required for characterization of the possible transport pathways, as presented in the conceptual model, at locations away from the individual units. These general, nonsite-specific needs include characterization of the following:

- Geologic stratigraphy, particularly for possible perched water zones
- Air transport of contamination
- Ecological impacts and transport mechanisms (bio-uptake, bio-concentration, secondary receptors through predation)
- Potential releases from process effluent lines between facilities and to waste disposal sites.

All of these needs will have to be addressed in the data collection program (Section 8.3).

8.3 DATA COLLECTION PROGRAM (STAGE 3 OF THE DQO PROCESS)

The data collection program is Stage 3 of the process to develop DQOs. Conducting an investigation with a mixture of screening and higher-level data is a common method for optimizing the quantity and quality of the data collected. It would be very inefficient and overly expensive to specify beforehand all the types of samples and analyses that will yield the most complete and accurate understanding of the contamination and physical behavior of the site. Data adequate to achieve all the goals and objectives for remedial action decisions are obtained at a lower cost by using the information obtained in the field to focus the ongoing investigation and remediation process.

Initial sampling should collect new data believed most necessary to confirm and refine the conceptual model particularly at priority sites. Sampling may then be extended to further reduce uncertainty, to fill in remaining data gaps, to collect more detailed information for certain points where such information is required, or to conduct any needed treatability studies or otherwise support the data needs of the remedial action selection process. An alternative of extrapolating the data from a limited number of sites to other analogous ones will also be used. The need for subsequent investigation phases will be assessed throughout the investigation and remediation activities as data become available. Assessing completeness of the investigation data through a formal statistical procedure is not possible, given the complexity and uncertainty of the parameters required to describe the site and the time to make decisions. Rather, the use of engineering judgement is considered sufficient to the decision process.

8.3.1 General Rationale

The general rationale for the investigation of sites in the PUREX Plant Aggregate Area is to collect needed data that are not available. Because of the size of the aggregate area, the complexity of past operations, and the number of unplanned releases and waste management units, a large amount of new information will be required such as the specific radionuclides and chemicals present, their spatial distribution and form, and the presence of special migration pathways (such as perched groundwater systems).

The following work plan approach will be used for LFIs and RI/FS in the PUREX Plant Aggregate Area. The results are described in Sections 8.3.2 and 8.3.3 in a general form.

- Existing data as described in Sections 2.0, 3.0, and 4.0 should be used to the maximum extent possible. Although existing data are not validated fully, the data are still useful in developing a preliminary conceptual model (Section 4.2) and in helping to focus and guide the planning of investigations, expedited actions, and interim measures.

- Additional data at validated and screening levels should be collected to obtain the maximum amount of useful information for the amount of time and resources invested in the investigation.

- Data should be collected to support the intended data uses identified in Section 8.2.1.

- Nonintrusive sampling (e.g., geophysical surveys, surface radiation surveys, soil gas, and spectral gamma probe surveys), and surficial and source sampling should be conducted early in any investigation effort to identify necessary interim response actions (i.e., additional ERAs or IRMs).

- Data collected from initial investigation activities should be used to confirm and refine the conceptual model (Section 4.2), refine the analyte constituents of concern, and provide information to conduct interim response actions or risk assessment activities.

- Additional investigation activities are proposed to support (if needed) quantitative baseline risk assessments for final cleanup actions and further refine the conceptual model.

- Field investigation techniques should be used to minimize the amount of hazardous or mixed waste generated. Any waste generated will be in accordance with EII 4.2, "Interim Control of Unknown Suspected Hazardous and Mixed Waste " (WHC 1988d).

8.3.2 General Strategy

The overall objective of any field investigation (LFI, IRM, or RI) of the sites in the PUREX Plant Aggregate Area will be to gather additional information to support risk assessment and remedial action selection according to the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) flow chart discussed in Section 8.1.5. The general approach or strategy for obtaining this additional information is presented below.

- Analytical parameter selection should be based on verifying overall conditions and then narrowed to specific constituents of concern, in consideration with regulatory requirements and site conditions. Periodic analyses of the long list of parameters should be conducted to verify that the list of constituents of concern has not changed, either because new constituents are identified or some of those considered as a potential concern do not appear to be significant.

- Similarly, investigations should work from a screening level (DQO Levels I or II, e.g., surface radiation surveys) to successively more specific sampling and analysis methodologies (e.g., beta/gamma spectral probes, then DQO Level III or IV soil sampling and analysis), without time consuming remobilizations.

- Dangerous and radioactive wastes may be generated during the field investigation. While efforts should be made to minimize these wastes, any waste generated will be handled in accordance with EII 4.2, "Interim Control of Unknown Suspected Hazardous and Mixed Waste" (WHC 1988d). The analyses of samples for constituents of concern analytes will allow wastes generated to be adequately designated.

8.3.3 Investigation Methodology

Initial field investigations (mainly LFIs, but also associated with IRMs at appropriate sites and possibly some RIs) may include some or all of the following integrated methodologies:

- Source Investigation (Section 8.3.3.1)

- Geological Investigation (Section 8.3.3.2)
- Surface Water Sediment Investigation (Section 8.3.3.3)
- Soil Investigation (Section 8.3.3.4)
- Air Investigation (Section 8.3.3.5)
- Ecological Investigation (Section 8.3.3.6)
- Geophysical Stratigraphic Survey (Section 8.3.3.7)
- Process Effluent Pipeline Integrity Assessment (Section 8.3.3.8)
- Geodetic Survey (Section 8.3.3.9).

Each investigation methodology is briefly outlined in the following sections. Specific survey methods (such as electromagnetics or ground-penetrating radar) have not been recommended to allow flexibility in the development of field sampling plans which can be sensitive to very local conditions. A summary of the applicable methods for each waste management unit is presented in Table 8-6. In addition, some of the data needs must be addressed on an area-wide basis (e.g., stratigraphy interpretation). More detailed descriptions and specific methods and instrumentation will be included in site-specific work plans, sampling and analysis plans, and field sampling plans for LFIs/IRMs at waste management units that require these investigations. These investigations are presented in the approximate priority of their need, with the source investigation first because of its importance to the decisions about remedial action on a site-by-site basis. The other investigations are of lower priority, and will be conducted according to the need to determine whether contamination has been transported beyond the immediate vicinity of the waste management units. To some extent, this need will depend on the results of the source investigation.

8.3.3.1 Source Investigation. The purpose of source investigation activities in the PUREX Plant Aggregate Area is to characterize the known waste management units and unplanned releases that exist in the area and that may contribute to contamination of surface soil, vadose zone, surface water, sediment, air, and biota. The completeness of the characterization effort will be assessed according to the needs of risk assessment and remedial action selection, which will also determine what levels of the various constituents of concern comprise "contamination."

Source sampling should be conducted at waste management units or unplanned release locations where the available data indicate that dangerous, mixed, or radioactive wastes may be present. Activities which are proposed to be performed during the source investigations include the following:

- Compile and evaluate additional existing data for the purpose of: verifying locations, specifications of engineered facilities, and pipelines, and waste stream characteristics; assessment of the construction and condition of boreholes/wells that exist in the operable unit and their suitability for use for investigation activities, QA/QC information, and raw data regarding radiological and hazardous substances monitoring; and integrating any additional environmental modeling data into the conceptual model. This has been done (on an aggregate area basis) in this report; the process will be extended to site-specific planning and on-going assessments of the investigation/remediation as it is carried out.

- Conduct surface radiological survey of suspected or known source areas to verify locations and nature of surface and subsurface radiological contamination. Conditions at specific sources within a waste management unit should also be noted in order to plan sampling/remediation activities and worker health and safety.

- Conduct nonintrusive surface geophysical surveys at specific waste management units such as the 2607-EL Septic Tank and Drain Field (Section 2.3.6.2), and unplanned release locations to verify locations and physical characteristics of source locations. Data generated from these activities can be used in planning intrusive source sampling activities.

- Conduct beta/gamma spectrometer probe survey to screen for near-surface contamination and to confirm the absence or presence of some specific radionuclides, which may be of particular concern. Existing boreholes will be used to the maximum extent, but new boreholes may be needed at many locations (to be decided based on screening results). Logging will be done both by NaI detectors or μR meters for rapid screening as well as the RLS high purity germanium logging system. Westinghouse Hanford will develop an EII Procedure for the beta/gamma spectrometer probe survey. The beta/gamma spectrometer probe survey serves two purposes depending on the source conditions: to confirm absence of contamination in the near-surface soils, and to serve as a screening tool to choose locations and quantities of vadose zone soil borings. The RLS procedure could demonstrate "assay quality" data for radionuclide concentrations, but will probably continue to require supporting Level IV soil analysis data to allow a risk assessment before final remedial

decisions. The need to conduct this survey will be based (at least in part) on the screening results of the surface survey and on information about site burial.

- Soil gas surveys should be conducted at waste management units (such as cribs) where volatile organic chemicals are suspected, as a screening method to identify compounds such as solvents and degreasers that may have been used in separate processes or during construction activities. The soil gas survey should not be considered conclusive that volatile organic compounds at lower concentrations may not be present. Data from the soil gas survey can be used to help locate surface and near-surface samples and vadose zone borings.

- Collect surface and near-surface samples of contaminated soils and/or waste materials at selected locations. Specific sampling sites will be chosen to assess particular facilities or releases. Additional sampling sites may be specified based on results from nonintrusive investigations.

- Wipe samples should be collected as part of the investigations of surface contamination or building (piping or pavement) surfaces. The wipe sample locations can be chosen based on visual observations and a surface radiation survey conducted during a site walkthrough. The methodology may be limited by the presence of soil, rough concrete, or paving and so may not be heavily used except as confirmation following removal of loose contamination.

8.3.3.2 Geologic Investigation. A geologic investigation should be performed to better characterize the vadose zone and the nature of unsaturated soils that make up this system. The geologic investigation will include the following tasks:

- Borings may be advanced into zones where an accurate interpolation of the subsurface stratigraphy is important to understanding migration pathways in the vadose zone.

- Geologic data collected during the ongoing vadose zone soil (Section 8.3.3.4) and other (deeper) investigations (e.g., geologic and geophysical logs from groundwater well installations for groundwater AAMS) will be compared, compiled, and evaluated.

8.3.3.3 Surface Water Sediment Investigation. A surface water sediment investigation should be conducted. The investigation will include:

- Radiation survey along ditches and trenches for health and safety purposes and to locate areas of elevated radiation for selection of specific sediment sampling locations.

- Sampling of sediment in any ditches and trenches that still contain water. This will probably be limited to the 207-A Retention Basins. This sediment is also likely to be just windblown soil.

8.3.3.4 Soil Investigation. The purpose of soil investigations is to determine physical and chemical properties of the soil and to determine the nature, type, and extent of soil contamination associated with waste management units and unplanned releases to allow initiation of interim remedial actions and to assess the quantitative risk at other sites. Sampling will include:

- Samples of vadose zone soil will be collected and analyzed for constituents of concern when wells are drilled for other studies (i.e., groundwater investigations) in the vicinity of a waste management unit or unplanned release with reported liquid disposals or spills. Organic vapor (at sites with suspected volatiles) and radiation sampling should also be performed with samples selected by onsite screening.

- Data collected during this investigation will be evaluated to further understand the contribution of contaminants to the vadose zone from specific waste management units and/or unplanned releases and to better define the hydrology and water quality in the vadose zone system through moisture content profiles and tracking of specific contaminants.

8.3.3.5 Air Investigation. Air investigations (on an aggregate area scale) should consist of onsite particle sampling as part of the health and safety program. In addition, high-volume air samplers should be placed in appropriate locations on-site based on evaluation of existing meteorological data. The purpose of these samplers will be to determine if any migration of airborne contaminants occurs.

8.3.3.6 Ecological Investigation. Ecological investigation activities, on an aggregate area scale, should include a literature search and data review, and a site walkthrough. These activities are intended to identify potential biota concerns which need to be addressed in the site investigation. Particular emphasis should be given to identifying potential exposure pathways to biota that migrate offsite or that introduce contaminants into the food web.

8.3.3.7 Geophysical Stratigraphic Survey. A geophysical survey of subsurface stratigraphy should be conducted across the aggregate area to help characterize the geology and hydrogeology of the vadose zone.

8.3.3.8 Process Effluent Pipeline Integrity Assessment. An assessment of process effluent pipeline integrity should be conducted early in site investigation activities to look for potential leaks and therefore possible areas of contamination. Initially, as part of this effort, drawings of the process lines and encasements within the aggregate area (Section 2.3.7) should be reviewed and their construction, installation, and operation evaluated. Specific lines will then be selected for integrity assessment with emphasis on lines serving the waste management units that have received large volumes of liquid (e.g., cribs). Investigation of operating high-level waste transfer lines will be deferred to their respective programs. Results of the integrity assessments will be evaluated and additional sampling activities may be recommended for subsequent studies.

8.3.3.9 Geodetic Survey. Geodetic surveys will be conducted after the installation and completion of each investigation activity. The survey will be to locate the horizontal locations of surface and near-surface soil samples; corners of geophysics, soil gas, and beta/gamma probe surveys; and surface water and sediment sample locations. Horizontal and vertical locations of all vadose zone soil borings and perched zone wells will be surveyed. The geodetic survey should be conducted by a professional surveyor licensed in the state of Washington and should be referenced to both historic (e.g., Hanford coordinates) and current coordinate datums (e.g., North American Datum of 1983 - NAD-83), both vertical and horizontal.

8.3.4 Data Evaluation and Decision Making

Data will be evaluated as soon as results (e.g., soil gas, radiation screening, drilling results) become available for use in restructuring and focusing the investigation activities. Data reports will be developed that summarize and interpret new data. This includes groundwater sampling and RLS borehole logging as part of the AAMS. Data will be used to refine the conceptual model, further assess potential contaminant-specific ARARs, develop the quantitative risk assessment, and assess remedial action alternatives.

The objectives of data evaluation are the following:

- To reduce and integrate data to ensure that data gaps are identified and that the goals and objectives of the PUREX Plant AAMS are met

- To confirm that data are representative of the media sampled and that QA/QC criteria have been met.

Table 8-1. Uses of Existing Data for PUREX Plant Aggregate Area Waste Management Units. Page 1 of 3

Waste Management Unit	Type of Unit	Development of Sampling Plans			Health and Safety	
		Location	Possible Contamination	Depth Contamination	Surface Radiation	Expected Maximum Level
		Cribs and Drains				
216-A-1	Crib	*	*		*	*
216-A-2	Crib	*	*		*	
216-A-3	Crib	*	*		*	
216-A-4	Crib	*	*		*	
216-A-5	Crib	*	*		*	
216-A-6	Crib	*	*		*	*
216-A-7	Crib	*	*		*	*
216-A-8	Crib	*	*		*	
216-A-9	Crib	*	*		*	*
216-A-10	Crib	*	*		*	
216-A-21	Crib	*	*		*	*
216-A-24	Crib	*	*		*	
216-A-27	Crib	*	*		*	
216-A-30	Crib	*	*		*	
216-A-31	Crib	*	*		*	
216-A-32	Crib	*			*	
216-A-36A	Crib	*	*		*	
216-A-36B	Crib	*	*	*	*	
216-A-37-1	Crib	*	*	*	*	
216-A-37-2	Crib	*			*	
216-A-38-1	Crib	*	*		*	
216-A-41	Crib	*				
216-A-45	Crib	*	*		*	
216-A-11	French Drain	*	*		*	
216-A-12	French Drain	*	*		*	
216-A-13	French Drain	*	*		*	
216-A-14	French Drain	*	*		*	
216-A-15	French Drain	*	*		*	
216-A-22	French Drain	*	*		*	
216-A-26	French Drain	*	*		*	
216-A-28	French Drain	*	*		*	
216-A-33	French Drain	*			*	
216-A-35	French Drain	*	*		*	
216-A-26A	French Drain	*	*		*	
216-C-8	French Drain	*	*			
		Reverse Wells				
299-E24-111	Injection Well	*	*		*	
		Ponds, Ditches and Trenches				
216-A-29	Ditch	*			*	
216-A-34	Ditch	*			*	
216-A-18	Trench	*			*	
216-A-19	Trench	*			*	
216-A-20	Trench	*			*	
216-A-40	Trench	*			*	*

Table 8-1. Uses of Existing Data for PUREX Plant Aggregate Area Waste Management Units.

Waste Management Unit	Type of Unit	Development of Sampling Plans			Health and Safety	
		Location	Possible Contamination	Depth Contamination	Surface Radiation	Expected Maximum Level
Septic Tanks and Associated Drain Fields						
2607-EA	Septic Tank/Drain Field	*				
2607-EC	Septic Tank/Drain Field	*				
2607-ED	Septic Tank/Drain Field	*				
2607-EG	Septic Tank	*				
2607-EJ	Septic Tank	*				
2607-EL	Septic Tank	*				
2607-E6	Septic Tank/Drain Field	*				
Basins						
207-A	Retention Basins	*			*	*
216-A-42	Retention Basin	*				
Burial Sites						
200-E	Burning Pit	*				
218-E-1	Burial Ground	*	*		*	
218-E-8	Burial Ground	*	*			
218-E-12A	Burial Ground	*	*		*	
218-E-12B	Burial Ground	*				
218-E-13	Burial Ground	*	*		*	
Unplanned Releases						
UN-200-E-10	Unplanned Release	*				
UN-200-E-11	Unplanned Release	*	*			
UN-200-E-12	Unplanned Release	*	*			
UN-200-E-13	Unplanned Release	*				
UN-200-E-15	Unplanned Release	*				
UN-200-E-19	Unplanned Release	*	*			
UN-200-E-20	Unplanned Release	*	*			
UN-200-E-22	Unplanned Release	*	*			
UN-200-E-25	Unplanned Release	*	*			
UN-200-E-26	Unplanned Release	*	*			
UN-200-E-28	Unplanned Release	*	*			
UN-200-E-31	Unplanned Release	*	*			
UN-200-E-33	Unplanned Release	*				
UN-200-E-35	Unplanned Release	*				
UN-200-E-39	Unplanned Release	*	*			
UN-200-E-40	Unplanned Release	*	*			
UN-200-E-42	Unplanned Release	*				
UN-200-E-47	Unplanned Release	*				
UN-200-E-49	Unplanned Release	*				
UN-200-E-56	Unplanned Release	*	*			
UN-200-E-58	Unplanned Release	*				
UN-200-E-60	Unplanned Release	*				
UN-200-E-62	Unplanned Release	*				
UN-200-E-65	Unplanned Release	*				
UN-200-E-67	Unplanned Release	*				
UN-200-E-68	Unplanned Release	*				

Table 8-1. Uses of Existing Data for PUREX Plant Aggregate Area Waste Management Units. Page 3 of 3

Waste Management Unit	Type of Unit	Development of Sampling Plans			Health and Safety	
		Location	Possible Contamination	Depth Contamination	Surface Radiation	Expected Maximum Level
UN-200-E-72	Unplanned Release	*				
UN-200-E-86	Unplanned Release	*	*	*	*	*
UN-200-E-88	Unplanned Release	*	*		*	*
UN-200-E-91	Unplanned Release	*				
UN-200-E-94	Unplanned Release	*				
UN-200-E-96	Unplanned Release	*	*			
UN-200-E-97	Unplanned Release	*				
UN-200-E-99	Unplanned Release	*				
UN-200-E-100	Unplanned Release	*	*			
UN-200-E-114	Unplanned Release	*	*			
UN-200-E-117	Unplanned Release	*	*			
UN-200-E-142	Unplanned Release	*				
UPR-200-E-17	Unplanned Release	*	*			
UPR-200-E-21	Unplanned Release	*	*			
UPR-200-E-24	Unplanned Release	*	*			
UPR-200-E-29	Unplanned Release	*	*			
UPR-200-E-30	Unplanned Release	*	*			
UPR-200-E-50	Unplanned Release	*	*			
UPR-200-E-53	Unplanned Release	*	*			
UPR-200-E-106	Unplanned Release	*	*			

Table 8-2. Data Needs for Preliminary Remedial Action Alternatives PUREX Plant Aggregate Area.

Alternative	Physical Attribute	Chemical/Radiochemical Attribute
1. Multimedia Cover (plus possible vertical barriers)	• areal extent • depth of contamination • structural integrity (collapse potential) • run-off/run-on potential • cover properties (permeability)	• surface radiation • biologic transport potential
2. In Situ Grouting/ Stabilization	• areal extent • depth • particle size • hydraulic properties (permeability/porosity) • stratigraphy • borehole spacing • grout/additive mix parameters	• solubility • reactivity • leachability from grout medium
3. Excavation, Soil Treatment, and Disposal	• areal extent[a/] • depth[a/] • particle size • silt-size (dust) content • excavation stability	• toxicity/radioactivity • levels of contaminants • solubility/reactivity • soil chemistry (relative affinity) • concentrations in PM-10 fraction • spent solvent treatment/disposal options
4. In Situ vitrification	• areal extent • depth • soil/waste conductivity • thermal properties • moisture contact • voids	• volatility • reactivity • leachability/integrity • off-gas treatment waste disposal options
5. Excavation, Above Ground Treatment, and Geologic Disposal	• areal extent[a/] • depth[a/] • mineralogy of soil/waste • particle size • silt-size (dust) content • excavation stability • treatment parameters	• concentrations of TRU • toxicity/radioactivity • levels of contaminants • concentrations in PM-10 fraction • reactivity • leachability/integrity of final waste form
6. In Situ Soil Vapor Extraction	• areal extent • depth • locations/depth of highest concentrations (vapors, adsorbed) • stratigraphy • soil permeability/porosity • voids	• volatility of constituents (Henry's Law Constant) • non-volatile organics • levels • volatile radionuclides (Radon) • treatability (catalytic oxidization)

[a/] May be obtained during remediation using the observational approach recommended by the Hanford Site Past-Practice Strategy (DOE/RL 1992a).

Table 8-3. Analytical Levels for the PUREX Plant Aggregate Area.

Level	Description
LEVEL I	Field screening. This level is characterized by the use of portable instruments which can provide real-time data to assist in the optimization of sampling point locations and for health and safety support. Data can be generated regarding the presence or absence of certain contaminants (especially volatiles) at sampling locations.
LEVEL II	Field analysis. This level is characterized by the use of portable analytical instruments which can be used onsite, or in mobile laboratories stationed near a site (close-support laboratories). Depending on the types of contaminants, sample matrix, and personnel skill, qualitative and quantitative data can be obtained.
LEVEL III	Laboratory analysis using methods other than the Contract Laboratory Program (CLP) Routine Analytical Services (RAS). This level is used primarily in support of engineering studies using standard EPA-approved procedures. Some procedures may be equivalent to CLP RAS without the CLP requirements for documentation.
LEVEL IV	Contract Laboratory Program (CLP) Routine Analytical Services (RAS). This level is characterized by rigorous QA/QC protocols and documentation and provides qualitative and quantitative analytical data. Some regions have obtained similar support via their own regional laboratories, university laboratories, or other commercial laboratories.
LEVEL V	Nonstandard methods. Analyses which may require method modification and/or development are considered Level V by CLP Special Analytical Services (SAS).

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit (pCi/g)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitatio n Limit (pCi/g)	Precision (RPD)	Accuracy (%)
RADIONUCLIDES								
Gross Alpha	900.0 M	TBD	±30	±25	900.0	10	±25	±25
Gross Beta	900.0 M	TBD	±30	±25	900.0	5	±25	±25
Gamma Scan	D3699 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Actinium-225	907.0 M	TBD	±30	±25	907.0	TBD	±25	±25
Actinium-227	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Americium-241	Am-01	TBD	±30	±25	Am-03	TBD	±25	±25
Americium-242	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Americium-242m	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Americium-243	Am-01	TBD	±30	±25	Am-03	TBD	±25	±25
Antinomy-126	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Antimony-126m	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Barium-137m	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Bismuth-210	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Bismuth-211	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Bismuth-213	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Bismuth-214	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Carbon-14	C-01 M	TBD	±30	±25	TBD	TBD	±25	±25
Cesium-134	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Cesium-135	901.0 M	TBD	±30	±25	901.0	TBD	±25	±25
Cesium-137	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Cobalt-60	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Curium-242	907.0 M	TBD	±30	±25	907.0	TBD	±25	±25
Curium-244	907.0 M	TBD	±30	±25	907.0	TBD	±25	±25
Curium-245	907.0 M	TBD	±30	±25	907.0	TBD	±25	±25
Europium-152	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Europium-154	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit (pCi/g)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit (pCi/g)	Precision (RPD)	Accuracy (%)
RADIONUCLIDES (cont.)								
Europium-155	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Francium-221	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Iodine-129	902.0 M	TBD	±30	±25	902.0	TBD	±25	±25
Lead-209	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Lead-210	Pb-01 M	TBD	±30	±25	Pb-01	TBD	±25	±25
Lead-211	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Lead-212	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Lead-214	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Neptunium-237	907.0 M	TBD	±30	±25	907.0	TBD	±25	±25
Neptunium-239	D35649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Nickel-59	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Nickel-63	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Niobium-93m	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Plutonium	Pu-02	TBD	±30	±25	Pu-10	TBD	±25	±25
Plutonium-238	Pu-02	TBD	±30	±25	Pu-10	TBD	±25	±25
Plutonium-239/240	Pu-02	TBD	±30	±25	Pu-10	TBD	±25	±25
Plutonium-241	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Polonium-214	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Polonium-215	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Polonium-218	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Potassium-40	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Protactinium-231	TBD	TBD	±30	±25	TBD	TBD	±25	±25

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit (pCi/g)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit (pCi/g)	Precision (RPD)	Accuracy (%)
RADIONUCLIDES (cont.)								
Protactinium-234m	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Radium	Ra-04	TBD	±30	±25	Ra-05	TBD	±25	±25
Radium-225	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Radium-226	Ra-04	TBD	±30	±25	Ra-05	TBD	±25	±25
Ruthenium-106	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Samarium-151	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Selenium-79	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Sodium-22	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Strontium-90	Sr-02	TBD	±30	±25	Sr-02	TBD	±25	±25
Technetium-99	Tc-01 M	TBD	±30	±25	Tc-01	TBD	±25	±25
Thallium-207	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Thorium-227	00-06	TBD	±30	±25	00-07	TBD	±25	±25
Thorium-229	00-06	TBD	±30	±25	00-07	TBD	±25	±25
Thorium-230	00-06	TBD	±30	±25	00-07	TBD	±25	±25
Thorium-231	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Tritium	906.0 M	TBD	±30	±25	906.0	300	±25	±25
Uranium	U-04	TBD	±30	±25	U-04	TBD	±25	±25
Uranium-233	U	TBD	±30	±25	908.0	TBD	±25	±25
Uranium-234	U	TBD	±30	±25	908.0	TBD	±25	±25
Uranium-235	U	TBD	±30	±25	908.0	TBD	±25	±25
Uranium-238	U	TBD	±30	±25	908.0	TBD	±25	±25
Yttrium-90	Sr-02	TBD	±30	±25	Sr-02	TBD	±25	±25
Zirconium-93	TBD	TBD	±30	±25	TBD	TBD	±25	±25

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit (mg/kg)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit (µg/L)	Precision (RPD)	Accuracy (%)
INORGANICS								
Arsenic	7061	0.02	±25	±30	7061	10	±20	±25
Barium	6010	0.02	±25	±30	6010	20	±20	±25
Boron	6010	TBD	±25	±30	6010	TBD	±20	±25
Cadmium	6010	0.09	±25	±30	6010	1	±20	±25
Chromium	6010	0.07	±25	±30	6010	10	±20	±25
Copper	6010	0.06	±25	±30	220.2	10	±20	±25
Cyanide	9010	TBD	±25	±30	335.3	50	±20	±25
Fluoride	300 M	TBD	±25	±30	300	50	±20	±25
Iron	6010	20	±25	±30	6010	70	±20	±25
Lead	6010	0.45	±25	±30	6010	450	±20	±25
Manganese	6010	0.02	±25	±30	6010	20	±20	±25
Mercury	7471	0.02	±25	±30	245.2	2	±20	±25
Nickel	6010	1.5	±25	±30	6010	50	±20	±25
Nitrate	300 M	TBD	±25	±30	300	130	±20	±25
Nitrite	300 M	TBD	±25	±30	300	40	±20	±25
Selenium	6010	0.75	±25	±30	270.2	20	±20	±25
Silver	6010	2	±25	±30	272.2	10	±20	±25
Titanium	6010	TBD	±25	±30	6010	TBD	±20	±25
Vanadium	6010	0.08	±25	±30	286.2	40	±20	±25
Zinc	6010	0.02	±25	±30	6010	20	±20	±25

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit (mg/kg)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit (μg/L)	Precision (RPD)	Accuracy (%)
ORGANICS								
Acetone	8240	0.1	±25	±30	8240	100	±20	±25
Carbon tetrachloride	8240	0.005	±25	±30	8240	1	±20	±25
Chloroform	8240	0.005	±25	±30	8240	5	±20	±25
Kerosene	8015	20	±35	±30	8015	500	±35	±25
Methylene chloride	8240	0.005	±25	±30	8240	5	±20	±25
1,1,1-Trichloroethane	8240	0.005	±25	±30	8240	5	±20	±25
Toluene	8240	0.005	±25	±30	8240	5	±20	±25
Tributyl phosphate	TBD	TBD	±25	±30	TBD	TBD	±30	±25

TBD = To Be Determined
M = method modified to include extraction from the solid medium, extraction method is matrix and laboratory-specific
RPD = Relative Percent Difference
Prescribed Procedures for Measurement of Radioactivity in Drinking Water (EPA 1980)
Test Methods for Evaluating Solid Wastes (SW 846) Third Edition (EPA 1986)
Methods for Chemical Analysis of Water and Wastes (EPA 1983)
Precision and accuracy are goals. Since these parameters are highly matrix dependent they could vary greatly from the goals listed.

Table 8-5. Data Gaps by Site Category.

Site Category	Identified Data Gaps
Tanks and Vaults	• Contaminant concentrations in waste management units other than single-shell tanks • Distribution of contaminants in subsurface soils released in leaks • Constituents concentrations in related surface contamination
Cribs and Drains	• Contaminant concentrations in cribs • Contaminant concentrations in soils beneath cribs • Specific constituents (especially organic chemicals) • Distribution and vertical/lateral extent of contamination
Reverse Wells	• Contaminant concentrations in subsurface soils impacted by discharges • Specific constituents (especially organics) • Extent of contamination
Ditches and Trenches	• Distribution/extent of subsurface contamination • Buried contaminant concentrations in stabilized portions/units
Septic Tanks and Associated Drain Fields	• Actual discharge levels • Possible discharge and presence/level of non-sanitary wastes (e.g., laboratory drains)
Transfer Facilities, Diversion Boxes, and Pipelines	• Contamination constituents and concentrations • Direct radiation levels in facilities • Constituents/concentrations in related surface contamination • Integrity of transfer lines
Basins (207-A)	• Constituents and concentrations in sediments • Distribution/extent of subsurface contamination
Unplanned Releases	• Surface soil constituents and concentrations • Buried contamination constituents and concentrations

Table 8-6. Applicable Characterization Methods at PUREX Plant Aggregate Area Waste Management Units.

Waste Management Unit		Source Investigation Method								
		Surface Radiation Survey	Subsurface Spectral Geophysics	Surface Geophysics	Soil Gas Survey	Surface Soil Sampling	Wipe Samples	Surface Water Sediment Sampling	Subsurface Soil Sampling	Remarks
Cribs and Drains										
216-A-1	Crib					X			X	
216-A-2	Crib				X	X			X	
216-A-3	Crib					X			X	
216-A-4	Crib					X			X	
216-A-5	Crib					X			X	
216-A-6	Crib					X			X	
216-A-7	Crib				X	X			X	
216-A-8	Crib				X	X			X	
216-A-9	Crib					X			X	
216-A-10	Crib					X			X	
216-A-21	Crib					X			X	
216-A-24	Crib				X	X			X	
216-A-27	Crib					X			X	
216-A-30	Crib					X			X	
216-A-31	Crib				X	X			X	
216-A-32	Crib					X			X	
216-A-36A	Crib					X			X	
216-A-36B	Crib					X			X	
216-A-37-1	Crib					X			X	
216-A-37-2	Crib					X			X	
216-A-38-1	Crib					X			X	
216-A-41	Crib	X				X			X	
216-A-45	Crib					X			X	
216-A-11	French Drain					X			X	
216-A-12	French Drain					X			X	
216-A-13	French Drain					X			X	
216-A-14	French Drain					X			X	

Table 8-6. Applicable Characterization Methods at PUREX Plant Aggregate Area Waste Management Units.

Waste Management Unit		Source Investigation Method								
		Surface Radiation Survey	Subsurface Spectral Geophysics	Surface Geophysics	Soil Gas Survey	Surface Soil Sampling	Wipe Samples	Surface Water Sediment Sampling	Subsurface Soil Sampling	Remarks
216-A-15	French Drain					X			X	
216-A-22	French Drain					X			X	
216-A-26	French Drain					X			X	
216-A-26A	French Drain					X			X	
216-A-28	French Drain					X			X	
216-A-33	French Drain					X			X	
216-A-35	French Drain					X			X	
216-C-8	French Drain	X				X			X	
Reverse Wells										
299-E24-111	Injection Well					X			X	
Ponds, Ditches and Trenches										
216-A-29	Ditch					X			X	
216-A-34	Ditch					X			X	
216-A-18	Trench					X			X	
216-A-19	Trench					X			X	
216-A-20	Trench					X			X	
216-A-40	Trench					X			X	
Septic Tanks and Associated Drain Fields										
2607-EA	Septic Tank/Drain Field	X				X			X	
2607-EC	Septic Tank/Drain Field	X				X			X	
2607-ED	Septic Tank/Drain Field	X				X			X	
2607-EG	Septic Tank	X				X			X	
2607-EJ	Septic Tank	X				X			X	
2607-EL	Septic Tank	X				X			X	
2607-E6	Septic Tank/Drain Field	X				X			X	
Basins										
207-A	Retention Basins							X		
216-A-42	Retention Basin	X				X		X	X	

Table 8-6. Applicable Characterization Methods at PUREX Plant Aggregate Area Waste Management Units.

Waste Management Unit		Source Investigation Method								
		Surface Radiation Survey	Subsurface Spectral Geophysics	Surface Geophysics	Soil Gas Survey	Surface Soil Sampling	Wipe Samples	Surface Water Sediment Sampling	Subsurface Soil Sampling	Remarks
Burial Sites										
200-E	Burning Pit	X				X			X	
218-E-1	Burial Ground	X				X			X	
218-E-8	Burial Ground	X				X			X	
218-E-12A	Burial Ground	X				X			X	
218-E-12B	Burial Ground	X				X			X	
218-E-13	Burial Ground	X				X			X	
Unplanned Releases										
UN-200-E-10	Unplanned Release	X				X			X	
UN-200-E-11	Unplanned Release	X				X			X	
UN-200-E-12	Unplanned Release	X				X			X	
UN-200-E-13	Unplanned Release	X				X			X	
UN-200-E-15	Unplanned Release	X				X			X	
UN-200-E-19	Unplanned Release	X				X			X	
UN-200-E-20	Unplanned Release	X				X			X	
UN-200-E-22	Unplanned Release	X				X			X	
UN-200-E-25	Unplanned Release	X				X			X	
UN-200-E-26	Unplanned Release	X				X			X	
UN-200-E-28	Unplanned Release	X				X			X	
UN-200-E-31	Unplanned Release	X				X			X	
UN-200-E-33	Unplanned Release	X				X			X	
UN-200-E-35	Unplanned Release	X				X			X	
UN-200-E-39	Unplanned Release	X				X			X	
UN-200-E-40	Unplanned Release	X				X			X	
UN-200-E-42	Unplanned Release	X				X			X	
UN-200-E-47	Unplanned Release	X				X			X	
UN-200-E-49	Unplanned Release	X				X			X	
UN-200-E-56	Unplanned Release	X				X			X	

Table 8-6. Applicable Characterization Methods at PUREX Plant Aggregate Area Waste Management Units. Page 4 of 4

Waste Management Unit	Source Investigation Method								
	Surface Radiation Survey	Subsurface Spectral Geophysics	Surface Geophysics	Soil Gas Survey	Surface Soil Sampling	Wipe Samples	Surface Water Sediment Sampling	Subsurface Soil Sampling	Remarks
UN-200-E-58 Unplanned Release	X				X			X	
UN-200-E-60 Unplanned Release	X				X			X	
UN-200-E-62 Unplanned Release	X				X			X	
UN-200-E-65 Unplanned Release	X				X			X	
UN-200-E-67 Unplanned Release	X				X			X	
UN-200-E-68 Unplanned Release	X				X			X	
UN-200-E-72 Unplanned Release	X				X			X	
UN-200-E-86 Unplanned Release	X				X			X	
UN-200-E-88 Unplanned Release	X				X			X	
UN-200-E-91 Unplanned Release	X				X			X	
UN-200-E-94 Unplanned Release	X				X			X	
UN-200-E-96 Unplanned Release	X				X			X	
UN-200-E-97 Unplanned Release	X				X			X	
UN-200-E-99 Unplanned Release	X				X			X	
UN-200-E-100 Unplanned Release	X				X			X	
UN-200-E-114 Unplanned Release	X				X			X	
UN-200-E-117 Unplanned Release	X				X			X	
UN-200-E-142 Unplanned Release	X				X			X	
UPR-200-E-17 Unplanned Release	X				X			X	
UPR-200-E-21 Unplanned Release	X				X			X	
UPR-200-E-24 Unplanned Release	X				X			X	
UPR-200-E-29 Unplanned Release	X				X			X	
UPR-200-E-30 Unplanned Release	X				X			X	
UPR-200-E-50 Unplanned Release	X				X			X	
UPR-200-E-53 Unplanned Release	X				X			X	
UPR-200-E-106 Unplanned Release	X				X			X	

X = Investigation at each individual site; A = Investigation representative of several analogous sites.

THIS PAGE INTENTIONALLY
LEFT BLANK

9.0 RECOMMENDATIONS

The purpose of the aggregate area management study (AAMS) is to compile and evaluate the existing body of knowledge to support the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) decision making process. A primary task in achieving this purpose is to assess each waste management unit and unplanned release within the aggregate area to determine the most expeditious path for remediation within the statutory requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA). The existing body of pertinent knowledge regarding PUREX Plant Aggregate Area waste management units and unplanned releases has been summarized and evaluated in the previous sections of this study. A data evaluation process has been established that uses the existing data to develop preliminary recommendations on the appropriate remediation path for each site. This data evaluation process is a refinement of the *Hanford Site Past-Practice Strategy* (Figure 1-2) and establishes criteria for selecting appropriate *Hanford Site Past-Practice Strategy* paths (expedited response action, ERA; interim remedial measures, IRM; limited field investigation, LFI; and final remedy selection, FRS) for individual waste management units and unplanned releases within the 200 Areas. A discussion of the criteria for path selection and the results of the data evaluation process are provided in Sections 9.1. and 9.2, respectively. Figure 9-1 provides a flowchart of the data evaluation process that will be discussed. Table 9-1 provide a summary of the results of data evaluation assessment of each unit. Table 9-2 provides the decisional matrix patterns each unit followed.

This section presents recommended assessment paths for the waste management units and unplanned releases at the PUREX Plant Aggregate Area. These recommendations are only proposed at this time and are subject to adjustment and change. Factors that may affect development of final recommendations include, but are not limited to, comments and advice from the U.S. Environmental Protection Agency (EPA), Washington State Department of Ecology (Ecology), or U.S. Department of Energy (DOE); identification and development of new information; and modification of the criteria used in the assessment path decision making process. The data evaluation process depicted in Figure 9-1 and discussed in Section 9.1 was developed to facilitate the only technical data evaluation step shown on the *Hanford Site Past-Practice Strategy* (Figure 1-2). Procedural and administrative requirements for implementation of the recommendations provided in this AAMS will be performed in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1990) and the *Hanford Site Past-Practice Strategy*. Changes in recommendations will be addressed, and more detail on recommended assessment paths for waste management units and unplanned releases will be included in workplans as they are developed for the actual investigation and remediation activities.

A majority of waste management units and unplanned releases do not have information regarding the nature and extent of contamination necessary for quantitative or qualitative risk assessment, especially with regard to hazardous constituents, and were recommended for additional investigation (e.g., LFI). Several units and releases assessed within the ERA path were recommended for actions that fall within the scope of existing operational programs. Sites with elevated levels of surface radionuclide contamination are addressed by the Radiation Area Remedial Action (RARA) program.

Waste management units and unplanned releases which are addressed entirely by other programs were not subjected to the data evaluation process. This includes units and unplanned releases that are within the scope of the Single-Shell Tank Program, Surplus Facilities Program, and Defense Waste Management Program.

A discussion of the four decision-making paths shown on Figure 9-1: ERA, IRM, LFI, and Final Remedy Selection, is provided in Section 9.1. Section 9.2 provides a discussion of the waste management units grouped under each of these paths. A discussion of regrouping and prioritization of the waste management units is provided in Section 9.3. Recommendations for redefining operable unit boundaries and prioritizing operable units for work plan development are also provided in Section 9.3. No additional aggregate area-based field characterization activities are recommended to be undertaken as a continuation of the AAMS. All recommendation for future characterization needs (see Section 8.0) will be more fully developed and implemented through work plans. Plan development and submittal will be accomplished in accordance with requirements of the *Hanford Site Past-Practice Strategy* and the Tri-Party Agreement (Ecology et al. 1990) and could include remedial investigation (RI)/feasibility study (FS); RCRA Facility Investigation (RFI)/Corrective Measures Study (CMS), or LFI work plans. Sections 9.4 and 9.5 provide recommendations for focused feasibility and treatability studies, respectively.

9.1 DECISION MAKING CRITERIA

The criteria used to assess the most expeditious remediation process path are based primarily on urgency for action and whether site data are adequate to proceed along a given path (Figure 9-1). All units and unplanned releases that are not completely addressed under other Hanford Site programs are assessed in the data evaluation process. All of the units and releases that are addressed in the data evaluation process are initially evaluated as candidates for an ERA. Sites where a release has occurred or is imminent are considered candidates for ERAs. Conditions that might trigger an ERA are the determination of an unacceptable health or environmental risk or a short time frame available to mitigate the problem (DOE/RL 1992a). As a result, candidate ERA units were evaluated against a set of criteria to determine whether potential for exposure to unacceptable health or environmental risks

exists. Units and unplanned releases that are recommended for ERAs will undergo a formal evaluation following the selection process outlined in WHC (1991b).

Waste management units and unplanned releases that are not recommended for consideration as an ERA continue through the data evaluation process. Sites continuing through the process that potentially pose a high risk (refer to Section 5.0), become candidates for consideration as an IRM. The criteria used to determine a potential for high risk, thereby indicating a high priority site, were the Hazard Ranking System (HRS) score used for nominating waste management units for CERCLA cleanup (40 CFR 300), the modified Hazard Ranking System (mHRS) scores, surface radiation survey data, and rankings by the Environmental Protection Program. Units and unplanned releases with HRS or mHRS scores greater than 28.5 (the CERCLA cleanup criterion) were designated as candidate sites for IRM consideration. Units and unplanned releases that did not have an HRS score were compared to similar sites to establish an estimated HRS score. Sites with surface contamination greater than 2 mR/h exposure rate, 100 ct/min beta/gamma above background or alpha greater than 20 ct/min were also designated as candidate IRM sites. In addition, surface contamination sites that had an Environmental Protection Program ranking of greater than 7 were also designated as candidate IRM sites. The candidate IRM sites are listed in Table 5-1, which summarizes the high priority sites. The four risk indicators are based on limited data (refer to Section 8.0) and therefore may not adequately represent the actual risk posed by the site. Technical judgement, including assessment of similarities in site operational histories, was used to include sites not ranked as high priority in the list of sites under consideration for an IRM. Candidate IRM sites were then further evaluated to determine if an IRM is appropriate for the site. Candidate IRM sites that did not meet the IRM criteria were placed into the FRS path. As future data become available the list of units recommended for consideration as IRM sites may be altered.

For certain units and unplanned releases, it was recognized that remedial actions could be undertaken under an existing operational or other Hanford Site program (e.g., Single-Shell Tank, RARA, or Surplus Facility programs). As a result, recommendations were made that remedial actions be undertaken (partially or completely) outside the 200 AAMS past practice program. Units or unplanned releases that could be addressed only in part by another program (e.g., surface contamination cleanup under the RARA program) remained in the 200 AAMS data evaluation process for further consideration. If it cannot be demonstrated that these sites will be addressed under the operational program within a time frame compatible with the past practice program, they will be readdressed by the 200 AAMS process.

Units and unplanned releases recommended for complete disposition under another program (e.g., single-shell tanks and associated structures under the Single-Shell Tank program) were not considered in the 200 AAMS data evaluation process. In addition potentially new sites that were identified during the AAMS were also not considered. It is

recommended that a formal determination be made regarding the regulatory status of all new sites following established procedures before they are considered further under the 200 AAMS data evaluation process. Potentially new sites identified in the PUREX Plant Aggregate Area are described in Section 2.3.10.

Specific criteria used to develop initial recommendations for ERAs, LFIs, and IRMs for units and unplanned releases within the aggregate area are provided in Sections 9.1.1 and 9.1.2. Units and unplanned releases not initially addressed under an ERA, LFI or IRM will be evaluated under the final remedy selection path discussed in Section 9.1.3.

9.1.1 Expedited Response Action Path

Candidate ERA sites are evaluated to determine if they pose an unacceptable health or environmental risk and a short time-frame available to mitigate the problem exists. All units and unplanned releases other than those recommended for complete disposition under another Hanford program are assessed against the ERA criteria. The *Hanford Site Past-Practice Strategy* describes conditions that might trigger abatement of a candidate waste management unit or unplanned release under an ERA. Generally, these conditions would rely on two things: (1) the determination of existing or near future unacceptable health or environmental risk, and (2) a short time-frame available to mitigate the problem. Conditions include, but are not limited to the following:

- Actual or potential exposure to nearby human populations, biota, or the food chain from hazardous substances and radioactive or mixed waste contaminants
- Actual or potential contamination of drinking water supplies or sensitive ecosystems
- Threats of release of hazardous substances and radioactive or mixed waste contaminants
- High levels of hazardous substances and radioactive or mixed waste contaminants in soils that pose or may pose a threat to human health or the environment, or have the potential for migration
- Weather conditions that may increase potential for release or migration of hazardous substances and radioactive or mixed waste contaminants
- The availability of other appropriate federal or state response mechanisms to respond to the release

- Time required to develop and implement a final remedy

- Further degradation of the medium which may occur if a response action is not expeditiously initiated

- Risks of fire or explosion or potential for exposure as a result of an accident or failure of a container or handling system

- Other situations or factors that may pose threats to human health or welfare or the environment.

These conditions were used as the initial screening criteria to identify candidate waste management units and unplanned releases for an ERA. Candidate waste management units and releases that did not meet these conditions were not assessed through the ERA evaluation path. Additional criteria for further, detailed screening of ERA candidates were developed based on the conditions outlined in the *Hanford Site Past-Practice Strategy*. Quantification of these criteria for further screening were developed. These additional screening criteria are depicted in Figure 9-1 and are described below.

The next decision point on Figure 9-1 used to assess each ERA candidate is whether a driving force to an exposure pathway exists or is likely to exist. Units or unplanned releases with contamination that is migrating or is likely to significantly migrate to a medium that can result in exposure and harm to humans required additional assessment under the ERA process. Units or unplanned releases where contamination could migrate and, therefore, potentially require significantly more extensive remedial action if left unabated were also assessed in the ERA path.

Waste management units and unplanned releases with a driving force were assessed to determine if unacceptable health or environmental risk and a short time-frame available to mitigate the problem exists from the release. The criteria used to determine unacceptable risks are based on the quantity and concentration of the release. If the release or imminent release is greater than 100 times the CERCLA reportable quantity for any constituent, the unit or unplanned release remains in consideration for an ERA. If the release or imminent release contains hazardous constituents at concentrations that are 100 times the most applicable standard, the unit or unplanned release continues to be considered for an ERA. Application of the criterion of 100 times applicable standards is for quantification of the strategy criterion that addresses "high levels of hazardous substances and radioactive or mixed waste contaminants...". The factor of 100 is based on best engineering judgement of what constitutes a high level of contamination warranting expedited action. In some cases, engineering judgment was used to estimate the quantity and concentration of a postulated release. Standards applied include Model Toxics Control Act (MTCA) standards for

industrial sites and DOE and Westinghouse Hanford radiation criteria (refer to Section 6.0). The application of these standards does not signify they are recognized as ARARs.

The ERA screening criteria in addition to those presented in the Hanford Site Past-Practice Strategy were applied to provide a consistent quantitative basis for making recommendations in the AAMS. The decision to implement the recommendations developed in the AAMS will be made collectively between DOE, EPA and Ecology based only on the criteria established in the Hanford Site Past-Practice Strategy.

If a release is unacceptable with respect to health or environmental risk, a technology must be readily available to control the release for a unit or unplanned release to be considered for an ERA (WHC 1991b). An example that would require substantial technology development before implementation of cleanup would be a tritium release since no established treatment technology is available to separate low concentrations of tritium from water.

The next step in the ERA evaluation path involves determining whether implementation of the available technology would have adverse consequences that would offset the benefits of an ERA. Examples of adverse consequences include: (1) use of technologies that result in risks to cleanup personnel that are much greater than the risks of the release; (2) the ERA would foreclose future remedial actions; and (3) the ERA would prevent or greatly hinder future data collection activities. If adverse consequences are not expected, the site remains in consideration for an ERA.

The final criterion is to determine if the candidate ERA is within the scope of an operational program. Maintenance and operation of active waste management facilities are within the scope of activities administered by the Defense Waste Management Program. Active facilities include certain transfer lines, diversion boxes, and catch tanks. Generally, active facilities will not be included in past practice investigations unless operation is discontinued prior to initiation of the investigation. The Surplus Facilities and RCRA Closure programs are responsible for safe and cost-effective surveillance, maintenance, and decommissioning of surplus facilities and RCRA closures at the Hanford Site. The Surplus Facilities program is also responsible for RARA activities that include surveillance, maintenance, decontamination, and/or stabilization of inactive burial grounds, cribs, ponds, trenches, and unplanned release sites.

If the proposed ERA will not address all the contamination present, the unit or unplanned release continues through the process to be evaluated under a second path. For example, surface contamination cleanup under the RARA program may not address subsurface contamination and, therefore, additional investigation may be needed.

A final decision regarding the conduct of ERAs in the aggregate area will be made among DOE, EPA, and Ecology based, at least in part, on the recommendations provided in this section, and results of the final selection process outlined in WHC (1991b).

9.1.2 Limited Field Investigation and Interim Remedial Measure Paths

High priority waste management units and unplanned release sites were evaluated to determine if sufficient need and information exists such that an IRM could be pursued. An IRM is desired for high priority units and unplanned releases where extensive characterization is not necessary to reach defensible cleanup decisions. Implementation of IRMs at waste management units and unplanned releases with minimal characterization is expected to rely on observational data acquired during remedial activities. Successful execution of this strategy is expected to reduce both time and cost for cleanup of units and unplanned releases without impacting the effectiveness of the implemented action.

The initial step in the IRM evaluation path is to categorize the units. The exposure pathways of interest are similar for each site in a category; therefore, it is effective to evaluate candidate units as a group. The groupings used in Section 2.3 (e.g., cribs; tanks and vaults; etc.) will continue to be used to group the units for IRM assessment. This grouping approach is especially effective in reducing characterization requirements. As done in the 100 Areas using the observational approach, the LFIs can be used to characterize a representative unit or units in detail to develop a remedial alternative for the group of units. Observational data obtained during implementation of the remedial alternative could be used to meet unit specific needs. Similarities of waste management units may make it possible to remediate them using the observational approach after first characterizing only a few units. It is expected, therefore, that a LFI would provide sufficient information to proceed with an IRM for groups of similar high priority waste management units.

Data adequacy is assessed in the next step. The existing data are evaluated to determine if: (1) existing data were sufficient to develop a conceptual model and qualitative risk assessment; (2) the IRM will work for this pathway; (3) implementing the IRM will have adverse impacts on the environment, future remediation activities or data collection efforts; (4) the benefits of implementing the IRM are greater than the costs. If data are not adequate an assessment was made to determine if an LFI might provide enough data to perform an IRM. If an LFI would not collect sufficient data to perform an IRM, the unit was addressed in the FRS path.

The final step in the IRM evaluation process is to assess if the IRM will work without significant adverse consequences. This includes: will the IRM be successful? will it create significant adverse environmental impacts (e.g., environmental releases)? will the costs

outweigh the benefits? will it preclude future cleanup or data collection efforts? and will the risks of the cleanup be greater than the risks of no action? Units where remediation is considered to be possible without adverse consequences outweighing benefits of the remediation are recommended for IRMs.

Final decisions will be made among DOE, EPA, and Ecology regarding the conduct of IRMs in the PUREX Plant Aggregate Area based, at least in part, and on the recommendation provided in this AAMSR, and the results of a supporting LFI.

9.1.3 Final Remedy Selection Path

Sites recommended for initial consideration in the FRS pathway are those not recommended for IRMs, LFIs, or ERAs and those considered to be low priority sites. It is recognized that all units and unplanned releases within the operable unit or aggregate area will eventually be addressed collectively under the final remedy path to support a final Record of Decision (ROD). The ROD will include an aggregate area-wide RI/FS report or multiple RI/FS reports for the operable units.

The initial step in the FRS process pathway is to assess whether the combined data from the AAMS, and any completed ERAs, IRMs, and LFIs are adequate for performing a risk assessment (RA) and selecting a final remedy. Whereas the scope of an ERA, IRM, and LFI is limited to individual waste management units or groups of similar waste management units, the FRS path will likely address an entire operable unit or aggregate area.

If the data are collectively sufficient, an operable unit or aggregate area risk assessment will be performed. If sufficient data are not available, additional needs will be identified and collected.

9.2 PATH RECOMMENDATIONS

Initial recommendations for ERA, IRM, and LFI are discussed in Section 9.2.1 through 9.2.3, respectively. Waste management units and unplanned releases proposed for initial consideration under the FRS path are discussed in Section 9.2.4. Table 9-1 provides a summary of the data evaluation process path assessment. A summary of the responses to the decision points on the flowchart that led to the recommendations is provided in Table 9-2. Following approval by DOE, EPA, and Ecology, these recommendations will be further developed and implemented in work plans.

9.2.1 Proposed Sites for Expedited Response Actions

Fifteen units were evaluated along the ERA path. Each of these units is a surface contamination site and is recommended for disposition under the RARA program.

9.2.1.1 Sites With Significant Surface Contamination. Each of the 15 sites has levels of surface contamination that are high enough to be of immediate concern. Surface contamination is immediately accessible to humans (i.e., workers) and biota. The potential for transport by the wind or biota is also significant and so surface migration is also a problem. It is expected that the releases of radionuclides and potential radiation exposure levels at these sites would be greater than 100 times reportable quantities and quality standards. The corrective actions for these surface contamination sites are addressed within the scope of the RARA program.

The following sites were evaluated along the ERA path because of surface contamination:

- 216-A-1 Crib
- 216-A-6 Crib
- 216-A-7 Crib
- 216-A-9 Crib
- 216-A-21 Crib
- 216-A-14 French Drain
- 216-A-28 French Drain
- 216-A-40 Trench
- 207-A Retention Basins
- 216-A-42 Retention Basin
- 218-E-1 Burial Ground
- 218-E-12A Burial Ground

- UN-200-E-88 Unplanned Release

- UN-200-E-100 Unplanned Release.

The surface contamination at each of these units is characterized below.

- The 216-A-1 Crib has an area of surface contamination of up to 3,000 dis/min.

- The 216-A-6 Crib has an area of surface contamination of up to 5,000 dis/min.

- The 216-A-7 Crib has been issued a Surveillance and Compliance Inspection Report (SCIR) and has been given a ranking of 7 out of 15 possible points. This means that the site has high surface radiation levels, that it is accessible, and that there is ongoing surface contaminant migration. This site contains areas of surface contamination of up to 30,000 dis/min.

- The 216-A-9 Crib has surface contamination of up to 30,000 dis/min.

- The 216-A-21 Crib has surface contamination of up to 15,000 dis/min.

- The 216-A-14 French Drain has surface contamination of up to 56,000 dis/min.

- The 216-A-28 French Drain has surface contamination of up to 10,000 dis/min.

- The 216-A-40 Trench has surface contamination of up to 4 mrem/h.

- The 207-A Retention Basins have surface contamination of up to 1,500 ct/min.

- The 216-A-42 Retention Basin has surface contamination of up to 200,000 dis/min.

- The 218-E-1 Burial Ground has surface contamination of up to 5,000 ct/min.

- The 218-E-12A Burial Ground has surface contamination of up to 20,000 dis/min.

- The UN-200-E-88 Unplanned Release has surface contamination of up to 60,000 dis/min.

- The UN-200-E-100 Unplanned Release has surface contamination of up to 5 mrem/h.

9.2.1.2 Non-ERA Sites. The primary reason most waste management units and unplanned releases were not recommended for ERAs was because of the lack of driving force to an exposure pathway. Inactive cribs, ponds, ditches, and trenches are no longer receiving waste and, therefore, no longer have artificial recharge as a driving force to move subsurface contaminants. Natural recharge from local precipitation was not considered a significant short-term driving force. Specifics for each waste management unit or unplanned release are provided in Table 9-2.

A majority of the unplanned release sites either will be addressed by the RARA program to eliminate the airborne release pathway or had insufficient quantity and concentration of contamination to qualify as an ERA.

9.2.2 Proposed Sites for Interim Remedial Measures

Twenty-six of the 98 waste management units and unplanned releases addressed in the PUREX Plant Aggregate Area data evaluation process were identified as high priority units (refer to section 5.0) and were assessed as candidates for IRMs. Fourteen of the 26 units were designated as high priority units and unplanned releases because of high HRS and mHRS scores. The other units and unplanned releases, 216-A-1 and 216-A-30 Cribs, 216-A-14 and 216-C-8 French Drains, 207-A Retention Basins, 218-E-1, 218-E-12A, and 218-E-12B Burial Grounds, 200-E Burning Pit and UN-200-E-88 and UN-200-E-100 Unplanned Releases, were designated as high priority because of surface radiation measurements. The Environmental Protection rankings did not add to the high priority sites because they had been included on the list due to other criteria. Septic tanks and drain fields and the majority of the unplanned releases were two primary classes of units not considered in the IRM path.

All units remain as IRM candidates but require LFIs to obtain sufficient information to proceed with the IRM. A discussion of the LFIs is provided in Section 9.2.3. The reason units and unplanned releases are not immediately recommended for IRMs was because none were considered to have adequate data to perform a qualitative risk assessment and/or select a remedy.

9.2.3 Proposed Sites for Limited Field Investigation Activities

A LFI is the collection of limited additional site data which are sufficient to support a decision on conducting ERAs or IRMs (DOE/RL 1992a). In contrast, a RI is a broader site-wide effort appropriate for lower priority sites. The goal for a RI is final remedy selection where as the goal of a LFI is focused on supporting ERAs and IRMs only.

Twenty-two waste management units are recommended to undergo LFIs. The rationale for IRM and LFI will be more completely developed in work plans, however, the following addresses possible considerations during work plan development.

Possible LFI objectives would be to:

- Evaluate the potential for releases from the waste management unit to impact underlying groundwater quality.
- Determine if contamination exists in the soil beneath the waste management unit, and if so, assess the extent.
- Assess the nature and extent of contaminant migration from the waste management unit in support of focused feasibility studies.

Candidate IRM units have been categorized into two groups that contain similar release waste, release mechanisms, and design. The two groups are cribs and french drains, and burial sites.

9.2.3.1 Cribs and French Drains. The cribs and french drains have been grouped together because french drains are essentially small-diameter cribs. The cribs and french drains recommended for a LFI also have been evaluated along the ERA path. All but three cribs were recommended for actions under the RARA program (Section 9.2.1). The actions implemented under the RARA program will precede the LFI activities. Cribs and french drains dispositioned under the RARA program include:

- 216-A-1 Crib
- 216-A-4 Crib
- 216-A-5 Crib
- 216-A-6 Crib

- 216-A-7 Crib
- 216-A-9 Crib
- 216-A-21 Crib
- 216-A-24 Crib
- 216-A-27 Crib
- 216-A-36A Crib
- 216-A-14 French Drain
- 216-A-28 French Drain
- 216-C-8 French Drain.

Cribs to be involved in LFI activities that do not require actions under the RARA program include the following:

- 216-A-8 Crib
- 216-A-30 Crib
- 216-A-36B Crib
- 216-A-37-2 Crib

The cribs with surface contamination were addressed in the IRM path after first being assessed in the ERA path. The actions recommended for the units will not address the subsurface contaminations in the facilities; therefore, they were included for assessment under the remaining criteria.

The initial decision point in the IRM path is to assess whether data are adequate to conduct an IRM. The data available for cribs are screening level data (Section 8.2.2.2) and estimated inventories (Tables 2-2 and 2-3) that do not provide information on the nature and extent of the contamination. Therefore, an IRM could not be implemented without further investigation.

Similarities of units may make it possible to remediate them using the observational approach after characterizing only a few of the units. Therefore, it was expected that a LFI would provide sufficient information to proceed with an IRM for waste management unit groups. Therefore, the basis for recommending a LFI is that sufficient information can be gained from a more detailed investigation of one or two of the cribs and a french drain that would allow a remedial decision to be made on the other cribs with little or no additional characterization.

Possible representative units for the PUREX Plant Aggregate Area would be the 216-A-9 Crib, the 216-A-24 Crib, and 216-A-28 French Drain. The 216-A-6 Crib was selected to represent cribs receiving waste during initial operations. The 216-A-6 Crib also received the greatest amount of waste for all of the cribs and has received a large amount contaminants. The 216-A30 Crib was selected to be representative of cribs receiving waste during more recent operations. The 216-A-28 French Drain was chosen because it received the most waste of the french drains and has the highest inventory of contaminants. The rationale for IRM and LFI will be more completely developed in work plans, however, the following addresses possible considerations during work plan development.

Possible LFI objectives would be to:

- Evaluate the potential for releases from the waste management unit to impact underlying groundwater quality;

- Determine if contamination exists in the soil beneath the cribs and, if so, assess the extent; and

- Assess the extent of contaminant migration from the cribs in support of focused feasibility studies.

If transuranic radionuclides and/or other hazardous chemicals are not found in soil below the representative cribs, it is unlikely to be present below the other units in the group, therefore additional sampling for transuranic radionuclides and/or hazardous chemicals would likely not be necessary at the other units. The actual extent of transuranic contamination, if any, could be determined during implementation of an IRM (if justified) and would not need to be fully known prior to the decision to proceed. The extent of IRM actions for the other facilities would be based on measurements from the representative cribs, therefore, no other sampling for extent of contamination at the other units would be anticipated.

9.2.3.2 Burial Sites. This group includes six burial grounds. The six burial grounds are not covered under a RCRA closure or Part B permit action, and include the following:

- 200-E Burning Pit
- 218-E-1 Burial Ground
- 218-E-8 Burial Ground
- 218-E-12A Burial Ground
- 218-E-12B Burial Ground
- 218-E-13 Burial Ground.

The 218-E-1 and 218-E-12A Burial Grounds were identified as high priority waste management units and were designated as IRM candidates. Because the 200-E Burning Pit, the 218-E-8, 218-E-12B, and the 218-E-13 Burial Grounds received similar wastes and are generally constructed in a similar fashion, they were included in the group with the 218-E-1 and the 218-E-12A Burial Grounds. These waste management units have insufficient data to conduct an IRM; therefore, they were recommended for LFIs. It is expected that sufficient information could be obtained from a limited investigation of one or two burial grounds to continue with IRM assessments (if justified) with little or no additional characterization of the other burial grounds.

A possible representative burial ground for the LFI would be the 218-E-12A Burial Ground. The 218-E-12A Burial Ground is recommended as being representative because it is a high priority site due to surface contamination and received the greatest volume of waste with the highest inventory of contaminants. It is expected to contain similar wastes and to be similar in design to the other burial sites.

Investigations of the active portion of the 218-E-12B Burial Ground will be included in the past practices investigation if the unit is deactivated prior to the investigation. Deactivation of the burial ground will remain with the ongoing program that is evaluating alternatives to replace the unit.

The rationale for IRM and LFI will be more completely developed in work plans; however, the following addresses possible considerations during work plan development.

Possible LFI objectives would be to:

- Conduct surface contamination surveys and assess likely source(s)

- Evaluate the potential for releases from the waste management unit to impact underlying groundwater quality

- Determine if contamination exists in the soil beneath the burial ground and, if so, assess the extent

- Assess the nature and extent of radionuclide and hazardous chemical contaminants in near-surface and surface soils at the burial ground sufficient to support a focused feasibility study.

Additional field inspections and document reviews might be desirable to evaluate the relative integrity of existing burial ground caps and buried waste containers. Some geophysical survey work might be desirable to update information found regarding the location and construction of burial ground disposal units such as trenches and caissons, and to identify potential subsurface voids that have a potential for major settlement.

If transuranic radionuclides and/or other hazardous chemicals are not found in soil below the representative burial ground, it is unlikely to be present below the other burial grounds; therefore, additional sampling for transuranic radionuclides and/or hazardous chemicals would likely not be necessary at the other units. The actual extent of transuranic contamination, if any, could be determined during implementation of an IRM (if justified) at the burial ground and would not need to be fully known prior to the decision to proceed. The extent of IRM actions for the other facilities would be based on measurements from the representative burial ground; therefore, no other sampling for extent of contamination at the other burial grounds would be anticipated.

9.2.4 Proposed Sites for Final Remedy Selection

A number of unplanned releases, along with several diverse waste management units which are unique because of design, contaminants received, or operational history, have been proposed for the final remedy selection path. Section 9.2.4.2 discusses the sites proposed for direct inclusion in the final remedy selection risk assessment. Direct inclusion in the final remedy selector RI is recommended for the remainder of the waste management units and unplanned releases due to the lack of information to perform RAs and select final remedies. These waste management units and unplanned releases are discussed in Section 9.2.4.1.

9.2.4.1 Proposed Sites for Remedial Investigation. A RI has been recommended for the PUREX Plant Aggregate Area which includes several groups of waste management units and unplanned releases. The first group contains cribs and french drains. The second group contains an injection well. The third group contains the ditches and trenches. The fourth

group contains the septic tanks and drain fields which require confirmatory sampling to show that the sites doe not contain hazardous or radioactive substances. The fifth group contains burial sites which require confirmatory sampling to show no contamination exists. The sixth group contains low priority unplanned releases which have unique contamination histories.

9.2.4.1.1 Cribs and French Drains. Eighteen cribs and french drains have been grouped as a single class because of their similarity (see Tables 9-1 and 9-2). The group consists of nine cribs and nine french drains. These units experienced similar disposal practices.

The units were first assessed along the ERA path. An ERA was warranted for each unit based on *Hanford Site Past-Practice Strategy* criteria (DOE/RL 1992a) and releases occurred in every case. However, no driving force to an exposure pathway existed for any of the units.

All 18 units were assessed as low priority on the IRM evaluation path. Insufficient data exists at these sites to conduct a risk assessment. A RI is recommended that would include each of these sites to provide nature and extent of contamination information to perform a risk assessment for final remedy selection.

Investigation of the two active cribs and one active french drain will be included in the past practices investigation if the units are deactivated prior to the investigation. Deactivation of the units will remain with the ongoing program that is currently operating them.

9.2.4.1.2 Injection Wells. Only one unit, the 299-E-34-11 Injection Well, appears in this group. This unit was first assessed along the ERA path. An ERA was warranted for this unit based on *Hanford Site Past-Practice Strategy* criteria (DOE/RL 1992a) and a release had occurred. The unit moved out of the ERA path as there was no driving force to an exposure pathway.

This unit was assessed as a low priority on the IRM evaluation path. Insufficient data exists at these sites to conduct a risk assessment. A RI is recommended to provide nature and extent of contamination information to perform a risk assessment for final remedy selection.

9.2.4.1.3 Ditches and Trenches. Six units have been placed in this group due to their similarity. The group consists of two ditches and four trenches (see Tables 9-1 and 9-2).

These units were first assessed along the ERA path. An ERA was warranted in each case due to *Hanford Site Past-Practice Strategy* criteria (DOE/RL 1992a) and releases occurred at each site. For four of the sites, no driving force to an exposure pathway existed for any of the units. All four units were assessed as low priority on the IRM evaluation path.

Two of the sites, the 216-A-29 Ditch and 216-A-40 Trench, were rated as high priority when evaluated along the IRM path. Data were not adequate because an IRM and an LFI would not collect sufficient data, so these units were moved to the FRS path. In each case insufficient data exists at these sites to provide nature and extent of contamination information to perform a risk assessment for FRS.

Investigations of the active 216-A-29 Ditch will be included in the past practices investigation if the unit is deactivated prior to the investigation. Deactivation of the ditch will remain with the ongoing program that is planning closure.

9.2.4.1.4 Septic Tanks and Associated Drain Fields. Seven units have been placed in this group because of their similarity. The group consists exclusively of septic tanks. This group was not assessed along the ERA path because an ERA was not warranted because of *Hanford Site Past-Practice Strategy* criteria (DOE/RL 1992a). The units were assessed as low priority on the IRM evaluation path. Insufficient data exists at these sites to conduct a risk assessment. A RI is recommended to provide nature and extent of contamination information to perform a risk assessment for FRS.

9.2.4.1.5 Retention Basins. Two units, 207-A and 216-A-42, have been placed in this group. Both retention basins were evaluated along the ERA path and recommended for actions under the RARA program (Section 9.2.1). The actions implemented under the RARA program will mitigate surface radiation of concern and will move the units onto the IRM evaluation path. The units will no longer be high priority and will be moved onto the FRS path. In both cases insufficient data exists to provide nature and extent of contamination information to perform a risk assessment for FRS.

Investigations of the active portion of the 207-A Retention Basins will be included in the past practices investigation if the unit is deactivated prior to the investigation. Deactivation of the retention basin will remain with the ongoing program that is evaluating alternatives to replace the unit.

9.2.4.1.6 Unplanned Releases. Forty-six sites have been placed in this group due to their similarity. The candidate sites are listed in Table 9-1. Forty-four of these units were assessed along the ERA path and an ERA was initially warranted due to *Hanford Site Past-Practice Strategy* criteria (DOE/RL 1992a). Releases also occurred at each site, however, no

driving force to an exposure pathway exists. All forty-four units were assessed as low priority on the IRM evaluation path.

Two of the forty-six unplanned releases, UN-200-E-88 and UN-200-E-100, were rated as high priority when evaluated along the IRM path. Data were not adequate for an IRM and an LFI would not collect sufficient data, so these units were moved to the FRS path. In all cases, insufficient data exists at these sites to provide nature and extent of contamination information to perform a risk assessment for FRS.

9.3 SOURCE OPERABLE UNIT REDEFINITION AND PRIORITIZATION

The investigation process can be made more efficient if units with similar histories and waste constituents are studied together. The data needs and remedial actions required for similar waste management units are generally the same. It is much easier to ensure a consistent level of effort and investigation methodology if like units are grouped together. Economies of scale also make the investigation process more cost effective if similar units are studied together.

9.3.1 Units Addressed By Other Aggregate Areas or Programs

The investigation of several sites should be transferred from the PUREX Plant Aggregate Area to other programs for investigation. The programs include the Surplus Facilities Program, the Defense Waste Management Program, the RCRA TSD and Hanford Site Single-Shell Tank Program. Table 9-3 lists the waste management units and unplanned releases that are recommended for deferral to these programs. No units within the PUREX plant aggregate area are recommended for deferral to another aggregate area.

The Defense Waste Management Program is recommended to include four catch tanks and eleven diversion boxes. These units are located in operable units 200-PO-1 and 200-PO-3. If the units are closed prior to investigation the units would be included in the aggregate area evaluation. If the units are closed after investigation the units would be deferred to the Surplus Facilities Program. The Surplus Facilities Program receives the Defense Waste Management Units upon decommissioning.

The RCRA programs, including the TSD and the Hanford Site Single-Shell Tank Program, are recommended to include all single-shell tanks (241-A, 241-AX, and 241-C Tank Farms) and unplanned releases in the three single-shell tank farms. The UPR-200-E-59 Unplanned Release in the 200-PO-1 Operable Unit and the four french drains, 216-A-16,

216-A-17, 216-A-23A and 216-A-23B in operable unit 200-PO-5 are also recommended for deferral to these programs.

One potentially new site consisting of a fission products release to the environment has not been verified as an unplanned release. Action on this site is deferred until an actual release has been verified and the regulatory status of the site determined. The unplanned release occurred within the 241-C Tank Farm area; therefore, it should be addressed by the Hanford Site Single-Shell Tank Program. This unplanned release is discussed in detail in Section 2.3.10.

9.3.2 PUREX Plant Operable Unit Redefinition

Redefinition of the 200-PO-1 through 200-PO-6 Operable Units is suggested based on the data valuation in this report. General redefinition is recommended as follows:

- Investigation of groundwater should be removed from the scope and included in a 200 East Area Groundwater Operable Unit. Groundwater beneath the PUREX Plant Operable Units interacts with all surrounding operable units since it is not confined by the geographic boundaries. Contamination from nearby operable units can migrate beneath any PUREX Plant Operable Units. Similarly, the contamination originating from the operable unit may migrate outside the boundaries of the operable unit. These interactions with other operable units will necessitate the integration of groundwater response actions throughout the 200 East Area. This integration would likely be best handled in a single 200 East Area-wide groundwater operable unit, rather than in individual source operable units.

- High-level waste transfer facilities and encased pipelines should remain within the scope of the Defense Waste Management Program and the Surplus Facilities Program. The facilities are also structures with no unplanned releases and can be dealt with more efficiently in these existing Hanford programs. The Tri-Party Agreement does not include these lines within the scope of the past-practices investigation.

- Units included in other programs (e.g., RCRA, Defense Waste Management Plan, etc.) are listed in Table 9-3. All operable units had sites included in other programs. Operable unit 200-PO-6 had the least number of sites recommended for inclusion in other programs; only one site, operable unit 200-PO-3, had the greatest number of sites recommended for inclusion into other programs; over 50 sites.

Specific redefinition of the operable units are as follows:

- 200-PO-1 will have UPR-200-E-59 reassigned to 200-PO-3. This unplanned release is associated with the 216-A-40 Trench, but spread into the tank farm area and is, therefore, recommended for inclusion in the 200-PO-3 Operable Unit and subsequent jurisdiction of the Single-Shell Tank Program.

- Four french drains currently residing in the 200-PO-5 Operable Unit should be reassigned to the 200-PO-3 Operable Unit. These french drains currently reside within the 241-A Tank Farm boundary and are more adequately addressed as part of this operable unit. It is, therefore, recommended that the geographic boundaries of the units be redrawn in the area of the 216-A-16, 216-A-17, 216-A-23A, and 216-A-23B French Drains. The units are located in close proximity to one another and very near to a common border of the two operable units. Movement of a section of the common border to the east would satisfy the recommendation.

9.3.3 Investigation Prioritization

Very little if any data exist to rank the waste management units and unplanned releases within the PUREX Plant Aggregate Area on a risk-related basis. The HRS and surface contamination data which were used to sort the waste management units and unplanned releases into either high or low priority are indicators of potential risk but are not suitable to develop a risk-related ranking. The most useful data for indicating potential risk are probably the waste inventories and facility construction or operation information.

In the Tri-Party Agreement, the operable units were prioritized in the following order: 1) 200-PO-2, 2) 200-PO-5, 3) 200-PO-1 and 200-PO-4, and 4) 200-PO-6. Operable unit 200-PO-3 was not prioritized because it contained single-shell tanks. Based on estimated waste inventories in Table 2-2, the cribs and french drains received the largest quantities of contamination and should be investigated first. This approach would change the prioritization order of the Tri-Party Agreement to the 200-PO-4 Operable Unit being recommended for highest priority of investigation. The new order of prioritization would be 1) 200-PO-4, 2) 200-PO-2, 3) 200-PO-5, 4) 200-PO-1, 5) 200-PO-6, and 6) 200-PO-3.

9.3.4 RCRA Facility Interface

Four RCRA waste management units exist in the PUREX Plant Aggregate Area that will require integration into future investigations. The 216-A-29 Ditch has been deactivated

and stabilized and the closure plan is currently being developed. The 216-A-10 and 216-A-36B Cribs are inactive and also slated for closure. The 218-E-12B Burial Ground is currently operating under a Landfill Permit. The RCRA facilities associated with all of the tank farms in the PUREX Plant Aggregate Area are not assessed under this study. These sites belong to a separate program with separate Tri-Party Agreement milestones.

The 216-A-29 Ditch and the 216-A-10 and 216-A-36B Cribs are recommended for clean closure under RCRA and investigation and remediation under CERCLA. Data to support closure will be developed in RIs and an LFI. Investigation and remediation of these facilities will be included with the investigation and remediation of their associated groupings.

Investigations have been recommended for several non-RCRA burial ground units under this AAMS. Since partial closures and corrective actions of the RCRA burial grounds have not been established, the recommended investigations may precede or overlap with RCRA activities. It will be necessary to ensure that investigations at non-RCRA units are integrated with schedules and proposed actions for the RCRA burial grounds as they are incorporated into the final status permit.

In addition, there are a number of unplanned releases associated with RCRA TSD facilities within the PUREX Plant Aggregate Area that are recommended to be addressed during RCRA closure and/or permitting activities. Investigation and remediation of affected soils associated with these unplanned releases, if any, would results in a need to interface with the planned RCRA facility activities.

9.4 FEASIBILITY STUDY

Two types of the FS will be conducted to support remediation in the 200 Area including focused and the final FS. Focused feasibility studies (FFSs) are studies in which a limited number of units or remedial alternatives are considered. Final FS will be prepared to provide the data necessary to support the preparation of final ROD. Insufficient data exists to prepare either a focused or final FS for any units or group of units within the PUREX Plant Aggregate Area. Sufficient data are considered available to prepare a FFS on selected remedial alternatives.

9.4.1 Focused Feasibility Study

Both LFIs and IRMs are planned for the PUREX Plant Aggregate Area for individual waste management units or waste management unit groups. The IRMs will be implemented

as they are approved, and the FFS will be prepared to support their implementation. The FFS applied in this manner is intended to examine a limited number of alternatives for a specific site or groups of sites. The FFS supporting IRMs will be based on the technology screening process applied in Section 7.0, engineering judgement, and/or new characterization data such as that generated by an LFI.

Recommendations for the FFS in support of IRMs are not provided in this report because of limited data availability. In most cases, LFIs will be conducted at sites initially identified for IRMs. The information gathered is considered necessary prior to making a final determination whether an IRM is actually necessary or whether a remedy can be selected.

Rather than being driven by an IRM, the FFS will also be prepared to evaluate select remedial alternatives. In this case the FFS focuses on technologies or alternatives that are considered to be viable based on their implementability, cost, and effectiveness and have broad application to a variety of sites. The following recommendations are made for FFS that focus on a particular technology or alternative:

- Capping
- Ex situ treatment of contaminated soils
- In situ stabilization

These recommendations reflect select technologies developed in Section 7.0 of this report.

The FFS is intended to provide a detailed analysis of select remedial alternatives. The results of the detailed analysis provide the basis for identifying preferred alternatives. The detailed analysis for alternatives consists of the following components:

- Further definition of each alternative, if appropriate, with respect to the volumes or areas of contaminated environmental media to be addressed, the technologies to be used, and any performance requirements associated with those technologies. Remedial investigations and treatability studies, if conducted, will also be used to further define applicable alternatives.
- An assessment and summary of each alternative against evaluation criteria specified in EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA 1988b).

- A comparative analysis of the alternatives that will facilitate the selection of a remedial action.

9.4.2 Final Feasibility Study

To complete the remediation process for an aggregate area, a final or summary FS will be prepared. This study will address those sites not previously evaluated and will summarize the results of preceding evaluations. The overall study and evaluation process for an aggregate area will consist of a number of FFSs, field investigations, and interim RODs. All of this study information will be summarized in one final FS to provide the data necessary for the final ROD. The summary FS will likely be conducted on an aggregate area basis; however, future considerations may indicate that a larger scope is appropriate.

9.5 TREATABILITY STUDIES

A range of technologies which are likely to be considered for remediation of sites within the PUREX Plant Aggregate Area were discussed in Section 7.3. The range of technologies included:

- Engineered multimedia cover
- In situ grouting
- Excavation and soil treatment
- In situ vitrification
- Excavation, treatment, and disposal of transuranic (TRU) radionuclides
- In situ soil vapor extraction of volatile organic compounds (VOCs)

Treatability testing will be required to conduct a detailed analysis for most of the technologies. Relevant EPA guidance will be relied upon to conduct these future treatability studies. A summary of treatability testing needs outlined in Section 7.3 is as follows:

- Engineered multimedia cover--performance testing (pilot-scale testing) of conceptual designs is needed.

- In situ grouting--testing required to optimize injection properties of grout and verify effectiveness in stabilizing contaminants.

- Excavation and soil treatment--testing of dust control measures, soil treatment reagents, and contacting methods will be required. Some limited soil washing bench scale studies have been initiated.

- In situ vitrification--testing required to verify contaminant stabilization effectiveness and to establish operating parameters. Some vitrification pilot testing is ongoing.

- Excavation, treatment, and disposal of TRU radionuclides--testing to evaluate dust control measures and stabilization or vitrification effectiveness and to establish operating parameters is required.

- In situ soil vapor extraction of VOCs--extraction effectiveness needs to be verified and operating parameters require development. A program is currently under way for field testing of vapor extraction techniques.

As treatability testing of the various alternatives progresses, other parameters are likely to be identified which require further development.

THIS PAGE INTENTIONALLY
LEFT BLANK

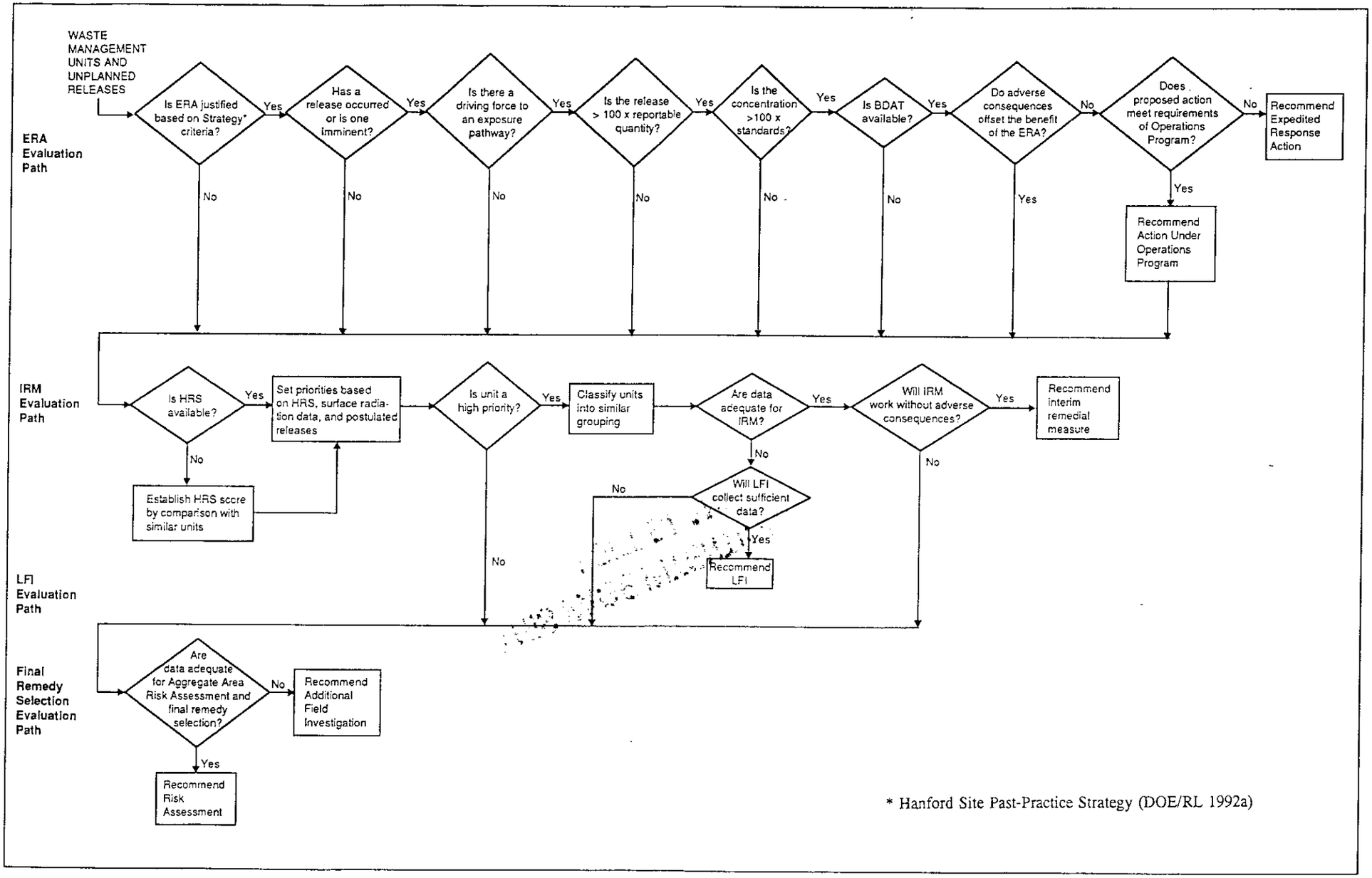


Figure 9-1. 200 Aggregate Area Management Study Data Evaluation Process.

THIS PAGE INTENTIONALLY
LEFT BLANK

Table 9-1. Summary of the Results of Data Evaluation Assessment for PUREX Plant Aggregate Area.

Waste Management Unit	Site Type	ERA	IRM	LFI	RA	RI	OPS	Remarks
Cribs and Drains								
216-A-1	Crib		X	X				
216-A-2	Crib					X		
216-A-3	Crib					X		
216-A-4	Crib		X	X				
216-A-5	Crib		X	X				
216-A-6	Crib		X	X				
216-A-7	Crib		X	X				
216-A-8	Crib		X	X			X	
216-A-9	Crib		X	X				
216-A-10	Crib					X		
216-A-21	Crib		X	X				
216-A-24	Crib		X	X				
216-A-27	Crib		X	X				
216-A-30	Crib		X	X				
216-A-31	Crib					X		
216-A-32	Crib					X		
216-A-36A	Crib		X	X				
216-A-36B	Crib		X	X				
216-A-37-1	Crib					X	X	
216-A-37-2	Crib		X	X			X	
216-A-38-1	Crib					X		
216-A-41	Crib					X		
216-A-45	Crib					X	X	
216-A-11	French Drain					X		
216-A-12	French Drain					X		
216-A-13	French Drain					X		
216-A-14	French Drain		X	X				
216-A-15	French Drain					X		
216-A-22	French Drain					X		
216-A-26	French Drain					X	X	
216-A-26A	French Drain					X		

Table 9-1. Summary of the Results of Data Evaluation Assessment for PUREX Plant Aggregate Area.

Waste Management Unit	Site Type	ERA	IRM	LFI	RA	RI	OPS	Remarks
Cribs and Drains								
216-A-28	French Drain		X	X				
216-A-33	French Drain					X		
216-A-35	French Drain					X		
216-C-8	French Drain		X	X				
Reverse Wells								
299-E24-111	Injection Well					X		
Ponds, Ditches and Trenches								
216-A-29	Ditch					X	X	
216-A-34	Ditch					X		
216-A-18	Trench					X		
216-A-19	Trench					X		
216-A-20	Trench					X		
216-A-40	Trench					X		
Septic Tanks and Associated Drain Fields								
2607-EA	Septic Tank/Drain Field					X	X	
2607-EC	Septic Tank/Drain Field					X	X	
2607-ED	Septic Tank/Drain Field					X	X	
2607-EG	Septic Tank					X	X	
2607-EJ	Septic Tank					X	X	
2607-EL	Septic Tank					X	X	
2607-E6	Septic Tank/Drain Field					X	X	
Basins								
207-A	Retention Basin					X	X	
216-A-42	Retention Basin					X	X	
Burial Sites								
200-E	Burning Pit		X	X				
218-E-1	Burial Ground		X	X				
218-E-8	Burial Ground		X	X				
218-E-12A	Burial Ground		X	X				
218-E-12B	Burial Ground		X	X			X	
218-E-13	Burial Ground		X	X				

Table 9-1. Summary of the Results of Data Evaluation Assessment for PUREX Plant Aggregate Area.

Waste Management Unit	Site Type	ERA	IRM	LFI	RA	RI	OPS	Remarks
Unplanned Releases								
UN-200-E-10	Unplanned Release					X		
UN-200-E-11	Unplanned Release					X		
UN-200-E-12	Unplanned Release					X		
UN-200-E-13	Unplanned Release					X		
UN-200-E-15	Unplanned Release					X		
UN-200-E-19	Unplanned Release					X		
UN-200-E-20	Unplanned Release					X		
UN-200-E-22	Unplanned Release					X		
UN-200-E-25	Unplanned Release					X		
UN-200-E-26	Unplanned Release					X		
UN-200-E-28	Unplanned Release					X		
UN-200-E-31	Unplanned Release					X		
UN-200-E-33	Unplanned Release					X		
UN-200-E-35	Unplanned Release					X		
UN-200-E-39	Unplanned Release					X		
UN-200-E-40	Unplanned Release					X		
UN-200-E-42	Unplanned Release					X		
UN-200-E-47	Unplanned Release					X		
UN-200-E-49	Unplanned Release					X		
UN-200-E-56	Unplanned Release					X		
UN-200-E-58	Unplanned Release					X		
UN-200-E-60	Unplanned Release					X		
UN-200-E-62	Unplanned Release					X		
UN-200-E-65	Unplanned Release					X		
UN-200-E-67	Unplanned Release					X		
UN-200-E-68	Unplanned Release					X		
UN-200-E-72	Unplanned Release					X		
UN-200-E-86	Unplanned Release					X		

Table 9-1. Summary of the Results of Data Evaluation Assessment for PUREX Plant Aggregate Area.

Waste Management Unit	Site Type	ERA	IRM	LFI	RA	RI	OPS	Remarks
Unplanned Releases								
UN-200-E-88	Unplanned Release					X		
UN-200-E-91	Unplanned Release					X		
UN-200-E-94	Unplanned Release					X		
UN-200-E-96	Unplanned Release					X		
UN-200-E-97	Unplanned Release					X		
UN-200-E-99	Unplanned Release					X		
UN-200-E-100	Unplanned Release					X		
UN-200-E-114	Unplanned Release					X		
UN-200-E-117	Unplanned Release					X		
UN-200-E-142	Unplanned Release					X		
UPR-200-E-17	Unplanned Release					X		
UPR-200-E-21	Unplanned Release					X		
UPR-200-E-24	Unplanned Release					X		
UPR-200-E-29	Unplanned Release					X		
UPR-200-E-30	Unplanned Release					X		
UPR-200-E-50	Unplanned Release					X		
UPR-200-E-53	Unplanned Release					X		
UPR-200-E-106	Unplanned Release					X		

Table 9-2. PUREX Plant Aggregate Area Data Evaluation Decision Matrix.

Waste Management Unit or Unplanned Release	ERA Evaluation Pathway								IRM Evaluation Pathway			LFI Path	Final Remedy
	Is an ERA Justified?	Release?	Pathway?	Quantity?	Concen-tration?	Treat-ment Avail-ability?	Adverse Conse-quences?	Opera-tional Programs?	High Priority?	Data Adequate?	Adverse Conse-quences?	Collect Data?	Data Adequate?
Cribs and Drains													
216-A-1 Crib	Y	Y	N	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-2 Crib	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-3 Crib	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-4 Crib	Y	Y	N	--	--	--	--	--	Y	N	--	Y	--
216-A-5 Crib	Y	Y	N	--	--	--	--	--	Y	N	--	Y	--
216-A-6 Crib	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-7 Crib	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-8 Crib	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-9 Crib	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-10 Crib	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-21 Crib	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-24 Crib	Y	Y	N	--	--	--	--	--	Y	N	--	Y	--
216-A-27 Crib	Y	Y	N	--	--	--	--	--	Y	N	--	Y	--
216-A-30 Crib	Y	Y	N	--	--	--	--	--	Y	N	--	Y	--
216-A-31 Crib	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-32 Crib	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-36A Crib	Y	Y	N	--	--	--	--	--	Y	N	--	Y	--
216-A-36B Crib	Y	Y	N	--	--	--	--	--	Y	N	--	Y	--
216-A-37-1 Crib	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-37-2 Crib	Y	Y	N	--	--	--	--	--	Y	N	--	Y	--
216-A-38-1 Crib	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-41 Crib	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-45 Crib	N	--	--	--	--	--	--	--	N	N	--	--	N
216-A-11 French Drain	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-12 French Drain	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-13 French Drain	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-14 French Drain	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-15 French Drain	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-22 French Drain	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-26 French Drain	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-26A French Drain	Y	Y	N	--	--	--	--	--	N	--	--	--	N

Table 9-2. PUREX Plant Aggregate Area Data Evaluation Decision Matrix.

Waste Management Unit or Unplanned Release	ERA Evaluation Pathway								IRM Evaluation Pathway			LFI Path	Final Remedy
	Is an ERA Justified?	Release?	Pathway?	Quantity?	Concen-tration?	Treat-ment Avail-ability?	Adverse Conse-quences?	Opera-tional Programs?	High Priority?	Data Adequate?	Adverse Conse-quences?	Collect Data?	Data Adequate?
Cribs and Drains													
216-A-28 French Drain	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-33 French Drain	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-35 French Drain	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-C-8 French Drain	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
Reverse Wells													
299-E34-111 Injection Well	Y	Y	N	--	--	--	--	--	N	--	--	--	N
Ponds, Ditches and Trenches													
216-A-29 Ditch	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-34 Ditch	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-18 Trench	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-19 Trench	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-20 Trench	Y	Y	N	--	--	--	--	--	N	--	--	--	N
216-A-40 Trench	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
Septic Tanks and Associated Drain Fields													
2607-E6 Septic Tank	N	--	--	--	--	--	--	--	N	--	--	--	N
2607-EA Septic Tank	N	--	--	--	--	--	--	--	N	--	--	--	N
2607-EC Septic Tank	N	--	--	--	--	--	--	--	N	--	--	--	N
2607-ED Septic Tank	N	--	--	--	--	--	--	--	N	--	--	--	N
2607-EG Septic Tank	N	--	--	--	--	--	--	--	N	--	--	--	N
2607-EJ Septic Tank	N	--	--	--	--	--	--	--	N	--	--	--	N
2607-EL Septic Tank	N	--	--	--	--	--	--	--	N	--	--	--	N
Basins													
207-A Retention Basins	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
216-A-42 Retention Basin	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
Burial Sites													
200-E Burning Pit	Y	Y	N	--	--	--	--	--	N	--	--	--	N
218-E-1 Burial Ground	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
218-E-8 Burial Ground	Y	Y	N	--	--	--	--	--	N	--	--	--	N
218-E-12A Burial Ground	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
218-E-12B Burial Ground	Y	Y	N	--	--	--	--	--	N	--	--	--	N

Table 9-2. PUREX Plant Aggregate Area Data Evaluation Decision Matrix.

Waste Management Unit or Unplanned Release	ERA Evaluation Pathway								IRM Evaluation Pathway			LFI Path	Final Remedy
	Is an ERA Justified?	Release?	Pathway?	Quantity?	Concen-tration?	Treat-ment Avail-ability?	Adverse Conse-quences?	Opera-tional Programs?	High Priority?	Data Adequate?	Adverse Conse-quences?	Collect Data?	Data Adequate?
Burial Sites													
218-E-13 Burial Ground	Y	Y	N	--	--	--	--	--	N	--	--	--	N
Unplanned Releases													
UN-200-E-10	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-11	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-12	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-13	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-15	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-19	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-20	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-22	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-25	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-26	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-28	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-31	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-33	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-35	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-39	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-40	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-43	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-47	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-49	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-56	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-58	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-60	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-63	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-65	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-67	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-68	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-72	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-86	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-88	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--

Table 9-2. PUREX Plant Aggregate Area Data Evaluation Decision Matrix.

Waste Management Unit or Unplanned Release	ERA Evaluation Pathway								IRM Evaluation Pathway			LFI Path	Final Remedy
	Is an ERA Justified?	Release?	Pathway?	Quantity?	Concen-tration?	Treat-ment Avail-ability?	Adverse Conse-quences?	Opera-tional Programs?	High Priority?	Data Adequate?	Adverse Conse-quences?	Collect Data?	Data Adequate?
Unplanned Releases													
UN-200-E-91	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-94	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-96	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-97	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-99	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-100	Y	Y	Y	Y	Y	Y	N	Y	Y	N	--	Y	--
UN-200-E-114	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-117	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UN-200-E-142	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UPR-200-E-17	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UPR-200-E-21	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UPR-200-E-24	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UPR-200-E-29	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UPR-200-E-30	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UPR-200-E-50	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UPR-200-E-53	Y	Y	N	--	--	--	--	--	N	--	--	--	N
UPR-200-E-106	Y	Y	N	--	--	--	--	--	N	--	--	--	N

"- -" Indicates decision point not reached on pathway. Evaluation branched to lower path.

Table 9-3. Waste Management Units and Unplanned Releases Deferred to Other Programs.

Site Name	Site Type	Program	Active/Inactive	Operable Units
Tanks & Vaults				
241-A-350	Catch Tank	DWMP	Active	200-PO-3
241-A-417	Catch Tank	DWMP	Active	200-PO-3
241-AX-152CT	Catch Tank	DWMP	Active	200-PO-3
241-A-101	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-A-102	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-A-103	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-A-104	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-A-105	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-A-106	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-A-302A	Catch Tank	DWMP	Active	200-PO-1
241-AX-101	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-AX-102	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-AX-103	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-AX-104	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-C-101	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-C-102	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-C-103	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-C-104	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-C-105	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-C-106	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-C-107	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-C-108	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-C-109	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-C-110	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-C-111	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-C-112	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-C-201	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-C-202	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-C-203	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-C-204	Single-Shell Tank	HSSTP	Inactive	200-PO-3
241-C-301C	Catch Tank	HSSTP	Inactive	200-PO-3
Cribs & Drains				
216-A-16	French Drain	HSSTP	Inactive	200-PO-5
216-A-17	French Drain	HSSTP	Inactive	200-PO-5
216-A-23A	French Drain	HSSTP	Inactive	200-PO-5
216-A-23B	French Drain	HSSTP	Inactive	200-PO-5
216-A-39	Crib	HSSTP	Inactive	200-PO-3
Diversion Boxes				
241-A-151	Diversion Box	DWMP	Active	200-PO-1
241-A-152	Diversion Box	HSSTP	Inactive	200-PO-3
241-A-153	Diversion Box	HSSTP	Inactive	200-PO-3
241-A-A	Diversion Box	DWMP	Active	200-PO-3
241-A-B	Diversion Box	DWMP	Active	200-PO-3
241-AR-151	Diversion Box	DWMP	Active	200-PO-3
241-AX-151	Diversion Box	DWMP	Active	200-PO-3

Table 9-3. Waste Management Units and Unplanned Releases Deferred to Other Programs.

Site Name	Site Type	Program	Active/Inactive	Operable Units
Diversion Boxes				
241-AX-152DS	Divertor Station	DWMP	Active	200-PO-3
241-AX-155	Diversion Box	DWMP	Active	200-PO-3
241-AX-501	Valve Pit	DWMP	Active	200-PO-3
241-AX-A	Diversion Box	DWMP	Active	200-PO-3
241-AX-B	Diversion Box	DWMP	Active	200-PO-3
241-C-151	Diversion Box	HSSTP	Inactive	200-PO-3
241-C-152	Diversion Box	HSSTP	Inactive	200-PO-3
241-C-153	Diversion Box	HSSTP	Inactive	200-PO-3
241-C-252	Diversion Box	HSSTP	Inactive	200-PO-3
241-CR-151	Diversion Box	HSSTP	Inactive	200-PO-3
241-CR-152	Diversion Box	HSSTP	Inactive	200-PO-3
241-CR-153	Diversion Box	HSSTP	Inactive	200-PO-3
241-ER-153	Diversion Box	DWMP	Active	200-PO-3
Unplanned Releases				
UN-200-E-16	Unplanned Release	HSSTP	--	200-PO-3
UN-200-E-18	Unplanned Release	HSSTP	--	200-PO-3
UN-200-E-27	Unplanned Release	HSSTP	--	200-PO-3
UN-200-E-48	Unplanned Release	HSSTP	--	200-PO-3
UN-200-E-81	Unplanned Release	HSSTP	--	200-PO-3
UN-200-E-82	Unplanned Release	HSSTP	--	200-PO-3
UN-200-E-107	Unplanned Release	HSSTP	--	200-PO-3
UN-200-E-118	Unplanned Release	HSSTP	--	200-PO-3
UPR-200-E-59	Unplanned Release	HSSTP	--	200-PO-1
UPR-200-E-119	Unplanned Release	HSSTP	--	200-PO-3
UPR-200-E-125	Unplanned Release	HSSTP	--	200-PO-3
UPR-200-E-126	Unplanned Release	HSSTP	--	200-PO-3
UPR-200-E-136	Unplanned Release	HSSTP	--	200-PO-3
UPR-200-E-137	Unplanned Release	HSSTP	--	200-PO-3

DWMP = Defense Waste Management Program
HSSTP = RCRA Hanford Site Single-Shell Tank Program

9 2 1 2 6 5 0 6 0 3

10.0 REFERENCES

Baker, S.M., J.L. Devary, R.P. Elmore, R.F. Lorang, A.J. Rossi, and M.D. Freshley, 1988, *U1/U2 Uranium Plume Characterization, Remedial Action Review and Recommendation for Future Action,* WHC-EP-0133, Westinghouse Hanford Company, Richland, Washington.

Baker, V.R., B.N. Bjornstad, A.J. Busacca, K.R. Fecht, E.P. Kiver, U.L. Moody, J.G. Rigby, D.F. Stradling, and A.M. Tallman, 1991, "Quaternary Geology of the Columbia Plateau" in *Quaternary Nonglacial Geology; Conterminous U.S.*, Geological Society of America, The Geology of North America, v.k-2, Boulder, Colorado.

Bierschenk, W.H., 1959, *Techniques for Estimating the Specific Retention Properties of Hanford Soils*, HW-61644, General Electric, Hanford Atomic Products Operation, Richland, Washington.

Bixler, R.B., G.L. Hanson, and R.R. Jackson, 1981, *Safety Analysis Report 204-AR Waste Unloading Facility*, RHO-CD-757, Rockwell Hanford Operations, Richland, Washington.

Bjornstad, B.N., 1984, *Suprabasalt Stratigraphy Within and Adjacent to the Reference Repository Location*, SD-BWI-DP-039, Rockwell Hanford Operations, Richland, Washington.

Bjornstad, B.N., 1985, *Late-Cenzoic Stratigraphy and Tectonic Evolution within a Subsidiary Basin, South-Central Washington*, Geological Society of America, Abstracts with Programs, v. 17, no. 7, p. 524.

Bjornstad, B.N., K.R. Fecht, and A.M. Tallman, 1987, *Quaternary Stratigraphy of the Pasco Basin Area, South-central Washington,* RHO-BW-SA-563A, Rockwell Hanford Operations, Richland, Washington.

Bjornstad, B.N., 1990, *Geohydrology of the 218-W-5 Burial Ground, 200-West Area, Hanford Site*, PNL-7336, Pacific Northwest Laboratory, Richland, Washington, May 1990.

Black, R.F., 1980, *Clastic Dikes of the Pasco Basin, Southwestern Washington,* RHO-BWI-C-64, Rockwell Hanford Operations, Richland, Washington.

Brownell, L.E., J.G. Backer, R.E. Isaacson, and D.J. Brown, 1975, *Soil Moisture Transport in Arid Site Vadose Zones,* ARH-ST-123, Atlantic Richfield Hanford Company, Richland, Washington.

Buelt, J.L., W. Conbere, M.D. Freshley, R.J. Hicks, W.L. Kuhn, D.A. Lamar, R.J. Serne, and J.L. Smoot, 1988, *The Predicted Impacts to the Groundwater and Columbia River from Ammoniated Water Discharges to the 216-A-36B Crib,* 1988, PNL-6463, Pacific Northwest Laboratory, Richland, Washington.

Chamness, M.A., D.C. Lanigan, A.W. Pearson, R.E. Lewis, S.S. Teel, R.J. Brockman, 1992, *PUREX Plant Geologic and Geophysics Data Package for the 200 Aggregate Area Management Study,* WHC-SD-EN-DP-025, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Connelly, M.P., B.H. Ford, and J.V. Borghese, 1992, *Hydrogeologic Model for the 200 West Groundwater Aggregate Area*, WHC-SD-EN-TI-014, Rev. O, Westinghouse Hanford Company, Richland, Washington.

DeFord, D.H., 1991, *200-UP-2 Operable Unit Technical Baseline Report*, WHC-EP-0400, Prepared for the U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Westinghouse Hanford Company, Richland, Washington.

Delaney, C.D., K.A. Lindsey, and S.P. Reidel, 1991, *Geology and Hydrology of the Hanford Site: A Standardized Text for Use in Westinghouse Hanford Company Documents and Reports*, WHC-SD-ER-TI-0003, Westinghouse Hanford Company, Richland, Washington.

DOE, 1980, *Double-Shell Tanks for Defense High-Level Radioactive Waste Storage*, DOE/EIS--0063, Final Environmental Impact Statement (Supplement to ERDA-1538, December 1975), Waste Management Operations, Hanford Site, Richland, Washington, U.S. Department of Energy, Richland, Washington.

DOE, 1986, *Hanford Inactive Site Survey (HISS) Database*, Phase I - Installation Assessment of Inactive Waste Disposal Sites.

DOE, 1988a, *Radioactive Waste Management*, DOE Order 5820.2A, U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Washington, D.C.

DOE, 1988b, *Consultation Draft Site Characterization Plan,* DOE/RW-0164, Vols. 1-9, Office of Civilian Radioactive Waste Management, U.S. Department of Energy, Washington, D.C.

DOE, 1991, *Quality Assurance*, DOE Order 5700.6C, U.S. Department of Energy, Washington, D.C.

DOE/RL, 1987, *216-A-29 Ditch Preliminary Closure/Post-Closure Plan,* A-T041-008065, U.S. Department of Energy, Richland, Washington.

DOE/RL, 1988, *Closure Plan 216-A-36B Crib*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL, 1991a, *Hanford Site Waste Management Units Report,* DOE-RL,-88-30, U.S. Department of Energy, Richland Field Office, Richland, Washington.

DOE/RL, 1991b, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities in 1990*, DOE-RL-91-03, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL, 1992a, *Hanford Site Past-Practice Strategy; Draft A* DOE/RL-91-40, U.S. Department of Energy, Richland, Washington.

DOE/RL, 1992b, *Hanford Site Baseline Risk Assessment Methodology*, DOE/RL-91-45, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Droppo, J.G., D.L. Strenge, J.W. Buck, B.L. Hoopes, R.D. Brockhaus, M.B. Walter, and G. Whelan, 1989, *Multimedia Environmental Pollutant Assessment System (MEPAS) Application Guidance*, PNL-7216, Pacific Northwest Laboratory, Richland, Washington.

Ecology, EPA, and DOE, 1989, *Community Relations Plan for the Hanford Federal Facility Agreement and Consent Order,* Olympia, Washington.

Ecology, EPA, and DOE, 1990, *Hanford Federal Facility Agreement and Consent Order* (First Amendment), 89-10 Rev. 1, Olympia, Washington.

Ecology, 1991, *Model Toxics Control Act Cleanup Regulation*, Chapter 173-340, WAC.

Ecology, EPA, and DOE/RL, 1991, *Hanford Federal Facility Agreement and Consent Order Change Package,* Washington State Department of Ecology, Olympia, Washington, U.S. Environmental Protection Agency, Region X, Seattle, Washington, and U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, and DOE, 1992, *Hanford Federal Facility Agreement and Consent Order*, 1992 Annual Update (Amendment 3), Change Form M-17-91-05, Washington State Department of Ecology, Environmental Protection Agency, and Department of Energy.

Elder, R.E., A.W. Conklin, D.D. Brekke, G.W. Egert, and W.L. Osborne, 1986, *Rockwell Hanford Operations Environmental Surveillance Annual Report - Calendar Year 1985*, RHO-HS-SR-85-13P, Rockwell Hanford Operations, Richland, Washington.

Elder, R.E., G.W. Egert, A.R. Johnson, and W.L. Osborne, 1987, *Rockwell Hanford Operations Environmental Surveillance Annual Report - Calendar Year 1986*, RHO-HS-SR-86-13P, Rockwell Hanford Operations, Richland, Washington.

Elder, R.E., G.W. Egert, A.R. Johnson, and W.L. Osborne, 1988, *Westinghouse Hanford Company Environmental Surveillance Report - Calendar Year 1987*, WHC-EP-0145, Westinghouse Hanford Company, Richland, Washington.

Elder, R.E., S.M. McKinney, and W.L. Osborne, 1989, *Westinghouse Hanford Company Environmental Surveillance Annual Report - 200/600 Areas*, Calendar Year 1988, WHC-EP-0145-1, Westinghouse Hanford Company, Richland, Washington.

EPA, 1980, *Prescribed Procedures for Measurement of Radioactivity in Drinking Water*, In-House Report EPA-600/4-80-032, Environmental Monitoring and Support Lab, Cincinnati, Ohio.

EPA, 1983, *Methods for Chemical Analysis of Water and Wastes*, EPA-600/14-79-020, U.S. Environmental Protection Agency, EMSL, Cincinnati, Ohio.

EPA, 1986, *Test Methods for Evaluating Solid Wastes*, SW-846, Third Edition, U.S. Environmental Protection Agency/Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, 1987, *Data Quality Objectives for Remedial Response Activities — Development Process*, EPA/540/G-87/003, OSWER Directive 9335.3-01, U.S. Environmental Protection Agency, Washington D.C.

EPA, 1988a, *USEPA Contract Laboratory Program Statement of Work for Organic Analysis*, Sample Management Office, U.S. Environmental Protection Agency, Washington D.C.

EPA, 1988b, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA*, Interim Final, EPA 540/G-89-004, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1989a, *Risk Assessment Guidance for Superfund, Vol. I: Human Health Evaluation Manual*, EPA/540/1-89/002, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1989b, *USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis*, Sample Management Office, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1991, *Integrated Risk Information System (IRIS)*, Toxnet online database.

Fecht, K.R., G.V. Last, and K.R. Price, 1977, *Evaluation of Scintillation Probe Profiles from 200 Area Crib Monitoring Wells: Volumes I, II, and III*, ARH-ST-156, Atlantic Richfield Hanford Company, Richland, Washington.

Fecht, K.R., 1978, *Geology of the Gable Mountain - Gable Butte Area*, RHO-BWI-LD-5, Rockwell Hanford Operations, Richland, Washington.

Fecht, K.R., S.P. Reidel, and A.M. Tallman, 1987, "Paleodrainage of the Columbia River System on the Columbia Plateau of Washington State--a Summary," in *Selected Papers on the Geology of Washington*, Division of Geology and Earth Resources, Bulletin 77, p. 219-248, edited by J.E. Schuster.

Gee, G.W. and P.R. Heller, 1985, *Unsaturated Water Flow at the Hanford Site: A Review of Literature and Annotated Bibliography*, PNL-5428, Pacific Northwest Laboratory, Richland, Washington.

Gee, G.W., 1987, *Recharge at the Hanford Site: Status Report*, PNL-6403, Pacific Northwest Laboratory, Richland, Washington.

Geier, R.G., 1976, *Interim Criteria for Waste Storage in the 241-AX Tank Farm*, ARH-CD-309D, Atlantic Richfield Hanford Company, Richland, Washington.

Goodwin, S.M., 1990, *Borehole Completion Data Package for the 216-U-12 Crib*, WHC-MR-0208, Westinghouse Hanford Company, Richland, Washington.

Graham, M.J., M.D. Hall, S.R. Strait, and W.R. Brown, 1981, *Hydrology of the Separations Area*, RHO-ST-42, Rockwell Hanford Operations, Richland, Washington.

Graham, M.J., G.V. Last, and K.R. Fecht, 1984, *An Assessment of Aquifer Intercommunication in the B Pond-Gable Mountain Pond Area of the Hanford Site*, RHO-RE-ST-12 P, Rockwell Hanford Operations, Richland, Washington.

Gustafson, F.W., 1991, *Site Selection Process for Expedited Response Actions at the Hanford Site*, WHC-MR-0290, Westinghouse Hanford Company, Richland, Washington.

Hanlon, B.M., 1992, *Tank Farm Surveillance and Waste Status Report for December 1991*, WHC-EP-0182-45, Westinghouse Hanford Company, Richland, Washington.

Hillel, D., 1971, *Soil and Water, Physical Principles and Process*, Academic Press, Inc., New York, New York.

Hoover, J.D. and T. LeGore, 1991, *Characterization and Use of Soil and Groundwater Background for the Hanford Site*, WHC-MR-0246, Westinghouse Hanford Company, Richland, Washington.

Huckfeldt, C.R., 1991, *Quarterly Environmental Radiological* Survey Summary Second Quarter 1991 - 100, 200, 300, and 600 Areas, WHC-SP-0665-1, Westinghouse Hanford Company, Richland, Washington.

Hughes, M.C., R.K. Wahlen, and R.H. Winship, 1990, *Hanford Surplus Facilities Program Plan*, WHC-EP-0231-3, Westinghouse Hanford Company, Richland, Washington.

Jungfleisch, F.M., 1984, *Preliminary Estimation of the Waste Inventories in Hanford Tanks through 1980,* Rockwell Hanford Operations, Richland, Washington.

Kasza, G.L., S.F. Harris, and M.J. Hartman, 1990, *Ground Water Maps of the Hanford Site*, WHC-EP-0394-1, Westinghouse Hanford Company.

Klepper, E.L., L.E. Rogers, J.D. Hedlund, and R.G. Schreckhise, 1979, *Radioactivity Associated with Biota and Soils of the 216-A-24 Crib,* PNL-1948, Pacific Northwest Laboratory, Richland, Washington.

Landeen, D.S., A.R. Johnson, and R.M. Mitchell, 1991, *Status of Birds at the Hanford Site in Southeastern Washington*, WHC-EP-0402, Westinghouse Hanford Company, Richland, Washington.

Last, G.V., B.N. Bjornstad, M.P. Bergeron, D.W. Wallace, D.R. Newcomer, J.A. Schramke, M.A. Chamness, C.S. Cline, S.P. Airhart, and J.S. Wilbur, 1989, *Hydrogeology of the 200 Areas Low-Level Burial Grounds - An Interim Report,* PNL-6820, Westinghouse Hanford Company.

Lindsey, K.A., and D.R. Gaylord, 1989, *Sedimentology and Stratigraphy of the Miocene-Pliocene Ringold Formation, Hanford Site, South-Central Washington,* WHC-SA-0740-FP, Westinghouse Hanford Company, Richland, Washington.

Lindsey, K.A., 1991a, *Revised Stratigraphy for the Ringold Formation, Hanford Site, South-central Washington,* WHC-SD-END-EE-004, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Lindsey, K.A., 1991b, *Sedimentation and Basin Evolution of the Late Neogene Ringold Formation, Central Columbia Plateau, South-Central Washington*, Geological Society of America Abstracts with Programs, v. 23, no. 5, p. A285.

Lindsey, K.A., B.N. Bjornstad, and M.P. Connelly, 1991, *Geologic Setting of the 200 West Area: An Update*, WHC-SD-EN-TI-008, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Lindsey, K.A., B.N. Bjornstad, J. Lindberg, and K. Hoffman, 1992, *Geologic Setting of the 200 East Area: An Update,* WHC-SD-EN-TI-02, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Lundgren, L.L., 1970, *200 East and North Areas Radioactive Liquid Waste Disposal Sites,* ARH-1562, Atlantic Richfield Hanford Company, Richland, Washington.

Maxfield, H.L., 1979, *Handbook - 200 Area Waste Sites,* RHO-CD-673, Rockwell Hanford Operations, Richland, Washington.

McCain, R.G., and W.L. Johnson, 1990, *A Proposal Data Quality Strategy for Hanford Site Characterization,* WHC-SD-EN-AP-023, Westinghouse Hanford Company, Richland, Washington.

McCown, J.J. 1988, *Final Report on Single-Shell Tank Sample 241-C-106,* Pacific Northwest Laboratory, Richland, Washington.

Myers, C.W., S.M. Price, and J.A. Caggiano, M.P. Cochran, W.J. Czimer, N.J. Davidson, R.C. Edwards, K.R. Fecht, G.E. Holmes, M.G. Jones, J.R. Kunk, R.D. Landon, R.K. Ledgerwood, J.T. Lillie, P.E. Long, T.H. Mitchell, E.H. Price, S.P. Reidel, and A.M. Tallman, 1979, *Geological Studies of The Columbia Plateau: A Status Report,* RHO-BWI-ST-4, Rockwell Hanford Operations, Richland, Washington.

Natural Heritage Program, 1990, *Endangered, Threatened, and Sensitive Vascular Plant Species of Washington,* Department of Natural Resources, Olympia, Washington.

Newcomb, R.C., 1958, "Ringold Formation of the Pleistocene Age in the Type Locality, the White Bluffs, Washington," *American Journal of Science*, Vol. 33, No. 1, p. 328-340.

Newcomb, R.C., and S.G. Brown, 1961, *Evaluation of Bank Storage Along the Columbia River Between Richland and China Bar, Washington,* Water-supply Paper 1539-I, U.S. Geological Survey, Washington, D.C.

Pines, A.G., 1985, *244-AR Vault Safety Analysis Report*, SD-WM-SAR-018, Rev. 0, Rockwell Hanford Operations, Richland, Washington.

PSPL, 1982, *Skagit/Hanford Nuclear Project, Preliminary Safety Analysis Report*, Vol. 4, App. 20, Amendment 23, Puget Sound Power and Light Company, Bellevue, Washington.

Reidel, S.P., 1984, "The Saddle Mountains: the Evolution of an Anticline in The Yakima Fold Belt," *American Journal of Science,* Vol. 284, p. 942-978.

Reidel, S.P., and K.R. Fecht, 1981, "Wanapum and Saddle Mountains Basalt in the Cold Creek Syncline Area" in *Subsurface Geology of the Cold Creek Syncline*, RHO-BWI-ST-14, Rockwell Hanford Operations, Richland, Washington.

Reidel, S.P., K.R. Fecht, M.C. Hagood, and T.L. Tolan, 1989a, "The Geologic Evolution of the Central Columbia Plateau," in *Volcanism and Tectonism in the Columbia River Flood-Basalt Province*, Special Paper 239, edited by S.P. Reidel and P.R. Hooper, Geological Society of America, Boulder, Colorado, p. 247-264.

Reidel, S.P., T.L. Tolan, P.R. Hooper, M.H. Beeson, K.R. Fecht, R.D. Bentley, J.L. Anderson, 1989b, "The Grande Ronde Basalt, Columbia River Basalt Group: Stratigraphic Descriptions and Correlations in Washington, Oregon, and Idaho," in *Volcanism and Tectonism in the Columbia River Flood-Basalt Province*, Special Paper 239, edited by S.P. Reidel and P.R. Hooper, Geological Society of America, Boulder, Colorado, p. 21-53.

Reiman, R.T. and T.S. Dahlstrom, 1988, *An Aerial Radiological Survey of the Hanford Site and Surrounding Area, Richland, Washington*, EGG-10617-1062, Performed by EGG/EM for the U.S. Department of Energy under Contract DE AC08-88NV-10617.

Rockhold, M.L., M.J. Fayer, and G.W. Gee, 1988, *Characterization of Unsaturated Hydraulic Conductivity at the Hanford Site*, PNL-6488, Pacific Northwest Laboratory, Richland, Washington.

Rockhold, M.L., M.J. Fayer, G.W. Gee, and M.J. Kanyid, 1990, *Natural Groundwater Recharge and Water Balance at the Hanford Site,* PNL-7215, Pacific Northwest Laboratory, Richland, Washington.

Rogers, L.E. and W.H. Rickard, 1977, *Ecology of the 200 Area Plateau Waste Management Environs: A Status Report*, PNL-2253, Pacific Northwest Laboratory, Richland, Washington.

Routson, R.C., and V.G. Johnson, 1990, "Recharge Estimates for the Hanford Site 200 Areas Plateau," *Northwest Science*, Vol. 64, No. 3.

Schmidt J.W., C.R. Huckfeldt, A.R. Johnson, and S.M. McKinney, 1990, *Westinghouse Hanford Company Environmental Surveillance Report--200-600 Areas, Calendar Year 1989*, WHC-EP-0145-2, Westinghouse Hanford Company, Richland, Washington.

Schmidt J.W., C.R. Huckfeldt, A.R. Johnson, and S.M. McKinney, 1991, *Westinghouse Hanford Company Environmental Surveillance Report--200-600 Areas, Calendar Year 1990*, WHC-EP-0145-3, Westinghouse Hanford Company, Richland, Washington.

Serne, R.J. and M.I. Wood, 1990, *Hanford Waste-Form Release and Sediment Interaction, A Status Report with Rationale and Recommendations for Additional Studies*, PNL-7297, Pacific Northwest Laboratory.

Smith, G.A., B.N. Bjornstad, and K.R. Fecht, 1989, "Neogene Terrestrial Sedimentation on and Adjacent to the Columbia Plateau; Washington, Oregon, and Idaho," in *Volcanism and Tectonism in the Columbia River Flood-Basalt Province*, Special Paper 239, edited by S.P. Reidel and P.R. Hooper, Geological Society of America, Boulder, Colorado, p. 187-198.

Smoot, J.L., J.E. Szecsody, B. Sagar, G.W. Gee, and C.T. Kincaid, 1989, *Simulations of Infiltration of Meteoric Water and Contaminant Plume Movement in the Vadose Zone at Single-Shell Tank 241-T-106 at the Hanford Site*, WHC-EP-0332, Westinghouse Hanford Company, Richland, Washington.

Stenner, R.D., K.H. Cramer, K.A. Higley, S.J. Jette, D.A. Lamar, T.J. McLaughlin, D.R. Sherwood, and N.C. Van Houten, 1988, *Hazard Ranking System Evaluation of CERCLA Inactive Waste Sites at Hanford*, PNL-6456, Pacific Northwest Laboratory, Richland, Washington.

Stone, W.A., J.M. Thorp, O.P. Gifford, and D.J. Hoitink, 1983, *Climatological Summary for the Hanford Area*, PNL-4622, Pacific Northwest Laboratory, Richland, Washington.

Strenge, D.L. and S.R. Peterson, 1989, *Chemical Data Bases for the Multimedia Environmental Pollutant Assessment System (MEPAS): Version 1*, PNL-7145, Pacific Northwest Laboratory.

Swanson, L.C., D.C. Weekes, S.P. Luttrell, R.M. Mitchell, D.S. Landeen, A.R. Johnson, and R.C. Roos, 1988, *Grout Treatment Facility Environmental Baseline and Site Characterization Report*, WHC-EP-0150, Westinghouse Hanford Company, Richland, Washington.

Swanson, D.A., T.L. Wright, P.R. Hooper, and R.D. Bentley, 1979, *Revisions in Stratigraphic Nomenclature of the Columbia River Basalt Group*, Bulletin 1457-G, U.S. Geological Survey, Washington, D.C.

Tallman, A.M., K.R. Fecht, M.C. Marratt, and G.V. Last, 1979, *Geology of the Separations Areas, Hanford Site, South-central Washington*, RHO-ST-23, Rockwell Hanford Operations, Richland, Washington.

Tallman, A.M., J.T. Lillie, and K.R. Fecht, 1981, "Suprabasalt Sediments of the Cold Creek Syncline Area," in *Subsurface Geology of the Cold Creek Syncline*, RHO-BWI-ST-14, edited by C.W. Myers and S.M. Price, Rockwell Hanford Operations, Richland, Washington.

Tolan, T.L. and S.P. Reidel, 1989, "Structure Map of a Portion of the Columbia River Flood-Basalt Province," in *Volcanism and Tectonism in the Columbia River Flood-Basalt Province,* Special Paper 239, edited by S.P. Reidel and P.R. Hooper, Geological Society of America, Boulder, Colorado, plate 1.

Tolan, T.L., S.P. Reidel, M.H. Beeson, J.L. Anderson, K.R. Fecht, and D.A. Swanson, 1989, "Revisions to the Extent and Volume of the Columbia River Basalt Group" in *Volcanism and Tectonism in the Columbia River Flood-Basalt Province,* Special Paper 239, edited by S.P. Reidel and P.R. Hooper, Geological Society of America, Boulder, Colorado, p. 1-20.

Van Genuchten, M.P., F.J. Lij, and S.R. Yates, 1991, "The RETC Code for Quantifying the Hydraulic Functions of Unsaturated Soils," Robt. S. Kerr Environmental Research Laboratory, Office of Research and Development, United States Environmental Protection Agency, Ada, Oklahoma.

Walker, C.M., 1977, *History and Status of Tanks 241-C-105 and 241-C-106*, ARH-CD-948, Atlantic Richfield, Hanford Company, Richland, Washington.

WHC, 1988a, *Quality Assurance Manual,* WHC-CM-4-2, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988b, *Properties and Environmental Impact of Ammonia Scrubber Discharge Waste to the 216-A-36B Crib*, WHC-EP-0100, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988c, *Radiation Protection - Safety, Quality Assurance and Security*, WHC-CM-4-10 Westinghouse Hanford Company, Richland, Washington.

WHC, 1988d, *Environmental Investigation and Site Characterization Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990a, *Environmental Engineering, Technology, and Permitting Function Quality Assurance Program Plan,* WHC-EP-0383, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990b, *PUREX Plant Steam Condensate Stream-Specific Report*, WHC-EP-0342, Addendum 5, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990c, *PUREX Plant Cooling Water Stream-Specific Report*, PUREX/UO_2 Operations, WHC-EP-0342, Addendum 20, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990d, *PUREX Plant Chemical Sewer Stream-Specific Report*, PUREX/UO_3 Operations, WHC-EP-0342, Addendum 2, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990e, *PUREX Plant Process Condensate Stream-Specific Report*, WHC-EP-0342, Addendum 12, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990f, *N Reactor Effluent Stream-Specific Report*, N Reactor Environmental Safety, WHC-EP-0342, Addendum 3, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990g, *242-A Evaporator Steam Condensate Stream-Specific Report,* Tank Farms Environmental Engineering, WHC-EP-0342, Addendum 26, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990h, *242-A Evaporator Cooling Water Stream-Specific Report,* Tank Farms Environmental Engineering, WHC-EP-0342, Addendum 21, Westinghouse Hanford Company, Richland Washington.

WHC, 1990i, *242-A Evaporator Process Condensate Stream-Specific Report,* Tank Farms Environmental Engineering, WHC-EP-0342, Addendum 15, Westinghouse Hanford Company, Richland Washington.

WHC, 1990j, *244-AR Vault Cooling Water Stream-Specific Report*, WHC-EP-0342, Addendum 25, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991a, *Waste Information Data System,* (WIDS), Westinghouse Hanford Company, Richland, Washington.

WHC, 1991b, *Prioritizing Sites for Expedited Response Actions at the Hanford Site,* WHC-MR-0244, Westinghouse Hanford Company, Richland, Washington.

Winship, R.A. and M.C. Hughes, 1991, *Hanford Site Surface Soil Radioactive Contamination Control Plan for Fiscal Year 1992*, WHC-EP-0489, Westinghouse Hanford Company, Richland, Washington.

Zimmerman, D.A., A.E. Reisenauer, G.D. Black, M.A. Young, 1986, *Hanford Site Water Table Changes 1950 through 1980, Data Observations and Evaluation,* PNL-5506, Pacific Northwest Laboratory, Richland, Washington.

APPENDIX A

SUPPLEMENTAL DATA

9 2 1 2 5 0 5 6 1 5

APPENDIX A.1

GEOPHYSICAL DATA

9 2 1 2 5 . 6 0 6 1 6

THIS PAGE INTENTIONALLY
LEFT BLANK

CONTENTS

Page

A-1.1 INTRODUCTION A1-1

A-1.2 GROSS GAMMA LOGGING A1-2

A-1.3 TECHNICAL APPROACH A1-5

A-1.4 EVALUATION OF WASTE MANAGEMENT UNIT AREAS A1-7
- A-1.4.1 216-A-1 AND 216-A-7 CRIBS A1-7
- A-1.4.2 216-A-2, -4, -21, -26, -27, -31, AND -36 CRIBS A1-9
- A-1.4.3 216-A-5, -10, -15, AND -38 CRIBS A1-14
- A-1.4.4 216-A-6 CRIB A1-17
- A-1.4.5 216-A-8, -18, -19, -20, -24, AND -34 CRIBS A1-18
- A-1.4.6 216-A-9 CRIB AND 216-A-40 TRENCH A1-22
- A-1.4.7 216-A-30, -37, AND -42 CRIBS A1-23
- A-1.4.8 216-A-45 CRIB A1-26
- A-1.4.9 241-A TANK FARM AREA A1-28
- A-1.4.10 241-AX TANK FARM AREA A1-31
- A-1.4.11 241-C TANK FARM AREA A1-34

A-1.5 REFERENCES A1-40

FIGURES:

A1-1 PUREX Plant Aggregate Area: Waste Management Unit Areas Evaluated A1F-1

A1-2 216-A-1 and -7 Waste Management Units: Scintillation Probe Profile Cross Section A1F-2

A1-3 216-A-2, -4, -21, -26, -27, -31, and -36 Waste Management Units: Scintillation Probe Profile Cross Sections A-A' and B-B' A1F-3

A1-4 216-A-2, -4, -21, -26, -27, -31, and -36 Waste Management Units: Scintillation Probe Profile Cross Sections C-C' and D-D' A1F-4

A1-5 216-A-2, -4, -21, -26, -27, -31, and -36 Waste Management Units: Additional Scintillation Probe Profiles A1F-5

A1-6 216-A-2, -4, -21, -26, -27, -31, and -36 Waste Management Units: Hanford Sand Elevated Gamma Radiation Isopach Map A1F-6

WHC.23B/5-22-92/02749A

A1-7 216-A-5, -10, -15, and -38 Waste Management Units: Scintillation Probe Profile Cross Sections A-A', B-B', and C-C' A1F-7
A1-8 216-A-5, -10, -15, and -38 Waste Management Units: Elevated Gamma Radiation Isopach Map A1F-8
A1-9 216-A-6 Waste Management Unit: Probe Profile Cross Section A-A' A1F-9
A1-10 216-A-8, -18, -19, -20, -24, -29, -34, and -524 Waste Management Units: Scintillation Probe Profile Cross Section A-A' and B-B' A1F-10
A1-11 216-A-8, -18, -19, -20, -24, -29, -34, and -524 Waste Management Units: Scintillation Probe Profile Cross Section C-C' A1F-11
A1-12 216-A-8, -18, -19, -20, -24, -29, -34, and -524 Waste Management Units: Elevated Gamma Radiation Isopach Map A1F-12
A1-13 216-A-24 Waste Management Unit: Change in Gamma Radiation Levels, 1968-1976 . . . . . A1F-13
A1-14 216-A-9 and -40 Waste Management Units: Scintillation Probe Profile Cross Section A-A' A1F-14
A1-15 216-A-30, -37, and -42 Waste Management Units: Scintillation Probe Profile Cross Section A-A' and B-B' A1F-15
A1-16 216-A-30, -37, and -42 Waste Management Units: Elevated Gamma Radiation Isopach Map A1F-16
A1-17 216-A-45 Waste Management Unit: Scintillation Probe Profile Cross Section A1F-17
A1-18 241-A Tank Farm: Scintillation Probe Profile Cross Sections A-A' and B-B' A1F-18
A1-19 241-A Tank Farm: Scintillation Probe Profile Cross Sections C-C' and C-C" A1F-19
A1-20 241-A Tank Farm: Scintillation Probe Profile Cross Sections D-D' and E-E' A1F-20
A1-21 241-A Tank Farm: Near Surface Elevated Gamma Radiation Isopach Map A1F-21
A1-22 241-A Tank Farm: Intra-Backfill Elevated Gamma Radiation Isopach Map A1F-22
A1-23 241-AX Tank Farm: Scintillation Probe Profile Cross Section A-A' A1F-23
A1-24 241-AX Tank Farm: Scintillation Probe Profile Cross Section B-B' and B-B" A1F-24
A1-25 241-AX Tank Farm: Scintillation Probe Profile Cross Section C-C' A1F-25
A1-26 241-AX Tank Farm: Elevated Gamma Radiation Isopach Map A1F-26

A1-27 241-C Tank Farm: Scintillation Probe Profile Cross Section A-A' A1F-27
A1-28 241-C Tank Farm: Scintillation Probe Profile Cross Section B-B' A1F-28
A1-29 241-C Tank Farm: Scintillation Probe Profile Cross Section C-C' A1F-29
A1-30 241-C Tank Farm: Scintillation Probe Profile Cross Section D-D' A1F-30
A1-31 241-C Tank Farm: Scintillation Probe Profile Cross Section E-E' A1F-31
A1-32 241-C Tank Farm: Near Surface Elevated Gamma Radiation Isopach Map A1F-32
A1-33 241-C Tank Farm: Elevated Gamma Radiation within Fill and Pebbly Facies Isopach Map A1F-33

TABLES:

A1-1 Summary of Waste Management Unit Evaluation Results A1T-1
A1-2 Details of Wells and Logs Used in Evaluation of 216-A-1 and -7 Waste Management Units A1T-2
A1-3 Details of Wells and Logs Used in Evaluation of 216-A-2, -4, -21, -26, -27, -31, and -36 Waste Management Units A1T-3
A1-4 Details of Wells and Logs Used in Evaluation of 216-A-5, -10, -15, and -38 Waste Management Units A1T-4
A1-5 Details of Wells and Logs Used in Evaluation of 216-A-6 Waste Management Unit A1T-5
A1-6 Details of Wells and Logs Used in Evaluation of 216-A-8, -18, -19, -20, -24, -29, -34, and 524 Waste Management Units A1T-6
A1-7 Details of Wells and Logs Used in Evaluation of 216-A-9 and -40 Waste Management Units A1T-7
A1-8 Details of Wells and Logs Used in Evaluation of 216-A-30, -37, and -42 Waste Management Units A1T-8
A1-9 Details of Wells and Logs Used in Evaluation of 216-A-45 Waste Management Unit A1T-9
A1-10 Details of Wells and Logs Used in 241-A Tank Farm Evaluation A1T-10

A1-11 Details of Wells and Logs Used in 241-AX Tank Farm Evaluation A1T-11
A1-12 Details of Wells and Logs Used in 241-C Tank Farm Evaluation A1T-12

9 2 1 2 5 1 5 7 5 2 0

A-1.1 INTRODUCTION

Geophysical well logging has been conducted in monitoring wells located within the 200 East and West Areas since 1954 and in the PUREX Plant Aggregate Area since at least as early as 1958. Such logging can be used to map lithologic boundaries (Additon 1978; Last et al. 1989; Brodeur and Koizumi 1989), soil moisture content (Lane 1990) and to evaluate the location and extent of radionuclides in the subsurface due to waste disposal activities (Fecht et al. 1977; Additon 1978; Brodeur 1988; Lane 1990). The geophysical borehole logging techniques that have been used include density, neutron, temperature, and gross gamma radiation logging. The most successful of these for mapping lithologic boundaries and monitoring radionuclides in the subsurface has been the gross gamma logging. The other techniques have been less successful because either they are not suitable for use in cased holes or they do not measure radiation (Lane 1990).

Previous studies based on the gross gamma logs collected from wells monitoring various waste management units in the 200 East and West Areas were conducted in 1964, 1969, 1977, 1978, 1986, and 1988. The tank farms located in the 200 East and West Areas were not considered in these reports. Additon et al. (1978) reports that the 1964 study by Raymond and McGhan discusses the disposition of radionuclides beneath most of the waste management units active between 1945 and 1963. The 1969 study (Tillson and McGhan 1969) is reported by Additon et al. (1978) to be a discussion of the waste management units where significant changes in the gamma logs were observed after 1963. The report by Fecht et al. (1977) is a qualitative study of the distribution, redistribution, and decay of radionuclides beneath approximately 100 waste management units in the 200 East and West Areas. Fecht et al. (1977) included a summary of the waste disposal history of each facility evaluated and based their conclusions on approximately 300 selected gross gamma logs collected between 1954 and 1976. Plots of the logs used were provided with the report. Additon et al. (1978) provided a complete summary of the logging systems used and a discussion of the limitations of using gross gamma logs to evaluate the distribution and composition of radionuclides in the subsurface. The methodologies used to qualitatively evaluate the gross gamma logs collected from wells monitoring the waste disposal facilities in the 200 East and West Areas were also summarized. Plots of the gross gamma logs collected from 154 monitoring wells outside the tank farms in the 200 East Area was included in the report by Additon et al. (1978). Chamness (1986) and Brodeur (1988) reviewed gross gamma logs available from selected wells in the 200 Areas and qualitatively summarized any changes in the logs between 1976 and the dates of their reports.

Thirty-one active and inactive waste management units in the PUREX Plant Aggregate Area, which are monitored by wells in which gross gamma logs are collected, were evaluated in this study. These waste management units were grouped into eight

geographically related areas and been qualitatively evaluated in terms of the location and extent of radionuclides in the subsurface, any evidence of vertical or lateral migration, and the potential for radionuclides reaching the ground water (Figure A1-1). The results of the evaluations for these waste management units are summarized in Table A1-1. Additionally, logs from the three inactive single-shell tank farms in the PUREX Plant Aggregate Area were reviewed and the approximate extent, location and source of radionuclides in the subsurface summarized. The results of the tank farm evaluations are summarized in Table A1-1.

A-1.2 GROSS GAMMA LOGGING

Borehole gross gamma radiation measurements are used to determine the level of gamma activity with depth in the vicinity of the well bore. These measurements do not differentiate between the mechanisms through which gamma radiation is produced or the energy of the gamma radiation photons detected. The response of the gamma radiation detector to different energy levels is generally unknown, except perhaps for the lowest energy photon detectable (Arthur 1990). Gross gamma logs cannot be used to determine the isotopic composition of the subsurface since this is determined through the analysis of the energy spectra of the gamma radiation detected. The capability to measure the spectra of gamma radiation detected in the subsurface and assay the types and amounts of isotopes present is currently being developed, but has not yet reached the stage of practical application (Lane 1990; Price et al. 1990).

The bulk of the gamma logs available for the PUREX Plant Aggregate Area were collected with scintillation probes by Pacific Northwest Laboratories (PNL) or by the Tank Farm Surveillance Analysis and Support group (TFSA&S). Scintillation probes detect the flash of light produced by the interaction between a gamma photon and a crystal of thallium-activated sodium iodide (NaI(Tl)) with a photomultiplier tube. The resulting pulse of electricity is amplified, routed through a signal generator and sent through the logging cable to the surface. The pulses are separated from the electrical signal with a discriminator, amplified, counted by a rate meter and output to a pen plotter, which is driven at a rate determined by the logging speed (Fecht et al. 1977; Additon et al. 1978; Brodeur and Koizumi 1989; Arthur 1990).

The accuracy and precision of gamma activity measurements in the subsurface is determined by details of the logging system instrumentation, the field data acquisition methodology, the surrounding media, and the radionuclides present. The relationship between the gamma activity detected by a scintillation probe and the actual activity, the

distance gamma radiation may travel through geologic materials before being completely attenuated and the vertical resolution of changes in activity by the logging systems used will be discussed below.

The time required for the logging system to process a detected gamma photon, or "dead time", is an important limitation in the measurement gamma activity (Brodeur and Koizumi 1989; Arthur 1990). During this short span of time, no other photons will be processed by the instrument. The "dead time" computed for the PNL system currently in use is 17.8 microseconds (Arthur 1990). Based upon this value, the maximum count rate this logging system is capable of is about 56,000 counts per second (ct/sec). If the activity is above that level, the system will become "paralyzed" and read 0 ct/sec until it resets itself. The maximum count rate of the TFSA&S system currently in use is about 100,000 ct/sec with Probe No. 4 (Strong 1980). This suggests that the "dead time" of their logging system is about 10 microseconds. There is no evidence that TFSA&S's system will become paralyzed if this activity level is exceeded.

The actual gamma activity on an interval may be computed by multiplying the "dead time" corrected activity by a factor consistent with the amount of attenuation due to well construction. The amount of attenuation of the gamma radiation experiences in penetrating well casing is significant. A single string of casing reduces the count rate measured by the scintillation probe by about 25%, groundwater in an uncased hole reduces the observed count rate by 11%, and groundwater in a cased hole reduces the observed count rate by about 33% (Brodeur and Koizumi 1989; Arthur 1990).

The relationship between the gamma activity observed with a scintillation probe and the actual activity is linear over much of the system's range. However, above some threshold activity level, the relationship between the observed and actual activity becomes non-linear. At this point the tool is said to be saturated. The gross gamma logging system currently in use by PNL becomes saturated around 14,500 ct/sec (Brodeur and Koizumi 1989; Arthur 1990), and that currently in use by TFSA&S with Probe No. 4 becomes saturated around 70,000 ct/sec (Strong 1980).

Where the relationship between the observed and actual gamma activity is linear, and complete details of well construction are available, the activity may be converted to standard units related to decay rates or to concentrations of specific radionuclides (thorium or uranium for example). Such conversions allow the direct comparison of data collected by different logging systems and quantitative analyses of the concentrations of gamma emitters with depth. To achieve this, it is necessary to calibrate the scintillation probes used with a model bore hole containing intervals with known activities (Strong 1980; Brodeur and Koizumi 1989; Arthur 1990). The rigorous procedures and facilities necessary for calibrating scintillation probes have not yet been completed.

A scintillation probe is calibrated by periodically adjusting the components of the system to meet established specifications and by logging a test well with intervals of known activity under standard conditions. The probe's calibration is then verified in the field before and after each logging run using portable equipment and procedures, which are correlated with those of the calibration procedure. Standard conditions are established by constructing the test bore hole in a known geologic environment with background radiation levels similar to those found in the area where the probe is used. The test well should be constructed in a similar fashion to the wells to be logged by the probe (Brodeur and Koizumi 1989).

The average distance through which gamma radiation penetrates geologic and well construction materials and is still detected by the scintillation probe is known as the radius of investigation. This distance is determined by the density of the media surrounding the bore hole, the well construction materials, and the energy and intensity of the gamma radiation. The average radius of investigation for gross gamma radiation measurements in an open hole is about 0.3 m (1 ft) from the wall of the bore hole in sedimentary rocks (Schlumberger 1972). The radius of investigation is larger on intervals where there are high concentrations of radionuclides since higher intensities of gamma radiation will penetrate a greater thickness of a given material. The radius of investigation is decreased by well casing, grout, and groundwater since they increase the effective density of sediments. Another factor in determining the radius of investigation is the tool response to low energy (frequency) gamma photons. The scintillation probe currently used by PNL has a low energy cutoff of between 46.5 and 59.5 keV (Arthur 1990). Gamma radiation with energies below this value will not be detected by that probe. The low energy cutoff for the probes used by TFSA&S is unknown.

The vertical resolution and apparent location of a change in the gamma activity measured by a scintillation probe depends upon details of how the probe signal is processed by the rate meter and the logging speed. The rate meter used in PNL's logging system differs from that used by TFSA&S. The rate meter used by PNL smooths its output using an electronic circuit (an RC circuit). The amount of smoothing is determined by the time constant of the circuit used. This removes statistical variations in the signal detected by the scintillation probe and improves the reproducibility and sensitivity of the data. However, a "lag" is introduced between the depth at which a change in the gamma activity is first encountered by the scintillation probe and the depth at which it is plotted. The size of this "depth lag" is the distance traveled before half of the amplitude of the change in activity is recorded. One time constant is required to reach 63% of the amplitude of any change in activity. So, the "depth lag" is approximately the product of the logging speed and the time constant used (Schlumberger 1972). Before 1989, the logging speed used by PNL was 4.5 m (15 ft) per minute (0.07 m, 0.25 ft per second) and the time constant used was 3 seconds. This results in a depth lag of 0.2 m (0.75 ft). The thinnest interval of elevated activity which can be resolved is also 0.2 m (0.75 ft) on these older profiles. In 1989, the logging

speed was reduced to 1.5 m/min (5 ft/min) 2.5 cm/sec (1 in./sec) and the time constant to 1 second. The expected vertical resolution and "depth lag" of these logs is 2.5 cm (1 in.). The rate meter used by TFSA&S sums the pulses over the period of time required for the probe to ascend through 0.3 m (1 ft) and averages the reading over time. This process does not remove the statistical variations from the data so the data are less reproducible. Since no time constant is used, no "lag" between the depth a change in gamma activity is encountered and the depth where it is plotted is introduced. However, the vertical resolution of changes in activity on these logs is 0.3 m (1 ft), the distance over which the activity is averaged.

A-1.3 TECHNICAL APPROACH

Scintillation probe profiles collected periodically from monitoring wells within the PUREX Plant Aggregate Area have been used to qualitatively to assess the location and extent of radionuclides in the subsurface, any evidence of vertical or lateral migration, and the potential for radionuclides from waste disposal activities reaching the groundwater. The approach used here is similar to that of Fecht et al. (1977). Scintillation probe profiles collected from wells monitoring a facility or group of facilities were compiled and analyzed in an attempt to gain an understanding of the subsurface distribution of gamma emitters from waste disposal activities. Each analysis is accompanied by a summary of the types and sources of wastes handled, the service dates and the volume of wastes disposed of or stored at a given facility. The conclusions reached in these evaluations should not be considered the final word since they are based on a limited data set, which can only be used for qualitative purposes.

The approach used here differs from that of Fecht et al. (1977) and other previous evaluations in the manner in which the data were compiled and analyzed. The thirty-one waste management units evaluated were grouped into eight geographic areas and evaluated as a whole (Figure A1-1). The three tank farms for which summary evaluations were made were accounted for three additional areas. Geological methods of analysis incorporating cross sections and mapping of subsurface attributes such as the thickness of zones of elevated gamma radiation and relevant lithologic horizons were used extensively. The advantages of this approach are the clearer representation of potential subsurface conditions around the waste disposal facilities, and identification of data deficiencies.

Fecht et al. (1977) attempted to "normalize" the scintillation probe profiles used in their evaluations to a level consistent with the profiles collected in 1976. This normalization scheme involved scaling the profiles from each vintage using an average "peak to background" ratio and bulk shifting the corrected curves to correspond to the 1976 profiles.

Since there are distinct differences between the response characteristics of each logging system and their modifications (in the saturation levels, low energy cutoff, etc), there are doubts to the validity of such an exercise. The logs used in the evaluations presented here have not been normalized.

No attempt has been made to quantitatively compare the activity levels detected by different vintages of scintillation probes in the evaluations presented here. If gross changes in the profiles are evident, they have been noted in a qualitative sense.
The criteria used to identify radionuclide decay are the significant, consistent decline of activity levels and the "narrowing" of the features representing elevated radiation on the logs over time. However, such changes may also be indicative of lateral migration of radionuclides away from a particular well. Identification of lateral migration is generally uncertain. The most reliable criteria for identifying lateral migration of radionuclides is the notable increase of activity on an interval in a well that is downgradient (of a stratigraphic or hydrologic boundary) from other wells with elevated activity on a similar interval. It is very important to consider the spacial and temporal context of the scintillation probe data in determining if lateral migration has occurred, even on a qualitative level.

Although the activity measured by the scintillation probes cannot be quantified to known standards, the activity in the subsurface may be reliably located. The location of features in the scintillation probe profiles such as the top and bottom of intervals of elevated gamma radiation are generally found at the same depth on successive logs. Care must be taken in comparing the logs collected by TFSA&S and PNL. Depth discrepancies of up to 5 feet have been noted between these logs. This error is due in part to the "depth lag" of the PNL logging system. This "depth lag" will place equivalent features on PNL logs (collected before 1989) 0.75 feet shallower than those on TFSA&S logs. Also, differences in the responses of the PNL and TFSA&S systems may account for some of this discrepancy.

Three criteria were used to establish downward migration of radionuclides in the vicinity of a well. The most important of these was an unambiguous downward displacement of the top and bottom of a region of elevated radiation with time. Downward migration of other correlatable features on an interval of elevated activity may be used in support of this evidence. Secondly, the total amount of downward migration should exceed the vertical resolution of the logging system used (0.22 m, 0.75 ft, for the PNL pre-1989 logs and 0.3 m, 1 ft, for TFSA&S logs). Finally, any change in the point from which depths are measured during logging should be identified and accounted for, this can be inferred from stationary subsurface features, such as lithologic boundaries and bottoms of casing strings.

All of the available well data were reviewed for each area evaluated, and selected logs were used to construct cross sections representative of subsurface conditions. These cross sections were correlated with stratigraphic information from nearby wells, regional cross

sections and regional mapping. Boundaries of zones of elevated gamma radiation were also marked. Any mappable attributes that could be used to represent the location and extent of the region of elevated gamma radiation were compiled into maps. The evaluation of the scintillation probe profiles referenced these graphical representations to describe the location and extent of any zones of elevated gamma radiation, and the behavior of this zone over time, particularly in regards to vertical or lateral migration. Any evidence of gamma emitters reaching the groundwater was also noted.

To represent the logs used in the cross sections in a clear, yet compact format and to facilitate comparisons between different vintages of data, it was necessary to digitize the original logs and to redisplay them on a semi-logarithmic scale. Depth in feet from the top of casing was represented on the linear scale, and activity in ct/sec on the logarithmic scale. The logs used in these evaluations which were collected before 1976, and some of the 1976 vintage logs had been previously digitized by PNL, who provided text files of the information. Unfortunately, it was not realized until late in the evaluations that the 1970 vintage and earlier logs had been plotted on a scale of counts per minute (ct/min). The reader should be aware that these logs are not plotted in ct/sec, but in ct/min. The apparent wide difference between these earlier logs and those collected in 1976 and later is due to an error in scaling. Logs plotted on a scale of ct/min were denoted on the legend for each plot of scintillation probe profiles. The cross sections are not scaled horizontally.

Features that were mapped in the evaluations for the PUREX Plant Aggregate Area include the thickness of the interval of elevated gamma radiation, the top of the elevated gamma radiation and the top of any correlatable lithologic horizon, which is useful in explaining the distribution of radionuclides in the subsurface. The most commonly used map was the thickness of the interval of elevated gamma radiation. Although such maps do not give any indication of gamma activity, they do provide a reasonable representation of the potential extent of gamma emitters. Use of activity data was avoided since the data are not suitable to be used in such a quantitative fashion.

A-1.4 EVALUATION OF WASTE MANAGEMENT UNIT AREAS

A-1.4.1 216-A-1 AND 216-A-7 CRIBS

Description of Waste: The 216-A-1 Crib received depleted uranium waste from the 202-A Building cold start-up run. The 216-A-7 Crib received the catch tank overflow waste, the sump waste, and the pump pit drainage from the 241-A-152 Diversion Box. Also, the 216-A-7 Crib received organic waste from the 202-A Building.

Service Dates: The 216-A-1 Crib was active from November through December 1955. The 216-A-7 Crib was active from November 1955 through November 1966.

Waste Volume: The 216-A-1 Crib received 98,400 L of mixed liquid waste. The 216-A-7 Crib received 326,000 L (86,000) of mixed liquid waste.

Waste Inventory:

	216-A-1		216-A-7	
	Total	Decayed Through 6/76	Total	Decayed Through 6/76
Pu (gm)	<1.0 E-1	<1.0 E-1		Not Available
Beta (Ci)	1.0 E+00	2.44 E-1		Not Available
^{90}Sr (Ci)	<1.0 E-1	<5.97 E-1		Not Available
^{106}Ru (Ci)	<1.0 E-1	<5.13 E-8		Not Available
^{137}Cs (Ci)	<1.0 E-1	<6.17 E-2		Not Available
^{60}Co (Ci)	<1.0 E-1	<6.28 E-3		Not Available
U (kg)	1.54 E+02	1.54 E+02		Not Available

Evaluation of Scintillation Probe Profiles:

Well E25-2 monitors the 216-A-1 Crib and Well E25-54 monitors the 216-A-7 Crib. Previous evaluations using the scintillation probe profiles have been done by Fecht et al. (1976) (for 216-A-1 Crib) and by Chamness (1986) (for 216-A-7 Crib). In both cases the authors concluded the level of gamma activity in the subsurface is declining. Fecht et al. also concluded that there was no measurable migration of radionuclides under the 216-A-1 Crib and that the contamination had not reached the groundwater. The following analysis is consistent with these conclusions.

Scintillation probe profiles for the 2 wells that monitor cribs 216-A-1 and 216-A-7 were compiled and roughly correlated with the stratigraphy of Well E24-5, located about 460 m (1,500 ft) to the east, and Well E26-6, located about 330 m (1,100 ft) to the north (Lindsey et al. 1990) (Figure A1-2). The data are inadequate to construct a map of the contaminant thickness and extent.

Elevated gamma radiation levels are found at two intervals in the subsurface. The upper interval is found beneath the 216-A-7 Crib from the surface to a depth of about 5 m (15 ft). The lower interval is found beneath both cribs at a depth of about 13 m (27 ft), and is about 5 m (15 ft) thick. The top of the lower interval of contamination is located at a depth consistent with that of the top of the fine-sandy facies of the Hanford formation. The

upper interval of contamination appears to coincide with an erosional surface found in the stratigraphic column of Well E26-6 (Figure A1-2).

There is no evidence of vertical or lateral migration of contaminants. However, since the top of the fine-sandy facies of the Hanford formation dips (Lindsey et al. 1990), it is unlikely that any lateral migration would be detected. Radiation levels have declined to near background levels beneath the 216-A-1 Crib, but remain significant beneath the 216-A-7 Crib.

A-1.4.2 216-A-2, -4, -21, -26, -27, -31 AND -36 CRIBS

Description of Waste:

216-A-2 Crib: Low salt, neutral/basic organic mixed waste, including normal paraffin hydrocarbons and tributyl phosphate from the 202-A Building.

216-A-4 Crib: Mixed laboratory cell drainage from the 202-A Building and 291-A-1 Stack drainage waste.

216-A-21 Crib: Low salt, neutral/basic mixed waste, including sump waste from the 293-A Building, laboratory cell drainage from the 202-A Building and 291-A-1 Stack drainage.

216-A-26 French Drain: Low-level floor drainage waste from the 291-A Fan Control House.

216-A-26A French Drain: Mixed floor drainage waste from the 219-A Fan Control House.

216-A-27 Crib: Mixed sump waste from the 293-A Building, laboratory cell drainage from the 202-A Building and 291-A-1 Stack drainage.

216-A-31 Crib: Neutral organic mixed waste from the 202-A Building.

216-A-36A Crib: Mixed ammonia scrubber waste from the 202-A Building.

216-A-36B Crib: Mixed ammonia scrubber waste from the 202-A Building.

Service Dates:

216-A-2 Crib: January 1956 to January 1963.

216-A-4 Crib: December 1955 to December 1958.

216-A-21 Crib: October 1957 to June 1958; December 1958 to June 1965.

216-A-26 French Drain: July 1965 to Present.

216-A-26A French Drain: March 1959 to July 1965.

216-A-27 Crib: June 1965 to July 1970.

216-A-31 Crib: July 1964 to November 1966.

216-A-36A Crib: September 1965 to March 1966.

216-A-36B Crib: March 1966 to October 1972; November 1982 to September 1987.

Waste Volume:

216-A-2 Crib: 230,000 L (61,000 gal).

216-A-4 Crib: 6,210,000 L (1,640,000 gal).

216-A-21 Crib: 77,900,000 L (20,600,000 gal).

216-A-26(B) French Drain: 0 L.

216-A-26A French Drain: 1,000 L (260 gal).

216-A-27 Crib: 23,200,000 L (6,130,000 gal).

216-A-31 Crib: 10,000 L (2,700 gal).

216-A-36A Crib: 1,070,000 L (283,000 gal).

216-A-36B Crib: 317,000,000 L (84,000,000 gal).

Evaluation of Scintillation Probe Profiles:

The 216-A-2, -4, -21, -27, -31, -36A, and -36B Cribs are located in the 200-PO-2 Operable Unit and the 216-A-26 and -26A French Drains in the 200-PO-1 Operable Unit. The 216-A-26(B) French Drain is the only active disposal unit in the area evaluated here. The 216-A-2 and 216-A-4 Cribs are monitored by Wells E24-53 and -54, respectively. Since the 216-A-26 and 216-A-26A French Drains are located between these cribs, they too are

monitored by these wells. The 216-A-21 Crib is monitored by Well E24-12. The 216-A-27 Crib is monitored by the E17-2 and -3 wells. Well E24-9 monitors the 216-A-31 Crib. The 216-A-36A Crib is monitored by Wells E17-4 (01-36-01), -9, and -10. The 216-A-36B Crib is monitored by Wells E17-5, -6, -7 (01-36-07), -11 (01-36-11), and -51 (01-36-06) (Fecht et al. 1977; Welty and Vermeulen 1989).

All of the monitoring wells in the area of the 216-A-2, -4, -21, -26, -27, -31, and -36 Cribs have been logged by PNL. Currently, Wells E17-4 (01-36-01), -7 (01-36-07), -11 (01-36-11), and -51 (01-36-06) are also logged on a semi-annual basis by TFSA&S (Welty and Vermeulen 1989). Details of the monitoring wells and the logs used in this evaluation are given in Table A1-3.

Scintillation probe profiles from the wells monitoring the 216-A-2, -4, -21, -26, -27, -31, and -36 Cribs have been evaluated in the past by Fecht et al. (1977), Chamness (1986) and Brodeur (1988).

Fecht et al. (1977) evaluated gross gamma logs from well monitoring the 216-A-2, -4, -21, -27, -31, -36A, and -36B Cribs and concluded that there was no evidence of significant vertical migration of gamma emitters beneath these waste management units after waste disposal activities ceased and that radionuclides from these units had not reached the water table. Fecht et al. (1977) concluded that radionuclides disposed of in the 216-A-36B Crib had not reached the southern end of the crib. This conclusion was based on the scintillation probe profiles collected from Well E17-6, which according to the Westinghouse Hanford GIS listing of well statistics and Welty and Vermeullen (1989), is located approximately 90 m (300 ft) south of the location used by Fecht et al. (1977). Some lateral migration of radionuclides was also noted under the 216-A-36B Crib.

Chamness (1986) noted that radiation levels beneath the 216-A-27 and 216-A-36A cribs was declining slowly based on logs collected in 1986.

Brodeur (1988) evaluated cribs 216-A-2, -4, -27, -31, -36A, and -36B. Brodeur (1988) noted significant levels of activity beneath cribs 216-A-2, -4, -27, -36A, and -36B, and that radionuclides probably had reached the groundwater between cribs 216-A-36A and 216-A-27. Brodeur (1988) used a log from Well E24-65 in the evaluation of 216-A-2 Crib. According to the Westinghouse Hanford GIS listing of well statistics, this well is located within the 241-A Tank Farm, a considerable distance northwest of the 216-A-2 Crib.

This evaluation concurs with Brodeur (1988) in regards to gamma emitters reaching the water table between the 216-A-27 and 216-A-36A Cribs. Fecht et al. (1977) had concluded that gamma emitters had not reached the water table in this area. This evaluation does not concur with Fecht et al. (1977) in regards to the distribution of radionuclides in the

216-A-36B Crib. The conclusions of the current evaluation on this point is based on profiles from a recently emplaced well (E17-51) located near the southern end of the 216-A-36B Crib and the coordinates for Well E17-6 from the Westinghouse Hanford GIS listing of well statistics.

Scintillation probe profiles from Wells E17-2, -3, -4, -5, -9, -10, -11, -51, E24-9, -12, -53, and -54 were compiled into four cross sections and correlated with the stratigraphy found in Well E17-4, and -12 (located about 265 m or 875 ft to the southeast), and with the regional mapping of Lindsey et al. (1992) (Figures A1-3 and A1-4). Although Wells E17-6 and -7 were not included in these cross sections, they were correlated with the stratigraphy from Wells E17-4 and -12 and used in this evaluation (Figure A1-5). The Hanford upper gravel, the Hanford sand, and the Ringold Formation are found in this area. The Hanford lower gravel may also be present on the edge of the area, in Well E17-10. The boundaries between these units are expressed as subtle features on the gamma logs from Wells E17-10, E24-9, and -12, which represent background conditions for the most part. Internal changes in facies within these units are not expressed on these background profiles.

Significant levels of gamma activity within the Hanford sand has been detected in the vicinity of the two wells monitoring the 216-A-2 and 216-A-4 Cribs and the 216-A-26 and 216-A-26A French Drains. The top of the zone of elevated radiation corresponds to the top of the Hanford sand and the base of the cribs (Figure A1-3). However, since the wells do not fully penetrate the zone of elevated radiation, the distribution of gamma emitters in that area cannot be further characterized.

The well data are adequate to characterize the distribution of radionuclides beneath cribs A-27, -36A, and -36B. The top of the elevated radiation in the immediate vicinity of these cribs corresponds to the top of the Hanford sand and the base of the cribs (6.1 to 7.6 m or 20 to 25 ft below grade) and becomes considerably deeper (16.2 to 40.5 m or 53 to 133 ft below grade) outside the confines of these cribs (Figures A1-3 and A1-4). Over most of the area, the base of the elevated activity roughly corresponds to the top of a silty interval within the Hanford sand. Elevated levels of radiation in the Ringold Formation, above the water table, are found under crib 216-A-36A and the northern and eastern ends of cribs 216-A-36B and 216-A-27, respectively. The thickness and possible extent of the elevated gamma radiation within the Hanford sand and the possible extent of elevated gamma radiation within the Ringold Formation are shown in Figure A-1.6. The approximate thickness of the elevated gamma radiation in the Hanford sand is currently 31.4 m (103 ft) near the southern end of crib 216-A-36A. In 1976, it was nearly 67 m (220 ft) thick, and the base of the interval of elevated radiation was within 4.6 m (15 ft) of the top of the Ringold Formation. This suggests that the 216-A-36A Crib was a source of gamma emitters to the groundwater before 1976. The thickness of the region of probable anthropogenic radionuclides within the Hanford sand also increases under the southern end of the 216-A-36B Crib and the 216-A-27

Crib. However, no gamma emitters are detected within the Ringold Formation in these areas.

There is evidence that the distribution of radionuclides below cribs 216-A-27, -36A, and -36B was controlled by lithologic facies changes within the Hanford sand. The scintillation probe profiles from the wells monitoring cribs 216-A-27, -36A, and -36B indicate that gamma emitters are confined to two distinct horizons within the Hanford sand beneath crib 216-A-36B and the western end of crib 216-A-27 (Figures A1-3, A1-4, and A1-5). This is manifested by two well developed peaks separated by a thin interval 2.1 to 4.6 m thick or 7 to 15 ft of near background readings found at a depth of 19.8 to 21.3 meters or 65 to 70 feet. In the past, gamma levels were much higher within this thin interval, but the character of the logs has remained consistent. This "notch" can be explained by postulating a thin, discontinuous lense of coarse grained material within the Hanford sand. Such a lense could act as a "leaky" barrier to the movement of wastes in the subsurface (Additon et al. 1978). Vertical movement would be inhibited because capillary attraction would prevent movement from less permeable to more permeable sediments. The scintillation profiles from Wells E17-2, -5, -7, -9, -11, and -51 (Figures A1-3, A1-4 and A1-5) indicate that this postulated lense is a synform whose axis is located between Wells E17-5 and -51 and plunges toward the northwest. This is consistent with deposition at the bottom of a river channel in an alluvial environment and the regional mapping of Lindsey et al. (1992). The profiles from Wells E17-3 and E17-4 do not have this "notched" character and the depth to the top of the elevated gamma activity is considerably deeper (Figures A1-3 and A1-4). This suggests that the postulated lense is absent in that area so radionuclides could penetrate to a greater depth. The edge of this postulated lense corresponds to increased gamma radiation levels in the Ringold Formation (Figure A1-3 and A1-4).

The wells monitoring cribs 216-A-21 and 216-A-31 do not appear to be optimally placed. The regional mapping of Lindsey et al. (1992) and the distribution of radionuclides beneath cribs 216-A-27, -36A, and -36B (Figure A1-6) suggest that potential contaminants may be found northwest of these cribs.

There is no evidence of lateral or vertical migration of radionuclides after their emplacement beneath cribs 216-A-2, -4, -27, -36A, and -36B. The only changes in the scintillation probe profiles from the wells monitoring these structures over time has been a thinning of the peaks due to radionuclide decay.

Scintillation profiles from all the wells reaching the water table indicate that although elevated gamma radiation was detected in the groundwater under cribs 216-A-21, -27, -31, -36A, and -36B prior to the 1976 logging campaign (Fecht et al. 1977), levels are currently at or near background levels.

A-1.4.3 216-A-5, -10, -15, AND -38 CRIBS

Description of Waste:

216-A-5 Crib: Process condensate (mixed waste) from the 202-A Building.

216-A-10 Crib: Process condensate (mixed waste) from the 202-A Building.

216-A-15 French Drain: Acidic mixed waste.

216-A-38 Crib: Never used.

Service Dates:

216-A-5 Crib: December 1955 to November 1961; October 1966.

216-A-10 Crib: 1956 (received non-radioactive water); November 1961 to January 1978; October 1981 to March 1987.

216-A-15 French Drain: December 1955 to 1972.

216-A-38 Crib: Never used.

Waste Volume:

216-A-5 Crib: 1,630,000,000 L (431,000,000 gal).

216-A-10 Crib: 3,210,000,000 L (979,000,000 gal).

216-A-15 French Drain: 10,000,000 L (2,642,000 gal).

216-A-38 Crib: 0 L.

Evaluation of Scintillation Probe Profiles:

The 216-A-5, -10, and -38 Cribs and the 216-A-15 French Drain are all located within the 200-PO-2 Operable Unit, south of building 202-A. The 216-A-5 Crib is monitored by Wells E24-1, -10, -56, -57, and -58. The 216-A-10 Crib is monitored by Wells E17-1, E24-2, -15 (01-10-02), -59 (01-10-03), -60 (01-10-09), and -160 (01-10-01). No wells are positioned to monitor the 216-A-15 French Drain. The 216-A-38 Crib is monitored by Wells E17-8 and E24-11. Except for Well E24-15, each of these monitoring

wells have been logged by PNL. Wells E24-59, -60, and -160 are also logged by TFSA&S on a semi-annual basis. Well E24-15 was monitored by TFSA&S before it was taken out of service. Details of the monitoring wells and scintillation probe profiles used in this evaluation are given in Table A1-4.

The 216-A-5, -10, and -38 Cribs were evaluated by Fecht et al. (1977), and the 216-A-5 and 216-A-38 Cribs were also evaluated by Brodeur (1988). No previous evaluations are available for the 216-A-15 French Drain. Fecht et al. (1977) and Brodeur (1988) both noted significant levels of gamma radiation in the vadose zone and in the groundwater beneath the 216-A-5 Crib. Both studies conclude that radionuclides from the 216-A-5 Crib may have reached the groundwater. Fecht et al. (1977) similarly concluded that radionuclides from the 216-A-10 Crib may also have reached the groundwater. Elevated gamma activity under the 216-A-38 Crib at a depth of about 30.5 m (100 ft) was observed by Fecht et al. (1977). Since that crib had never been used, this activity was attributed to lateral migration of radionuclides from the 216-A-10 Crib. Brodeur (1988) noted that elevated gamma radiation is evident only in the groundwater beneath the 216-A-38 Crib. The results of this evaluation do not differ significantly from those of Fecht et al. (1977) and Brodeur (1988).

Except for Wells E24-2 and -11, the wells monitoring the 216-A-5, -10, and -38-1 Cribs were compiled into three cross sections and correlated with the stratigraphy from Wells E17-4, located about 160 m (535 ft) to the northwest; E17-12, located about 350 m (1,150 ft) south-southwest; and E24-5, located about 600 m (1,960 ft) north-northwest (Lindsey et al. 1992) (Figure A1-7). This correlation should be considered fair since the changes in lithology have very subtle expression on the gamma logs and the regional mapping by Lindsey et al. (1992) is not detailed on the scale used in this evaluation.

Significant levels of gamma radiation are found under the 216-A-5 and 216-A-10 Cribs. The top of the interval of containing probable anthropogenic radionuclides is found between 9.1 to 11.9 m (30 to 39 ft) below the surface, and the bottom of this interval at a depth of about 53.4 m (175 ft). The top of the elevated gamma radiation is correlated with the top of the Hanford sand in Well E24-10, adjacent to the 216-A-5 Crib (Figure A1-7). Elsewhere, the top of the elevated activity does not correspond to a particular lithologic unit (Figure A1-7). The base of the elevated radiation appears to be controlled by the top of a silty interval found within the Hanford sand (Lindsey et al. 1992). The "sawtoothed" character of the scintillation probe profiles from wells that penetrate the interval of elevated activity suggest that this silty interval inhibited but did not stop the downward migration of gamma emitters (Figure A1-7).

In the evaluations of the 216-A-5 and 216-A-10 Cribs by Fecht et al. (1977) and Brodeur (1988), secondary peaks were noted in the scintillation probe profiles from wells in

the area. Fecht et al. (1977) attributed these secondary peaks to the relatively high retention of gamma emitting radionuclides in fine grained sediments versus that of coarse grained sediments. The well data are inadequate to further characterize these postulated lenses of fine grained material.

The current gross thickness and probable extent of the interval of elevated gamma radiation was mapped (Figure A1-8). This map suggests that the gamma emitters from the 216-A-10 Crib merged with those from the 216-A-5 Crib to the west. This is consistent with the dip of the top of the Hanford sand in this area (Lindsey et al. 1992). There is no explicit evidence of the presence of gamma emitters from the 216-A-15 French Drain. However, the "spreading" of the contours near Well E24-57 and the 13.4 m (44 ft) disposal depth for the 216-A-15 French Drain suggests that there may be some influence on the shape of the region of elevated gamma activity due to radionuclides from the 216-A-15 French Drain.

The extent of the elevated gamma radiation in the subsurface toward the east may have been influenced by the lateral migration of radionuclides from the 216-A-10 Crib when it was active. Fecht et al. (1977) proposed that elevated gamma radiation observed at a depth of about 21.3 m (70 ft) in Well E17-8 was due to gamma emitters migrating laterally from the 216-A-10 Crib. However, to reach the 216-A-38 Crib from the 216-A-10 Crib, gamma emitters would have had to travel up the regional dip of the top of the Hanford sand (Lindsey et al. 1992). The available scintillation profiles from Well E17-8 indicate that gamma activity on this interval had declined to near background levels by 1976. Brodeur (1988) observed no subsequent changes in the profiles for Well E17-8 on this interval. Based on the available data, only small quantities, if any, of radionuclides from the 216-A-10 Crib reached the 216-A-38 Crib area.

Currently, the gamma radiation levels measured by scintillation probes in the groundwater beneath the 216-A-5, -10, -15, and -38 Crib areas are at or near background levels. However, the scintillation probe profiles from Wells E24-10 and E17-1, which monitor the 216-A-5 and 216-A-10 Cribs, respectively, suggest that gamma emitters did reach the groundwater between 1958 and 1979 (Figure A1-7).

There is no evidence that gamma emitters placed in the 216-A-5 and 216-A-10 Cribs are currently migrating laterally or vertically in the subsurface. The location of features on the scintillation probe profiles from the wells monitoring the cribs have remained constant over time (Figure A1-7). The consistent reduction in the amplitude of features on the profiles over time indicates that radionuclide decay is occurring.

A-1.4.4 216-A-6 CRIB

Description of Waste: Steam condensate, equipment disposal tunnel floor drainage, water filled door drainage and the slug storage basin overflow waste from the 202-A Building.

Service Dates: 1955 to 1961, 1966 to 1970.

Waste Volume: 3,400,000,000 L (898,000,000 gal).

Evaluation of Scintillation Probe Profiles:

Wells E25-3 and -53 monitor the 216-A-6 Crib. Details of these wells and the scintillation probe profiles used in this evaluation are given in Table A-1.5.

The scintillation probe profiles for Wells E25-3 and -53 have been evaluated by Fecht et al. (1977), Chamness (1986) and Brodeur (1988). Fecht et al. (1977) observed elevated levels of gamma radiation at the surface and between 6.1 to 12.2 m (20 to 40 ft) below the surface. Chamness (1986) noted that the 1986 profile for Well E25-53 did not differ from previous logs. Brodeur (1988) found no change in the character of the 1987 profiles from earlier profiles for both Wells E25-3 and -53. Brodeur (1988) also observed elevated activity at a depth of 10.7 m (35 ft). This evaluation is consistent with these previous reports.

A cross section was constructed from the compiled scintillation probe profiles from Wells E25-3 and 53 (Figure A1-9). The profiles were roughly correlated with the stratigraphy from Wells E24-5 and E17-4 (Lindsey et al. 1992), located approximately 670 m (2,200 ft) northeast and southeast of the 216-A-6 Crib, respectively.

Elevated gamma radiation was detected at a depth between 6.1 to 12.2 m (20 to 40 ft) in Well E25-3. Slightly elevated radiation levels are also detected in Well E25-53 between 6.1 to 12.2 m (20 to 40 ft). The top of the elevated activity is correlated with the top of the Hanford sand in this area (Lindsey et al. 1992). The distribution of the elevated gamma radiation levels is consistent with the northwesterly regional dip of the top of the Hanford sand (Lindsey et al. 1992).

There is no evidence of vertical migration of radionuclides from the 216-A-6 Crib. The data are inadequate to assess the lateral extent of contaminants in the subsurface down dip from the 216-A-6 Crib.

A-1.4.5 216-A-8, -18, -19, -20, -24, AND -34 CRIBS

Description of Waste:

216-A-8 Crib: Condensate storage tanks in the 241-A Tank Farms and cooling water from the contact condenser in the 241-A-431 Building.

216-A-18 Trench: Depleted uranium mixed waste from the 202-A Building.

216-A-19 and -20 Trenches: Contact condenser cooling water from the 241-A-431 Building and depleted uranium mixed waste from the 202-A Building.

216-A-24 Crib: Condensate from waste storage tanks in the 241-A and 241-AX Tank Farms (low salt mixed waste).

216-A-29 Ditch: Acid fractionator condensate, condenser cooling water, process cooling water, seal cooling water (from air sampler vacuum pumps) and chemical sewer waste from the 202-A Building enroute to the 216-B-3 Pond.

216-A-34 Ditch: Cooling water from the contact condenser in the 241-A-431 Building enroute to the 216-A-19 and -20 Trenches (mixed waste).

216-A-524 Control Structure: Mixed waste, radioactive concrete and piping, details not available.

Service Dates:

216-A-8 Crib: November 1955 to May 1958; January 1966 to April 1976; January 1978 to April 1978; October 1983; March 1984 to 1991.

216-A-18 Trench: November 1955 to January 1956.

216-A-19 and -20 Trenches: November 1955 to January 1956.

216-A-24 Crib: May 1958 to January 1966; inadvertently used 1966 to 1979.

216-A-29 Ditch: November 1955 to 1991.

216-A-34 Ditch: November 1955 to December 1957.

216-A-524 Control Structure: 1957 to January 1966.

Waste Volume:

216-A-8 Crib: 1,150,000,000 L (304,000,000 gal).

216-A-18 Trench: 488,000 L (129,000 gal).

216-A-19 Trench: 1,100,000 L (291,000 gal).

216-A-20 Trench: 96,000 L (25,000 gal).

216-A-24 Crib: 820,000,000 L (217,000,000 gal).

216-A-29 Ditch: 10,400,000,000.

216-A-34 Ditch: No information available.

216-A-524 Control Structure: No information available.

Evaluation of Scintillation Probe Profiles:

The 216-A-8 and 216-A-24 Cribs, 216-A-18, -19, and -20 Trenches, 216-A-29 and 216-A-34 Ditches, and the 216-A-524 Control Structure are all located within the 200-PO-5 Operable Unit, east of the 241-A and 241-AX Tank Farms. The 216-A-8 Crib is monitored by Wells E25-4 (01-08-08), -5 (01-08-09), -6 (01-08-07), -7 (01-08-10), -8 (01-08-03), -9, and -14. The 216-A-18, -19, and -20 Trenches and the 216-A-34 Ditch are monitored by Well E25-10. The 216-A-24 Crib is monitored by Wells E26-2, -3, -4, -5, -7, -53, and -54. The 216-A-29 Ditch is monitored by Wells E25-28 and -169. No monitoring wells are located near the 216-A-524 Control Structure. All of these monitoring wells have been logged by PNL. Wells E25-4 (01-08-08), -5 (01-08-09), -6 (01-08-07), -7 (01-08-10), and -8 (01-08-03) are currently logged by TFSA&S on a semi-annual basis (Welty and Vermeulen 1989). Details of the monitoring wells are given in Table A1-6.

The 216-A-8 Crib has been evaluated by Fecht et al. (1977). They concluded that no measurable migration of radionuclides has occurred beneath this crib and that breakthrough to the groundwater has not occurred. The conclusions of this evaluation differ from those of Fecht et al. (1977) on both points.

The 216-A-24 Crib has been evaluated by Fecht et al. (1977), Chamness (1986) and Brodeur (1988). Fecht et al. (1977) concluded that measurable downward migration of contaminants occurred beneath the 216-A-24 Crib during waste disposal activities. They also concluded that gamma emitters have reached the water table under the western end of the

216-A-24 Crib. Chamness (1986) reported that by 1986, activity in the vadose zone had decayed to background levels. Brodeur (1988) also reported background levels in the vadose zone. The activity detected between 61 to 73.2 m (200 to 240 ft) in depth reported by Brodeur (1988) is probably due to changes in lithology at that depth. The conclusions of this evaluation for the 216-A-24 Crib are consistent with the previous studies.

Scintillation probe profiles from wells monitoring the 216-A-18, -19, and -20 Trenches, the 216-A-29 and 216-A-34 Ditches, and the 216-A-524 Control Structure have not been previously evaluated.

Except for Wells E25-6, -28, and E26-54, the wells monitoring the 216-A-8 and 216-A-24 Cribs, the 216-A-18, -19, and -20 Trenches, and the 216-A-29 and 216-A-34 Ditches were compiled into three cross sections and correlated with the lithologic column for Well E26-6 (Lindsey et al. 1992) and the regional mapping of Lindsey et al. (1992) (Figures A1-10 and A1-11). There is a discrepancy between the location of Well E25-6 given by the GIS coordinates used to construct the basemap and that used on the TFSA&S map (Welty and Vermeulen 1989). The elevation for the top of casing of 207 m (680 ft) given by the GIS listing for Well E25-14 is probably incorrect. The top of casing of 2 nearby Wells (E25-4 and 5) are both less than 200 m (660 ft). On cross section B-B' (Figure A1-10), the scintillation probe profile for well E25-14 was positioned to reflect a more consistent top of casing. Although the expression of the lithologic changes is subtle on the scintillation profiles in this area, the correlation may be considered good since well E26-6 is located adjacent to the area (about 175 m or 600 ft west of the 216-A-24 Crib).

Significant levels of gamma radiation are currently found beneath the 216-A-8 and 216-A-24 Cribs and the 216-A-29 Ditch. The thickness and estimated extent of these regions of elevated gamma radiation are shown in Figure A1-12. Except in Wells E25-14 (monitoring the 216-A-8 Crib) and E26-7 (monitoring the 216-A-24 Crib), the region of elevated gamma radiation is confined to the lower of 2 upward-fining sequences, which comprise the Hanford upper gravel in this area (Lindsey et al. 1992). The top of this lower sequence is 3 to 8.2 m (10 to 27 ft) below the surface and the bottom at 15.2 to 21.3 m (50 to 70 ft) below the surface (Figures A1-10 and A1-11). The highest levels of gamma radiation are currently detected at the top of this lower sequence and, except in Wells E25-14 and E26-7, decline to background levels at its base. In the vicinity of Wells E25-14 and E26-7, elevated radiation levels are detected well into the Hanford sand.

The existing data from wells monitoring the 216-A-8 Crib are inadequate to fully define the lateral extent and potential for lateral migration of radionuclides in the subsurface. The map representing the thickness and extent of radionuclides in the subsurface is poorly constrained north and northeast of the 216-A-8 Crib due to lack of well control (Figure A1-12). No wells have been placed north of the 216-A-8 Crib, near potential contributors

(the 216-A-18, -19, -20, and -34 waste management units) to the elevated activity detected, and no wells have been placed northeast of the 216-A-8 Crib, down the regional dip of the top of the Hanford sand.

The increased thickness of the interval of elevated gamma activity under the 216-A-8 Crib in the vicinity of Well E25-14 (Figure A1-12) suggests that the radionuclides placed in the crib have moved southward. This is not consistent with the northeasterly regional dip of the top of the Hanford sand (Lindsey et al. 1992). Although the cross sections in Figures A1-10 and A1-11 are consistent with the regional mapping of Lindsey et al. (1992), the correlations used are open to interpretation. It is possible that locally, the top of the Hanford sand dips toward the south. An alternative interpretation is that Well E25-14 was not properly constructed and serves as a conduit for the downward migration of contaminants. This would explain the inconsistent location of the thickest interval of elevated radiation relative to the 216-A-8 Crib and the regional dip of the Hanford sand. Also, the inconsistent character of the profiles from Well E25-14 relative to those from the surrounding wells could be explained by the difference in the pathways into the subsurface followed by the gamma emitters (Figure A1-10).

There is evidence of measurable downward migration of contaminants under the 216-A-8 Crib. Peaks and troughs in the profiles for Wells E25-4, -5, -7, and -14 show a downward displacement of about 1 m (3 ft) over 5 years (Figure A1-10) within the Hanford upper gravel. The development of a secondary peak at a depth of 50 to 55 m (165 to 180 ft) on the 1982 scintillation probe profile for Well E25-14 (Figure A1-10) is additional evidence of vertical migration of gamma emitters. Increasing radiation levels detected near the bottom of the 1987 profile (at a depth of 44 m or 145 ft) suggest that the peak is broadening. Currently, all of the wells monitored by TFSA&S are only logged to a depth of 45.7 m (150 ft), which is inadequate to detect this secondary peak.

Currently, there is no evidence that gamma emitters reach the water table under the 216-A-8 Crib. However, logs collected in 1958 from the wells monitoring this crib show levels of activity 2 or 3 orders of magnitude above background levels for logs of this vintage within the Ringold Formation and approaching the water table (Figure A1-10).

The lateral extent of elevated gamma radiation beneath the 216-A-24 Crib is adequately constrained by surrounding wells (Figure A1-12). Fecht et al. (1977) noted that there was measurable downward migration of contaminants under the western end of this crib when it was active. There is no evidence of downward migration of gamma emitters on more recent profiles (Figures A1-10 and A1-11). The extreme thickness of the interval of elevated gamma activity in Well E26-7 relative to that of detected other, nearby wells suggests that the well bore itself may be a conduit for downward migration of radionuclides (Figure A1-12). The increase in activity from 1968 levels measured in Well E26-7 in 1976

while all of the other wells monitoring the 216-A-24 Crib had lower levels of activity is further evidence that Well E26-7 may be improperly constructed (Figure A1-13).

Currently there is no evidence that gamma emitters reach the water table under the 216-A-24 Crib. However, levels of activity well above background levels were detected within the Ringold Formation in 1958 (Figures A1-10, A1-11 and A1-13). The proximity of elevated radiation levels to the water table suggests that radionuclides may have reached the groundwater under this crib.

There is evidence of gamma emitters from the 216-A-29 ditch in the subsurface. A thin interval 4 m (13 ft) of elevated gamma radiation is detected in Well E25-169 and background levels are detected in Well E25-28 (Figure A1-12). Since background gamma radiation levels are measured in Wells E25-8 and E25-9, at the eastern end of the 216-A-8 Crib and there are no other waste management units in the area, it is likely that the source of the gamma emitters detected in Well E25-169 is the 216-A-29 Ditch. The data from Wells E25-28 and E25-169 are inadequate to further constrain the extent of gamma emitters under the 216-A-29 Ditch.

A-1.4.6 216-A-9 CRIB AND 216-A-40 TRENCH

Waste Description:

216-A-9 Crib: Acid fractionator condensate and condenser cooling water from the 202-A Building; N Reactor decontamination waste.

216-A-40 Trench: Cooling water and steam condensate from the 244-AR Vault.

Service Dates:

216-A-9 Crib: March 1956 to February 1958; April 1966 to October 1966; August 1969.

216-A-40 Trench: January 1968 to 1979.

Waste Volume:

216-A-9 Crib: 981,000,000 L (259,000,000 gal).

216-A-40 Trench: 946,000 L (250,000 gal).

Evaluation of Scintillation Probe Profiles:

Both the 216-A-9 Crib and the 216-A-40 Trench are located within the 200-PO-1 Operable Unit, west of the 241-A and 241-AX Tank Farms. The 216-A-9 Crib is monitored by Wells E24-3, -4, -5, and -63. The 216-A-40 Trench is monitored by the E27-3 well, located about 45.7 m (150 ft) off the northern end of the trench. Details of the monitoring wells and scintillation probe profiles used in this evaluation are given in Table A-1.7.

The 216-A-9 Crib has been evaluated in the past by Fecht et al. (1977) and Chamness (1986). No previous evaluations are available for the 216-A-40 Trench. Fecht et al. (1977) reported that the region of elevated gamma radiation under the 216-A-9 Crib detected in 1963 had declined to near background levels by 1976. Chamness (1986) found no further change in the conditions under the 216-A-9 Crib in the profile from well E24-63 collected in 1986. The conclusions of the current evaluation does not differ from those of the previous studies.

The scintillation probe profiles from the wells monitoring the 216-A-9 Crib were compiled into a cross section and correlated with the stratigraphic column available from Well E24-5 (Lindsey et al. 1992) (Figure A1-14). The well monitoring the 216-A-40 Trench was also correlated with the stratigraphic column for Well E24-5 (located about 230 m or 750 ft to the south-southwest) (Figure A1-14). Although Well E24-5 is within the area evaluated, the lithographic correlations are only fair because the changes in lithology have very subtle or no expression on the scintillation profiles, and the regional mapping of Lindsey et al. (1992) is not detailed on the scale used in this evaluation.

Currently, there is no evidence of elevated gamma radiation beneath the 216-A-9 Crib and the 216-A-40 Trench. Based upon the regional dip of the top of the Hanford sand (Lindsey et al. 1992), which probably controls the lateral distribution of radionuclides from the waste management units, the wells near the 216-A-9 Crib are well placed to detect the presence of gamma emitters in the subsurface. Although the well monitoring the 216-A-40 Trench is also down dip, it may be too far from the trench (45.7 m or 150 ft off the northern end of the trench) to detect any gamma emitters from the trench.

A-1.4.7 216-A-30, -37, AND -42 CRIBS

The crib statistics were taken from Fecht et al. (1977) unless otherwise noted.

Description of Waste:

216-A-30 Crib: Low-level liquid waste from the 202-A Building; steam condensate, equipment disposal tunnel floor drainage, water filled door drainage and slug storage basin overflow.

216-A-37-1 Crib: Low-level process condensate from the 242-A Evaporator.

216-A-37-2 Crib: Low-level steam condensate from the 202-A Building.

216-A-42 Retention Basin: Chemically or radioactively contaminated diversions from the PUREX sewer line cooling water line and steam condensate discharge. Depending on treatment required for waste, it may be released to the 216-A-30 and 216-A-37-2 Cribs, to PUREX process piping or to the tank farms.

Service Dates:

216-A-30 Crib: January 1961 to November 1965; January 1970 to 1991.

216-A-37-1 Crib: March 1977 to 1991.

216-A-37-2 Crib: 1983 to Present.

216-A-42 Retention Basin: September 1978 to Present.

Monitoring Frequency:

216-A-30 Crib: Semi-Annual.

216-A-37-1 & 2 Cribs: Semi-Annual.

216-A-42 Retention Basin: Not Monitored Regularly.

Waste Volume:

216-A-30 Crib: 7,110,000,000 L (1,880,000,000 gal).

216-A-37-1 Crib: 377,000,000 L (99,600,000 gal).

216-A-37-2 Crib: 1,090,000,000 L (288,000,000 gal).

216-A-42 Retention Basin: Not Applicable.

Evaluation of Scintillation Probe Profiles:

The 216-A-30, -37-1, and -37-2 Cribs and the 216-A-42 Retention Basin are located within the 200-PO-4 Operable Unit. Each of these 4 units are active. The 216-A-30 Crib is monitored by Wells E16-2, E25-11, -12 (01-30-06), -190 (01-30-11), -191 (01-30-23) and -193 (01-30-03) (Fecht et al. 1977; Welty and Vermeulen 1989). The 216-A-37-1 Crib is monitored by Wells E25-17, -18 (01-37-11), -19 (01-37-05), and -20 (Welty and Vermeulen 1989). Well E25-17 is also in a location suitable to monitor the 216-A-42 Retention Basin. The 216-A-37-2 Crib is monitored by Wells E25-21, -22 (01-37-22), -23 (01-37-17), and -24 (Welty and Vermeulen 1989). The location of the 216-A-37-2 Crib does not agree with that shown by Welty and Vermeulen (1989).

Scintillation probe profiles have been collected for most of these wells by PNL or Westinghouse's TFSA&S. Wells E25-12, -17, -18, -190, -191, and -193 are currently logged by TFSA&S on a semi-annual basis (Welty and Vermeulen 1989). Well E25-19 has been taken out of service (Welty and Vermeulen 1989). The PNL has logged Wells E16-2, E25-17, -18, -19, and -20. Wells E25-37 and -38, which are northwest of the 216-A-30, -37 and -42 Crib area, have also been logged by PNL. There are no profiles available for the wells monitoring the 216-A-37-2 Crib (Wells E25-21, -22, -23, and -24). Details of the monitoring wells and the logs used in this evaluation are given in Table A1-8.

The only available previous evaluation of scintillation probe profiles from the monitoring wells in the 216-A-30, -37, and -42 area is that of Fecht et al. (1977) for the 216-A-30 Crib. They found that the low levels detected in 1963 had declined to near background levels. They found no evidence of radionuclide migration beneath the 216-A-30 Crib and concluded that breakthrough to the groundwater had not occurred. The present evaluation does not address the issue of the 1963 contamination since levels had reached background by 1976 and there is no evidence of migration of radionuclides.

Scintillation probe profiles from Wells E16-2, E25-12, -17, -18, -19, -190, -191, and -193 were compiled into two cross sections (Figure A-12). These cross sections were roughly correlated with the stratigraphy from Wells E17-12 and E26-6 (Lindsey et al. 1990), located 1,130 m (3,720 ft) east and 820 m (2,700 ft) north, respectively, and with the regional mapping of Lindsey et al. (1990). This correlation must be considered poor since the wells are very far from the area evaluated, the mapping of Lindsey et al. (1990) is not detailed on the scale used and the lithologic boundaries do not have a clear signature on the gamma logs in this area.

Low to moderate levels of gamma radiation is detected under the 216-A-30 Crib (Figure A1-12). The potential extent and thickness of the region of elevated gamma radiation is shown in Figure A1-13. The top of this plume corresponds to the base of the 216-A-30 Crib, within the Hanford Upper Gravel and the base of the plume is at or near the top of the Hanford Sand (Figure A1-12). The northwesterly location of this plume relative to the 216-A-30 Crib implies that the lateral migration of radionuclides during emplacement is controlled by the regional dip of the top of the Hanford Sand (Lindsey et al. 1990).

There is evidence that the region of elevated gamma radiation under the 216-A-30 Crib is currently migrating in a vertical direction. The peaks on the scintillation profiles from wells E25-190, -191, and -193 have broadened and moved downward 0.3 to 1.5 m (1 to 5 ft) in the 8 years between 1982 and 1990 (Figure A1-12).

Background levels of gamma radiation were detected in the vicinity of the wells monitoring the 216-A-37-1 Crib and 216-A-42 Retention Basin. The wells monitoring these structures are well placed to detect any laterally migrating radionuclides (assuming the 216-A-42 Retention Basin is properly located) given the northwesterly dip of the top of the Hanford Sand in this area and the behavior of the contaminant plume from the 216-A-30 Crib.

Since there are no scintillation probe profiles available for the wells monitoring the 216-A-37-2 Crib, no evaluation could be done of this active unit.

A-1.4.8 216-A-45 CRIB

Description of Waste: Process condensate (low-level waste) from the 202-A Building.

Service Dates: March 4, 1987 to 1989.

Monitoring Frequency: Semi-Annual.

Waste Volume: 103,000,000 L (27,000,000 gal).

Evaluation of Scintillation Probe Profiles:

The 216-A-45 Waste Management Unit is an active crib monitored by Wells E25-12, -13, -53 (01-45-04) and -54 (01-45-10). Wells E25-53 and 54 are logged by TFSA&S on a semi-annual basis (Welty 1988). Wells E25-12 and -13 were last monitored by PNL in 1986, prior to the commencement of waste disposal activities. Details of the monitoring wells and scintillation probe profiles used in this evaluation are given in Table A1-9.

Scintillation probe profiles from the wells monitoring the 216-A-45 Crib have not been previously evaluated.

Scintillation probe profiles from Wells E25-53 and E25-54 were compiled into a cross scetion and roughly correlated with a stratigraphic column for Well E25-12 (Lindsey et al. 1992) (Figure A1-17). Since the scintillation probe profile for E25-12 was collected before wastes were placed in the 216-A-45 Crib, it represents background conditions in the subsurface. Subtle changes in the profile for Well E25-12 correspond to the top of the Hanford sand, the top of the Hanford lower gravel and the top of the Ringold Formation (Figure A1-17). Internal facies changes of these lithologic units are not expressed on the gamma logs.

Elevated gamma radiation (2 to 3 times background levels) is evident in Wells E25-53 and E25-54 from a depth of about 12.2 m (40 ft) to the bottom of the wells (Figure A1-17). The top of the elevated radiation corresponds to the base of the crib and to the top of the Hanford sand. A secondary peak appears to be developing at a depth of about 32 m (105 ft) in Well E25-53. This can be correlated with the top of a silty interval within the Hanford sand.

The vertical extent of elevated gamma radiation beneath cannot be determined from these data since Wells E25-53 and E25-54 do not penetrate the region of elevated activity and no current scintillation probe profiles are available for Wells E25-12 and E25-13. However, assuming that background conditions existed in the subsurface before waste disposal activities commenced, the current interval of elevated radiation detected in wells E25-53 and E25-54 is good evidence of vertical migration of radionuclides.

Although the lateral extent of contaminants in the 216-A-45 Crib area cannot be determined from these data, the potential for lateral migration can be assessed. Such migration is likely to be controlled by the dip direction of the top of the Hanford sand and the silty interval within the Hanford sand. The top of the Hanford sand is dipping to the northeast according to the regional mapping of Lindsey et al. (1992). Since the top of the Hanford Sand is an erosional surface, the dip direction of the silty interval within the Hanford sand cannot be determined from the mapped data.

A-1.4.9 241-A TANK FARM AREA

Description of Waste

101-A Tank: Mixed wastes including B Plant and PUREX high-level waste, PUREX organic and carbonate wash waste, double-shell slurry feed, and complexed and noncomplexed waste. Potential flammable gases (hydrogen).

102-A Tank: Mixed wastes including B Plant and PUREX high-level waste, PUREX carbonate wash waste, PUREX sludge supernatant, double-shell slurry feed, evaporator waste, and complexed and noncomplexed waste.

103-A Tank: Mixed wastes including B Plant and PUREX high-level waste, PUREX organic and carbonate wash waste, PUREX sludge supernatant, double-shell slurry feed, evaporator waste, waste fractionization ion exchange waste and complexed and noncomplexed waste.

104-A Tank: Mixed noncomplexed wastes including B Plant and PUREX high-level waste, PUREX organic and carbonate wash waste, and PUREX sludge supernatant. High heat waste.

105-A Tank: Mixed noncomplexed wastes including PUREX high-level waste and PUREX inorganic wash waste. High heat waste.

106-A Tank: Mixed wastes including concentrated phosphate waste, PUREX organic, inorganic and carbonate wash waste, B Plant and PUREX high-level waste, and complexed concentrate.

Service Dates:

101-A Tank: 1/24/56 to 11/21/80.
Partially Isolated 12/15/82.

102-A Tank: 3/22/56 to 11/21/80.
Interim Isolated 12/15/82.
Interim Stabilized

103-A Tank: 5/17/56 to 8/14/80.
Partially Isolated 12/15/82.
Assumed Leaker 1987.
Interim Stabilized 8/88.

104-A Tank: 6/30/58 to 4/75.
Confirmed Leaker 1975.
Interim Stabilized 9/78.
Interim Isolated 12/15/82.
Stabilized (1984).

105-A Tank: 1962 to 11/71.
Confirmed Leaker 1963.
Interim Stabilized 7/79.
Stabilized 1984.
Interim Isolated 10/3/85.

106-A Tank: 1957 to 1980.
Interim Stabilized 8/82.
Interim Isolated 12/25/82.
Stabilized 1984.

Waste Volume:

101-A Tank: 953,000 gal Total Waste Volume.
950,000 gal Salt cake.
3,000 gal Sludge.
(413,000 gal Drainable Interstitial Liquid).

102-A Tank: 41,000 gal Total Waste Volume.
22,000 gal Salt cake.
15,000 gal Sludge.
4,000 gal Supernatant.
(6,000 gal Drainable Interstitial Liquid).

103-A Tank: 370,000 gal Total Waste Volume.
366,000 gal Sludge.
4,000 gal Supernatant.
(17,000 gal Drainable Interstitial Liquid).
5,500 gal Estimated Leaked Volume.

104-A Tank: 28,000 gal Total Waste Volume.
28,000 gal Sludge.
2,500 gal Estimated Leaked Volume.

105-A Tank: 19,000 gal Total Waste Volume.
19,000 gal Sludge.
(4,000 gal Drainable Interstitial Liquid).
3,000 to 15,000 gal Estimated Leaked Volume.

106-A Tank: 125,000 gal Total Waste Volume.
125,000 gal Sludge.
(7,000 gal Drainable Interstitial Liquid).

Evaluation of Scintillation Probe Profiles

The 241-A Tank Farm is located within the 200-PO-3 Operable Unit, northeast of the PUREX Chemical Separations Facility. Each of the 6 single-shell tanks in the 241-A Tank Farm has a capacity of 1,000,000 gal. All of these tanks were removed from service by 1980, and have been initially stabilized. Each tank has a status of interim isolated or partially interim isolated. Tanks 241-A-104 and 241-A-105 have been categorized as confirmed leakers (Welty 1988) (assumed leakers in Hanlon 1991) and tank 241-A-103 as an assumed leaker (Hanlon 1991; Welty 1988). Vapors from these tanks are processed along with those from the 241-AZ Tank Farm in the 241-AX facilities and routed to the 241-A or 241-AX Tank Farm tanks or are disposed of in the 216-A-24 Crib.

There are 7 outlying monitoring wells around the 241-A Tank Farm, 3 of which reach the water table. Tank 241-A-101 is monitored by 11 drywells, and by one well that reaches the water table (E25-1, 10-01-05). Tanks 241-A-102, -103, -104, -105, and -106 are monitored by 7 drywells each. The wells that are used to monitor the subsurface gamma activity in the 241-A Tank Farm are periodically logged by TFSA&S. Only 1 well, E24-65, is not logged by TFSA&S. This well was logged once by PNL in 1987. Details of each monitoring well within the 241-A Tank Farm are given in Table A-1.10.

The wells used in this evaluation were selected based upon their historic activity as reported by Welty (1988). Logs from wells in which activity above 50 ct/sec was reported (Welty 1988) and logs from neighboring wells were used. It appears that elevated near surface activity was not always reported. It is possible that many wells where potential surface contamination was recorded may have been left out by the screening process used, so the extent of the near-surface region of elevated gamma radiation may not be adequately characterized in this evaluation.

Scintillation probe profiles from selected monitoring wells within the 241-A Tank Farm were compiled into five cross sections and correlated with the lithologic cross sections of Price and Fecht (1976) (Figures A1-18, A1-19, and A1-20). The correlation between

features on the scintillation probe profiles and the lithologic sections of Price and Fecht (1976) were good.

The stratigraphy of the 241-A Tank Farm area can be divided into 3 units. The shallowest of these is the poorly sorted backfill composed of native material, which was used to fill the excavation where the tanks were placed (Price and Fecht 1976). The fill extends from the local surface grade to the base of the tanks, at a depth of about 16.8 m (55 ft). The fill material is composed of poorly sorted, slightly silty, pebbly, very coarse to coarse sand (Price and Fecht 1976). Beneath the backfill, a pebbly facies of the Hanford sand is found that reaches depths of 29 to 38.1 m (95 to 125 ft) below the surface. This pebbly facies is composed of interfingering lenses of pebbly material with varying amounts of silt and grain distributions of sand. Occasionally, well sorted lenses of sandy material, with no pebbles, are found (Price and Fecht 1976). Beneath the pebbly facies, a relatively homogenous sandy facies of the Hanford sand is found. This sandy facies grades laterally from slightly silty, coarse to medium sands and coarse to medium sands into slightly pebbly, very coarse to coarse sands and slightly silty coarse to medium sands in the southeastern part of the farm, under tank A-101 (Price and Fecht 1976). On the lithologic sections of Price and Fecht (1976), a "high" trending to the north is evident in the top of the sandy facies beneath tanks 241-A-102 and 241-A-103.

Significant levels of gamma radiation are detected at or near the ground surface, within the backfill and within the pebbly facies of the Hanford sand in several areas of the 241-A Tank Farm. The relationships between the depths and lateral extent of each occurrence of gamma emitters is complex. It appears that the near surface occurrences of elevated gamma radiation merge laterally over much of the area into two or three large areas (Figure A1-21). There may be several different sources of gamma emitters within these areas. At greater depths, there appears to be two areas where elevated gamma radiation is detected in the backfill, and three within the pebbly facies (Figure A1-22). These areas overlap to a certain extent and may merge in some places.

A-1.4.10 241-AX TANK FARM AREA

Description of Waste:

101-AX Tank: Mixed wastes including double-shell slurry feed, PUREX sludge supernatant, fission product waste, and organic wash waste. Potential flammable gases (Hydrogen).

102-AX Tank: Mixed wastes including B-Plant high-level waste, PUREX high-level waste, complexed and noncomplexed waste, complexed concentrate.

103-AX Tank: Mixed wastes including PUREX high-level waste and PUREX sludge supernatant (complexant concentrate waste in Hanlon (1991)). Potential flammable gases Hydrogen).

104-AX Tank: Mixed waste including PUREX high-level waste and PUREX sludge supernatant (noncomplexed waste in Hanlon (1991)).

Service Dates:

101-AX Tank: 1965 to 11/12/80.
Partially Isolated 12/15/82.

102-AX Tank: 1966 to 9/8/80.
Interim Isolated 12/15/82.
Interim Stabilized 9/88.
Assumed Leaker 1988.

103-Ax Tank: 1965 to 9/8/80.
Partially Isolated 12/15/82.
Interim Isolated
Interim Stabilized

104-AX Tank: 1966 to 1976 (9/78 in Welty (1988)).
Assumed Leaker 11/77.
Primary Stabilization 9/78.
Interim Stabilized 8/10/81.
Interim Isolated 12/15/82.
Stabilized 1984.

Waste Volume:

101-AX Tank: 748,000 gal Total Waste Volume.
3,000 gal Sludge.
745,000 gal Salt cake.
320,000 gal Drainable Interstitial Liquid.

102-AX Tank: 39,000 gal Total Waste Volume.
7,000 gal Sludge.
29,000 gal Salt cake.
3,000 gal Supernatant.
14,000 gal Drainable Interstitial Liquid.

Estimated Volume of Leaked Waste: 3,000 gal.

103-AX Tank: 112,000 gal Total Waste Volume.
2,000 gal Sludge.
110,000 gal Salt cake.
36,000 gal Drainable Interstitial Liquid.

104-AX Tank: 7,000 gal Total Waste Volume.
7,000 gal Sludge.

Estimated Volume of Leaked Waste: N/A

Evaluation of Scintillation Probe Profiles

The 241-AX Tank Farm is located within the 200-PO-3 Operable Unit, northeast of the PUREX Chemical Separation Facility. Each of the 4 single-shell tanks in the 241-AX Tank Farm has a capacity of 1,000,000 gal. These tanks have been removed from service and the ventilation system isolated from other tank farms. The 241-101-AX Single-Shell Tank is monitored by 8 drywells, the 241-102-AX Single-Shell Tank by 11 drywells, the 241-103-AX Single-Shell Tank by 6 drywells, and the 241-104-AX Single-Shell Tank by 7 drywells. These wells are periodically logged by TFSA&S. Details of the wells monitoring the 241-AX Tank Farm tanks are given in Table A1-11.

Several of the wells monitoring the 241-AX Tank Farm tanks were compiled into four cross sections and correlated with the lithologic cross sections in Price (1976) (Figures A1-23, A1-24, and A1-25). Subtle changes in the logs often correspond to changes in the grain size distribution of the sediments. There is a discrepancy between the location for Well E25-121 (11-04-07) on the as-built drawing (Drawing # H-2-36935, Rev. 4, Welty 1988) and that of Price (1976), so that well was not used in any of the cross sections. The top of casing for each well in the 241-AX Tank Farm was scaled from the cross sections of Price (1976).

The stratigraphy of the 241-AX Tank Farm area can be divided into 3 units. The shallowest of this is the poorly sorted fill which envelops the tanks and consists of slightly pebbly, slightly silty coarse to fine sand (Price, 1976). At the base of the fill and the tanks, a pebbly facies of the Hanford sand is present. This pebbly facies is made up of discontinuous lenses of pebbly material with varying amounts of silt and grain distributions of sand. The top of the pebbly facies is at an elevation of about 190 m (625 ft) and its base dips in a westerly direction from an elevation of about 182 m (600 ft) to about 175 m (575 ft) (Price 1976). A relatively homogeneous sandy facies of the Hanford sand is found. This

sandy facies consists of slightly silty, very coarse to medium sand with occasional lenses of relatively sandy or silty material (Price 1976).

Presently, there are eight areas of potential contamination by anthropogenic radionuclides within the 241-AX Tank Farm (Figure A1-26). In two of these areas, elevated gamma activity can be correlated between three or four adjacent wells. The remaining occurrences of elevated gamma radiation are isolated areas near single wells. In all of these areas, the gamma emitters detected are confined to the fill material. Activity is mainly found at or near the surface and declines to background levels with increasing depth. There is no evidence of elevated gamma radiation within the Hanford sand.

A-1.4.11 241-C Tank Farm

Description of Waste:

101-C Tank: Bismuth phosphate, tributyl phosphate and PUREX coating mixed wastes.

102-C Tank: Bismuth phosphate, tributyl phosphate, PUREX coating, Thoria high-level and PUREX organic wash mixed wastes.

103-C Tank: Tributyl phosphate, Purex coating, organic wash, PUREX high- and low-level, PUREX sludge supernatant, B-Plant waste fractionization, B-Plant high-level, laboratory, decontamination, REDOX ion exchange and high-level, noncomplexed, N Reactor, PNL and evaporator bottom mixed wastes.

104-C Tank: Bismuth phosphate, PUREX coating, organic wash, tributyl phosphate, PUREX high- and low-level, B-Plant high-level, decontamination, REDOX high-level, waste fractionization ion exchange, N Reactor, PNL, evaporator bottoms, Thoria high- and low-level and complexed mixed wastes.

105-C Tank: Tributyl phosphate , PUREX coating and sludge supernatant, bismuth phosphate first-cycle, PUREX high-level, B-Plant waste fractionization, REDOX high-level and supernatant, noncomplexed, metal and cesium feet mixed wastes.

106-C Tank: PUREX coating and high-level, waste fractionization ion exchange, tributyl phosphate and PUREX sludge supernatant mixed wastes.

107-C Tank: Tributyl phosphate, PUREX coating, bismuth phosphate first-cycle, Hot Semiworks, Hanford laboratory operations, decontamination, waste fractionization ion exchange, N Reactor, PNL and evaporator bottom mixed wastes.

108-C Tank: Tributyl phosphate, PUREX coating, bismuth phosphate first-cycle, Hot Semiworks, organic wash, laboratory, decontamination, REDOX high-level, waste fractionization ion exchange, N Reactor and PNL mixed wastes.

109-C Tank: Bismuth phosphate, tributyl phosphate, PUREX coating, Hot Semiworks, evaporator bottom and ion exchange mixed wastes.

110-C Tank: Bismuth phosphate, tributyl phosphate, organic wash, coating, REDOX ion exchange and evaporator bottom mixed wastes.

111-C Tank: Tributyl phosphate, PUREX coating and organic wash, bismuth phosphate first-cycle, Hot Semiworks, evaporator bottom and ion exchange mixed wastes.

112-C Tank: Tributyl phosphate, PUREX coating, Hot Semiworks and ion exchange mixed wastes.

201-C Tank: Bismuth phosphate and strontium Semiworks mixed wastes.

202-C Tank: Bismuth phosphate, strontium Semiworks and ion exchange mixed wastes.

203-C Tank: PUREX high-level mixed waste.

204-C Tank: PUREX high-level mixed waste.

<u>Service Dates:</u>

101-C Tank: 3/46 to 12/69.
Questionable Integrity 1970.
Primary Stabilization 3/78.
Confirmed Leaker 1/80.
Interim Isolated 12/82.
Interim Stabilized 11/83.

102-C Tank: 5/46 to 1976.
Partially Isolated 12/82.

103-C Tank: 8/46 to
Partially Isolated 12/82.

104-C Tank: 10/46 to
Partially Isolated 12/82.
Interim Stabilized
Interim Isolated

105-C Tank: 2/46 to
Partially Isolated

106-C Tank: 6/47 to 1979.
Partially Isolated

107-C Tank: 4/46 to 1976.
Partially Isolated 12/82.

108-C Tank: 9/47 to 1976.
Interim Isolated 12/82.
Interim Stabilized 3/84.

109-C Tank: 4/48 to 1976.
Interim Isolated 12/82.
Interim Stabilized 11/83.

110-C Tank: 5/46 to 1976.
Questionable Integrity 1977.
Primary Stabilization 9/79.
Partially Isolated 12/82.
Assumed Leaker 1984.

111-C Tank: 8/46 to 1968.
Questionable Integrity 1968.
Interim Isolated 12/82.
Interim Stabilized 3/84.

112-C Tank: 11/46 to 1976.
Partially Isolated 12/82.
Interim Stabilized

201-C Tank: 1953 to 1977.
Interim Stabilized 3/82.
Interim Isolated 12/82.
Assumed Leaker

202-C Tank: 1953 to 1977.
Interim Stabilized 8/81.
Interim Isolated 12/82.
Assumed Leaker

203-C Tank: 1953 to 1977.
Interim Stabilized 3/82.
Interim Isolated 12/82.
Confirmed Leaker 8/84.

204-C Tank: 1953 to 1977.
Primary Stabilization 12/78.
Interim Stabilization 9/82.
Interim Isolated 12/82.
Assumed Leaker

Waste Volume:

101-C Tank: 333,000 L (88,000 gal) Total Waste Volume.
333,000 L (88,000 gal) Sludge.
11,000 L (3,000 gal) Drainable Interstitial Liquid.

102-C Tank: 1,616,000 L (427,000 gal) Total Waste Volume.
1,605,000 L (424,000 gal) Sludge.
11,000 L (3,000 gal) Supernatant.
170,000 L (45,000 gal) Drainable Interstitial Liquid.

103-C Tank: 738,000 L (195,000 gal) Total Waste Volume.
235,000 L (62,000 gal) Sludge.
503,000 L (133,000 gal) Supernatant.

104-C Tank: 1,117,000 L (295,000 gal) Total Waste Volume.
1,117,000 L (295,000 gal) Sludge.
42,000 L (11,000 gal) Drainable Interstitial Liquid.

105-C Tank: 568,000 L (150,000 gal) Total Waste Volume.
568,000 L (150,000 gal) Sludge.
42,000 L (11,000 gal) Drainable Interstitial Liquid.

106-C Tank: 867,000 L (229,000 gal) Total Waste Volume.
746,000 L (197,000 gal) Sludge.
121,000 L (32,000 gal) Supernatant.
61,000 L (16,000 gal) Drainable Interstitial Liquid.

107-C Tank: 1,276,000 L (337,000 gal) Total Waste Volume.
1,276,000 L (337,000 gal) Sludge.
129,000 L (34,000 gal) Drainable Interstitial Liquid.

108-C Tank: 250,000 L (66,000 gal) Total Waste Volume.
250,000 L (66,000 gal) Sludge.

109-C Tank: 250,000 L (66,000 gal) Total Waste Volume.
235,000 L (62,000 gal) Sludge.
15,000 L (4,000 gal) Supernatant.

110-C Tank: 761,000 L (201,000 gal) Total Waste Volume.
742,000 L (196,000 gal) Sludge.
19,000 L (5,000 gal) Supernatant.
61,000 L (16,000 gal) Drainable Interstitial Liquid.

111-C Tank: 216,000 L (57,000 gal) Total Waste Volume.
216,000 L (57,000 gal) Sludge.

112-C Tank: 394,000 L (104,000 gal) Total Waste Volume.
394,000 L (104,000 gal) Sludge.
121,000 L (32,000 gal) Drainable Interstitial Liquid.

201-C Tank: 7,600 L (2,000 gal) Total Waste Volume.
7,600 L (2,000 gal) Sludge.

202-C Tank: 3,800 L (1,000 gal) Total Waste Volume.
3,800 L (1,000 gal) Sludge.

203-C Tank: 19,000 L (5,000 gal) Total Waste Volume.
19,000 L (5,000 gal) Sludge.

204-C Tank: 11,000 L (3,000 gal) Total Waste Volume.
11,000 L (3,000 gal) Sludge.

Evaluation of Scintillation Probe Profiles

The 241-C tank farm is located with in the 200-PO-3 operable unit, north of the PUREX Chemical Separation Facility. Twelve of the sixteen single shell tanks in the 241-C tank farm have a capacity of 533,000 gal., and the remaining four tanks have a capacity of 55,000 gal. These tanks have all been removed from service and have been partially or interim isolated. Tanks C-101, C-110 and C-112 are monitored by 4 drywells, tanks C-103 and C-111 by 5 drywells, tanks C-104 and C-107 by 7 drywells, tank C-105 by 9 drywells, tank C-106 by 6 dry wells and tank C-108 by 3 dry wells. No drywells are constructed to monitor tanks C-102, C-201, C-202, C-203 and C-204. However, the 11 drywells on the perimeter of the 241-C tank farm or wells which monitor neighboring tanks provide a degree of monitoring capability for these tanks. These wells are logged on a periodic basis by TFSA&S. Details of the wells monitoring the C-farm tanks and the scintillation probe profiles used in this evaluation are given in Table A1-12.

Scintillation probe profiles from several of the drywells in the C-farm were compiled into 5 cross sections and correlated with the lithologic cross sections of Price & Fecht (1976c) (Figures A1-27, A1-28, A1-29, A1-30 and A1-31). Although the response of the gamma logs to changes in lithology is often subtle, the correlation between the lithology and the gamma logs can be considered good due to the detail of the available lithologic information and the uniform response between the different vintages of logs used.

The stratigraphy of the C-farm area can be divided into three units. The shallowest of these is the poorly sorted fill which envelops the tanks and consists of gravelly, very coarse to medium sand and occasional silt (Price & Fecht, 1976). The base of the fill, and the tanks, is at an elevation of about 610 feet. Beneath the backfilled excavation for the tank farm, a pebbly facies of the Hanford sand is present. This pebbly facies consists of discontinuous lenses of pebbly material with varying grain size distributions. In the southern portion of the C-farm, there is a lens of slightly silty coarse sand which does not contain pebbles between deeper pebbly material and the backfill. The base of the pebbly facies sediments dip toward the south from an elevation of about 600 feet to about 560 feet across the tank farm. Beneath the pebbly facies of the Hanford sand, a relatively homogeneous sandy facies is found. This sandy facies is generally composed slightly silty, coarse to very coarse sand. Over much of the area, there is discontinuous lens, up to 30 feet thick, of slightly silty coarse to medium sands at the top of the sandy facies sediments. Also, at greater depths within the sandy facies, a lens of slightly pebbly material is present in the northern part of the tank farm (Price & Fecht, 1976c).

Elevated gamma radiation is found within several regions in the fill, the pebbly facies and the sandy facies. There are three areas where elevated activity is detected at or near the surface (Figure A1-32). The sources of this near surface activity can be attributed to known

surface contamination or to radionuclides contained within piping at or near the surface. There is clear evidence of downward migration of gamma emitters in all three of these areas. There are eight areas where elevated radiation is found within the backfill and the pebbly facies (Figure A1-33). Of these, two can be attributed to leaking tanks, five are related to near surface releases and one is of unknown origin (adjacent to tank C-109). The is evidence of downward migration of gamma emitters in seven of the eight occurrences of elevated activity within the fill and the pebbly facies. There are two occurrences of elevated radiation within the sandy facies. The levels of activity of these occurrences is very low and may not be statistically significant on some of the profiles where it is identified (Figures A1-29, A1-30 and A1-31). The source of one of these occurrences can be attributed to a leaking tank, the source of the other is unknown. There is no evidence of downward migration of radionuclides for either of these occurrences of elevated gamma radiation in the sandy facies.

A-1.5 REFERENCES

Additon, M.K., K.R. Fecht, T.L. Jones and G.V. Last, 1978, *Scintillation Probe Profiles 200 East Area Crib Monitoring Wells*, RHO-LD-28, Rockwell Hanford Operations, Richland, Washington.

Arthur, R.J., 1990, 1990 *Yearly Calibration of Pacific Northwest Laboratory's Gross Gamma Borehole Geophysical Logging System,* PNL-7460, Pacific Northwest Laboratory, Richland, Washington.

Brodeur, J.R., 1988, *Fiscal Year 1987 Inactive Crib Monitoring Report*, 80230-88-004, Westinghouse Hanford Company, Richland, Washington.

Brodeur, J.R. and C.J. Koizumi, 1989, *Base Calibration of Pacific Northwest Laboratory's Gross Gamma Borehole Geophysical Logging System,* WHC-EP-0246, Westinghouse Hanford Company, Richland, Washington.

Chamness, M.A., 1986, *Fisical Year 1986 Scintillation Logging Status,* 65633-86-107, Rockwell Hanford Operations, Richland, Washington.

Fecht, K.R., G.V. Last and K.R. Price, 1977, *Evaluation of Scintillation Probe Profiles from 200 Area Crib Monitoring Wells,* ARH-ST-156, Atlantic Richfield Hanford Company, Richland, Washington.

Hanlon, B.M., 1991, *Tank Farm Surveillance and Waste Status Report for July 1991*, WHC-EP-0182-40, Westinghouse Hanford Company, Richland, Washington.

Lane, K.A., 1990, *Requirements Analysis for Surveillance of Single Shell Tank Farm Vadose Zone*, WHC-SD-WM-RD-006, Westinghouse Hanford Company, Richland Washington.

Last, G.V., B.N. Bjornstad, M.P. Bergeron, D.W. Wallace, D.R. Newcomer, J.A. Schramke, M.A. Chamness, C.S. Cline, S.P. Airhart and J.S. Wilbur, 1989, *Hydrogeology of the 200 Areas Low-Level Burial Grounds - An Interim Report*, PNL-6820, Westinghouse Hanford Company, Richland, Washington.

Lindsey, K.A., B.N. Bjornstad, J. Lindberg and K. Hoffman, 1992, *Geologic Setting of the 200 East Area: An Update,* WHC-SD-EN-TI-02, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Price, W.H. and K.R. Fecht, 1976a, *Geology of the 241-A Tank Farm,* ARH-LD-127, Atlantic Richfield Hanford Company, Richland, Washington.

Price, W.H. and K.R.Fecht, 1976b, *Geology of the 241-AX Tank Farm*, ARH-LD-128, Atlantic Richfield Hanford Company, Richland, Washington.

Price, W.H. and K.R.Fecht, 1976c, *Geology of the 241-C Tank Farm*, ARH-LD-132, Atlantic Richfield Hanford Company, Richland, Washington.

Raymond, J.R. and V.L. McGhan, 1964, *Scintillation Probe Results - 200 Area Waste Disposal Site Monitoring Wells*, HW-84577, General Electric Company, Richland, Washington.

Strong, F.S., 1980, *Gamma Calibration Curves - Dry Well Van Probes, Drawing No. H-2-72449*, Rockwell Hanford Operations, Richland, Washington.

Tillson, D.D. and V.L. McGhan, 1969, *Changes in Scintillation Probe Findings - 1964 to 1968, 200 Area Waste Disposal Site Monitoring Wells*, BNWL-CC-2255, Battelle Pacific Northwest Laboratories, Richland, Washington.

Welty, R.K. and N.J. Vermeulen, 1989, *Waste Storage Tank Status and Leak Detection Criteria,* WHC-SD-WM-TI-357, Westinghouse Hanford Company, Richland, Washington.

Welty, R.K., 1988, *Waste Storage Tank Status and Leak Detection Criteria*, SD-WM-TI-356, Westinghouse Hanford Company, Richland, Washington.

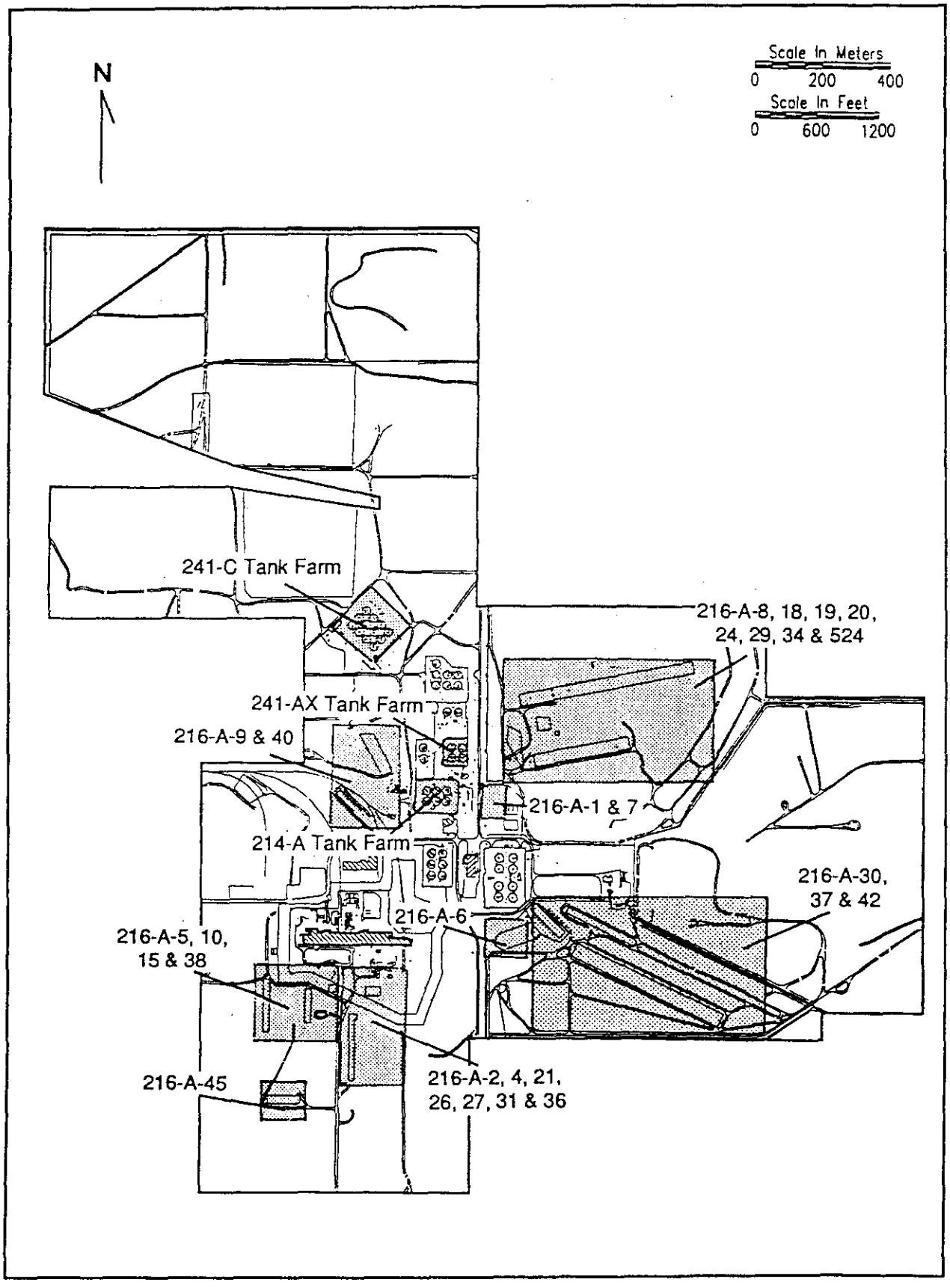


Figure A1-1. PUREX Plant Aggregate Area: Waste Management Unit Areas Evaluated.

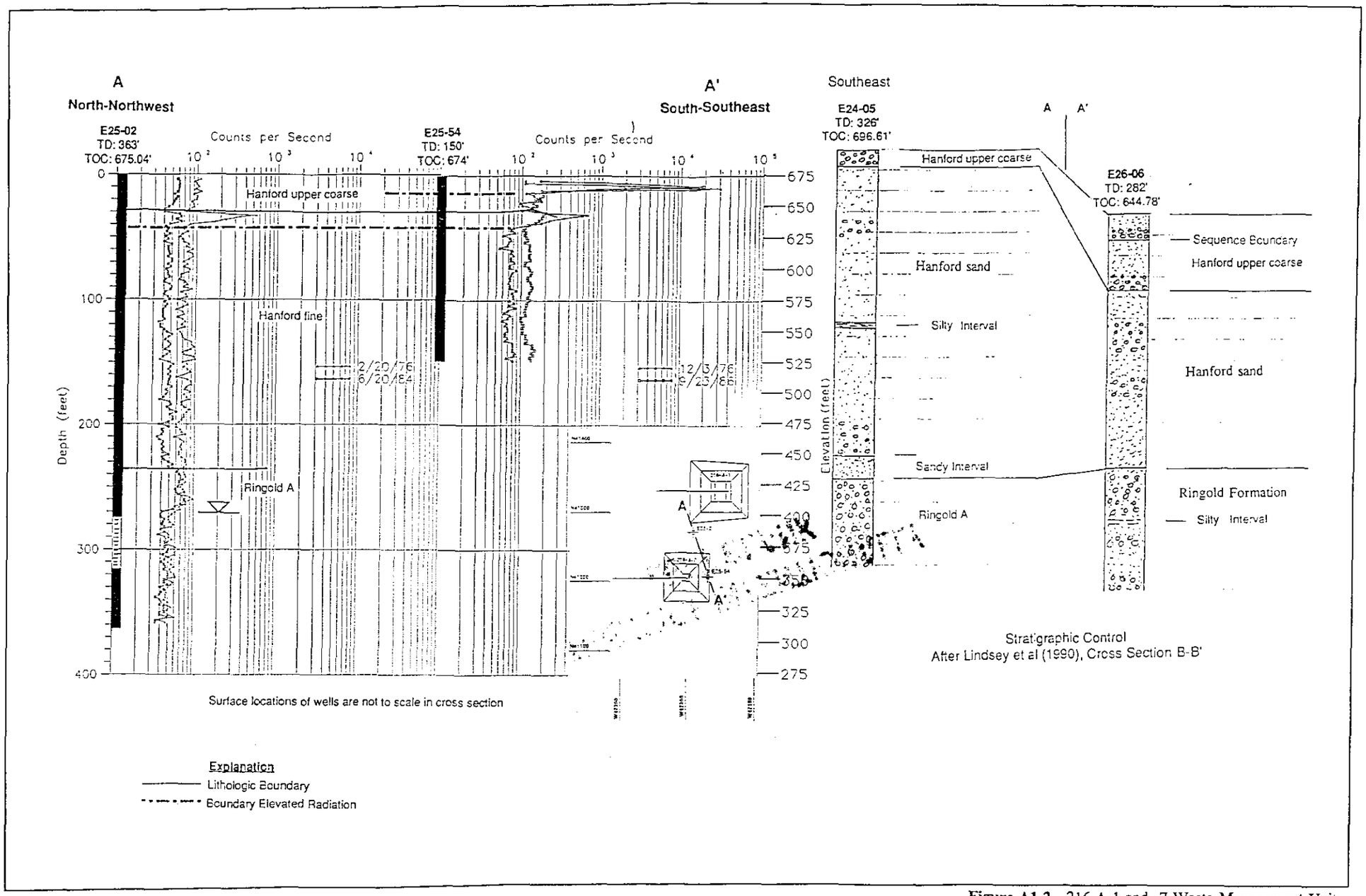
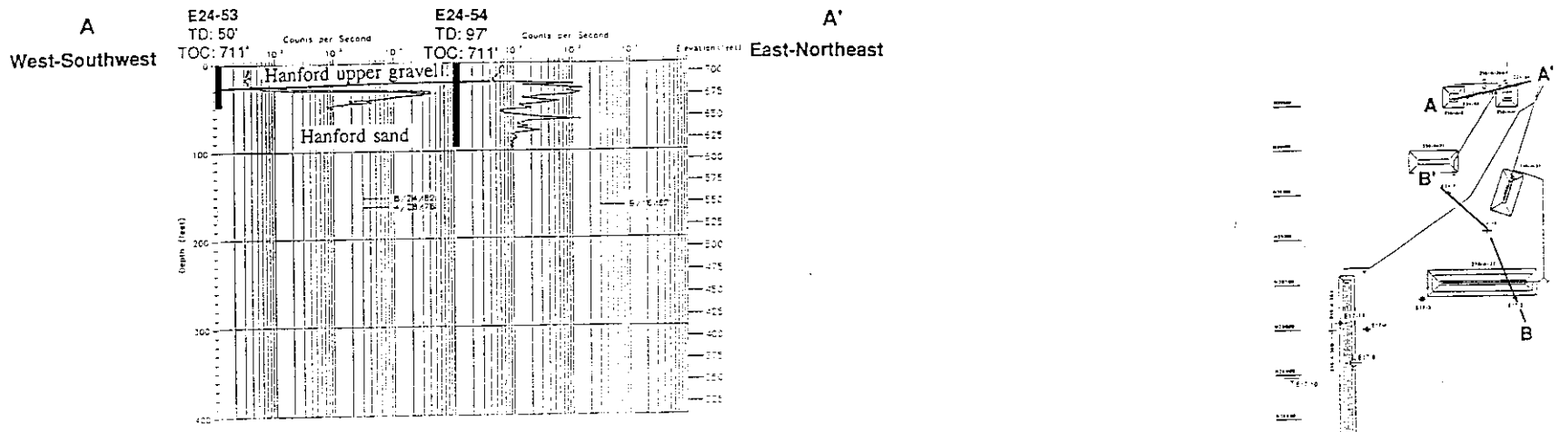
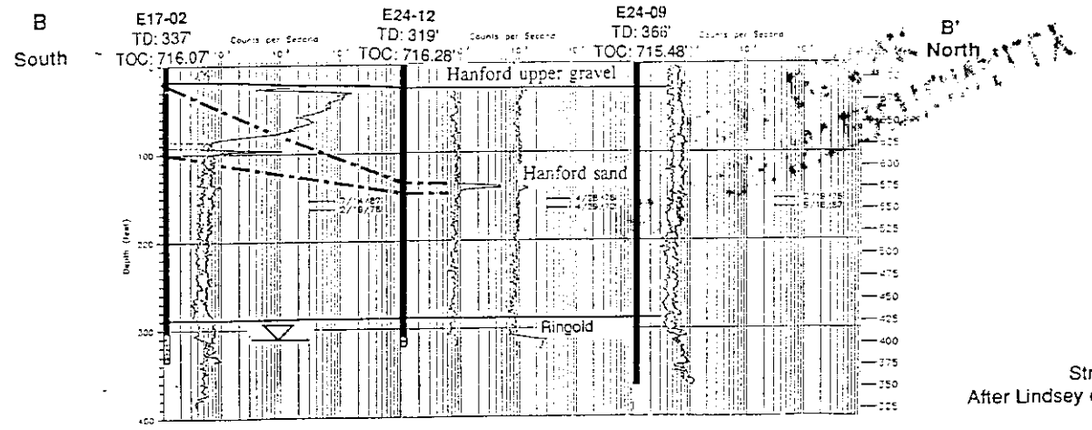
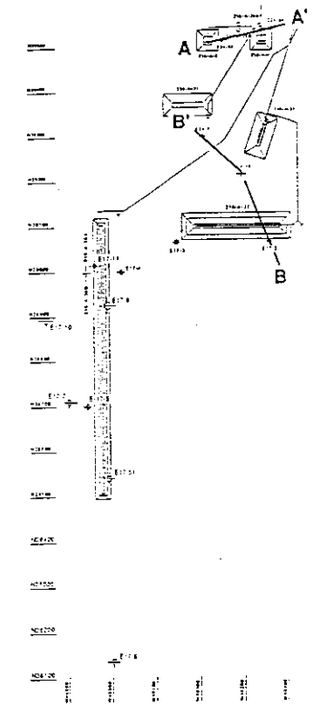


Figure A1-2. 216-A-1 and -7 Waste Management Units: Scintillation Probe Profile Cross Section.

THIS PAGE INTENTIONALLY
LEFT BLANK







Stratigraphic Control
After Lindsey et al (1990), Cross Section I-I'

Explanation
Lithologic Boundary
Boundary Elevated Radiation

Figure A1-3. 216-2, -4, -21, -26, -27, -31, and -36 Waste Management Units: Scintillation Probe Profile Cross Sections A-A' and B-B'.

THIS PAGE INTENTIONALLY
LEFT BLANK

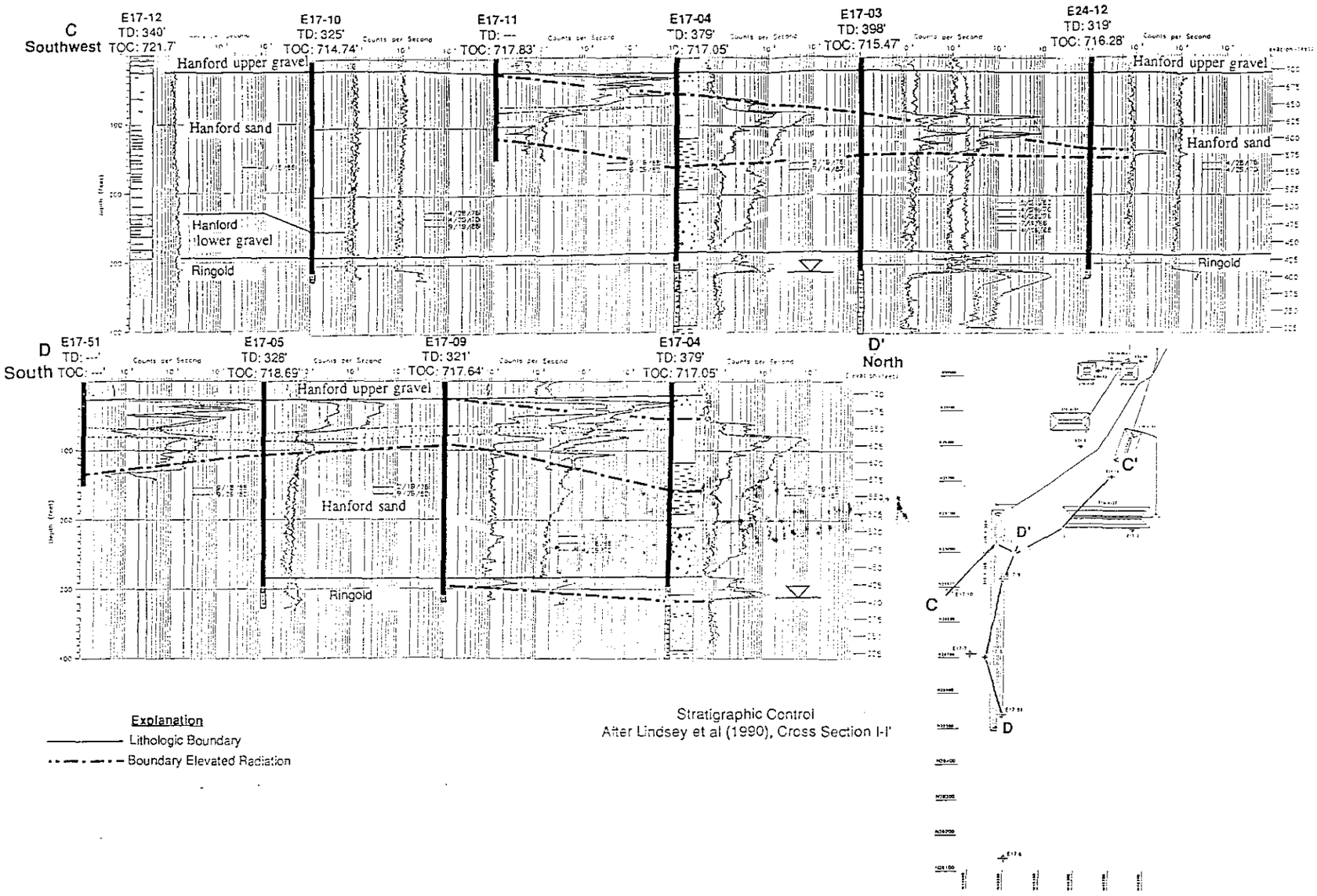


Figure A1-4. 216-2, -4, -21, -26, -27, -31, and -36 Waste Management Units: Scintillation Probe Profile Cross Sections C-C' and D-D'.

THIS PAGE INTENTIONALLY
LEFT BLANK

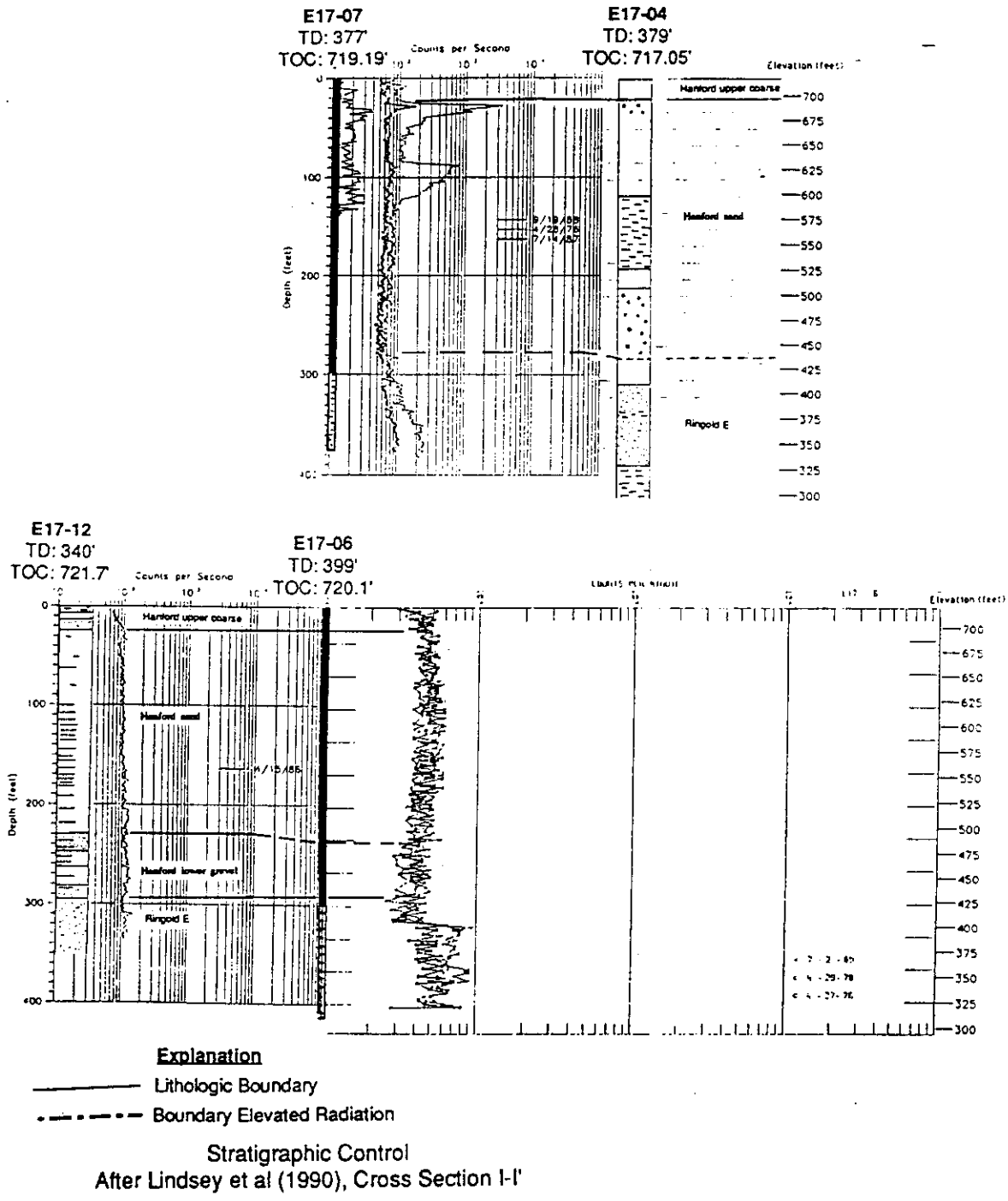


Figure A1-5. 216-2, -4, -21, -26, -27, -31, and -36 Waste Management Units: Additional Scintillation Probe Profiles.

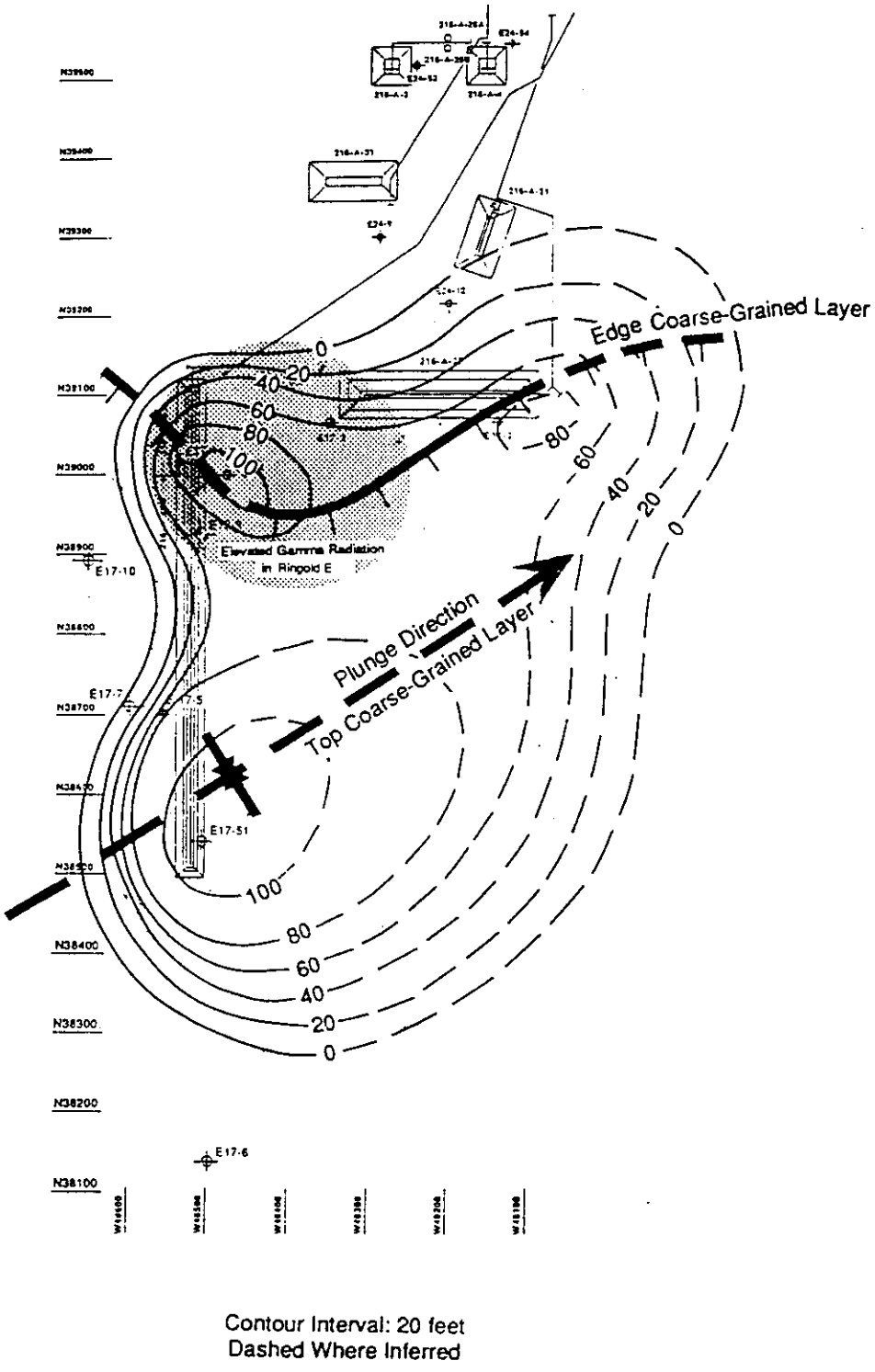


Figure A1-6. 216-2, -4, -21, -26, -27, -31, and -36 Waste Management Units: Hanford Sand Elevated Gamma Radiation Isopach Map.

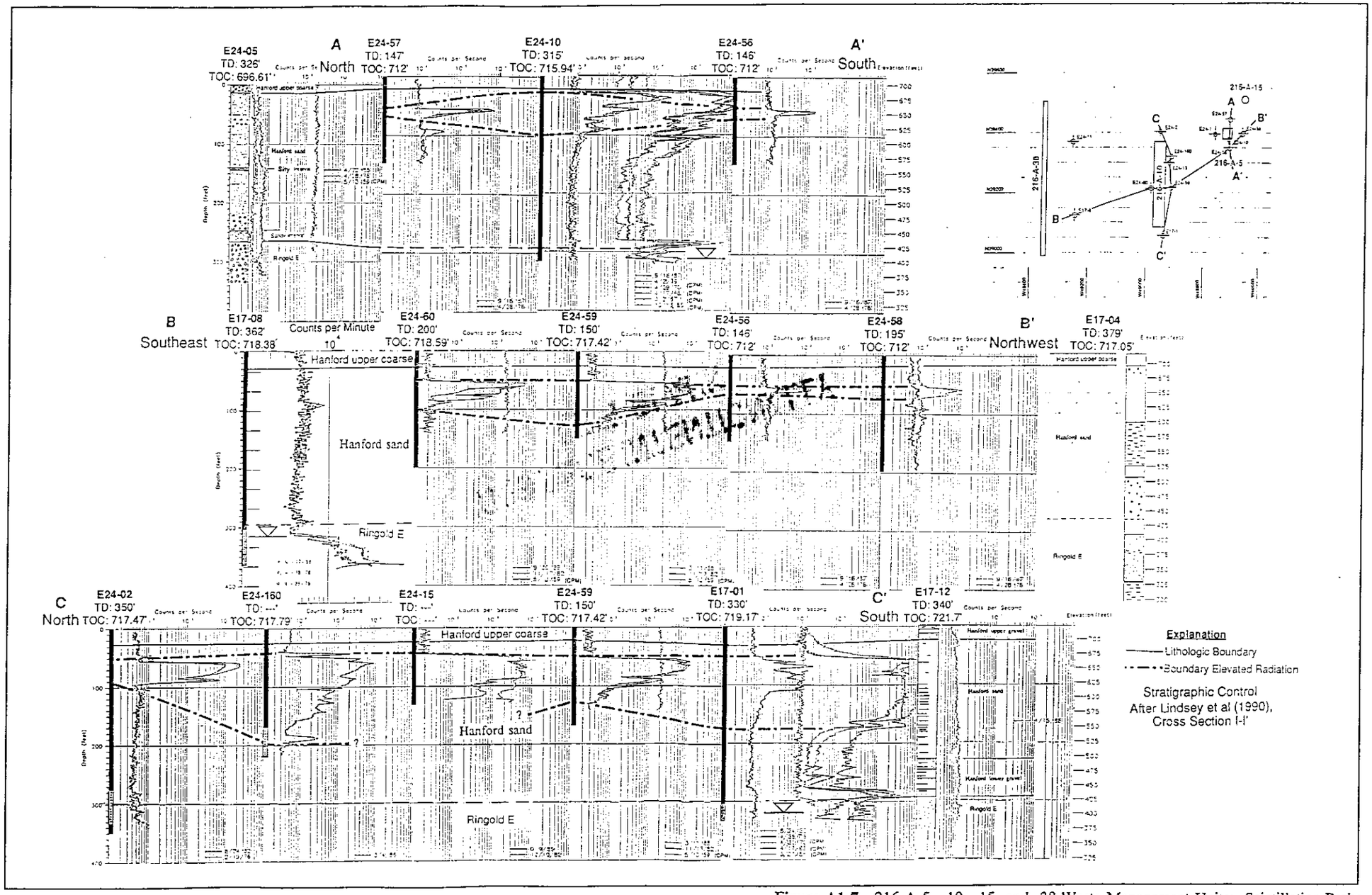
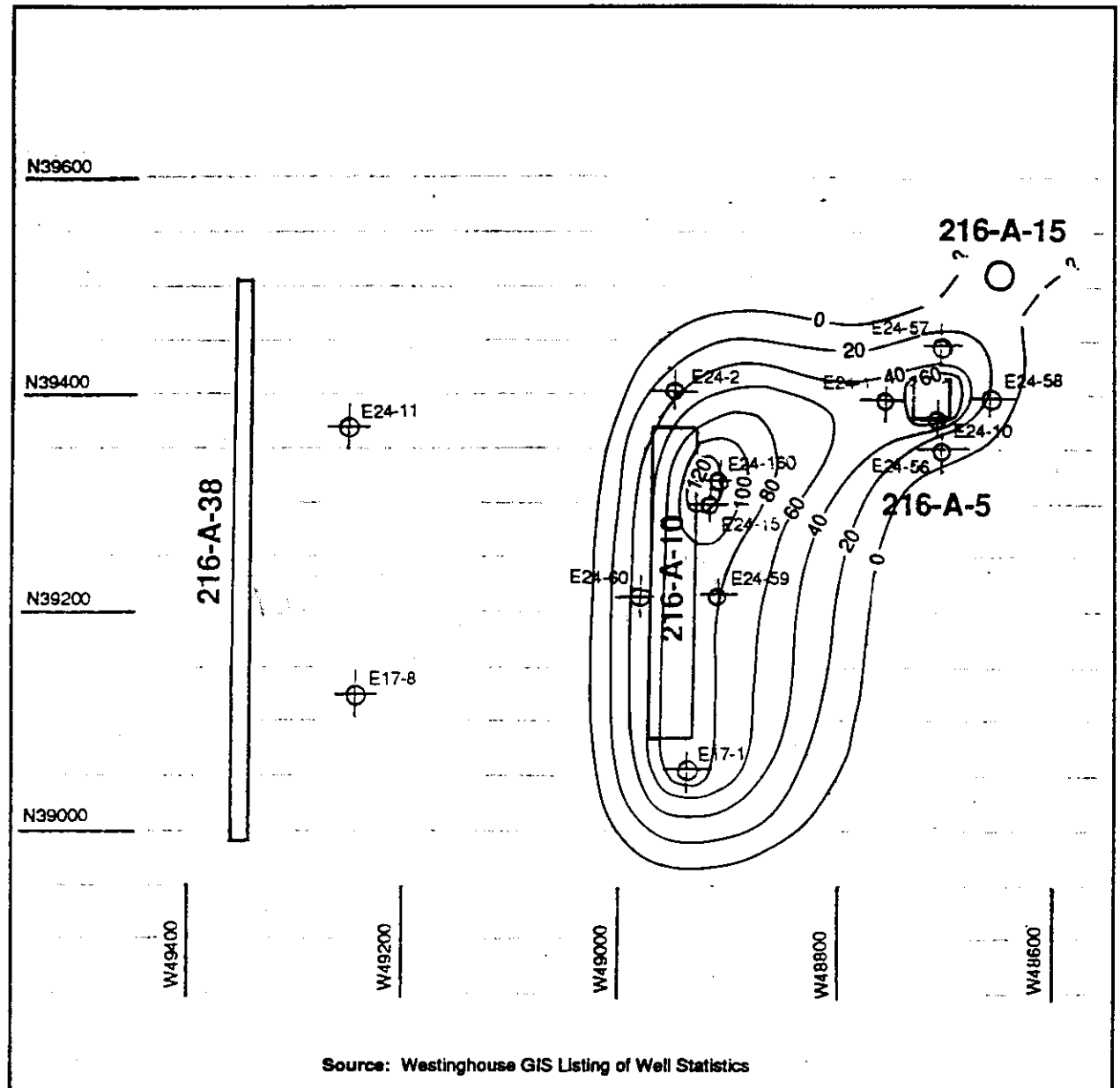


Figure A1-7. 216-A-5, -10, -15, and -38 Waste Management Units: Scintillation Probe Profile Cross Sections A-A', B-B', and C-C'.

THIS PAGE INTENTIONALLY
LEFT BLANK



Source: Westinghouse GIS Listing of Well Statistics

Figure A1-8. 216-A-5, -10, -15, and -38 Waste Management Units: Elevated Gamma Radiation Isopach Map.

THIS PAGE INTENTIONALLY
LEFT BLANK

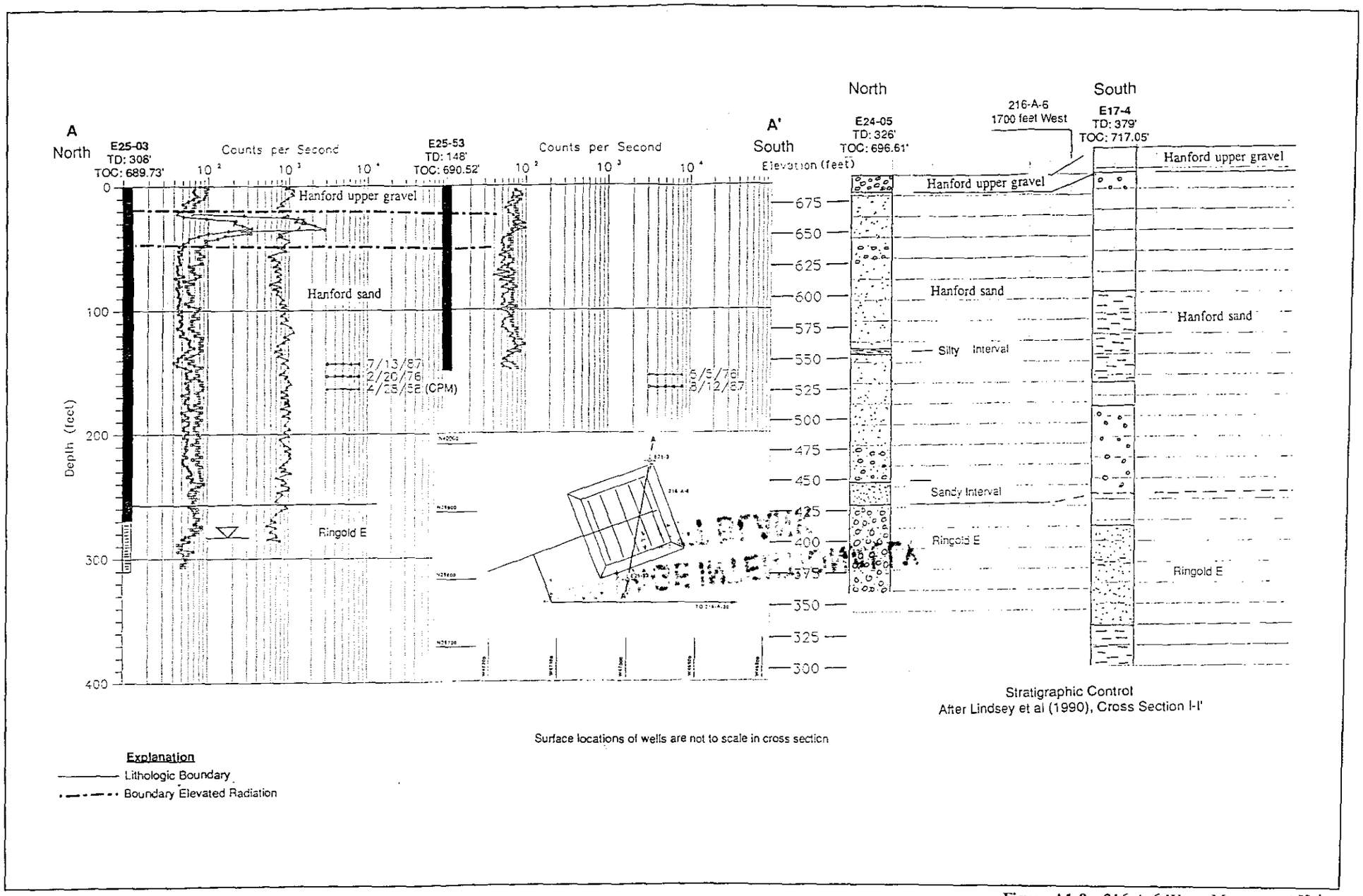


Figure A1-9. 216-A-6 Waste Management Unit: Scintillation Probe Profile Cross Section A-A'.

THIS PAGE INTENTIONALLY
LEFT BLANK

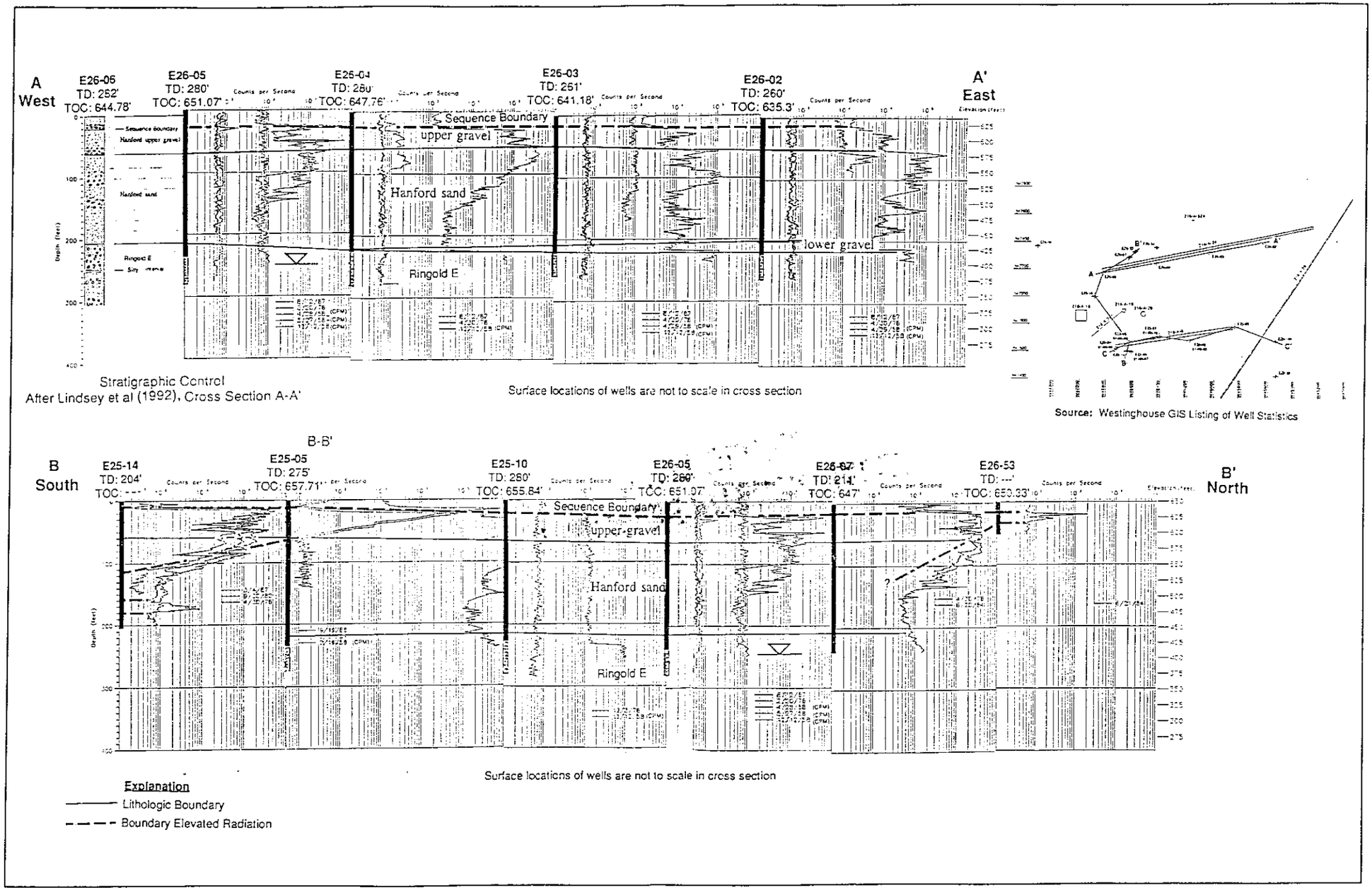
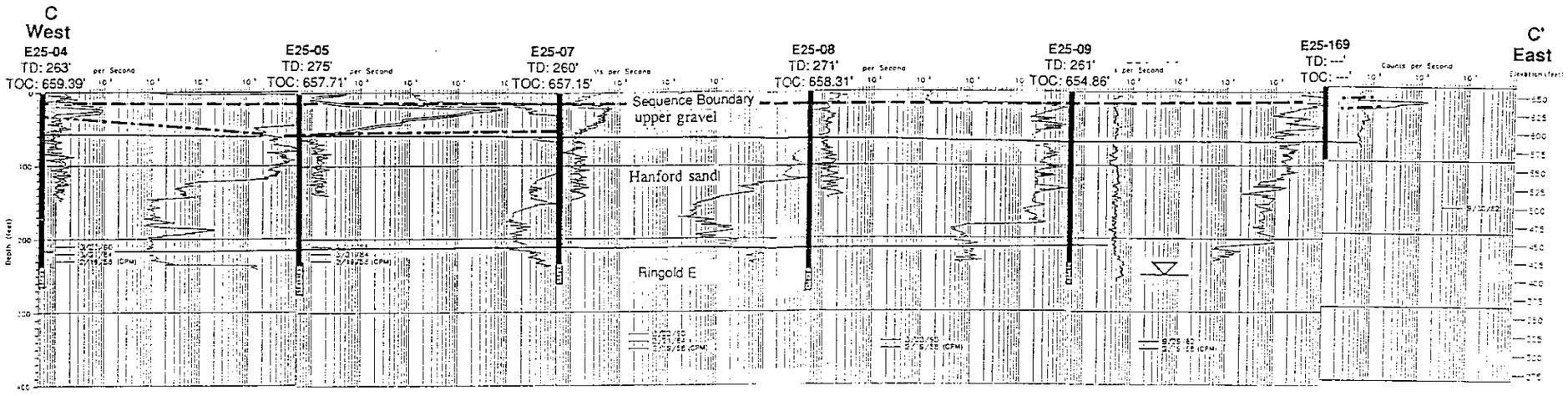


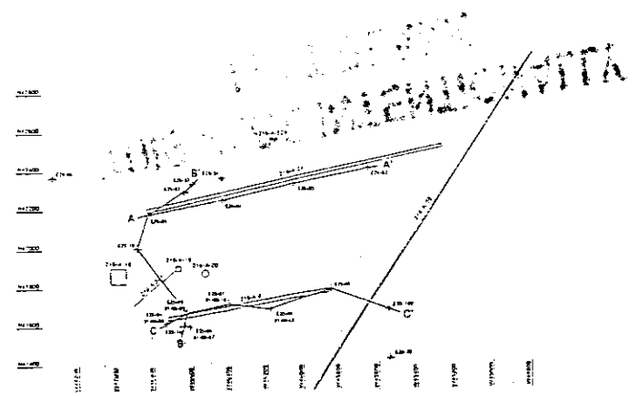
Figure A1-10. 216-A-8, -18, -19, -20, -24, -29, -34, and -524 Waste Management Units: Scintillation Probe Profile Cross Sections A-A' and B-B'.

THIS PAGE INTENTIONALLY
LEFT BLANK



Surface locations of wells are not to scale in cross section

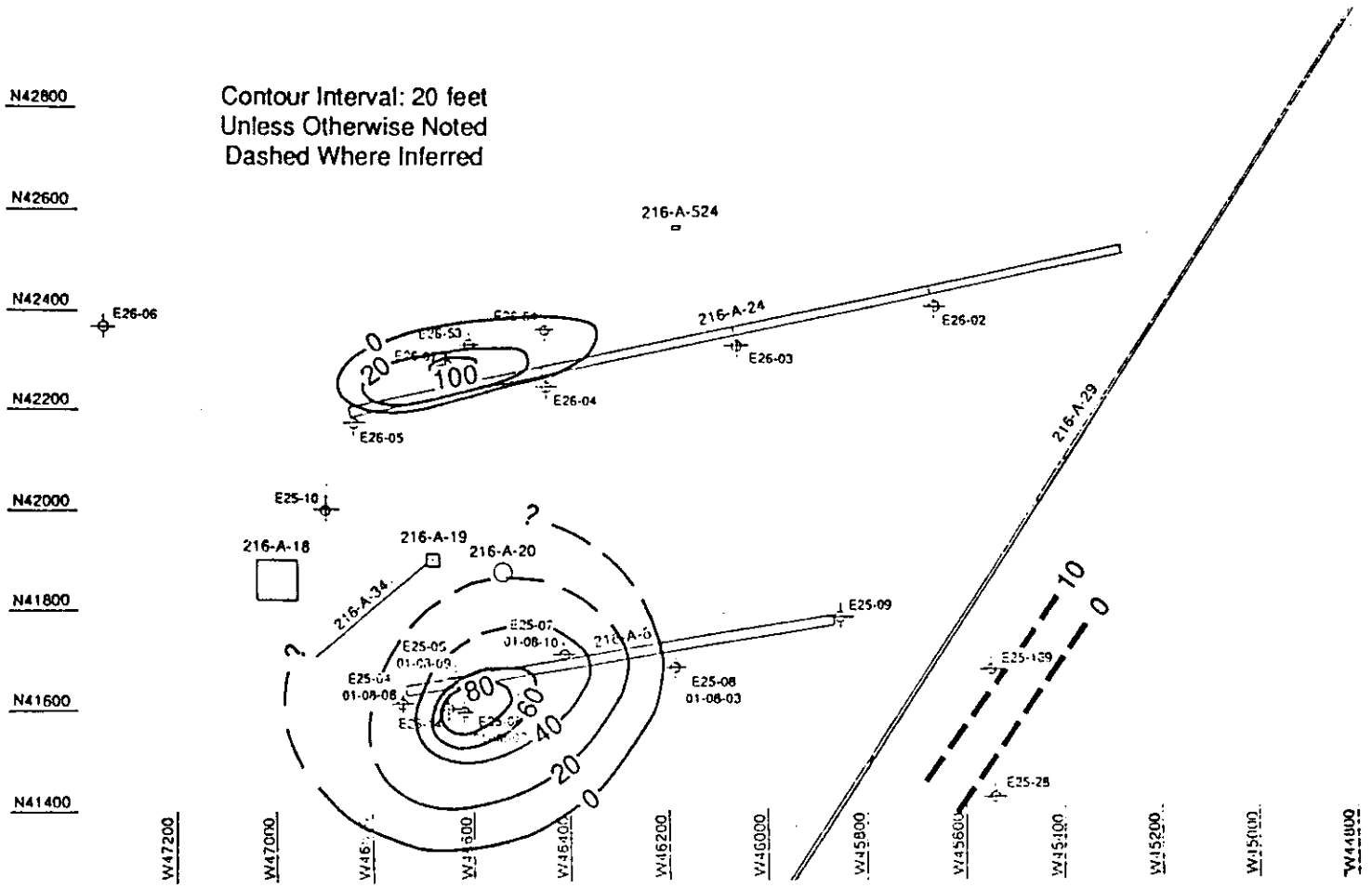
Explanation
Lithologic Boundary
Boundary Elevated Radiation



Source: Westinghouse GIS Listing of Well Statistics

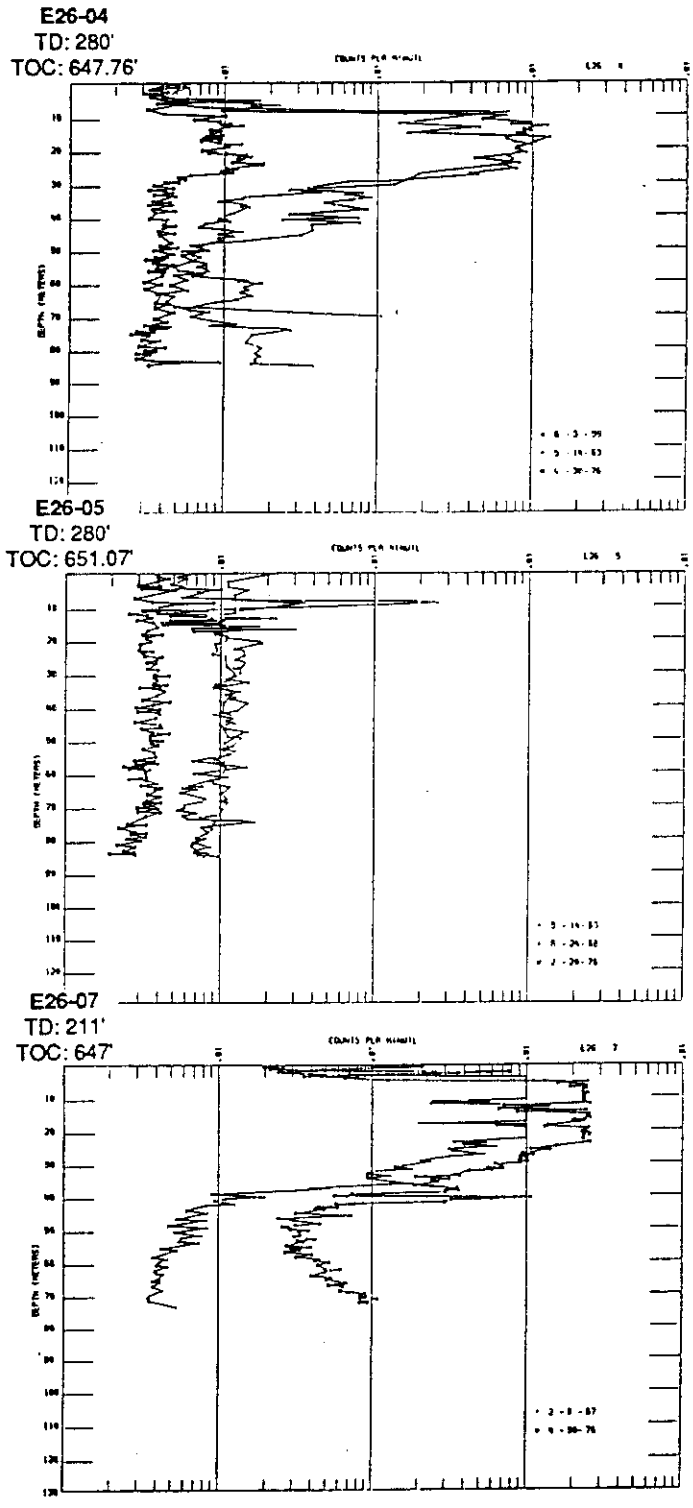
Figure A1-11. 216-A-8, -18, -19, -20, -24, -29, -34, and -524 Waste Management Units: Scintillation Probe Profile Cross Section C-C'.

THIS PAGE INTENTIONALLY
LEFT BLANK



Source: Westinghouse GIS Listing of Well Statistics

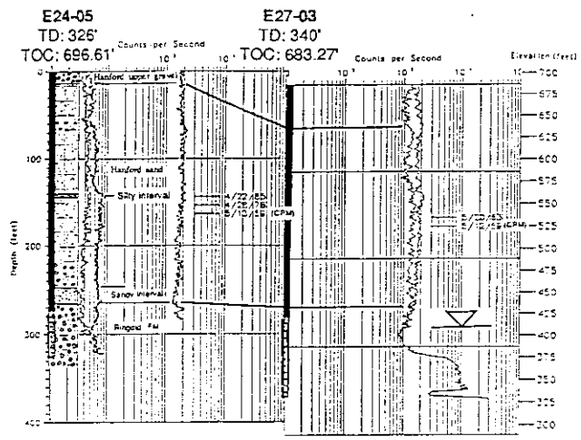
Figure A1-12. 216-A-8, -18, -19, -20, -24, -29, -34, and -524 Waste Management Units: Elevated Gamma



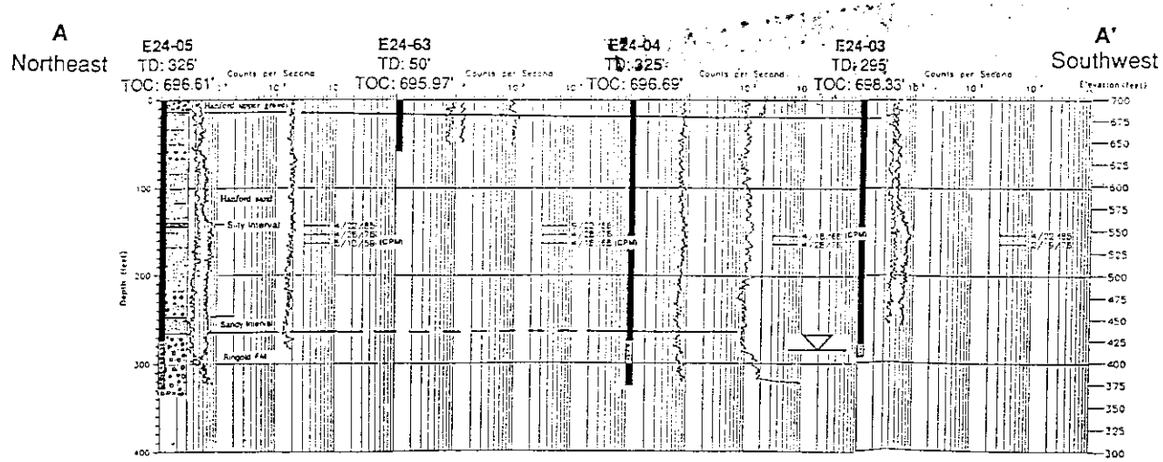
Both wells E26-4 and 5 show a decline in gamma radiation levels to background on the scintillation probe profiles collected between 1968 and 1976.

In well E26-7 there is an increase in the levels of gamma radiation from 1967 to 1976, after the waste disposal activities in the A-24 crib ceased. This is evidence of downward migration of radionuclides, possibly in the well bore. The water table is found at a depth of about 230 to 240 feet (70 to 73 meters)

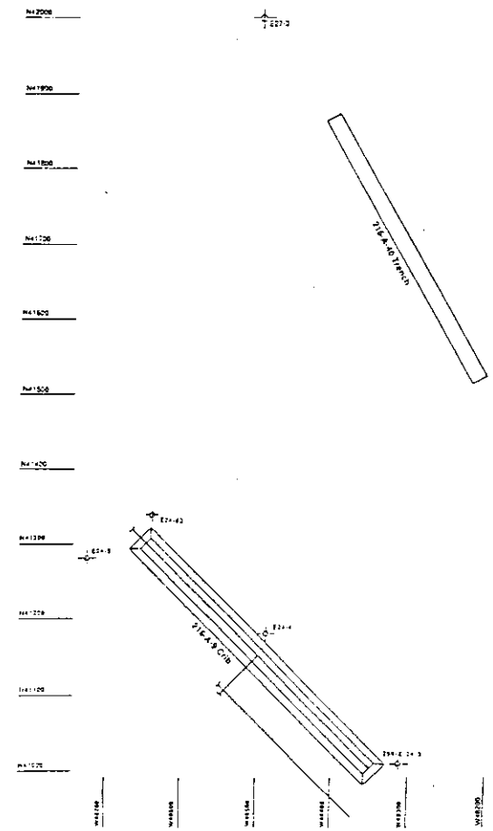
Figure A1-13. 216-A-24 Waste Management Unit: Change in Gamma Radiation Levels, 1968-1976.



Surface locations of wells are not to scale in cross section



Surface locations of wells are not to scale in cross section



Stratigraphic Control
After Lindsey et al. (1992), Cross Sections
B-B' and I-I'

Explanation
Lithologic Boundary
Boundary Elevated Radiation

Figure A1-14. 216-A-9 and -40 Waste Management Units: Scintillation Probe Profile Cross Section A-A'.

THIS PAGE INTENTIONALLY
LEFT BLANK

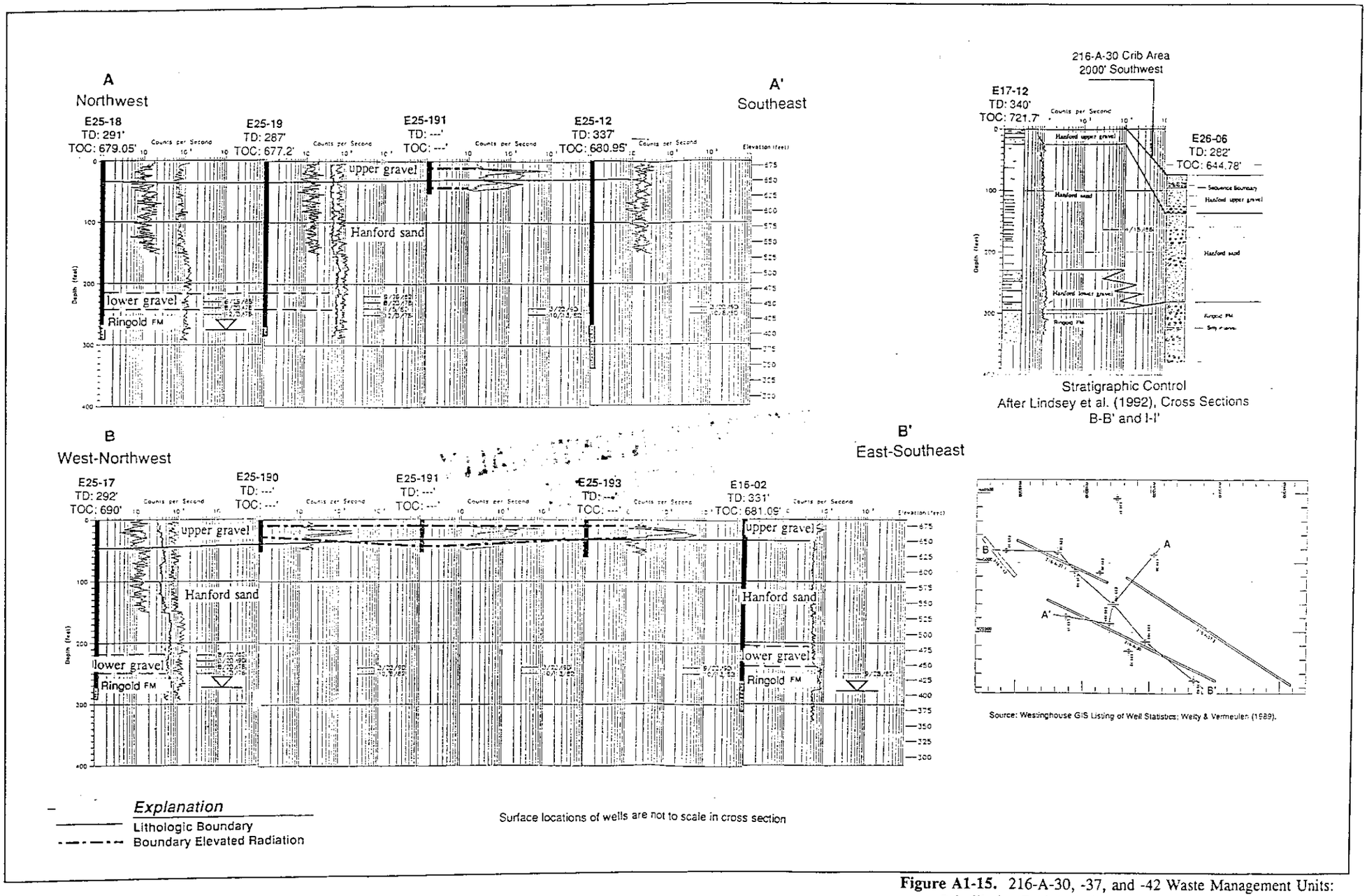
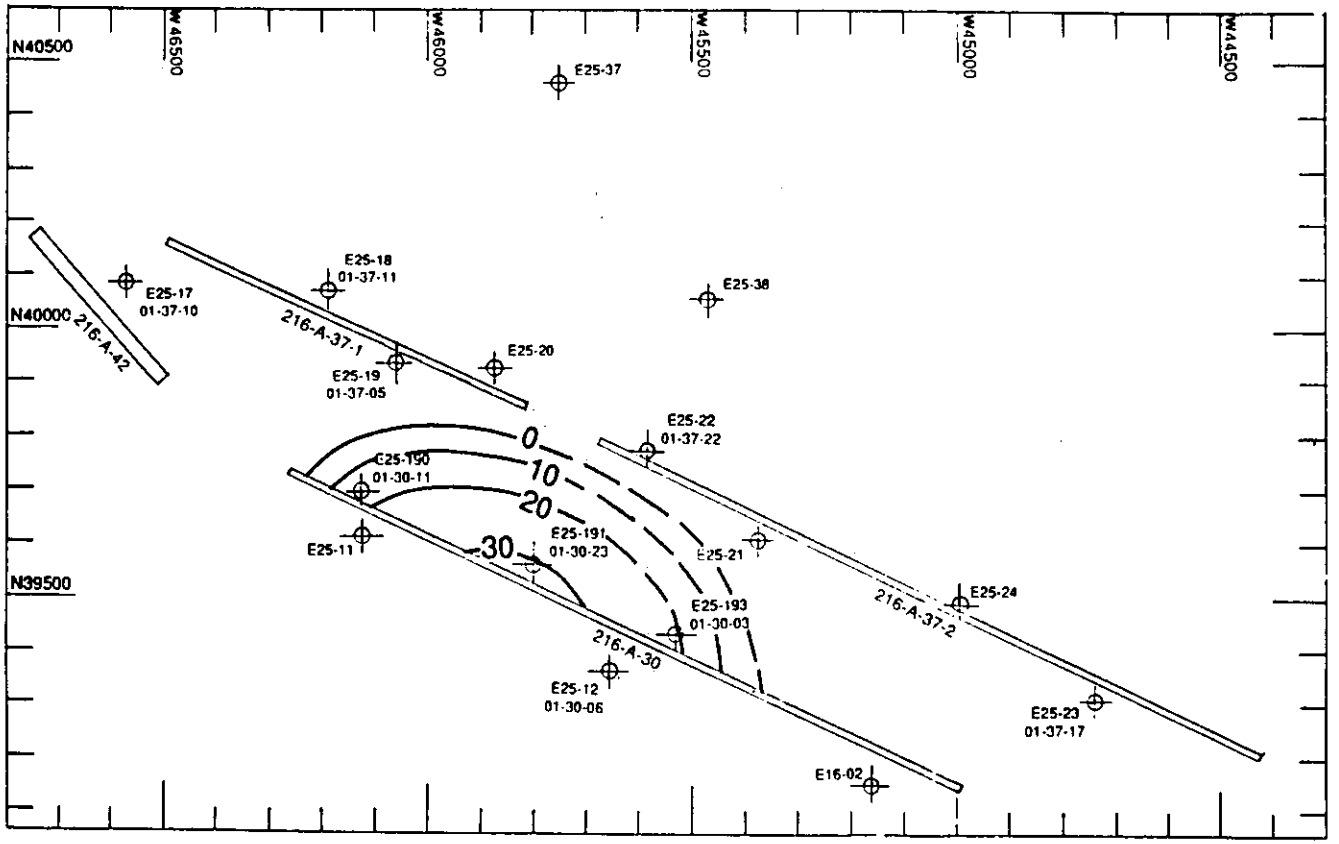


Figure A1-15. 216-A-30, -37, and -42 Waste Management Units: Scintillation Probe Profile Cross Section A-A' and B-B'.

THIS PAGE INTENTIONALLY
LEFT BLANK



Source: Westinghouse GIS Listing of Well Statistics; Welty & Vermeulen (1989).

Figure A1-16. 216-A-30, -37, and -42 Waste Management Units: Elevated Gamma Radiation Isopach Map.

THIS PAGE INTENTIONALLY
LEFT BLANK

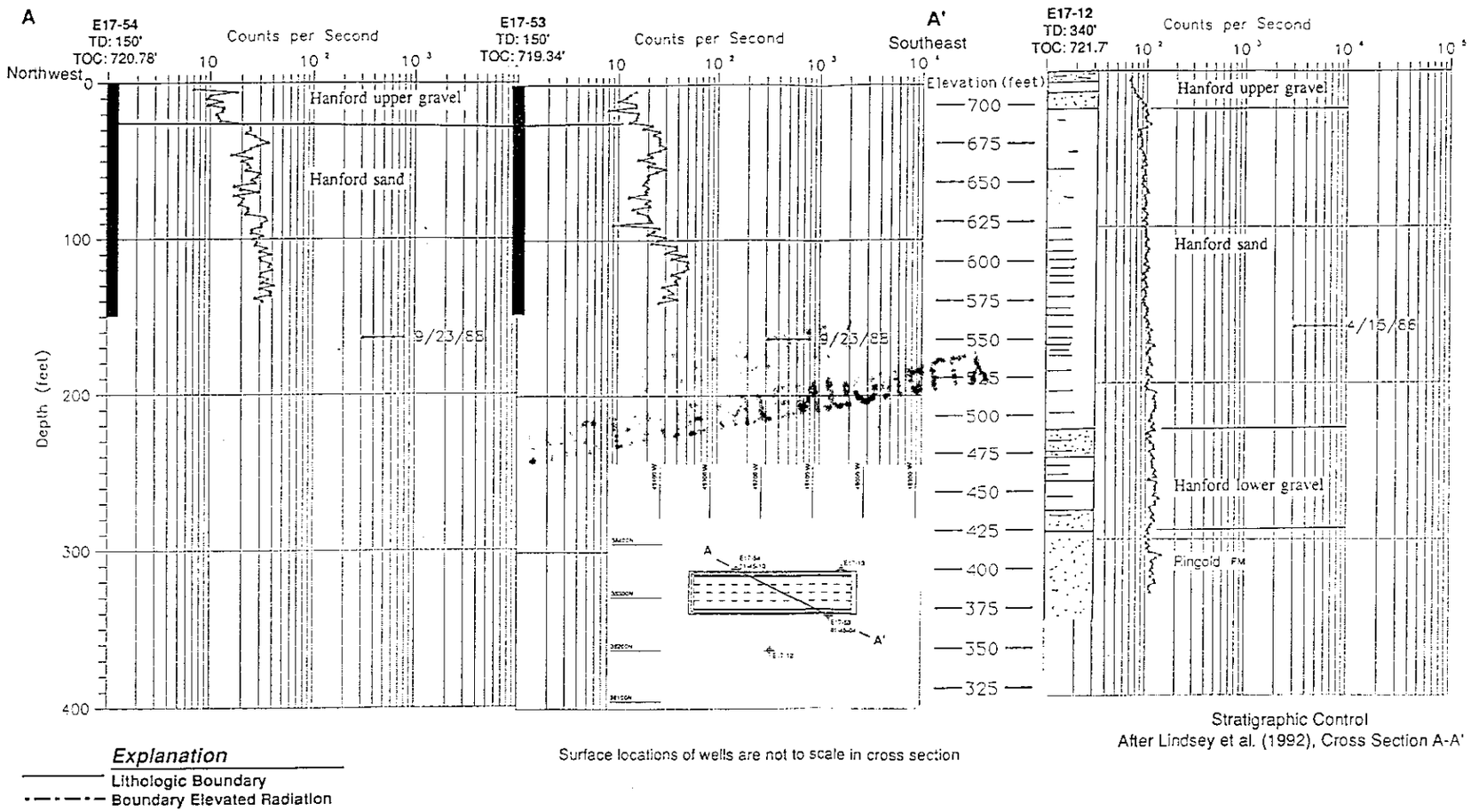


Figure A1-17. 216-A-45 Waste Management Unit: Scintillation Probe Profile Cross Section.

THIS PAGE INTENTIONALLY
LEFT BLANK

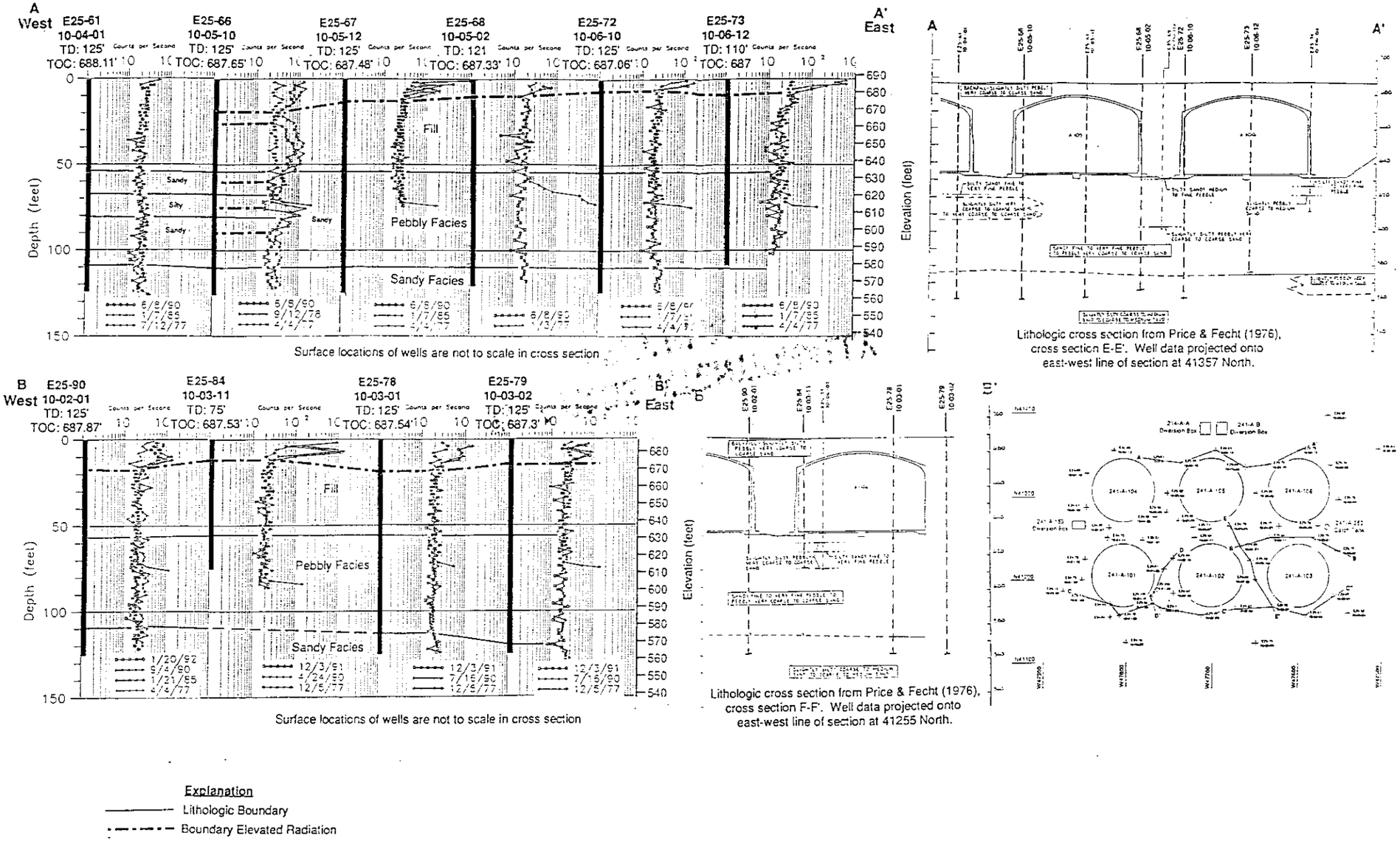
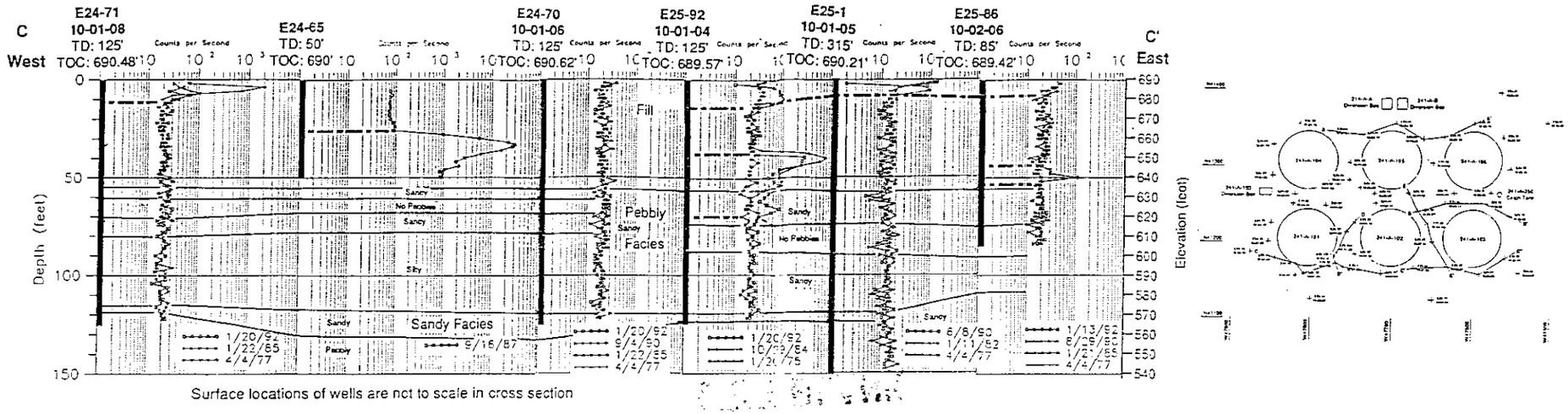
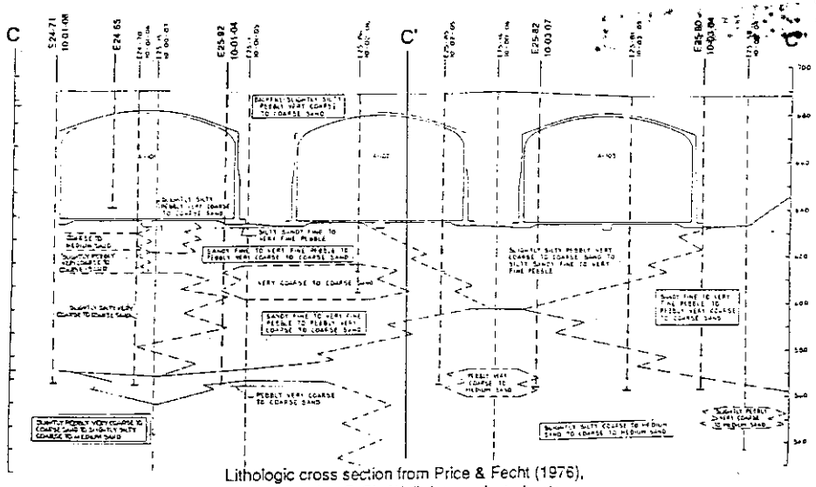


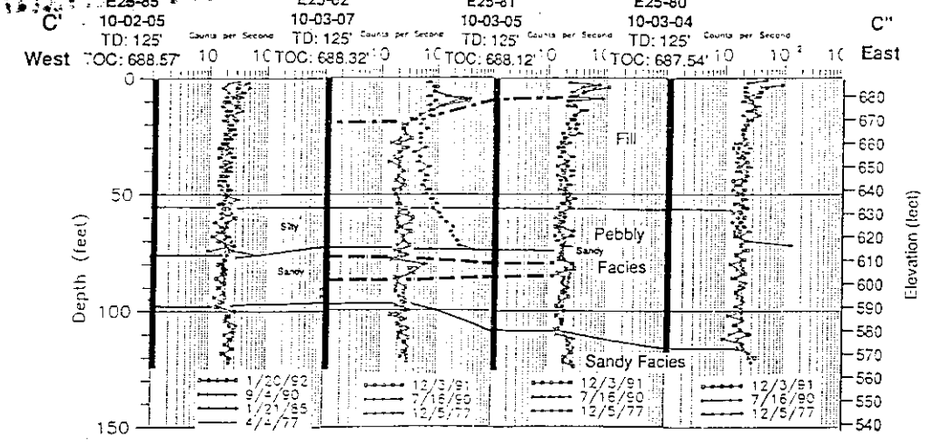
Figure A1-18. 241-A Tank Farm: Scintillation Probe Profile Cross Sections A-A' and B-B'.

THIS PAGE INTENTIONALLY
LEFT BLANK





Lithologic cross section from Price & Fecht (1976), cross section G-G'. Well data projected onto east-west line of section at 41153 North.



Explanation

Lithologic Boundary

Boundary Elevated Radiation

Figure A1-19. 241-A Tank Farm: Scintillation Probe Profile Cross Section C-C' and C-C''.

THIS PAGE INTENTIONALLY
LEFT BLANK

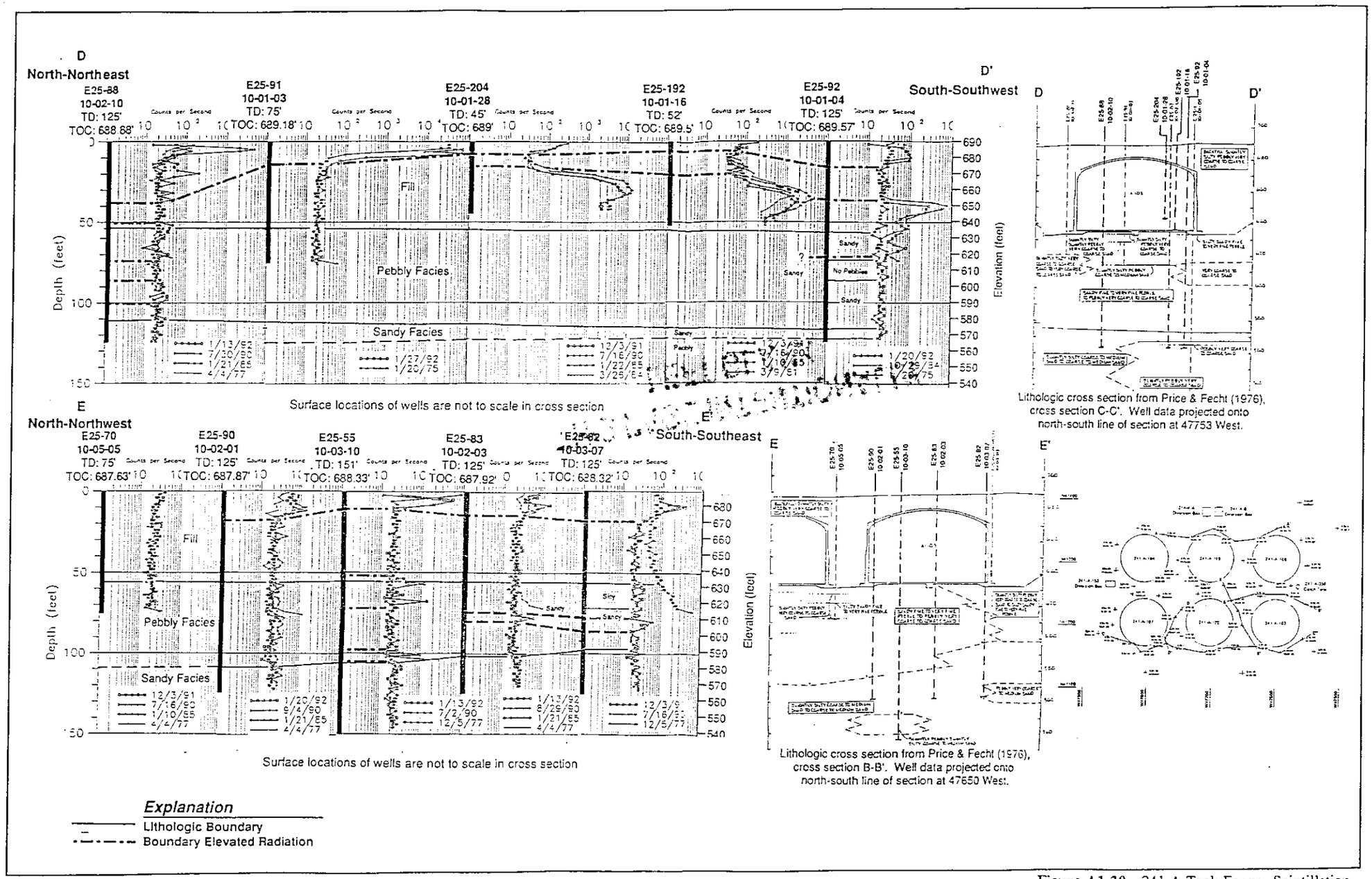


Figure A1-20. 241-A Tank Farm: Scintillation Probe Profile Cross Sections D-D' and E-E'.

THIS PAGE INTENTIONALLY
LEFT BLANK

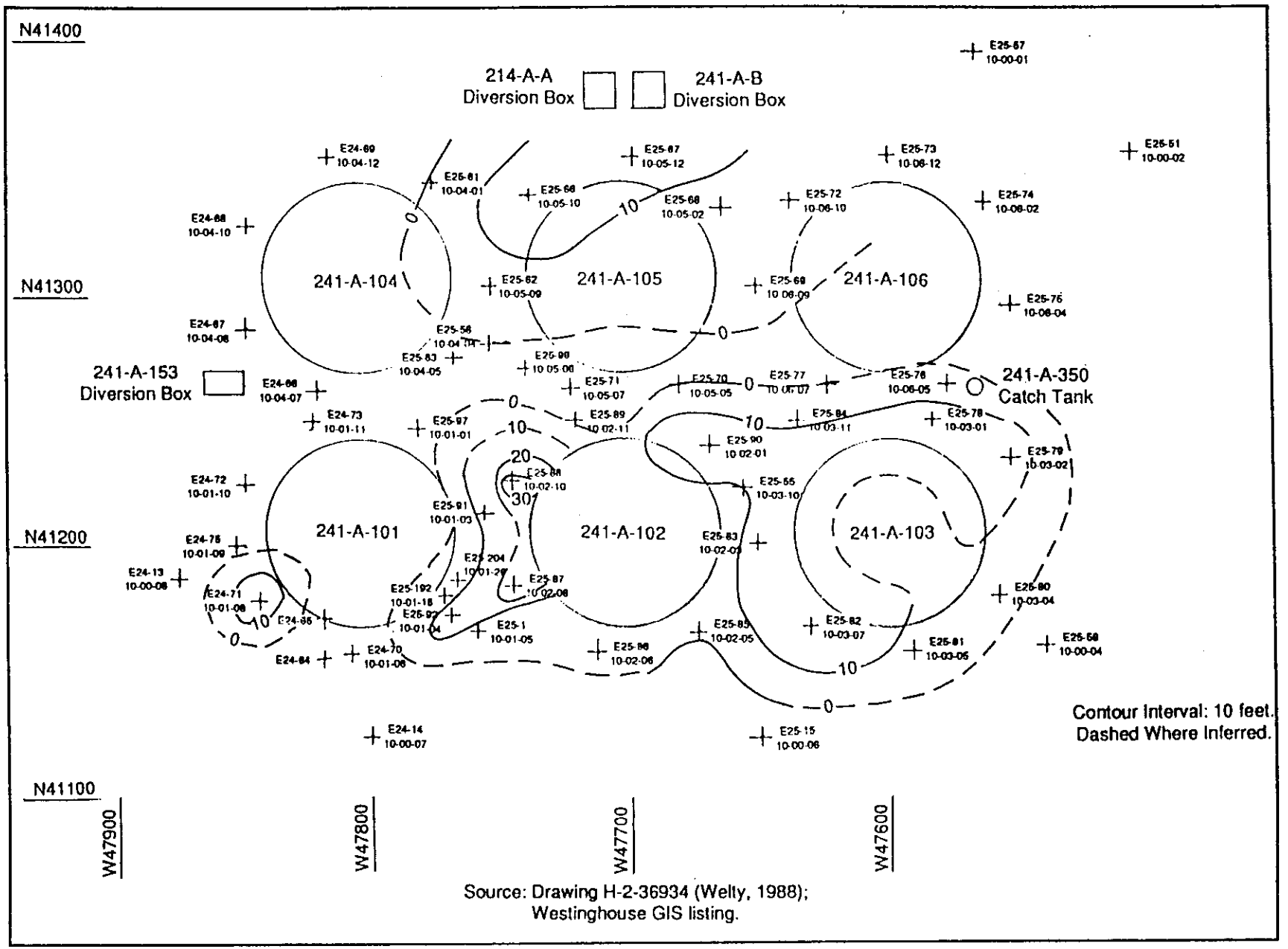


Figure A1-21. 241-A Tank Farm: Near Surface Elevated Gamma Radiation Isopach Map.

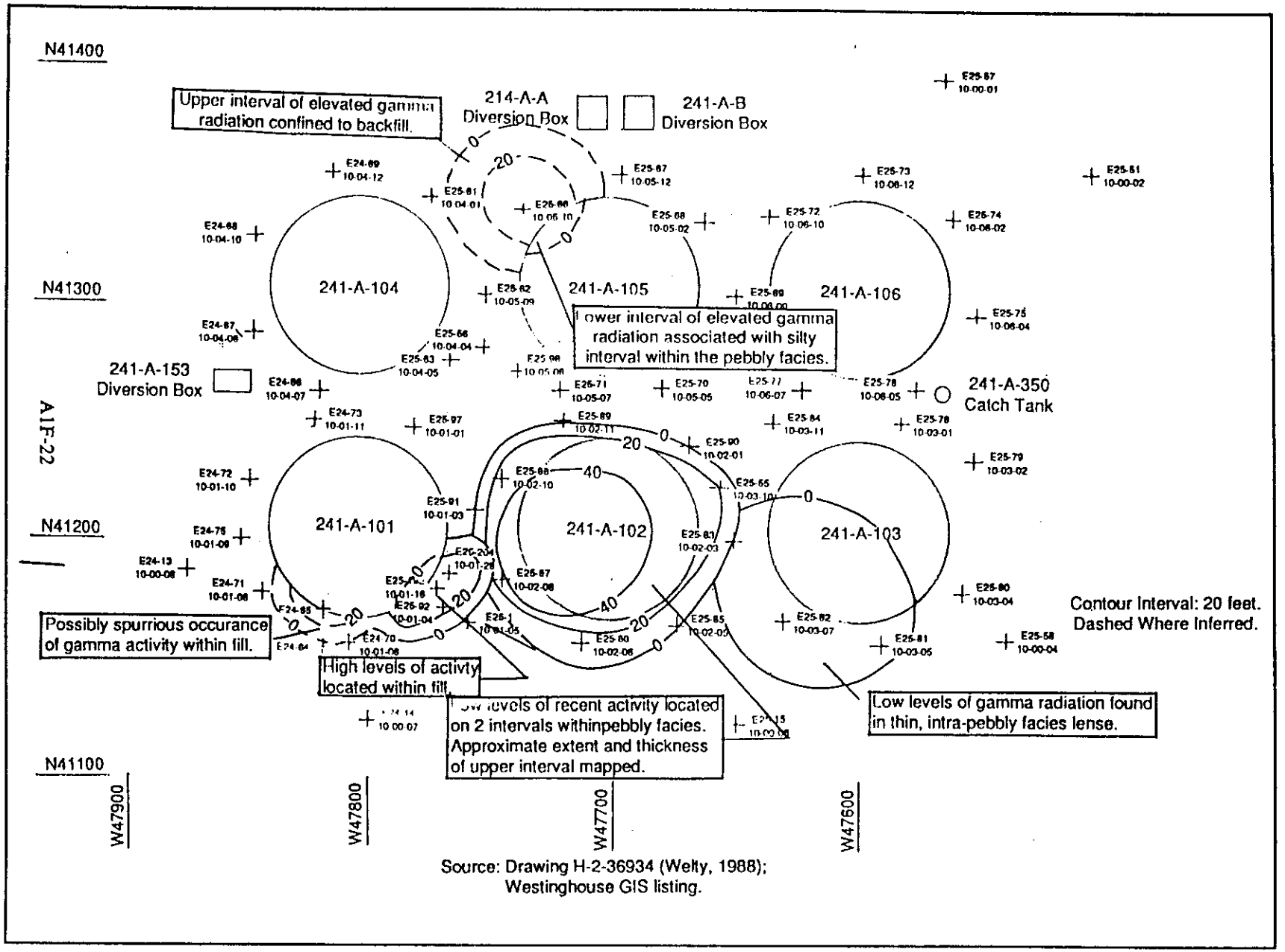
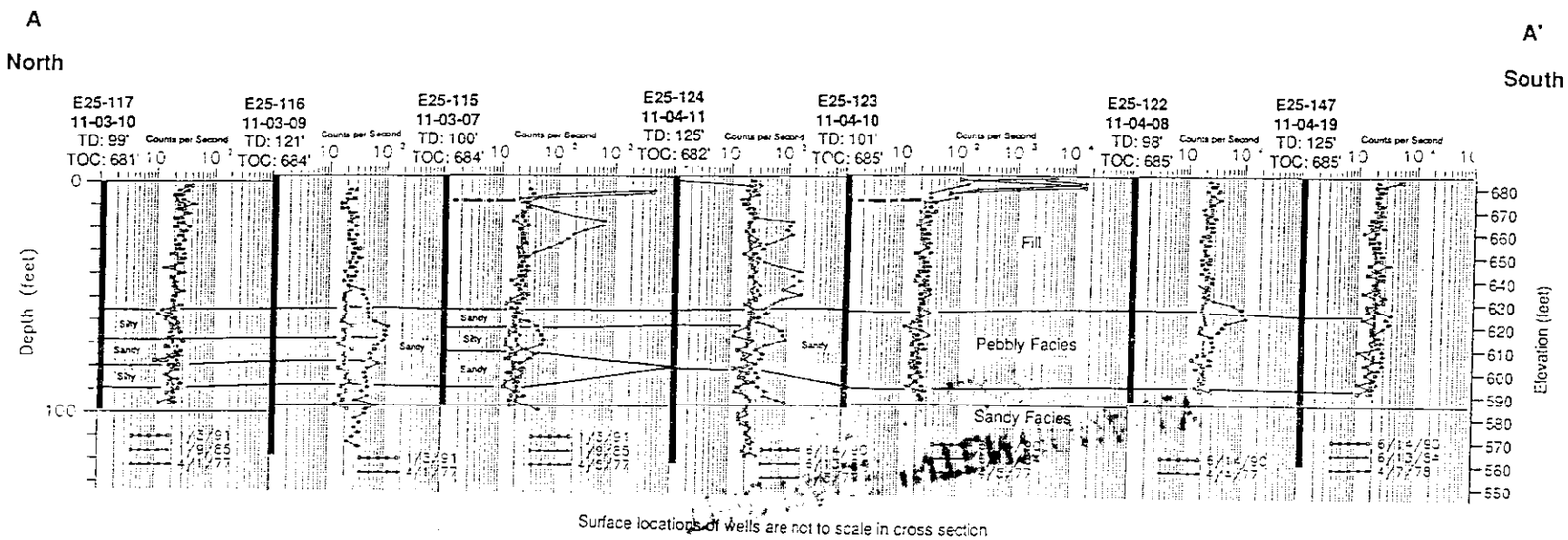
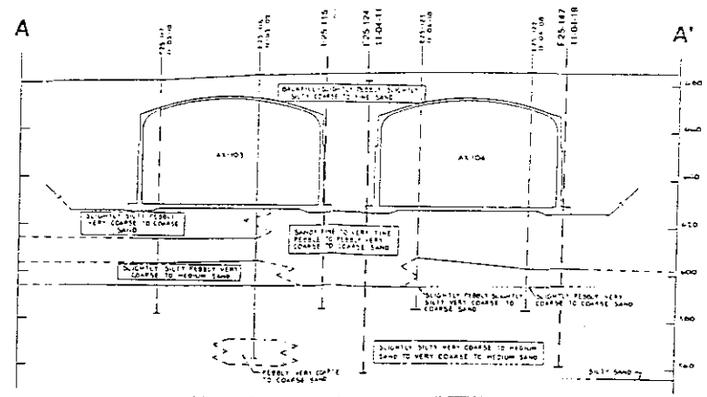


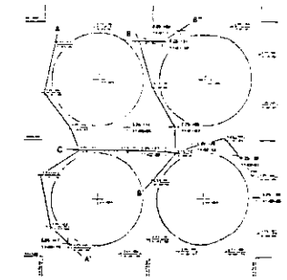
Figure A1-22. 241-A Tank Farm: Intra-Backfill Elevated Gamma Radiation Isopach Map.



Surface locations of wells are not to scale in cross section



Lithologic cross section from Price (1976), cross section F-F'. Well data projected onto north-south line of section at 47610 west.



Explanation

Lithologic Boundary

Boundary Elevated Radiation

Figure A1-23. 241-AX Tank Farm: Scintillation Probe Profile Cross Section A-A'.

THIS PAGE INTENTIONALLY
LEFT BLANK

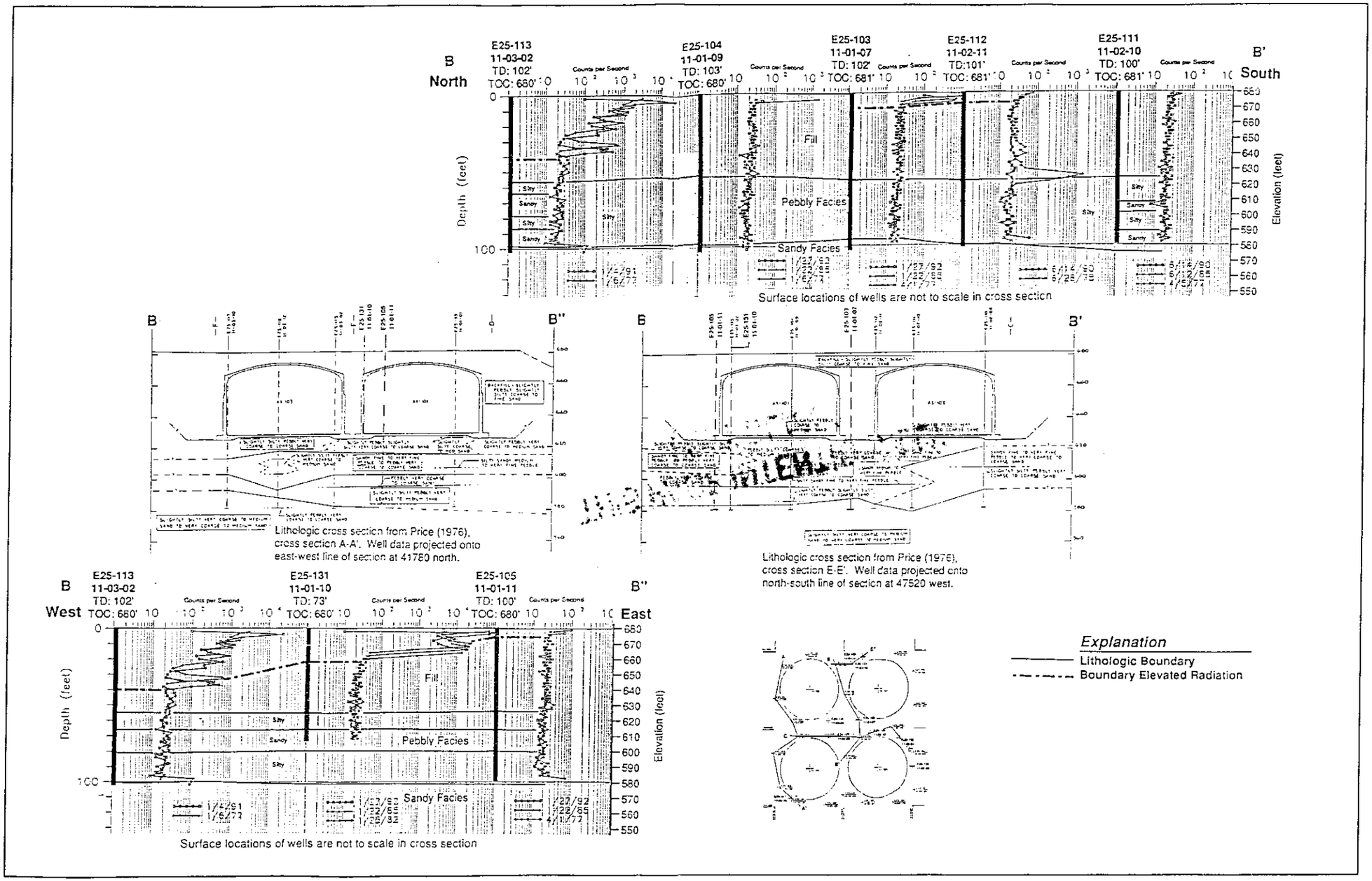
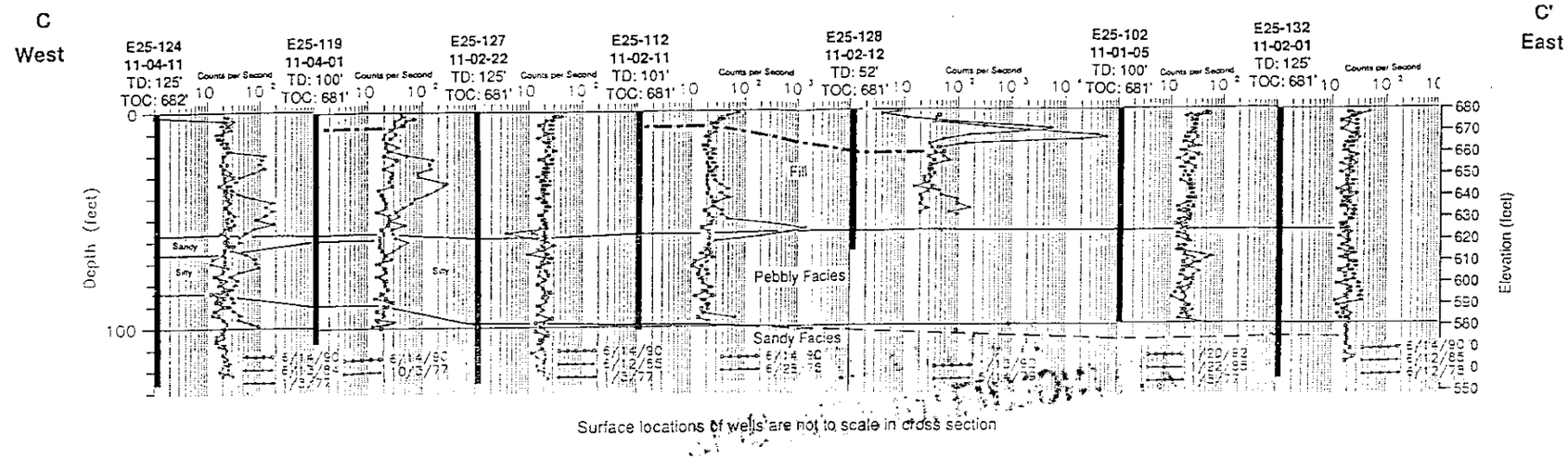
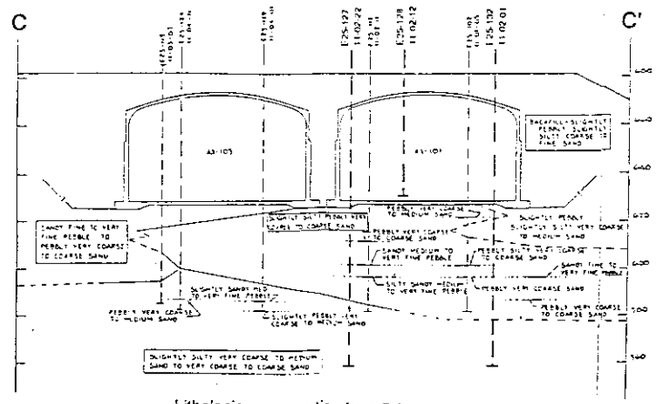


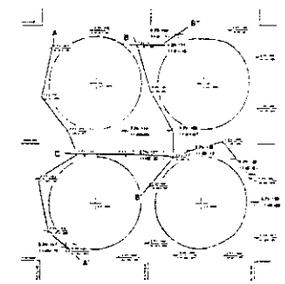
Figure A1-24. 241-AX Tank Farm: Scintillation Probe Profile Cross Sections B-B' and B-B''.

THIS PAGE INTENTIONALLY
LEFT BLANK





Lithologic cross section from Price (1976), cross section B-B'. Well data projected onto east-west line of section at 41680 north.



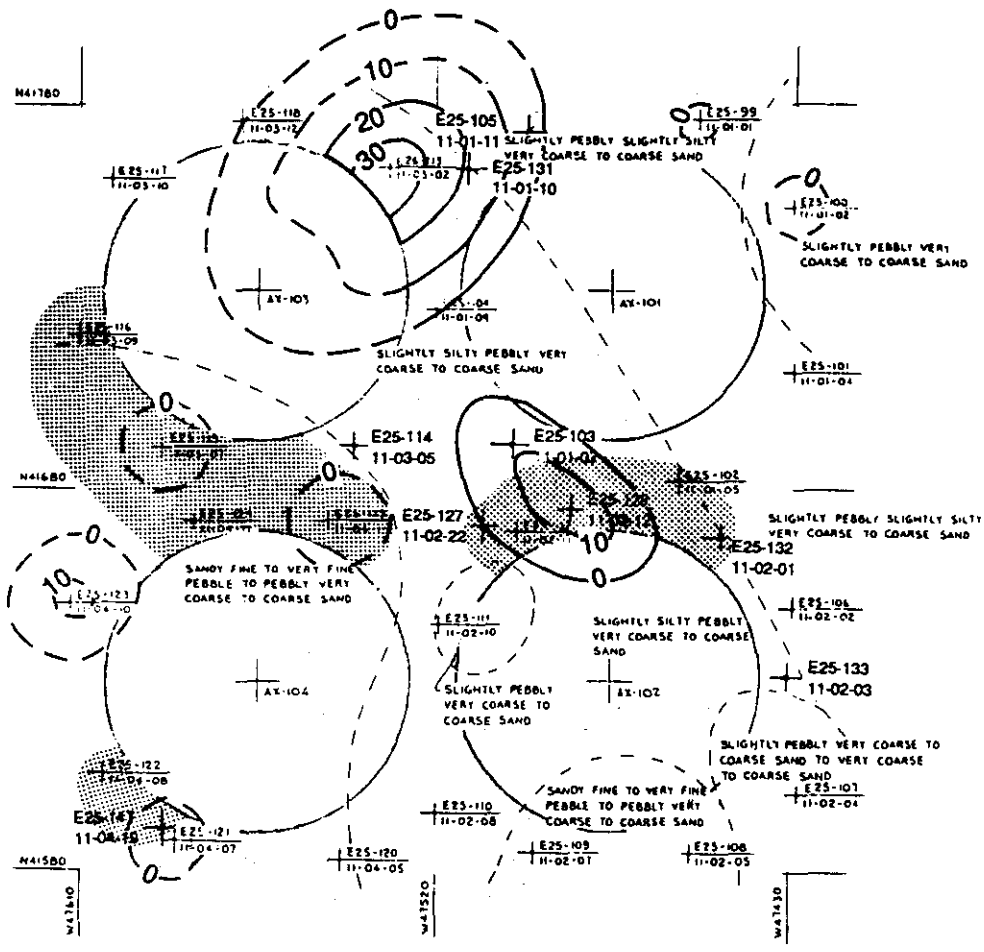
Explanation

Lithologic Boundary

Boundary Elevated Radiation

Figure A1-25. 241-AX Tank Farm: Scintillation Probe Profile Cross Section C-C'.

THIS PAGE INTENTIONALLY
LEFT BLANK



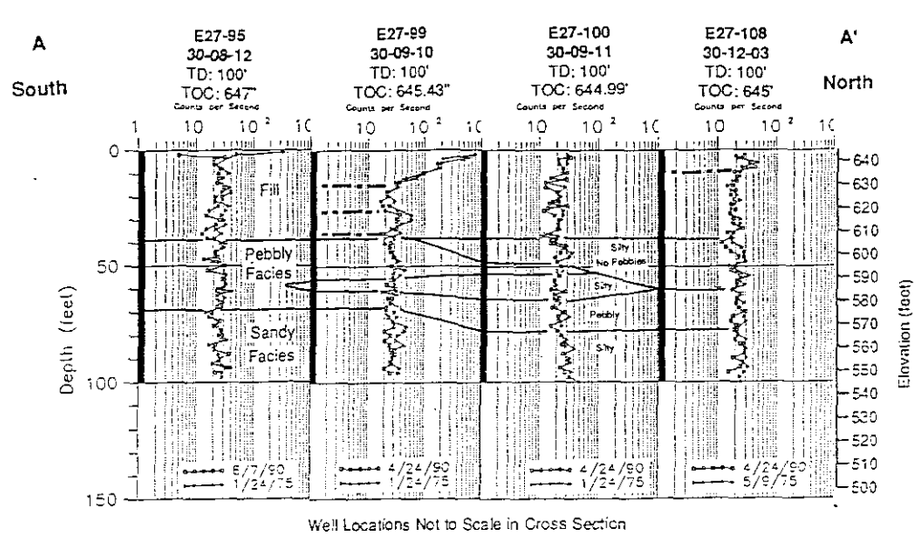
Areas of Fill and Pebbly Facies Contamination Identified on 1977 Vintage Logs.

Light Dashed Lines and Text Describe Geology Subcropping Fill.

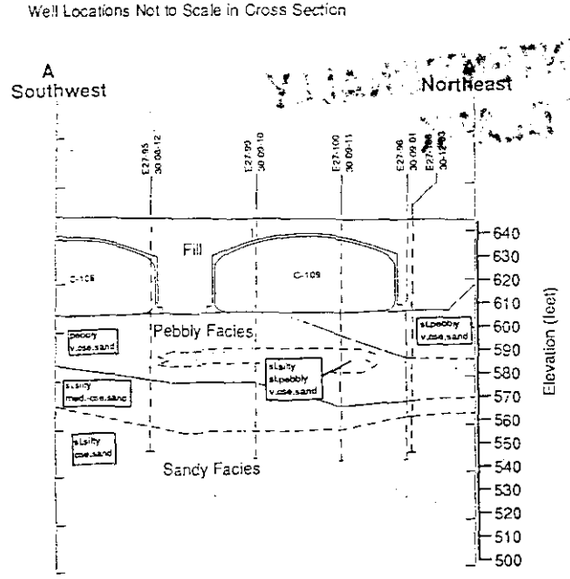
Contour Interval: 10 feet
Dashed Where Inferred

Figure A1-26. 241-AX Tank Farm: Elevated Gamma Radiation Isopach Map.

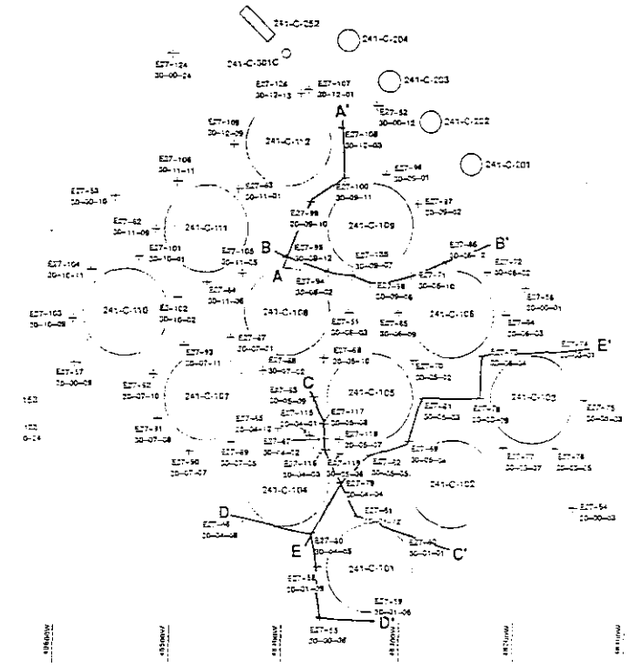
THIS PAGE INTENTIONALLY
LEFT BLANK



Well Locations Not to Scale in Cross Section



Lithologic Section after Price & Fecht (1976); Cross Section D-D'

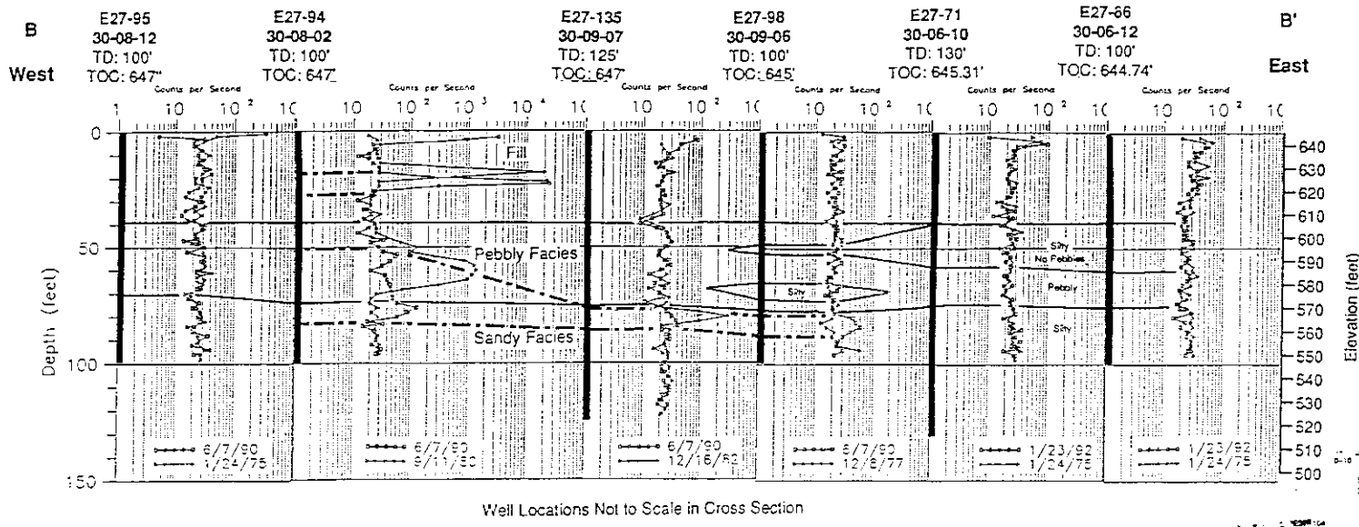


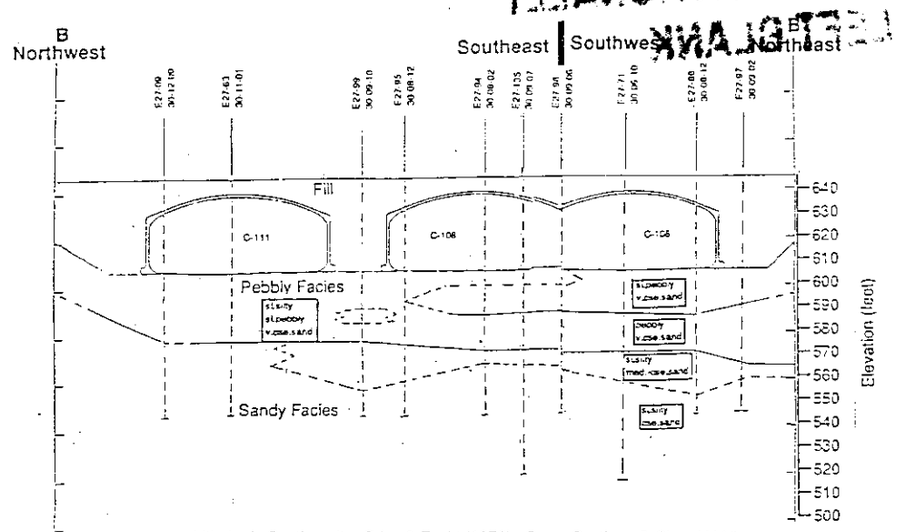
Source: Welty (1988)

Explanation
Lithologic boundary
Elevated Radiation Boundary

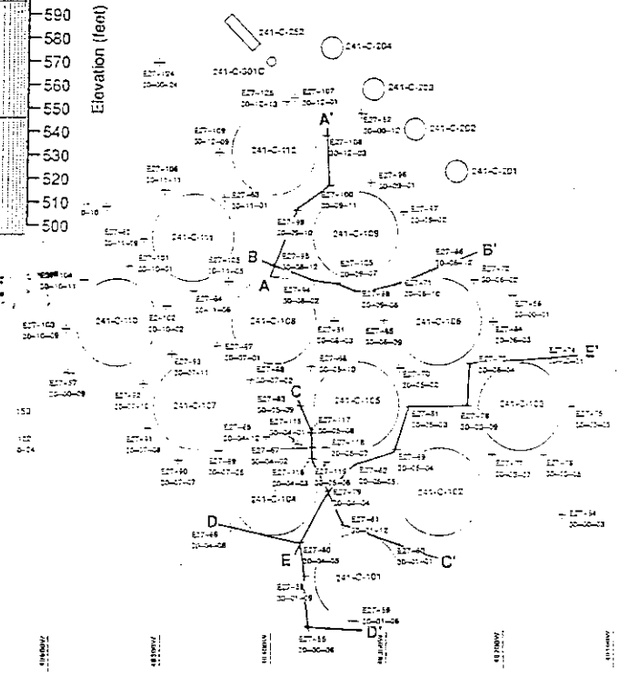
Figure A1-27. 241-C Tank Farm: Scintillation Probe Profile Cross Section A-A'.

THIS PAGE INTENTIONALLY
LEFT BLANK





Lithologic Section after Price & Fecht (1976); Cross Sections C-C' and H-H'



Source: Welty (1988)

Explanation
Lithologic boundary
Elevated Radiation Boundary

Figure A1-28. 241-C Tank Farm: Scintillation Probe Profile Cross Sections B-B'.

THIS PAGE INTENTIONALLY
LEFT BLANK

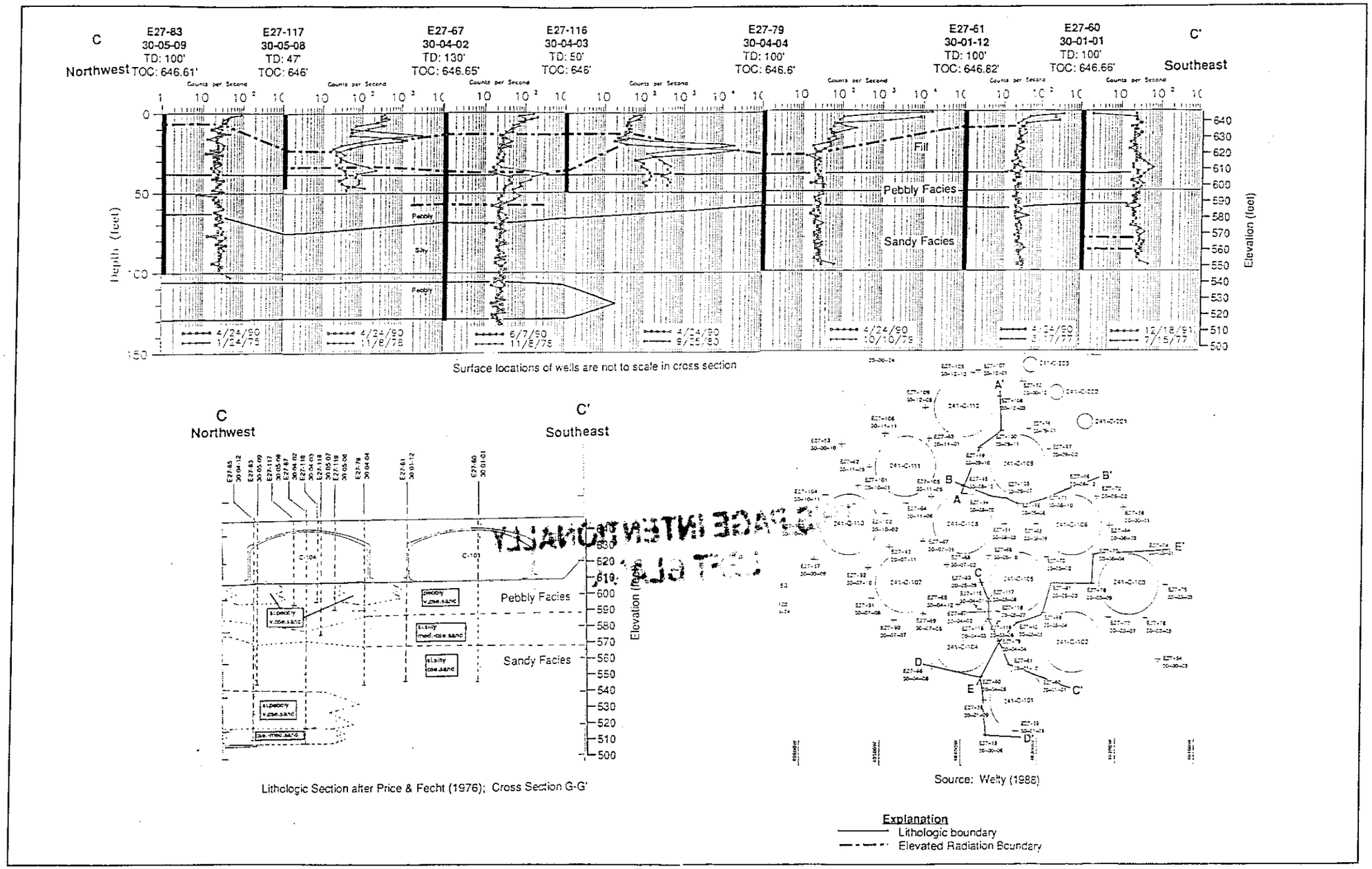


Figure A1-29. 241-C Tank Farm: Scintillation Probe Profile Cross Section C-C'.

THIS PAGE INTENTIONALLY
LEFT BLANK

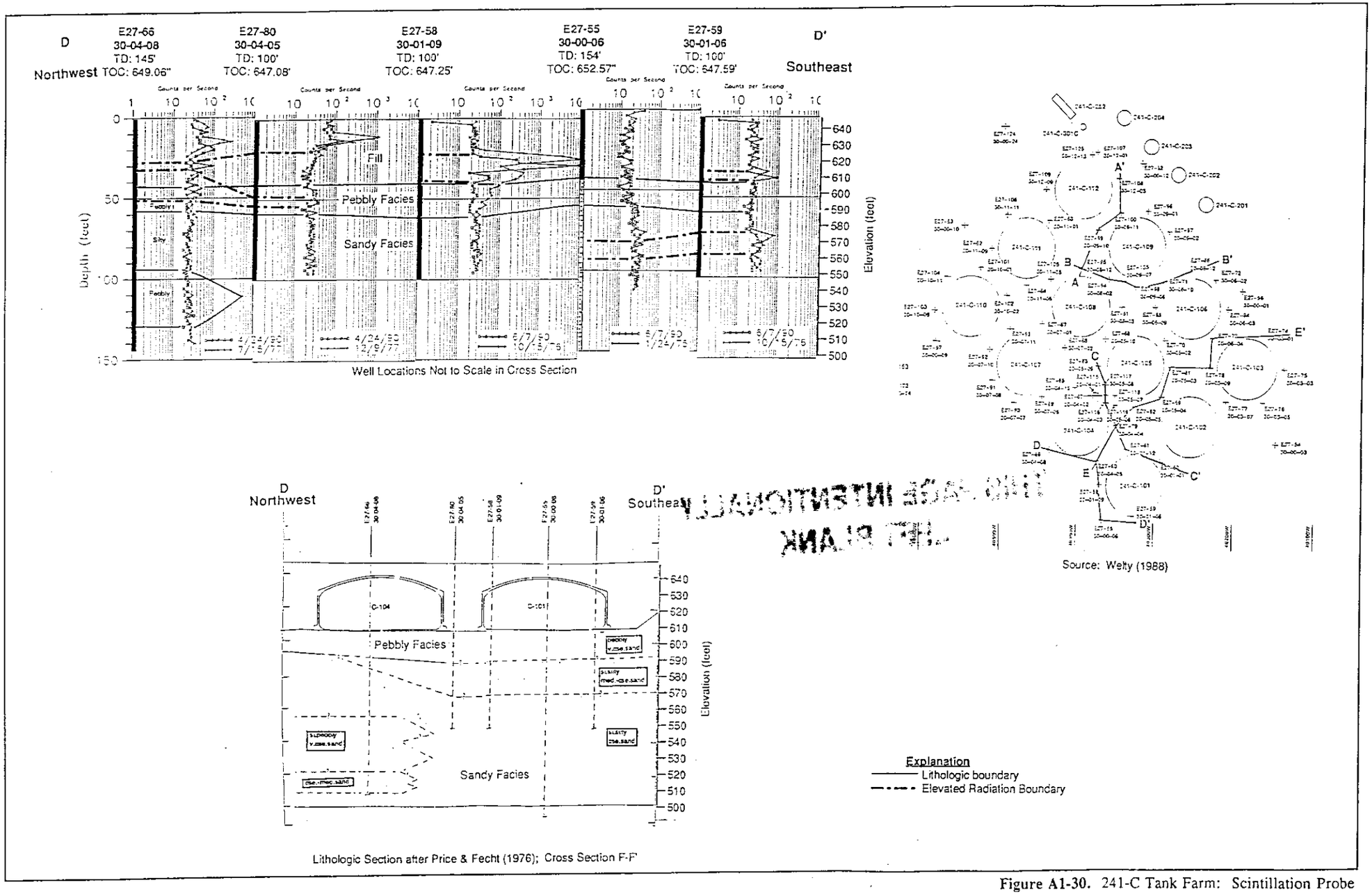


Figure A1-30. 241-C Tank Farm: Scintillation Probe Profile Cross Sections D-D'.

THIS PAGE INTENTIONALLY
LEFT BLANK

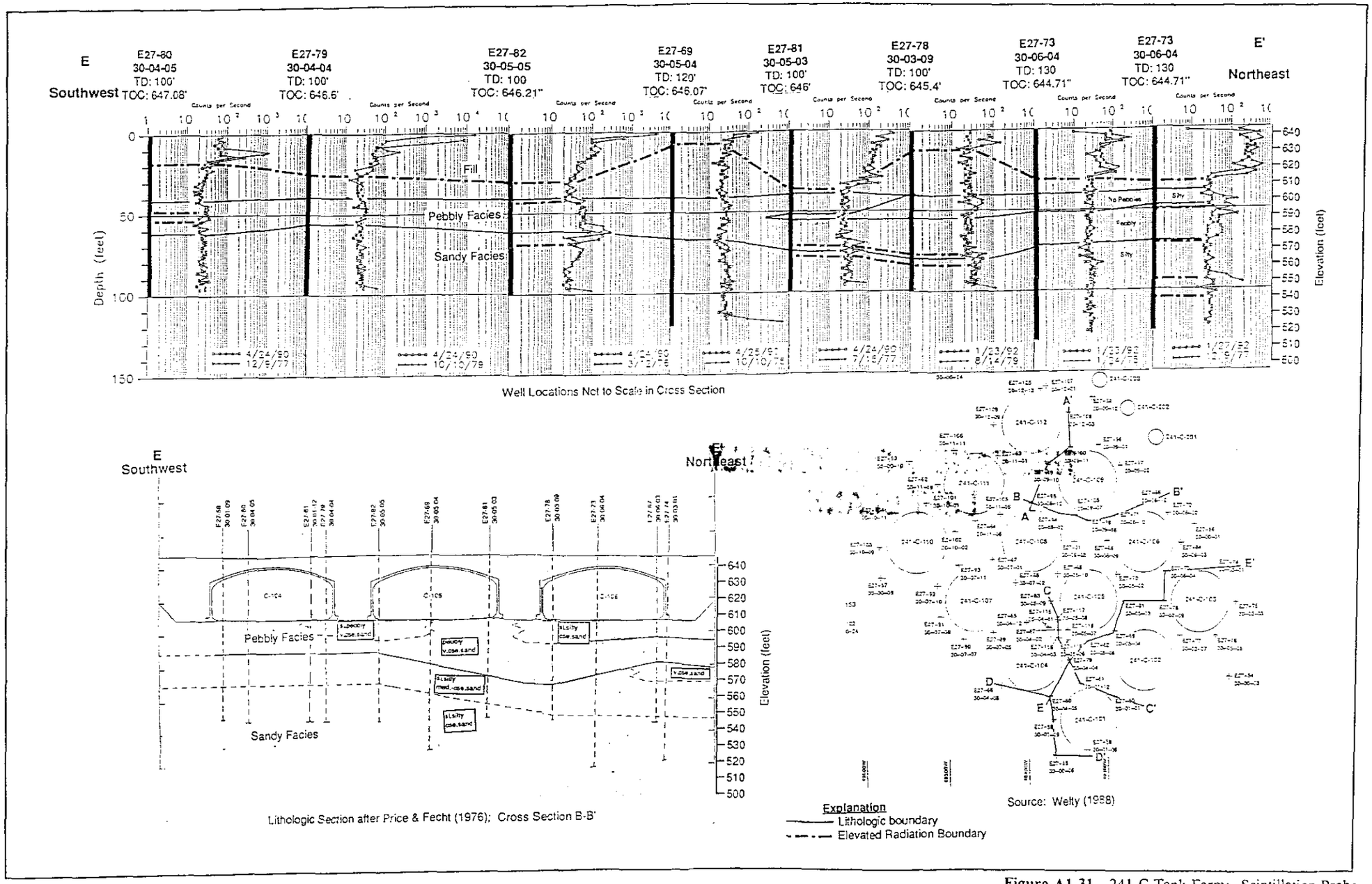


Figure A1-31. 241-C Tank Farm: Scintillation Probe Profile Cross Section E-E'.

THIS PAGE INTENTIONALLY
LEFT BLANK

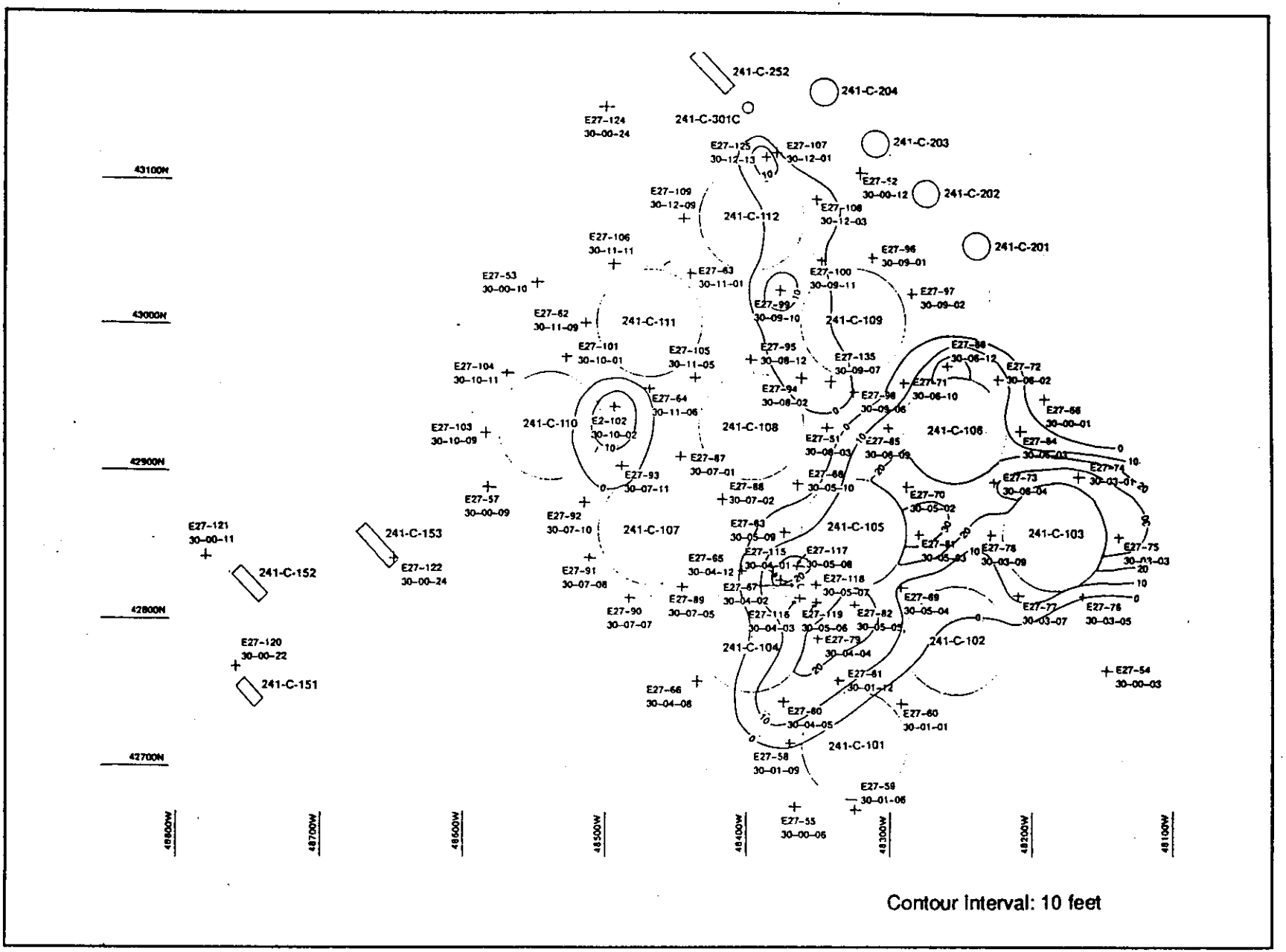


Figure A1-32. 241-C Tank Farm: Near Surface Elevated Gamma Radiation Isopach Map.

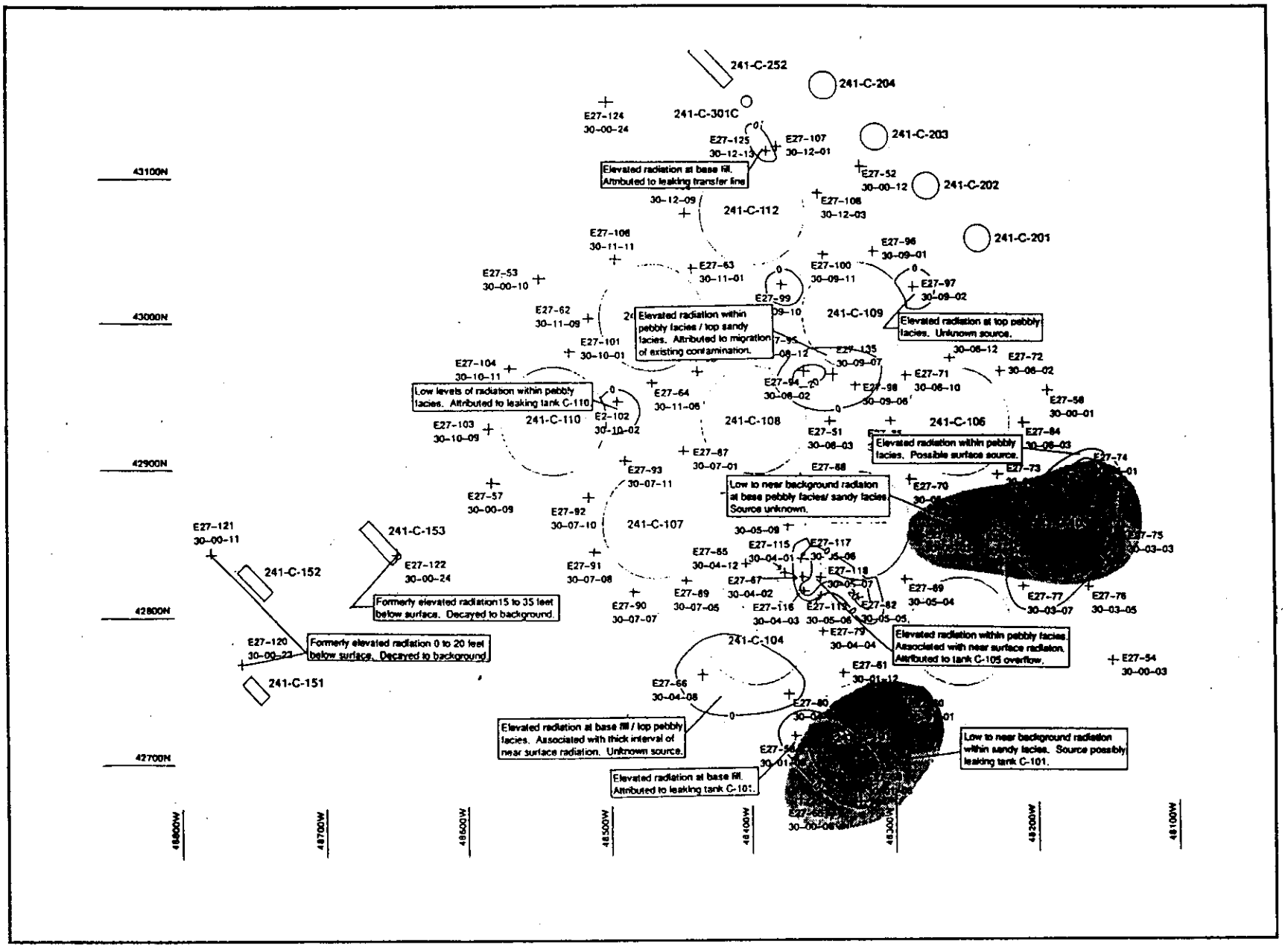


Figure A1-33. 241-C Tank Farm: Elevated Gamma Radiation within Fill and Pebbly Facies Isopach Map.

Table A1-1. Summary of Waste Management Unit Evaluation Results.

WMU	Description	Radiation Detected	Depth Interval (ft)	Evidence of Migration	Detected in Groundwater
216-A-1	Crib	Yes	27-42	No	No
216-A-7	Crib	Yes	0-15 27-42	No No	No
216-A-2	Crib	Yes	25-??	No	No
216-A-4	Crib	Yes	25-??	No	No
216-A-21	Crib	Unknown	---	---	---
216-A-26	French Drain*	Yes	25-??	No	No
216-A-26A	French Drain	Yes	25-??	No	No
216-A-27	Crib	Yes	20-140 280-320	No No	No
216-A-31	Crib	Unknown	---	---	---
216-A-36A	Crib	Yes	20-160 280-320	No	No
216-A-36B	Crib	Yes	20-135+	No	No
216-A-5	Crib	Yes	25-50	No	No
216-A-10	Crib	Yes	50-200	No	No
216-A-15	French Drain	Unknown	---	---	No
216-A-38	Crib	No	---	---	---
216-A-6	Crib	Yes	20-40	No	No
216-A-8	Crib*	Yes	0-120 145-180+	Yes	Unknown
216-A-18	Trench	No	---	---	---
216-A-19	Trench	No	---	---	---
216-A-20	Trench	No	---	---	---
216-A-24	Crib	Yes	0-123+	No	Unknown
216-A-29	Ditch*	Yes	18-31	Unknown	No
216-A-34	Ditch	No	---	---	---
216-A-524	Control Structure	No	---	---	---
216-A-9	Crib	No	---	---	---
216-A-40	Trench	No	---	---	---
216-A-30	Crib*	Yes	8-42	Yes	No
216-A-37-1	Crib*	No	---	---	---
216-A-37-2	Crib*	Unknown	---	---	---
216-A-42	Retention Basin*	No	---	---	---
216-A-45	Crib*	Yes	40-150+	Yes	Unknown
241-A-101 to 106	Tank Farm	Yes	0-100	Yes	No
241-AX-101 to 104	Tank Farm	Yes	0-39	Yes	No
241-C-101 to 112	Tank Farm	Yes			

* Unit is Currently Active.

Table A1-2. Details of Wells and Logs Used in Evaluation of 216-A-1 and -7 Waste Management Units.

Well #	Northing	Westing	TOC	TD	Perforations	Logs Used	
E25-2	41270	47190	675.04	363	276-316	6/20/84	*
						2/20/76	*
						4/25/68	
						5/14/63	
						5/14/59	
E25-54	41205	47169	674	150	---	9/23/86	*
						12/3/78	*

* Digitized Logs

Source: Westinghouse GIS Listing of Well Statistics.

9 2 1 2 6 . 5 3 6 9 5

Table A1-3. Details of Wells and Logs Used in Evaluation of 216-A-2, -4, -21, -26, -27, -31, and -36 Waste Management Units.

Well #	Northing	Westing	TOC	TD	Perforations	Logs Used	
E17-2	39063	48141	716.07	337	303-398	7/14/87	*
						2/19/76	*
						4/29/70	
						5/21/63	
E17-3	39066	48340	715.47	398	310-400	7/1/86	*
						4/28/76	*
						4/29/70	*
						4/16/68	*
						5/21/63	*
E17-4	38999	48480	717.05	379	298-398	7/14/87	*
						2/19/76	*
						4/29/70	
						4/16/68	
E17-5	38699	48560	718.69	328	298-335	9/29/82	*
						2/19/76	*
						4/28/70	
						4/16/68	
						10/18/65	
E17-6	38140	48499	720.1	499	300-460	4/27/76	
						4/29/70	
						7/2/65	
E17-7	38711	48599	719.19	377	300-385	9/19/88	*
						7/14/87	*
						4/28/76	*
						4/29/70	
						7/2/65	
E17-9	39027	48538	717.64	321	310-320	4/2/79	*
						4/28/76	
						4/29/70	*
						4/18/68	*
E17-10	38896	48650	714.74	325	310-320	9/19/86	*
						4/28/76	*
						4/29/70	*
E17-11	38924	48509	717.83	150	---	9/19/88	*
						9/29/82	*
E17-51	38540	48510	---	150	---	9/18/88	*
						9/29/82	*
E24-9	39295	48292	715.48	366	---	9/16/87	*
						2/19/76	*
						4/29/70	
						5/21/63	
E24-12	39219	48203	716.28	319	310-320	4/28/76	*
						4/29/70	*
E24-53	39515	48245	711	50	---	8/24/82	*
						4/28/76	*
						5/21/63	
E24-54	39542	48130	711	97	---	9/16/87	*
						5/21/63	

* Digitized Logs

Sources: Westinghouse GIS Listing of Well Statistics, Welty & Vermeullen (1989)

Table A1-4. Details of Wells and Logs Used in Evaluation of 216-A-5, -10, -15, and -38 Waste Management Units.

Well #	Northing	Westing	TOC	TD	Perforations	Logs Used
E17-1	39053	48942	719.17	330	303-333	8/24/82 *
						4/28/76 *
						4/30/70 *
						4/17/63 *
						5/21/63
						5/13/59
						3/27/58 *
E17-8	39123	49247	718.38	362	303-362	4/28/76
						4/30/70
						4/17/68
E24-1	39396	48761	716.22	338	300-341	9/16/87 *
						2/19/76 *
						4/29/70
						5/21/63
						5/13/59
						3/27/58 *
E24-2	39404	48953	717.47	350	277-331	8/24/82 *
						2/19/76 *
						4/30/70
						4/17/68
						5/21/63
						5/13/59
E24-10	39379	48710	715.94	315	---	9/16/87 *
						4/2/79 *
						4/29/70 *
						4/17/68 *
						3/2/67 *
						10/13/65 *
E24-11	39371	49252	718.39	336	308-362	7/14/87 *
						2/19/76 *
						4/30/70
						4/17/68
E24-15	39300	48920	---	---	---	9/9/85 *
						12/10/82 *
E24-56	39350	48704	712	146	---	9/16/87 *
						4/28/76 *
						5/21/63
						5/23/59
E24-57	39447	48704	712	147	---	9/16/87 *
						4/28/76 *
						5/21/63
						5/13/59
E24-58	39397	48666	712	195	---	9/16/87 *
						4/28/76 *
						5/21/63
						5/13/59
E24-59	39215	48913	717.42	150	---	3/11/88 *
						11/17/82 *
						4/28/76
						4/17/68
						5/21/63
						5/13/59 *
E24-60	39216	48984	718.59	200	---	9/30/88 *
						11/17/82 *
						4/28/76
						4/17/68
						5/21/63
						5/13/59 *
E24-160	39320	48910	717.79	---	170-218	3/4/86 *

* Digitized Logs
Sources: Westinghouse GIS Listing of Well Statistics, Welty & Vermeullen (1989).

Table A1-5. Details of Wells and Logs Used in Evaluation of 216-A-6 Waste Management Unit.

Well #	Northing	Westing	TOC	TD	Perforations	Logs Used	
E25-3	39980	46960	689.73	308	270-312	7/13/87	*
						2/20/76	*
						4/25/68	
						5/13/63	
						5/14/59	
						4/28/58	*
E25-53	39795	47000	690.52	148	---	8/12/87	*
						5/5/76	*

* Digitized Logs

Source: Westinghouse GIS Listing of Well Statistics.

Table A1-6. Details of Wells and Logs Used in Evaluation of 216-A-8, -18, -19, -20, -24, -29, -34, and -524 Waste Management Units.

Well#	Northing	Westing	TOC	TD	Perforations	Logs Used	
E25-4	41615	46739	659.39	263	239-281	3/23/90	•
01-08-08						3/21/84	•
						2/20/76	
						5/14/63	
						6/1/59	
						2/19/58	•
E25-5	41667	46632	657.71	275	235-291	9/19/88	•
01-08-09						3/21/84	•
						4/30/76	
						5/14/63	
						6/1/59	
						2/19/58	
E25-6	41598°	46619°	658.31	274	234-288	3/23/90	•
01-08-07						9/30/82	•
						4/30/76	•
						4/25/68	
						5/14/63	
						6/3/59	
						2/19/58	•
E25-7	41709	46416	657.15	260	235-290	3/23/90	•
01-08-10						3/21/84	•
						4/30/76	
						4/25/68	
						5/14/63	
						6/1/59	
						2/19/58	•
E25-8	41682	46187	658.31	271	244-284	3/23/90	•
01-08-03						4/30/76	
						5/14/63	
						6/1/59	
						2/19/58	•
						12/3/76	•
E25-9	41779	45860	654.86	261	233-288	9/29/82	•
						2/20/76	
						4/25/68	
						5/14/63	
						6/1/59	
						2/19/58	•
E25-10	42000	46900	655.84	280	226-291	12/3/76	•
						12/12/58	•
E25-14	41600	46650	680"	204	---	3/4/87	•
						9/30/82	•
						4/30/76	•
						2/9/67	
E25-28	41424	45541	662.44	335	---	4/15/88	•
E25-169	41675	45550	---	---	---	9/30/82	•

•Digitized Logs
°Discrepency between GIS listing and Welty & Vermeulen (1989)
"TOC inconsistent with nearby wells.
Sources: Westinghouse GIS Listing of Well Statistics and Welty & Vermeulen (1989).

Table A1-6. Details of Wells and Logs Used in Evaluation of 216-A-8, -18, -19, -20, -24, -29, -34, and -524 Waste Management Units.

Well#	Northing	Easting	TOC	TD	Perforations	Logs Used	
E26-2	42400	45664	635.3	260	220-265	8/12/87	*
						4/30/76	*
						5/14/63	
						6/3/59	
						12/12/58	*
						4/29/58	*
E26-3	42324	46-57	641.18	261	222-272	8/12/87	*
						4/30/76	*
						5/14/63	
						6/3/59	
						12/12/58	*
						4/29/58	*
E26-4	42245	46449	647.76	280	225-281	8/12/87	*
						4/30/76	*
						5/14/63	
						6/3/59	
						12/12/58	*
E26-5	42172	46842	651.07	280	237-290	8/12/87	*
						2/20/76	*
						6/24/68	
						5/14/63	
						6/3/59	
						12/12/58	*
						5/27/58	*
						4/28/58	*
E26-7	42285	46650	647	211	---	6/20/84	*
						4/30/76	*
						2/9/67	
E26-53	42325	46605	650.33	---	---	6/21/84	*
E26-54	42355	46449	---	---	---	6/21/84	*

*Digitized Logs

Sources: Westinghouse GIS Listing of Well Statistics and Welty & Vermeulen (1989).

Table A1-7. Details of Wells and Logs Used in Evaluation of 216-A-9 and -40 Waste Management Units.

Well#	Northing	Westing	TOC	TD	Perforations	Logs Used	
E24-3	41011	48310	698.33	295	277-331	4/22/85	*
						2/19/76	*
						4/17/68	
						5/20/63	
						5/12/59	
E24-4	41182	48483	696.69	325	272-298	4/28/76	*
						4/18/68	*
						5/20/63	
						5/12/59	
E24-5	41275	48727	696.61	326	274-327	4/22/85	*
						4/28/76	*
						5/13/59	*
E24-63	41335	48644	695.97	50	---	9/23/86	*
						4/28/76	*
						4/18/68	*
E27-3	42000	48500	683.27	340	265-348	5/20/63	*
						5/12/59	*

*Digitized Logs
Sources: Westinghouse GIS Listing of Well Statistics, Fecht et al. (1977) and Weity & Vermeulen (1989

Table A1-8. Details of Wells and Logs Used in Evaluation of 216-A-30, -37, and -42 Waste Management Units.

Well#	Northing	Westing	TOC	TD	Perforations	Logs Used
E16-2	39151	45162	681.09	331	265-336	9/28/82 *
						4/29/76
						4/25/68
						5/13/63
E25-11	39611	46126	681.28	309	265-338	10/8/80 *
						2/26/63
						5/13/63
E25-12	39388	45655	680.95	337	265-338	3/23/90 *
						10/8/80 *
						4/29/76
						5/13/63
E25-17	40086	46570	690	292	273-295	3/23/90 *
						8/20/82 *
						8/23/78 *
						12/3/76 *
E25-18	40070	46187	679.05	291	269-294	6/29/88 *
						8/23/78 *
						12/3/76 *
E25-19	39935	46060	677.2	287	270-295	9/29/82 *
						1/5/82 *
						8/23/78 *
						12/3/76 *
E25-20	39925	45875	676.3	294	268-293	9/29/82 *
						1/5/82 *
						8/23/78 *
						12/3/76 *
E25-21	39609	45377	677.27	295	270-293	N/A
E25-22	39776	45589	674.02	295	---	N/A
E25-23	39308	44746	680.13	295	273-304	N/A
E25-24	39484	44949	679.55	293	270-290	N/A
E25-37	40462	45749	673.29	280	260-280	6/28/89 *
E25-38	40056	45469	673.52	280	260-280	7/5/89 *
E25-190	39700	46075"	---	50	---	3/23/90 *
						10/8/82 *
E25-191	39560	45800	---	50	---	3/23/90 *
						10/13/82 *
E25-193	39430	45532	---	60	---	9/23/90 *
						10/13/82 *

*Digitized Logs
"Coordinate changed to correspond to Welty & Vermeulen (1989).
N/A Not Available
Sources: Westinghouse GIS Listing of Well Statistics; Welty & Vermeulen (1989).

Table A1-9. Details of Wells and Logs Used in Evaluation of 216-A-45 Waste Management Unit.

Well#	Northing	Westing	TOC	TD	Perforations	Logs Used
E17-12	38200	47180	721.7	340	---	4/15/86 *
E17-13	38353	49040	719.25	---	---	8/11/86 *
E17-53 01-45-04	38266	49065	719.34	150	---	9/23/88 *
E17-54 01-45-10	38354	49246	720.78	150	---	9/23/88 *

*Digitized Logs
Source: Westinghouse GIS Listing of Well Statistics.

Table A1-10. Details of Wells and Logs Used in 241-A Tank Farm Evaluation.

Well #	Northing	Westing	TOC	TD	Logging Freq (/yr)	Logs Used
E25-57 10-00-01	41379	47565	687.47	150	1	Not Used
E25-51 10-00-02	41357	47505	---	---	0	Not Used
E25-58 10-00-04	41160	47540	688.02	151	1	Not Used
E25-15 10-00-06	41125	47651	689.67	340	1	6/8/90 6/13/85 4/5/77
E24-14 10-00-07	41125	47799	690.8	340	1	Not Used
E24-13 10-00-08	41187	47875	691.05	308*	1	Not Used
E24-64	41155	47819	685	80	0	Not Used
E25-97 10-01-01	41247	47781	689.09	125	52	Not Used
E25-91 10-01-03	41213	47757	689.18	75	52	1/27/92 1/20/75
E25-92 10-01-04	41172	47770	689.57	125	52	1/20/92 10/29/84 1/20/75
E25-1 10-01-05	41166	47759	690.21	315*	1	6/8/90 1/11/82 4/4/77
E24-70 10-01-06	41157	47809	690.62	125	26	1/20/92 9/4/90 1/22/85 4/4/77
E24-71 10-01-08	41178	47845	690.48	125	26	1/20/92 1/22/85 4/4/77
E24-75 10-01-09	41200	47853	691[2]	75	26	Not Used
E24-72 10-01-10	41224	47850	689.89	125	26	Not Used
E24-73 10-01-11	41250	47822	689.83	125	26	Not Used
E25-192 10-01-16	41179	47772	689.5[2]	52	4	12/3/91 7/16/90 1/10/85 3/9/81
E25-204 10-01-28	41187	47768	689[2]	45	4	12/3/91 7/16/90 1/22/85 3/26/84
E24-65°	41170	47819	690	50	0	9/16/87

Sources: Welty & Vermeulen (1989); Price & Fecht (1976); Jacques (1972); Westinghouse GIS listing.
*TD from Westinghouse GIS listing used, differs from Welty & Vermeullen (1989).
°Logged by PNL.
"Coordinate used from Westinghouse GIS listing differs from Jacques (1972).
[2]Scaled from Price & Fecht (1976).

Table A1-10. Details of Wells and Logs Used in 241-A Tank Farm Evaluation.

Well #	Northing	Westing	TOC	TD	Logging Freq (/yr)	Logs Used
E25-90 10-02-01	41240	47670	687.87	125	26	1/20/92 9/4/90 1/21/85 4/4/77
E25-83 10-02-03	41201	47652	687.92	125	12	1/13/92 8/29/90 1/21/85 4/4/77
E25-85 10-02-05	41166	47675	688.57	125	26	1/20/92 9/4/90 1/20/85 4/4/77
E25-86 10-02-06	41158	47714	689.42	85*	12	1/13/92 8/29/90 1/21/85 4/4/77
E25-87 10-02-08	41184	47746	689.42	125	12	1/13/92 1/21/85 4/4/77
E25-88 10-02-10	41226	47746	688.88	125	12	1/13/92 7/30/90 4/4/77
E25-89 10-02-11	41250	47720	688.9	125	12	Not Used
E25-78 10-03-01	41250	47583	687.54	125	4	12/3/91 7/16/90 12/5/77
E25-79 10-03-02	41234	47553	687.3	125	4	12/3/91 7/16/90 12/5/77
E25-80 10-03-04	41180	47558	687.54	125	4	12/3/91 7/16/90 12/5/77
E25-81 10-03-05	41158	47591	688.12	125	4	12/3/91 7/16/90 12/5/77
E25-82 10-03-07	41168	47632	688.32	125	4	12/3/91 7/16/90 12/5/77
E25-55 10-03-10	41223	47651#	688.33	151	12	1/13/92 7/2/90 12/5/77
E25-84 10-03-11	41250	47635	687.53	75*	4	12/3/91 4/24/90 12/5/77

Sources: Welty & Vermeulen (1989); Price & Fecht (1976); Jacques (1972); Westinghouse GIS listing.
*TD from Westinghouse GIS listing used, differs from Welty & Vermeulen (1989).
°Logged by PNL.
#Coordinate used from Westinghouse GIS listing differs from Jacques (1972).

Table A1-10. Details of Wells and Logs Used in 241-A Tank Farm Evaluation.

Well #	Northing	Westing	TOC	TD	Logging Freq (/yr)	Logs Used
E25-61 10-04-01	41345	47774	688.11	125	1	6/8/90 1/7/85 7/12/77
E25-56 10-04-04	41283	47753	682.62	151	1	Not Used
E25-63 10-04-05	41275	47768	688.43	130*	1	Not Used
E24-66 10-04-07	41262	47819	689.36	125*	1	Not Used
E24-67 10-04-08	41287	47849	689.35	125	1	Not Used
E24-68 10-04-10	41328	47848	689.09	125*	1	Not Used
E24-69 10-04-12	41355	47815	688.32	125*	1	Not Used
E25-68 10-05-02	41335	47663	687.33	121*	1	6/8/90 1/3/77
E25-70 10-05-05	41264	47679	687.63	75	4	12/3/91 7/16/90 1/10/85 4/4/77
E25-71 10-05-07	41263	47721	688.48	74	1	Not Used
E25-98 10-05-08	41274	47749	688.64	56	1	Not Used
E25-62 10-05-09	41304	47753	688.21	125*	1	6/8/90 1/7/85 4/4/77
E25-66 10-05-10	41340#	46637	687.65	125	1	6/8/90 9/12/78 4/4/77
E25-67 10-05-12	41355	47697	687.48	125*	1	6/8/90 1/7/85 4/4/77
E25-74 10-06-02	41337	47562	687.27	125	1	Not Used
E25-75 10-06-04	41296	47552	686.9	125	1	Not Used
E25-76 10-06-05	41264	47577#	687.15	75	1	Not Used
E25-77 10-06-07	41264	47623#	687.25	125	1	Not Used
E25-69 10-06-09	41304	47651	687	125	1	6/8/90 1/8/85 4/4/77
E25-72 10-06-10	41338	47637	687.06	125	1	6/8/90 1/7/85 4/4/77
E25-73 10-06-12	41356	47598	687	110*	1	6/8/90 1/7/85 4/4/77

Sources: Welty & Vermeulen (1989); Price & Fecht (1976); Jacques (1972); Westinghouse GIS listing.
*TD from Westinghouse GIS listing used, differs from Welty & Vermeullen (1989).
°Logged by PNL.
#Coordinate used from Westinghouse GIS listing differs from Jacques (1972).

Table A1-11. Details of Wells and Logs Used in 241-AX Tank Farm Evaluation.

Well #	Northing	Westing	TOC	TD	Logging Freq (/yr)	Logs Used
E25-99 11-01-01	41776	47453	681	100	12	1/20/92 1/22/85 4/1/78
E25-100 11-01-02	41753	47429	680	100	12	1/20/92 1/22/85 4/1/77
E25-101 11-01-04	41710	47429	681	100	12	1/20/92 1/22/85 4/1/77
E25-102 11-01-05	41682	47458	681	100	12	1/20/92 1/22/85 1/3/77
E25-105 11-01-07	41692	47500	681	102	18	1/27/92 1/22/85 4/1/77
E25-104 11-01-09	41726	47520	680	103	18	1/27/92 1/22/85 1/6/77
E25-131 11-01-10	41763*	47511*	680	73	18	1/27/92 1/22/85 1/25/82
E25-105 11-01-11	41773	47495	680	100	18	1/27/92 1/22/85 6/12/78
E25-132 11-02-01	41668*	47449*	681	125	1	6/14/90 6/12/85 6/12/78
E25-106 11-02-02	41648	47429	682	100	1	Not Used
E25-133 11-02-03	41629*	41728*	682	75	1	Not Used
E25-107 11-02-04	41600	47428	680	100	1	Not Used
E25-108 11-02-05	41585	47455	682	104	1	Not Used
E25-109 11-02-07	41585*	47496*	682	99	1	Not Used
E25-110 11-02-08	41595	47520	682	N/A	0	Not Used
E25-111 11-02-10	41644	47519	681	100	1	6/14/90 6/12/85 4/5/77
E25-112 11-02-11	41669	47499	681	101	1	6/14/90 6/28/75
E25-128 11-02-12	41675	47485	681	52	12	1/13/92 5/14/79
E25-127 11-02-22	41670	47508	681	125	1	6/14/90 6/12/85 1/3/77

* Scaled from Drawing H-2-36935, Rev.4 (Tabasinski, 1978).
Sources: Welty & Vermeulen (1989); Tabasinski (1978).

Table A1-11. Details of Wells and Logs Used in 241-AX Tank Farm Evaluation.

Well #	Northing	Westing	TOC	TD	Logging Freq (/yr)	Logs Used
E25-113 11-03-02	41764	47532	680	102	4	1/4/91 1/6/77
E25-114 11-03-05	41691	47540	682	100	4	1/3/91 1/9/85 1/6/77
E25-115 11-03-07	41691	47589	684	100	4	1/3/91 1/9/85 4/5/77
E25-116 11-03-09	41720	47610	684	121	4	1/3/91 4/1/77
E25-117 11-03-10	41761	47602	681	99	4	1/3/91 1/9/85 4/1/77
E25-118 11-03-12	41776	47569	681	100	4	Not Used
E25-119 11-04-01	41672	47547	681	100	1	6/14/90 10/3/77
E25-120 11-04-05	41583	47544	682	100	1	Not Used
E25-121 11-04-07	41585	47686	682	95	1	6/13/90 6/15/84 10/5/77
E25-122 11-04-08	41605	47604	685	98	1	6/14/90 4/4/77
E25-123 11-04-10	41650	47612	685	101	1	6/14/90 6/13/84 4/5/77
E25-124 11-04-11	41672	47581	682	125	1	6/14/90 6/13/84 1/3/77
E25-147 11-04-19	41591	47588	685	125	1	6/14/90 6/13/84 4/7/78

* Scaled from Drawing H-2-36935, Rev.4 (Tabasinski, 1978).
Sources: Welty & Vermeulen (1989); Tabasinski (1978).

Table A1-12. Details of Wells and Logs Used in 241-C Tank Farm Evaluation.

Well #	Northing	Westing	TOC	TD	Logging Freq. (/yr)	Logs Used
E27-56 30-00-01	42954	48191	639.17	145*	4	Not Used
E27-54 30-00-03	42771	48149	651.57	155*	4	Not Used
E27-55 30-00-06	42677	48370	652.57	154*	1	6/7/90 1/24/75
E27-57 30-00-09	42889	48583	653.46	150*	4	4/24/90 1/24/75
E27-53 30-00-10	43029	48549	649.17	150*	1	Not Used
E27-121 30-00-11	42840	48780	---	60	1	6/7/90 12/9/77
E27-52 30-00-12	43096	48322	645.96	150*	1	Not Used
E27-123 30-00-13	43150	48500	---	60	1	Not Used
E27-120 30-00-22	42770	48760	---	60	1	6/14/90 12/9/77
E27-122 30-00-24	42840	48650	---	60	1	6/7/90 12/9/77
E27-60 30-01-01	42747	48295	646.66	100	12	12/18/91 7/15/77
E27-59 30-01-06	42676	48328	647.59	100	1	6/7/90 10/15/76
E27-58 30-01-09	42719	48373	647.25	100	1	6/7/90 10/15/76
E27-61 30-01-12	42762	48339	646.82	100	4	4/24/90 3/17/77
E27-74 30-03-01	42901	48168	645	125	26	1/27/92 12/9/77
E27-75 30-03-03	42861	48140	645	100	17	1/23/92 5/7/79
E27-76 30-03-05	42820	48165	645	100	17	1/23/92 1/24/75
E27-77 30-03-07	42825	48215	645.64	100	12	1/16/92 1/24/75
E27-78 30-03-09	42861	48231	---	100	17	1/23/92 8/14/79

* Log collected with Probe #2 (shielded probe) not with Probe #4 (unshielded).

o Bottom 100 feet of well is perforated.

Sources: Westinghouse GIS Listing of Well Statistics;
Welty & Vermeulen (1989); Welty (1988).

Table A1-12. Details of Wells and Logs Used in 241-C Tank Farm Evaluation.

Well #	Northing	Westing	TOC	TD	Logging Freq. (/yr)	Logs Used
E27-115 30-04-01	42829	48378	646	50	4	4/24/90 1/24/75
E27-67 30-04-02	42827	48365	646.65	130	1	6/7/90 11/8/78
E27-116 30-04-03	42817	48365	646	50	4	4/24/90 9/25/80
E27-79 30-04-04	42790	48352	646.6	100	4	4/24/90 10/10/79
E27-80 30-04-05	42748	48377	647.08	100	4	4/24/90 12/9/77
E27-66 30-04-08	42759	48437	649.06	145	4	4/24/90 7/15/77
E27-65 30-04-12	42835	48405	647.21	135	4	4/24/90 1/24/75
E27-70 30-05-02	42893	48290	645.7	126	4	4/24/90 10/6/78
E27-81 30-05-03	42861	48282	646	100	4	4/24/90 7/15/77
E27-69 30-05-04	42825	48294	646.07	120	4	4/25/90 10/10/75
E27-82 30-05-05	42813	48328	646.21	100	4	4/24/90 3/12/76
E27-119 30-05-06	42814	48353	646	55	4	4/24/90 9/15/78
E27-118 30-05-07	42826	48353	646	66	4	4/24/90 * 11/2/76 * 2/14/75
E27-117 30-05-08	42838	48367	646	47	4	4/24/90 11/8/78
E27-83 30-05-09	42861	48375	646.61	100	4	4/24/90 1/24/75
E27-68 30-05-10	42893	48366	646.23	135	4	4/24/90 3/10/82
E27-72 30-06-02	42967	48244	645.33	125	17	1/23/92 1/24/75
E27-84 30-06-03	42933	48209	644.8	100	17	1/23/92 7/15/77
E27-73 30-06-04	42897	48288	644.71	130	17	1/23/92 1/24/75
E27-85 30-06-09	42932	48302	645.44	100	17	1/23/92 1/24/75
E27-71 30-06-10	42963	48291	645.31	130	17	1/23/92 1/24/75
E27-86 30-06-12	42976	48260	644.74	100	26	1/23/92 1/24/75

* Log collected with Probe #2 (shielded probe) not with Probe #4 (unshielded).

o Bottom 100 feet of well is perforated.

Sources: Westinghouse GIS Listing of Well Statistics;
Welty & Vermeulen (1989); Welty (1988).

Table A1-12. Details of Wells and Logs Used in 241-C Tank Farm Evaluation.

Well #	Northing	Westing	TOC	TD	Logging Freq. (/yr)	Logs Used
E27-87 30-07-01	42911	48448	646	100	4	Not Used
E27-88 30-07-02	42883	48419	646	100	4	Not Used
E27-89 30-07-05	42823	48447	646	100	4	Not Used
E27-90 30-07-07	42815	48485	646	99	4	Not Used
E27-91 30-07-08	42842	48512	646	99	4	Not Used
E27-92 30-07-10	42879	48515	646	100	4	Not Used
E27-93 30-07-11	42898	48489	646.59	100	4	4/25/90 1/24/75
E27-94 30-08-02	42965	48363	647	100	1	6/7/90 9/11/80
E27-51 30-08-03	42932	48345	646.96	150°	1	Not Used
E27-95 30-08-12	42978	48398	647	100	1	6/7/90 1/24/75
E27-96 30-09-01	43047	48313	644.85	100	1	6/7/90 1/24/75
E27-97 30-09-02	43023	48284	645.17	100	1	6/7/90 6/7/79
E27-98 30-09-06	42956	48327	645	100	1	6/7/90 12/8/77
E27-135 30-09-07	42965	48342	---	125	1	6/7/90 12/16/82
E27-99 30-09-10	43026	48385	645.43	100	4	4/24/90 1/24/75
E27-100 30-09-11	43045	48349	644.99	100	4	4/24/90 1/24/75
E27-101 30-10-01	42979	48528	646	100	4	4/25/90 1/24/75
E27-102 30-10-02	42945	48494	646.52	100	4	4/24/90 1/24/75
E27-103 30-10-09	42926	48585	646	100	4	4/14/90 7/15/77
E27-104 30-10-11	42967	48570	646	100	4	4/25/90 9/11/79

* Log collected with Probe #2 (shielded probe) not with Probe #4 (unshielded).

o Bottom 100 feet of well is perforated.

Sources: Westinghouse GIS Listing of Well Statistics;
Welty & Vermeulen (1989); Welty (1988).

Table A1-12. Details of Wells and Logs Used in 241-C Tank Farm Evaluation.

Well #	Northing	Westing	TOC	TD	Logging Freq. (/yr)	Logs Used
E27-63 30-11-01	43036	48441	645.77	100	4	4/24/90 1/31/75
E27-105 30-11-05	42964	48438	646	100	1	Not Used
E27-64 30-11-06	42957	48469	646.49	100	1	6/7/90 1/24/75
E27-62 30-11-09	43002	48514	646.37	100	1	Not Used
E27-106 30-11-11	43043	48495	646	100	1	Not Used
E27-107 30-12-01	43120	48380	645	100	4	4/24/90 9/11/79
E27-108 30-12-03	43088	48352	645	100	4	4/24/90 5/9/75
E27-109 30-12-09	43074	48446	645	100	4	4/24/90 10/9/79
E27-125 30-12-13	43116	48387	---	116	4	4/24/90 5/9/79

* Log collected with Probe #2 (shielded probe) not with Probe #4 (unshielded).

o Bottom 100 feet of well is perforated.

Sources: Westinghouse GIS Listing of Well Statistics;
Welty & Vermeulen (1989); Welty (1988).

APPENDIX A.2

SAMPLE DATA

9 2 1 2 5 0 6 0 7 1 4

Table A-2.1 Results of Grid Soil Sampling (pCi/g)
Location 2E11

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141											
Ce-144			2.10E-01	1.90E-01			< 6.00E-02	1.30E-01			1.35E-01
Co-58	-						< -5.00E-03	1.70E-02			-5.00E-03
Co-60	-		2.00E-02	2.00E-02			< 7.70E-03	1.70E-02			1.39E-02
Cs-134	-		8.00E-02	3.00E-02			< -2.40E-04	1.90E-02			3.99E-02
Cs-137	1.30E+01	8.33E-01	1.40E+01	1.42E+00			8.60E+00	8.70E-01			1.19E+01
Eu-152	1.82E-01	1.65E-01	2.30E-01	9.00E-02			1.20E-01	9.90E-02			1.77E-01
Eu-154	-						< -5.50E-02	5.40E-02			-5.50E-02
Eu-155	-						< 1.80E-02	7.10E-02			1.80E-02
I-129											
K-40											
Mn-54	-						2.60E-02	1.60E-02			2.60E-02
Nb-95	-										
Pb-212											
Pb-214							7.90E-01	1.10E-01			7.90E-01
Pu-238	2.60E-03	8.00E-04	1.00E-03	5.00E-04			8.60E-04	6.50E-04			1.49E-03
Pu-239	7.30E-02	8.00E-03	7.30E-02	8.00E-03			4.20E-02	6.20E-03			6.27E-02
Ru-106	-						< 3.50E-02	1.80E-01			3.50E-02
Sr-90	2.18E+00	3.98E-01	8.90E-01	1.70E-01			2.70E+00	5.10E-01			1.92E+00
Tc-99											
U (total)	3.85E-01	1.26E-01	3.70E-01	1.20E-01			1.80E-01	6.40E-02			3.12E-01
Zn-65	-						< -1.60E-02	4.20E-02			-1.60E-02
Zr-95	-						< 1.40E-02	3.30E-02			1.40E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.1 Results of Grid Soil Sampling (pCi/g) (cont.)
Location 2E12

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< -4.40E-03	3.50E-02			1.02E-01	1.51E-01	4.88E-02
Ce-144			3.00E-01	2.60E-01	< -7.00E-03	9.70E-02	< -1.10E-02	1.10E-01	1.45E-01	2.29E-01	1.07E-01
Co-58	-				< -6.40E-03	1.80E-02	< -4.80E-03	1.60E-02	8.28E-03	2.72E-02	-9.73E-04
Co-60	-				< -2.60E-03	2.00E-02	< 7.40E-04	1.60E-02	1.69E-02	2.29E-02	5.01E-03
Cs-134	6.60E-02	3.40E-02	8.00E-02	3.00E-02	4.50E-02	2.00E-02	< -8.50E-03	1.80E-02	2.73E-02	3.30E-02	4.20E-02
Cs-137	1.21E+01	7.84E-01	2.55E+01	2.56E+00	1.50E-01	3.00E-02	6.80E+00	6.90E-01	2.35E+01	2.36E+00	1.36E+01
Eu-152	-				1.10E-01	8.80E-02	< 6.80E-02	7.10E-02	1.75E-02	1.03E-01	6.52E-02
Eu-154	-				< 4.60E-02	5.00E-02	< -1.80E-02	5.20E-02	2.54E-02	7.07E-02	1.78E-02
Eu-155	-		1.90E-01	1.50E-01	7.00E-02	5.40E-02	7.30E-02	6.20E-02	4.85E-02	1.02E-01	9.54E-02
I-129									2.37E-02	2.79E-01	2.37E-02
K-40									1.19E+01	1.46E+00	1.19E+01
Mn-54	-		3.00E-02	2.00E-02	2.20E-02	1.50E-02	2.10E-02	1.50E-02	1.24E-02	2.47E-02	2.14E-02
Nb-95	-								1.21E-01	6.42E-02	1.21E-01
Pb-212									7.85E-01	1.07E-01	7.85E-01
Pb-214							7.40E-01	1.10E-01	6.42E-01	1.30E-01	6.91E-01
Pu-238	9.00E-04	5.00E-04	1.00E-03	5.00E-04	4.50E-04	2.50E-04	< 4.40E-04	5.70E-04	4.18E-03	7.82E-04	1.39E-03
Pu-239	2.80E-02	4.00E-03	4.20E-02	5.00E-03	7.40E-03	1.20E-03	1.60E-02	3.70E-03	1.05E-01	1.10E-02	3.97E-02
Ru-106	-				< 2.10E-02	1.30E-01	< -2.20E-01	1.80E-01	1.98E-01	3.22E-01	-3.33E-04
Sr-90	1.36E+00	2.48E-01	2.10E+00	3.80E-01	4.10E-01	1.00E-01	6.50E-01	1.30E-01	1.67E+00	3.20E-01	1.24E+00
Tc-99									3.41E-01	1.07E+00	3.41E-01
U (total)	2.79E-01	9.50E-02	2.20E-01	8.00E-02	1.30E-01	4.30E-02	2.10E-01	7.00E-02	1.92E-01	6.32E-02	2.06E-01
Zn-65	-				< -3.20E-02	4.70E-02	< -1.20E-01	4.80E-02	2.27E-02	5.80E-02	-4.31E-02
Zr-95	9.80E-02	6.10E-02	8.00E-02	6.00E-02	5.00E-02	2.90E-02	< 1.30E-02	2.90E-02	3.52E-02	6.06E-02	5.52E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.1 Results of Grid Soil Sampling (pCi/g) (cont.)
Location 2E17

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					4.10E-02	3.80E-02			6.65E-02	9.90E-02	5.38E-02
Ce-144					< -8.40E-02	1.30E-01	< 5.60E-02	1.50E-01	6.51E-02	1.27E-01	1.24E-02
Co-58	-		5.00E-02	3.00E-02	2.30E-02	1.40E-02	< 6.00E-04	1.80E-02	8.00E-03	2.67E-02	2.04E-02
Co-60	-				< -1.20E-02	1.90E-02	< -3.00E-03	2.00E-02	7.69E-03	1.89E-02	-2.44E-03
Cs-134	-		5.00E-02	4.00E-02	3.70E-02	2.10E-02	< -1.80E-03	2.10E-02	4.23E-02	2.16E-02	3.19E-02
Cs-137	3.37E+00	2.51E-01	2.19E+00	2.50E-01	5.70E+00	5.90E-01	6.40E+00	6.50E-01	4.07E+00	4.19E-01	4.35E+00
Eu-152	-				< -5.50E-02	9.80E-02	8.40E-02	8.30E-02	1.19E-01	8.41E-02	4.93E-02
Eu-154	2.16E-01	1.03E-01			< 4.40E-02	5.40E-02	< -3.30E-02	6.10E-02	3.35E-02	5.68E-02	6.51E-02
Eu-155	-				< -2.80E-02	7.50E-02	< 2.30E-02	8.10E-02	4.67E-02	7.11E-02	1.39E-02
I-129									3.55E-02	2.63E-01	3.55E-02
K-40									1.50E+01	1.69E+00	1.50E+01
Mn-54	-				< 1.90E-03	1.90E-02	< 1.40E-02	1.70E-02	5.78E-04	2.07E-02	5.49E-03
Nb-95	-								7.69E-02	6.96E-02	7.69E-02
Pb-212									7.90E-01	9.26E-02	7.90E-01
Pb-214							5.40E-01	9.10E-02	6.17E-01	8.87E-02	5.79E-01
Pu-238	-				4.60E-04	3.90E-04	1.30E-03	5.60E-04	4.81E-04	2.60E-04	7.47E-04
Pu-239	2.00E-02	5.00E-03	7.00E-03	2.00E-03	1.70E-02	2.80E-03	3.20E-02	4.30E-03	4.09E-02	4.70E-03	2.34E-02
Ru-106	-				2.60E-01	1.70E-01	< -2.60E-02	2.00E-01	2.05E-01	1.94E-01	1.46E-01
Sr-90	2.71E+00	4.89E-01	3.04E+00	5.60E-01	5.20E+00	1.30E+00	3.40E+00	6.20E-01	3.10E+00	6.17E-01	3.49E+00
Tc-99									2.35E-01	1.06E+00	2.35E-01
U (total)	2.57E-01	8.90E-02	2.20E-01	7.00E-02	1.60E-01	5.20E-02	2.20E-01	7.20E-02	2.88E-01	9.07E-02	2.29E-01
Zn-65	-				< -9.60E-02	5.40E-02	< -3.00E-02	4.70E-02	8.76E-02	5.61E-02	-1.28E-02
Zr-95	1.05E-01	6.60E-02			< 1.10E-02	3.60E-02	< 1.90E-02	3.20E-02	2.90E-02	5.98E-02	4.10E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.1 Results of Grid Soil Sampling (pCi/g) (cont.)
Location 2E18

Radionuclide	1985		1986		1987		1988		1989		Average
	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result
Ce-141					< -2.40E-02	3.90E-02			1.35E-03	9.21E-02	-1.13E-02
Ce-144					< -2.60E-02	1.10E-01	< 1.40E-02	1.10E-01	-2.71E-02	1.25E-01	-1.30E-02
Co-58	-				< 1.40E-03	1.60E-02	< -2.20E-02	1.70E-02	8.06E-03	2.50E-02	-4.18E-03
Co-60	-				< 1.00E-02	1.40E-02	< -9.50E-03	1.70E-02	7.46E-03	1.55E-02	2.65E-03
Cs-134	4.30E-02	2.90E-02	9.00E-02	3.00E-02	3.20E-02	1.90E-02	< -3.80E-02	1.90E-02	5.57E-03	1.72E-02	2.65E-02
Cs-137	5.15E+00	3.49E-01	1.03E+01	1.05E+00	4.60E+00	4.70E-01	3.20E+00	3.30E-01	7.96E+00	8.06E-01	6.24E+00
Eu-152	1.77E-01	1.08E-01	1.30E-01	1.00E-01	7.60E-02	6.60E-02	< 3.50E-02	7.80E-02	1.79E-02	8.11E-02	8.72E-02
Eu-154	-				7.10E-02	4.20E-02	< 7.50E-03	5.60E-02	3.95E-03	4.98E-02	2.75E-02
Eu-155	-				< 3.90E-03	6.10E-02	< 5.10E-02	7.20E-02	5.98E-02	6.07E-02	3.82E-02
I-129									1.85E-01	4.53E-01	1.85E-01
K-40									1.51E+01	1.67E+00	1.51E+01
Mn-54	-				3.10E-02	1.50E-02	< 1.10E-02	1.60E-02	1.06E-02	1.74E-02	1.75E-02
Nb-95	-								3.44E-02	6.23E-02	3.44E-02
Pb-212									7.48E-01	8.78E-02	7.48E-01
Pb-214							6.30E-01	8.80E-02	7.48E-01	1.02E-01	6.89E-01
Pu-238	6.00E-04	4.00E-04	4.00E-04	3.00E-04	< 2.10E-05	1.10E-04	< 7.30E-05	1.00E-04	2.23E-04	1.62E-04	2.63E-04
Pu-239	1.10E-02	2.00E-03	1.10E-02	2.00E-03	6.80E-03	1.20E-03	6.20E-03	1.10E-03	1.49E-02	1.95E-03	9.98E-03
Ru-106	-				< -4.60E-02	1.60E-01	< 5.50E-02	1.60E-01	-8.82E-02	1.79E-01	-2.64E-02
Sr-90	1.18E+00	2.17E-01	1.29E+00	2.40E-01	1.20E+00	3.00E-01	5.60E-01	1.10E-01	2.40E+00	4.75E-01	1.33E+00
Tc-99									6.86E-01	1.10E+00	6.86E-01
U (total)	4.30E-01	1.38E-01	3.80E-01	1.20E-01	2.60E-01	7.70E-02	2.10E-01	7.00E-02	4.08E-01	1.23E-01	3.38E-01
Zn-65	-		8.00E-02	5.00E-02	< 3.20E-02	3.60E-02	< -9.80E-02	5.00E-02	-7.07E-02	4.70E-02	-1.42E-02
Zr-95	-				< -4.80E-04	3.10E-02	3.50E-02	2.90E-02	2.48E-02	4.96E-02	1.98E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.1 Results of Grid Soil Sampling (pCi/g) (cont.)
Location 2E23

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< 2.00E-02	5.10E-02					2.00E-02
Ce-144					< -1.10E-01	1.80E-01	1.80E-01	1.40E-01			3.50E-02
Co-58	-				< -2.70E-03	1.90E-02	< -2.20E-02	1.80E-02			-1.24E-02
Co-60	-		3.00E-02	2.00E-02	2.90E-02	2.00E-02	< 1.40E-02	2.10E-02			2.43E-02
Cs-134	-		6.00E-02	4.00E-02	< 1.70E-02	2.60E-02	< -7.90E-02	2.90E-02			-6.67E-04
Cs-137	9.29E+00	6.08E-01	9.98E+00	1.02E+00	1.10E+01	1.10E+00	9.60E+00	9.80E-01			9.97E+00
Eu-152	1.25E-01	1.16E-01	2.30E-01	1.00E-01	< 6.90E-02	8.60E-02	1.60E-01	9.60E-02			1.46E-01
Eu-154	-				< 4.80E-02	6.80E-02	< 3.00E-02	6.80E-02			3.90E-02
Eu-155	-		1.90E-01	1.60E-01	1.50E-01	1.00E-01	< 3.10E-02	8.20E-02			1.24E-01
I-129											
K-40											
Mn-54	2.10E-02	2.00E-02			< 1.70E-03	2.10E-02	< 1.40E-02	2.10E-02			1.22E-02
Nb-95	-										
Pb-212											
Pb-214							6.80E-01	1.10E-01			6.80E-01
Pu-238	5.30E-03	1.20E-03	4.00E-03	1.40E-03	1.50E-01	1.50E-02	5.00E-03	1.40E-03			4.11E-02
Pu-239	1.84E-01	1.80E-02	1.20E-01	1.60E-02	3.90E-02	4.70E-03	1.60E-01	1.90E-02			1.26E-01
Ru-106	-				< 1.40E-01	2.40E-01	< 1.10E-02	2.40E-01			7.55E-02
Sr-90	2.34E+00	4.25E-01	4.74E+00	8.50E-01	1.60E+00	3.90E-01	1.10E-01	2.50E-02			2.20E+00
Tc-99											
U (total)	3.00E-01	1.01E-01	5.30E-01	1.70E-01	2.90E-01	8.70E-02	2.70E-01	8.80E-02			3.48E-01
Zn-65	-		1.10E-01	5.00E-02	< -6.10E-02	5.70E-02	< -1.10E-01	5.80E-02			-2.03E-02
Zr-95	-		9.00E-02	6.00E-02	< 3.20E-02	3.70E-02	< 1.20E-02	3.60E-02			4.47E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.1 Results of Grid Soil Sampling (pCi/g) (cont.)
Location 2E24

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< 2.20E-02	3.60E-02			2.97E-02	1.17E-01	2.59E-02
Ce-144					< -5.00E-02	1.20E-01	< 7.60E-02	1.50E-01	-1.94E-02	1.44E-01	2.20E-03
Co-58	-				< -8.10E-03	1.60E-02	< -4.60E-03	1.80E-02	2.87E-03	2.43E-02	-3.28E-03
Co-60	-				< 9.00E-03	1.10E-02	< 8.60E-03	1.70E-02	3.09E-03	1.71E-02	6.90E-03
Cs-134	1.18E-01	3.60E-02	5.00E-02	4.00E-02	3.50E-02	1.90E-02	< -1.20E-02	2.00E-02	6.50E-03	1.52E-02	3.95E-02
Cs-137	4.94E+00	3.48E-01	8.95E+00	9.20E-01	6.80E+00	6.90E-01	5.80E+00	5.90E-01	9.68E-01	1.12E-01	5.49E+00
Eu-152	2.31E-01	1.48E-01	1.60E-01	1.20E-01	1.00E-01	6.50E-02	< 6.40E-02	1.00E-01	6.49E-02	8.95E-02	1.24E-01
Eu-154	-				< -3.90E-02	5.20E-02	< 2.50E-02	5.60E-02	-3.89E-03	4.50E-02	-5.96E-03
Eu-155	-				< -1.30E-02	6.90E-02	< 3.50E-02	8.00E-02	2.35E-02	8.05E-02	1.52E-02
I-129					< -3.20E-01	3.70E-01			1.74E-01	2.59E-01	-7.30E-02
K-40									1.37E+01	1.60E+00	1.37E+01
Mn-54	-				< -3.80E-03	1.40E-02	< 1.30E-02	1.90E-02	-1.31E-02	1.83E-02	-1.30E-03
Nb-95	-								-1.07E-01	6.58E-02	-1.07E-01
Pb-212									8.55E-01	1.00E-01	8.55E-01
Pb-214							6.60E-01	9.90E-02	6.84E-01	9.64E-02	6.72E-01
Pu-238	5.00E-04	3.00E-04	1.10E-03	5.00E-04	4.10E-04	3.30E-04	6.20E-04	4.40E-04	7.92E-04	2.89E-04	6.84E-04
Pu-239	2.60E-02	3.00E-03	4.00E-02	5.00E-03	2.50E-02	3.20E-03	2.70E-02	4.00E-03	3.35E-02	3.75E-03	3.03E-02
Ru-106	-				< 1.50E-01	1.60E-01	< -1.00E-02	2.10E-01	-8.61E-02	1.68E-01	1.80E-02
Sr-90	1.28E+00	2.38E-01	1.27E+00	2.30E-01	1.20E+00	3.00E-01	< 1.80E-03	5.70E-03	2.19E-01	4.37E-02	7.94E-01
Tc-99					< 7.60E-03	7.70E-01			3.25E-01	1.07E+00	1.66E-01
U (total)	3.42E-01	1.13E-01	4.60E-01	1.50E-01	2.10E-01	6.40E-02	3.20E-01	1.00E-01	3.27E-01	1.02E-01	3.32E-01
Zn-65	-				< -2.20E-02	4.00E-02	< -3.50E-02	4.60E-02	-1.72E-02	4.08E-02	-2.47E-02
Zr-95	-				4.10E-02	2.70E-02	< -1.80E-03	3.50E-02	2.01E-02	5.19E-02	1.98E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.1 Results of Grid Soil Sampling (pCi/g) (cont.)
Location 2E29

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141									3.03E-02	7.97E-02	3.03E-02
Ce-144							< -1.60E-01	1.50E-01	-4.50E-02	1.02E-01	-1.03E-01
Co-58	4.50E-02	4.10E-02					2.70E-02	2.20E-02	1.53E-02	2.65E-02	2.91E-02
Co-60	-						< 9.00E-03	1.80E-02	5.42E-03	1.70E-02	7.21E-03
Cs-134	6.60E-02	4.20E-02	8.00E-02	3.00E-02			< 3.00E-03	2.20E-02	-7.63E-03	1.69E-02	3.53E-02
Cs-137	2.98E+00	2.31E-01	2.37E+00	2.50E-01			3.20E+00	3.40E-01	1.93E+00	2.07E-01	2.62E+00
Eu-152	-		1.50E-01	8.00E-02			< -2.20E-03	1.20E-01	5.63E-02	6.98E-02	6.80E-02
Eu-154	-						< 9.50E-03	7.30E-02	3.97E-03	5.14E-02	6.74E-03
Eu-155	-						< 2.80E-02	8.30E-02	1.43E-02	5.52E-02	2.12E-02
I-129									1.74E-01	3.09E-01	1.74E-01
K-40									1.54E+01	1.74E+00	1.54E+01
Mn-54	-						< 4.50E-04	2.10E-02	-1.01E-02	1.96E-02	-4.83E-03
Nb-95	1.23E-01	6.20E-02							-3.27E-02	7.08E-02	4.52E-02
Pb-212									8.75E-01	1.01E-01	8.75E-01
Pb-214							7.60E-01	1.10E-01	6.67E-01	9.09E-02	7.14E-01
Pu-238	2.40E-03	7.00E-04	1.80E-03	1.00E-03			1.90E-03	5.60E-04	1.24E-03	3.70E-04	1.84E-03
Pu-239	7.70E-02	8.00E-03	4.60E-02	7.00E-03			6.80E-02	7.80E-03	5.06E-02	5.48E-03	6.04E-02
Ru-106	-		4.00E-01	2.20E-01			< 1.40E-01	2.20E-01	1.30E-01	1.79E-01	2.23E-01
Sr-90	1.91E+00	3.51E-01	4.20E-01	8.00E-02			4.80E-01	8.80E-02	3.32E-01	6.28E-02	7.86E-01
Tc-99									2.24E-01	1.06E+00	2.24E-01
U (total)	3.99E-01	1.29E-01	5.90E-01	2.00E-01			3.20E-01	1.00E-01	4.82E-01	1.42E-01	4.48E-01
Zn-65	-						< -1.60E-02	5.80E-02	-1.87E-02	4.41E-02	-1.74E-02
Zr-95	9.60E-02	7.90E-02					< -1.00E-02	4.50E-02	-2.22E-02	5.98E-02	2.13E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.1 Results of Grid Soil Sampling (pCi/g) (cont.)
Location 2E30

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< -1.90E-02	2.80E-02			-4.98E-02	7.60E-02	-3.44E-02
Ce-144					< 2.40E-02	9.60E-02	< 8.30E-03	1.20E-01	-4.86E-02	9.92E-02	-5.43E-03
Co-58	-				< -7.30E-03	1.50E-02	< -5.10E-03	1.80E-02	3.24E-04	2.47E-02	-4.03E-03
Co-60	-				< 5.00E-03	1.70E-02	< 3.00E-03	2.00E-02	-1.84E-03	1.45E-02	2.05E-03
Cs-134	-				4.70E-02	1.80E-02	< 1.40E-02	1.60E-02	-7.36E-02	1.93E-02	-4.20E-03
Cs-137	2.33E-01	4.20E-02			2.20E-01	3.30E-02	3.20E-01	4.60E-02	3.41E-01	4.66E-02	2.79E-01
Eu-152	-				< 5.70E-02	6.20E-02	< 2.10E-02	9.90E-02	9.74E-02	7.13E-02	5.85E-02
Eu-154	-				< 4.30E-02	4.90E-02	< 3.10E-02	4.80E-02	-4.69E-02	5.44E-02	9.03E-03
Eu-155	-				< 3.80E-02	5.50E-02	< 2.80E-02	7.50E-02	7.85E-02	5.03E-02	4.82E-02
I-129									6.30E-02	4.65E-01	6.30E-02
K-40									1.35E+01	1.51E+00	1.35E+01
Mn-54	3.10E-02	2.30E-02			< -1.30E-02	1.80E-02	< 2.30E-03	1.80E-02	-4.48E-03	1.70E-02	3.96E-03
Nb-95	-								-1.14E-02	6.82E-02	-1.14E-02
Pb-212									7.04E-01	8.07E-02	7.04E-01
Pb-214							6.50E-01	8.90E-02	6.02E-01	7.97E-02	6.26E-01
Pu-238	7.00E-04	4.00E-04			5.90E-04	2.70E-04	5.40E-04	2.40E-04	2.68E-03	5.62E-04	1.13E-03
Pu-239	1.90E-02	3.00E-03			1.70E-02	2.10E-03	1.80E-02	2.30E-03	3.53E-02	3.89E-03	2.23E-02
Ru-106	-				5.00E-01	1.70E-01	3.20E-01	1.70E-01	3.28E-01	1.52E-01	3.83E-01
Sr-90	6.48E-01	1.23E-01			2.00E-01	5.00E-02	4.20E-01	7.70E-02	2.03E-01	4.31E-02	3.68E-01
Tc-99									1.66E-01	1.05E+00	1.66E-01
U (total)	4.50E-01	1.45E-01			5.10E-02	2.30E-02	1.70E-01	5.90E-02	5.56E-01	1.62E-01	3.07E-01
Zn-65	-				< 6.20E-03	3.30E-02	4.30E-02	4.00E-02	-9.23E-02	5.26E-02	-1.44E-02
Zr-95	-				< 3.50E-03	3.10E-02	< 2.00E-02	3.30E-02	3.36E-02	5.22E-02	1.90E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.1 Results of Grid Soil Sampling (pCi/g) (cont.)
Location 2ED

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					3.80E-02	3.30E-02			-2.74E-02	8.64E-02	5.30E-03
Ce-144					< -1.50E-02	1.10E-01	< 3.70E-02	9.70E-02	-5.57E-02	1.06E-01	-1.12E-02
Co-58	-				< 8.70E-03	1.70E-02	< -1.00E-02	1.40E-02	2.44E-02	2.57E-02	7.70E-03
Co-60	-				2.50E-02	1.50E-02	< -7.10E-03	1.70E-02	-8.91E-03	1.56E-02	3.00E-03
Cs-134	7.30E-02	2.20E-02	6.00E-02	3.00E-02	4.30E-02	2.20E-02	< -5.60E-03	1.50E-02	1.29E-03	1.40E-02	3.43E-02
Cs-137	8.15E+00	5.10E-01	2.33E+00	2.50E-01	2.80E+00	2.90E-01	3.40E+00	3.50E-01	2.42E+00	2.53E-01	3.82E+00
Eu-152	-		1.10E-01	8.00E-02	< 5.50E-02	7.80E-02	1.30E-01	8.50E-02	1.29E-01	7.95E-02	1.06E-01
Eu-154	-				8.40E-02	4.70E-02	< -2.50E-02	5.50E-02	3.94E-02	5.77E-02	3.28E-02
Eu-155	-		9.00E-02	7.00E-02	< 6.00E-02	6.20E-02	< 4.60E-02	5.30E-02	6.19E-02	5.08E-02	6.45E-02
I-129					5.60E-01	3.20E-01			-2.52E-01	5.34E-01	1.54E-01
K-40									1.63E+01	1.79E+00	1.63E+01
Mn-54	-				1.80E-02	1.50E-02	2.40E-02	1.70E-02	-1.50E-02	1.83E-02	9.00E-03
Nb-95	-								-6.84E-02	7.10E-02	-6.84E-02
Pb-212									7.70E-01	8.71E-02	7.70E-01
Pb-214							6.90E-01	9.00E-02	6.76E-01	8.82E-02	6.83E-01
Pu-238	2.50E-03	7.00E-04	5.00E-04	3.00E-04	6.50E-04	2.90E-04	9.00E-04	3.10E-04	1.60E-04	1.35E-04	9.42E-04
Pu-239	7.10E-02	7.00E-03	3.10E-02	4.00E-03	4.50E-02	5.10E-03	3.90E-02	4.30E-03	1.80E-02	2.24E-03	4.08E-02
Ru-106	-				< 2.70E-02	1.50E-01	< 6.40E-02	1.50E-01	7.01E-02	1.48E-01	5.37E-02
Sr-90	1.83E+00	3.40E-01	7.20E-01	1.40E-01	7.00E-01	1.70E-01	8.00E-01	1.50E-01	4.51E-01	9.42E-02	9.00E-01
Tc-99					< 2.20E-02	9.80E-01			2.30E-01	1.03E+00	1.26E-01
U (total)	5.16E-01	1.63E-01	9.50E-01	3.10E-01	3.40E-01	9.80E-02	3.20E-01	1.00E-01	3.56E-01	1.09E-01	4.96E-01
Zn-65	-				4.60E-02	3.80E-02	< -1.60E-01	5.30E-02	-8.64E-02	4.89E-02	-6.68E-02
Zr-95	-				< 2.20E-02	3.40E-02	< -1.60E-02	2.80E-02	3.73E-02	5.25E-02	1.44E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.1 Results of Grid Soil Sampling (pCi/g) (cont.)
Location 2EDB

Radionuclide	1985		1986		1987		1988		1989		Average
	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result
Ce-141					< 1.90E-02	3.10E-02					1.90E-02
Ce-144					< 9.20E-03	1.10E-01					9.20E-03
Co-58					< 7.60E-03	1.30E-02					7.60E-03
Co-60					< 8.40E-03	1.60E-02					8.40E-03
Cs-134					6.60E-02	2.10E-02					6.60E-02
Cs-137					2.80E+00	2.90E-01					2.80E+00
Eu-152					1.50E-01	6.80E-02					1.50E-01
Eu-154					< -3.90E-02	6.10E-02					-3.90E-02
Eu-155					5.80E-02	5.50E-02					5.80E-02
I-129					< 1.00E-01	3.40E-01					1.00E-01
K-40											
Mn-54					1.70E-02	1.60E-02					1.70E-02
Nb-95											
Pb-212											
Pb-214											
Pu-238					5.00E-04	2.40E-04					5.00E-04
Pu-239					4.00E-02	4.40E-03					4.00E-02
Ru-106					< 1.00E-01	1.30E-01					1.00E-01
Sr-90					6.60E-01	1.60E-01					6.60E-01
Tc-99					< 5.20E-01	1.10E+00					5.20E-01
U (total)					3.70E-01	1.10E-01					3.70E-01
Zn-65					< 4.00E-03	3.60E-02					4.00E-03
Zr-95					< -2.00E-03	3.20E-02					-2.00E-03

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.1 Results of Grid Soil Sampling (pCi/g) (cont.)
Location GRT1

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< -1.50E-02	3.50E-02			-3.37E-02	8.04E-02	-2.44E-02
Ce-144					< -9.30E-02	1.20E-01	< -1.40E-02	7.40E-02	-1.60E-02	1.03E-01	-4.10E-02
Co-58					< -1.40E-02	1.80E-02	< 1.00E-02	1.10E-02	1.74E-02	2.47E-02	4.47E-03
Co-60					< -2.30E-02	2.00E-02	< -3.20E-03	1.30E-02	-1.09E-02	1.57E-02	-1.24E-02
Cs-134					3.90E-02	2.20E-02	< -4.40E-03	1.10E-02	-4.60E-04	1.47E-02	1.14E-02
Cs-137					1.80E+00	1.90E-01	7.10E-01	7.90E-02	1.98E+00	2.09E-01	1.50E+00
Eu-152					1.30E-01	8.10E-02	< 5.80E-02	6.30E-02	1.35E-01	8.53E-02	1.08E-01
Eu-154					< -4.60E-02	6.00E-02	< -9.90E-04	4.20E-02	-1.70E-02	5.03E-02	-2.13E-02
Eu-155					< 4.00E-02	5.90E-02	5.10E-02	4.20E-02	4.48E-02	5.03E-02	4.53E-02
I-129					< -1.40E-01	3.40E-01	3.30E-01	2.80E-01	-1.75E-01	5.51E-01	5.00E-03
K-40									1.45E+01	1.62E+00	1.45E+01
Mn-54					3.90E-02	1.60E-02	< 4.20E-03	1.30E-02	2.05E-02	1.82E-02	2.12E-02
Nb-95									-5.28E-02	7.16E-02	-5.28E-02
Pb-212									7.63E-01	8.72E-02	7.63E-01
Pb-214							5.80E-01	7.30E-02	5.97E-01	8.27E-02	5.89E-01
Pu-238					3.90E-04	2.50E-04	< 1.40E-04	2.20E-04	5.34E-04	2.31E-04	3.55E-04
Pu-239					1.70E-02	2.20E-03	7.30E-03	1.80E-03	2.00E-02	2.38E-03	1.48E-02
Ru-106					< -1.80E-01	1.70E-01	< -4.00E-02	1.00E-01	-1.26E-02	1.48E-01	-7.75E-02
Sr-90					4.40E-01	1.10E-01	3.00E-01	5.80E-02	3.65E-01	7.02E-02	3.68E-01
Tc-99					< 5.20E-01	8.60E-01			4.92E-02	1.16E+00	2.85E-01
U (total)					2.20E-01	6.90E-02			4.42E-01	1.33E-01	3.31E-01
Zn-65					4.80E-02	3.90E-02	< -1.70E-02	2.80E-02	-5.70E-02	4.55E-02	-8.67E-03
Zr-95					4.10E-02	3.70E-02	< -8.70E-03	2.20E-02	2.57E-02	5.11E-02	1.93E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.1 Results of Grid Soil Sampling (pCi/g) (cont.)
Location GRT2

Radionuclide	1985		1986		1987		1988		1989		Average
	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result
Ce-141					< -1.50E-02	4.40E-02			2.47E-02	9.40E-02	4.85E-03
Ce-144					< -2.50E-02	1.40E-01	< -1.50E-02	9.90E-02	2.08E-03	1.12E-01	-1.26E-02
Co-58					< -7.10E-03	1.80E-02	< -1.10E-03	1.40E-02	1.84E-02	2.58E-02	3.40E-03
Co-60					1.80E-02	1.70E-02	< -7.40E-03	1.50E-02	-1.43E-02	1.87E-02	-1.23E-03
Cs-134					3.20E-02	2.40E-02	< 3.40E-03	1.40E-02	-5.30E-02	2.07E-02	-5.87E-03
Cs-137					2.30E+00	2.40E-01	2.30E+00	2.40E-01	1.19E+00	1.31E-01	1.93E+00
Eu-152					9.20E-02	8.60E-02	< 7.60E-02	7.60E-02	-2.45E-02	8.30E-02	4.78E-02
Eu-154					< 2.30E-02	5.70E-02	< -3.00E-02	5.30E-02	4.84E-02	6.34E-02	1.38E-02
Eu-155					< -6.70E-03	8.40E-02	7.30E-02	5.80E-02	3.09E-02	5.60E-02	3.24E-02
I-129					< 1.80E-01	3.30E-01	< 1.60E-02	3.40E-01	9.59E-02	4.68E-01	9.73E-02
K-40									1.42E+01	1.60E+00	1.42E+01
Mn-54					< 1.10E-02	1.70E-02	< -2.20E-03	1.60E-02	-3.87E-03	1.78E-02	1.64E-03
Nb-95									-8.71E-02	7.34E-02	-8.71E-02
Pb-212									8.43E-01	9.71E-02	8.43E-01
Pb-214							6.40E-01	8.40E-02	6.04E-01	8.36E-02	6.22E-01
Pu-238					7.70E-04	2.90E-04	< -1.60E-05	4.30E-04	7.33E-04	2.93E-04	4.96E-04
Pu-239					7.10E-02	7.50E-03	1.10E-02	3.10E-03	9.48E-03	1.39E-03	3.05E-02
Ru-106					< 1.20E-01	1.60E-01	< 9.40E-02	1.30E-01	5.72E-02	1.69E-01	9.04E-02
Sr-90					3.90E-01	1.00E-01	4.80E-01	9.40E-02	1.83E-01	3.52E-02	3.51E-01
Tc-99					< 5.30E-01	1.10E+00			2.47E-01	1.17E+00	3.89E-01
U (total)					3.20E-01	9.40E-02			4.51E-01	1.34E-01	3.86E-01
Zn-65					8.20E-02	3.90E-02	< -1.80E-02	4.10E-02	-1.60E-01	6.10E-02	-3.20E-02
Zr-95					< -3.10E-02	4.10E-02	3.00E-02	2.80E-02	4.95E-02	6.43E-02	1.62E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.1 Results of Grid Soil Sampling (pCi/g) (cont.)
Location GRT4

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< -3.40E-02	4.40E-02			2.24E-02	7.90E-02	-5.80E-03
Ce-144					< -2.30E-02	1.30E-01	< -4.00E-03	8.50E-02	2.49E-02	9.69E-02	-7.00E-04
Co-58					< -3.10E-03	1.80E-02	< 9.30E-03	1.40E-02	1.10E-02	2.53E-02	5.73E-03
Co-60					< -2.30E-02	2.00E-02	< -4.30E-03	1.40E-02	-2.82E-02	1.82E-02	-1.85E-02
Cs-134					6.50E-02	2.40E-02	< -7.30E-03	1.40E-02	-8.10E-02	1.97E-02	-7.77E-03
Cs-137					1.30E+00	1.40E-01	1.20E+00	1.30E-01	5.26E-01	6.43E-02	1.01E+00
Eu-152					1.10E-01	7.40E-02	1.20E-01	7.50E-02	8.71E-02	7.78E-02	1.06E-01
Eu-154					< -1.50E-02	6.30E-02	< -1.80E-02	4.40E-02	1.16E-02	5.12E-02	-7.13E-03
Eu-155					< 7.50E-02	7.60E-02	6.70E-02	4.70E-02	3.24E-02	4.93E-02	5.81E-02
I-129					< -1.10E+00	6.50E-01	< -5.70E-01	5.70E-01	-9.87E-02	4.90E-01	-5.90E-01
K-40									1.51E+01	1.67E+00	1.51E+01
Mn-54					2.30E-02	1.70E-02	< 1.30E-02	1.50E-02	-6.94E-03	1.84E-02	9.69E-03
Nb-95									-2.89E-02	6.53E-02	-2.89E-02
Pb-212									7.91E-01	8.86E-02	7.91E-01
Pb-214							6.90E-01	8.80E-02	5.98E-01	7.77E-02	6.44E-01
Pu-238					3.40E-04	1.90E-04	< 3.30E-04	3.30E-04	6.64E-04	3.05E-04	4.45E-04
Pu-239					1.60E-02	1.90E-03	2.00E-02	3.20E-03	7.35E-03	1.24E-03	1.45E-02
Ru-106					< -2.70E-03	1.80E-01	< 5.30E-02	1.20E-01	5.74E-02	1.40E-01	3.59E-02
Sr-90					3.40E-01	8.50E-02	3.80E-01	7.20E-02	1.80E-01	3.53E-02	3.00E-01
Tc-99					< 2.40E-01	8.50E-01			4.23E-01	1.04E+00	3.32E-01
U (total)					3.10E-01	9.10E-02			3.24E-01	9.97E-02	3.17E-01
Zn-65					< 1.80E-03	4.00E-02	< -6.60E-02	4.10E-02	-9.95E-02	4.99E-02	-5.46E-02
Zr-95					< 1.80E-02	3.20E-02	< -1.60E-02	2.80E-02	2.23E-02	5.46E-02	8.10E-03

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.1 Results of Grid Soil Sampling (pCi/g) (cont.)
Location GRT5

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< -7.20E-03	3.10E-02			-2.47E-02	8.02E-02	-1.60E-02
Ce-144					< -6.00E-02	1.00E-01	< -1.70E-02	7.70E-02	-1.36E-03	9.95E-02	-2.61E-02
Co-58					< 9.20E-04	1.70E-02	< -7.10E-03	1.20E-02	-2.34E-02	2.93E-02	-9.86E-03
Co-60					< 1.20E-03	1.70E-02	< -9.30E-03	1.20E-02	1.24E-02	1.64E-02	1.43E-03
Cs-134					6.30E-02	2.00E-02	< 8.10E-04	1.20E-02	9.82E-03	1.54E-02	2.45E-02
Cs-137					1.20E+00	1.30E-01	1.30E+00	1.30E-01	2.33E+00	2.44E-01	1.61E+00
Eu-152					9.30E-02	7.20E-02	< 4.60E-02	6.40E-02	4.24E-02	7.41E-02	6.05E-02
Eu-154					< 2.10E-02	5.90E-02	< 5.90E-03	4.10E-02	-4.09E-02	5.44E-02	-4.67E-03
Eu-155					< 2.40E-02	5.60E-02	< 4.10E-02	4.30E-02	2.35E-02	5.31E-02	2.95E-02
I-129					3.60E-01	3.00E-01	< -2.60E-01	5.10E-01	-3.37E-01	5.73E-01	-7.90E-02
K-40									1.48E+01	1.65E+00	1.48E+01
Mn-54					< 1.30E-02	1.50E-02	< 1.30E-03	1.40E-02	5.56E-03	1.93E-02	6.62E-03
Nb-95									-1.49E-01	7.13E-02	-1.49E-01
Pb-212									7.97E-01	9.25E-02	7.97E-01
Pb-214							6.90E-01	8.50E-02	6.51E-01	8.70E-02	6.71E-01
Pu-238					2.60E-04	1.80E-04	3.90E-04	2.60E-04	3.60E-04	1.92E-04	3.37E-04
Pu-239					6.90E-03	1.00E-03	1.30E-02	2.10E-03	1.84E-02	2.23E-03	1.28E-02
Ru-106					< -2.00E-01	1.50E-01	< 5.20E-02	1.10E-01	-7.51E-03	1.67E-01	-5.18E-02
Sr-90					2.20E-01	5.50E-02	3.30E-01	6.50E-02	9.76E-01	1.91E-01	5.09E-01
Tc-99					< 2.70E-01	8.50E-01			5.62E-01	1.05E+00	4.16E-01
U (total)					3.50E-01	1.00E-01			4.13E-01	1.25E-01	3.82E-01
Zn-65					< 8.40E-03	4.10E-02	< -8.20E-02	3.80E-02	-9.42E-03	5.14E-02	-2.77E-02
Zr-95					< 2.10E-03	3.30E-02	< 1.50E-02	2.30E-02	0.00E+00	5.76E-02	5.70E-03

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.1 Results of Grid Soil Sampling (pCi/g) (cont.)
Location GRT6

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< -3.60E-03	3.90E-02			-5.63E-02	8.22E-02	-3.00E-02
Ce-144					< -2.90E-02	1.30E-01	< 2.50E-03	9.30E-02	-5.48E-02	1.10E-01	-2.71E-02
Co-58					< 8.80E-03	1.80E-02	< -4.00E-03	1.50E-02	-2.92E-02	3.34E-02	-8.13E-03
Co-60					< -2.50E-03	2.10E-02	< 6.30E-03	1.40E-02	1.20E-02	1.97E-02	5.27E-03
Cs-134					3.80E-02	2.30E-02	< -4.50E-03	1.30E-02	2.19E-03	1.78E-02	1.19E-02
Cs-137					2.30E+00	2.50E-01	1.20E+00	1.30E-01	1.70E+00	1.83E-01	1.73E+00
Eu-152					< 4.60E-02	8.30E-02	< 6.90E-02	7.10E-02	5.60E-02	7.58E-02	5.70E-02
Eu-154					< 4.40E-02	5.70E-02	< 1.40E-02	4.70E-02	-9.17E-03	6.06E-02	1.63E-02
Eu-155					< 5.60E-02	7.30E-02	5.90E-02	5.30E-02	2.62E-02	5.80E-02	4.71E-02
I-129					3.90E-01	2.90E-01	4.60E-01	2.70E-01	1.11E-01	3.24E-01	3.20E-01
K-40									1.50E+01	1.71E+00	1.50E+01
Mn-54					< -7.10E-03	2.00E-02	< 6.00E-04	1.50E-02	9.42E-03	2.28E-02	9.73E-04
Nb-95									-1.38E-01	7.12E-02	-1.38E-01
Pb-212									8.28E-01	9.69E-02	8.28E-01
Pb-214							5.80E-01	7.80E-02	6.68E-01	9.50E-02	6.24E-01
Pu-238					8.50E-04	3.50E-04	< -1.60E-05	1.70E-04	1.58E-04	1.44E-04	3.31E-04
Pu-239					1.60E-02	2.20E-03	5.90E-03	1.40E-03	1.02E-02	1.50E-03	1.07E-02
Ru-106					< -1.30E-02	1.50E-01	< 3.60E-02	1.20E-01	-3.91E-02	1.70E-01	-5.37E-03
Sr-90					4.10E-01	1.00E-01	2.10E-01	4.10E-02	2.39E-01	4.64E-02	2.86E-01
Tc-99					< 2.50E-01	8.50E-01			3.59E-01	1.04E+00	3.05E-01
U (total)					3.50E-01	1.00E-01			4.47E-01	1.34E-01	3.99E-01
Zn-65					< 2.30E-02	4.20E-02	< -1.30E-02	3.60E-02	-2.36E-02	5.45E-02	-4.53E-03
Zr-95					< 3.20E-02	3.70E-02	< 2.30E-02	2.70E-02	7.18E-02	6.10E-02	4.23E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g)
Location 2E-1

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< 9.10E-03	2.80E-02	< 1.20E-02	2.60E-02	-2.40E-02	8.26E-02	-9.67E-04
Ce-144					< 2.90E-02	9.30E-02			-4.48E-04	1.06E-01	1.43E-02
Co-58	-				< 3.40E-03	1.50E-02			0.00E+00	2.37E-02	1.70E-03
Co-60	6.10E-02	3.10E-02			< 1.30E-02	1.60E-02			7.06E-04	1.45E-02	2.49E-02
Cs-134	7.00E-02	3.50E-02	3.00E-02	2.90E-02	< 1.00E-02	2.00E-02	< 7.30E-03	1.20E-02	-5.15E-02	1.94E-02	1.32E-02
Cs-137	3.59E+00	2.91E-01	1.31E+00	1.52E-01	1.10E+00	1.20E-01	1.50E+00	1.60E-01	4.85E+00	4.94E-01	2.47E+00
Eu-152	-		2.35E-01	8.90E-02	1.30E-01	6.60E-02	7.60E-02	6.40E-02	4.16E-02	6.84E-02	1.21E-01
Eu-154	-				1.20E-01	4.50E-02	< 1.10E-02	4.90E-02	-1.74E-02	4.67E-02	3.79E-02
Eu-155	-				< -3.70E-02	5.70E-02	< 3.00E-02	5.20E-02	2.32E-02	5.69E-02	5.40E-03
I-129											
K-40									1.32E+01	1.46E+00	1.32E+01
Mn-54	-				< 5.80E-03	1.60E-02	< 1.90E-03	1.50E-02	1.16E-02	1.64E-02	6.43E-03
Nb-95	-								2.00E-03	5.15E-02	2.00E-03
Pb-212									6.29E-01	7.46E-02	6.29E-01
Pb-214									4.60E-01	7.01E-02	4.60E-01
Pu-238	2.00E-04	2.00E-04			< 4.40E-05	1.20E-04	< -1.60E-05	9.20E-05			7.60E-05
Pu-239	2.80E-02	3.00E-03	2.00E-03	1.00E-03	1.10E-03	4.00E-04	1.60E-03	4.80E-04			8.18E-03
Ru-106	-				< 1.20E-01	1.30E-01	< 2.20E-02	1.20E-01	4.33E-02	1.60E-01	6.18E-02
Sr-90	1.12E+00	2.05E-01	4.42E-01	8.60E-02	3.50E-01	8.70E-02	5.20E-01	9.80E-02			6.08E-01
Tc-99											
U (total)	2.50E-01	8.70E-02	3.60E-01	1.18E-01	3.20E-01	1.50E-01	1.30E-01	4.80E-02			2.65E-01
Zn-65	-				< -5.50E-02	4.20E-02			-1.13E-01	4.97E-02	-8.40E-02
Zr-95	-				< -7.90E-03	3.00E-02	< -8.70E-03	2.60E-02	-3.56E-03	4.43E-02	-6.72E-03

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g) (cont.)
Location 2E-2

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< -3.10E-02	5.90E-02	< 2.20E-03	3.70E-03	5.23E-02	8.72E-02	7.83E-03
Ce-144					< 8.20E-02	2.00E-01			-4.45E-02	1.17E-01	1.88E-02
Co-58	-				< 3.10E-04	1.70E-02			-1.22E-02	2.17E-02	-5.95E-03
Co-60	-				< -7.60E-03	1.60E-02			-1.20E-03	1.58E-02	-4.40E-03
Cs-134	-				7.50E-02	2.10E-02	< 1.80E-02	1.90E-02	-4.95E-03	1.76E-02	2.94E-02
Cs-137	2.10E+01	1.35E+00	2.12E+01	2.15E+00	2.50E+01	2.50E+00	1.50E+01	1.50E+00	7.66E+00	7.76E-01	1.80E+01
Eu-152	-		1.67E-01	1.06E-01	< 5.60E-02	7.40E-02	8.50E-02	8.10E-02	6.20E-02	6.74E-02	9.25E-02
Eu-154	-				< 5.00E-02	5.30E-02	< -6.50E-04	4.80E-02	6.12E-02	4.40E-02	3.69E-02
Eu-155	-				< 8.70E-02	1.20E-01	< 5.40E-02	7.50E-02	3.61E-03	5.73E-02	4.82E-02
I-129											
K-40									1.36E+01	1.52E+00	1.36E+01
Mn-54	-				< 8.40E-03	1.60E-02	< 7.70E-03	1.40E-02	1.56E-02	1.61E-02	1.06E-02
Nb-95	-								-1.64E-02	4.46E-02	-1.64E-02
Pb-212									6.13E-01	7.50E-02	6.13E-01
Pb-214									4.69E-01	7.60E-02	4.69E-01
Pu-238	5.00E-04	3.00E-04			< 2.70E-04	4.00E-04	< -3.20E-05	3.30E-04			2.46E-04
Pu-239	8.00E-03	2.00E-03	7.00E-03	2.00E-03	7.30E-03	1.70E-03	4.30E-03	1.50E-03			6.65E-03
Ru-106	-		4.88E-01	4.45E-01	< 2.30E-01	2.50E-01	< 1.20E-01	2.00E-01	3.73E-02	1.71E-01	2.19E-01
Sr-90	2.67E+00	4.95E-01	2.35E+00	4.28E-01	2.60E+00	6.60E-01	2.10E+00	3.90E-01			2.43E+00
Tc-99											
U (total)	3.08E-01	1.03E-01	2.87E-01	9.50E-02	3.90E-01	1.80E-01	3.30E-01	1.00E-01			3.29E-01
Zn-65	-		1.09E-01	6.20E-02	< 1.60E-02	4.00E-02			-3.69E-02	4.26E-02	2.94E-02
Zr-95	-				< -2.40E-02	3.20E-02	< 6.80E-03	2.50E-02	-2.52E-02	4.19E-02	-1.41E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g) (cont.)
Location 2E-3

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< -8.70E-03	2.90E-02	< 7.50E-03	2.60E-02	-1.94E-02	6.85E-02	-6.87E-03
Ce-144					< -9.30E-02	9.80E-02			-7.68E-02	8.80E-02	-8.49E-02
Co-58	-				< 7.80E-03	1.60E-02			-8.49E-03	2.53E-02	-3.45E-04
Co-60	-				< 6.40E-03	1.60E-02			5.46E-03	1.51E-02	5.93E-03
Cs-134	9.60E-02	6.40E-02			4.90E-02	2.40E-02	2.50E-02	1.40E-02	-4.99E-03	1.39E-02	4.13E-02
Cs-137	6.00E-01	1.17E-01	2.23E-01	4.60E-02	4.90E-01	6.40E-02	7.80E-01	8.90E-02	2.90E-01	3.94E-02	4.77E-01
Eu-152	-		1.41E-01	9.40E-02	1.00E-01	6.10E-02	7.20E-02	5.70E-02	1.28E-01	7.51E-02	1.10E-01
Eu-154	-				< 7.40E-03	5.20E-02	< 1.80E-02	4.40E-02	-3.33E-04	5.06E-02	8.36E-03
Eu-155	-				< -4.00E-03	5.90E-02	5.50E-02	5.30E-02	5.17E-02	4.59E-02	3.42E-02
I-129											
K-40									1.43E+01	1.58E+00	1.43E+01
Mn-54	-				2.30E-02	1.70E-02	< 9.30E-03	1.50E-02	5.33E-03	1.66E-02	1.25E-02
Nb-95	-								-4.15E-02	5.45E-02	-4.15E-02
Pb-212									6.61E-01	7.65E-02	6.61E-01
Pb-214									5.28E-01	7.05E-02	5.28E-01
Pu-238	4.00E-04	3.00E-04	4.00E-04	3.00E-04	3.90E-04	2.40E-04	3.50E-04	1.90E-04			3.85E-04
Pu-239	4.20E-02	5.00E-03	1.00E-02	2.00E-03	1.00E-02	1.60E-03	1.30E-02	1.70E-03			1.88E-02
Ru-106	9.89E-01	6.89E-01	2.22E-01	2.19E-01	4.40E-01	1.80E-01	2.30E-01	1.40E-01	2.11E-02	1.48E-01	3.80E-01
Sr-90	1.00E+00	1.87E-01	3.06E-01	6.20E-02	5.70E-01	1.40E-01	2.50E-01	4.80E-02			5.32E-01
Tc-99											
U (total)	2.67E-01	9.20E-02	3.97E-01	1.29E-01	2.40E-01	1.20E-01	3.20E-01	1.00E-01			3.06E-01
Zn-65	-				< 3.30E-02	3.60E-02			-1.60E-02	4.31E-02	8.50E-03
Zr-95	-				< 2.60E-02	3.10E-02	< -1.60E-02	2.80E-02	2.03E-02	4.83E-02	1.01E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g) (cont.)
Location 2E-4

Radionuclide	1985		1986		1987		1988		1989		Average
	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result
Ce-141											
Ce-144											
Co-58	-										
Co-60	-										
Cs-134	-										
Cs-137	8.60E+01										8.60E+01
Eu-152	-										
Eu-154	-										
Eu-155											
I-129											
K-40											
Mn-54	-										
Nb-95	-										
Pb-212											
Pb-214											
Pu-238	-										
Pu-239	2.30E+02										2.30E+02
Ru-106	-										
Sr-90	7.80E+00										7.80E+00
Tc-99											
U (total)	-										
Zn-65	-										
Zr-95	-										

A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g) (cont.)
Location 2E-NE

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< 1.80E-02	2.80E-02	< -2.00E-03	3.10E-02	-3.88E-02	7.66E-02	-7.60E-03
Ce-144					< -6.40E-02	1.00E-01			1.67E-02	1.10E-01	-2.37E-02
Co-58	-				< -1.00E-02	1.80E-02			-9.15E-03	2.69E-02	-9.58E-03
Co-60	-				< 1.20E-02	1.50E-02			8.39E-03	1.60E-02	1.02E-02
Cs-134	9.40E-02	5.60E-02	9.80E-02	3.40E-02	3.20E-02	2.00E-02	< -3.00E-03	2.10E-02	-2.16E-03	1.55E-02	4.38E-02
Cs-137	5.10E-01	1.83E-01	1.54E+00	1.75E-01	1.10E+00	1.20E-01	1.70E+00	1.90E-01	1.08E+00	1.20E-01	1.19E+00
Eu-152	-				< -2.00E-03	8.10E-02	< 8.00E-02	9.60E-02	1.71E-02	8.30E-02	3.17E-02
Eu-154	-				< 3.90E-02	4.40E-02	< 1.80E-02	6.60E-02	1.21E-03	5.78E-02	1.94E-02
Eu-155	-				< 4.10E-02	5.30E-02	< 6.80E-02	7.30E-02	2.00E-02	4.83E-02	4.30E-02
I-129											
K-40									1.38E+01	1.57E+00	1.38E+01
Mn-54	6.70E-02	4.90E-02	2.90E-02	2.40E-02	< -1.10E-02	1.80E-02	< 1.60E-02	1.90E-02	1.72E-02	1.93E-02	2.36E-02
Nb-95	-								-4.63E-02	6.43E-02	-4.63E-02
Pb-212									7.27E-01	8.47E-02	7.27E-01
Pb-214									6.00E-01	8.36E-02	6.00E-01
Pu-238	6.00E-04	4.00E-04			< 1.60E-04	1.80E-04	< 2.20E-04	2.40E-04			3.27E-04
Pu-239	5.00E-03	1.00E-03	5.00E-03	1.00E-03	5.10E-03	1.00E-03	6.50E-03	1.50E-03			5.40E-03
Ru-106	-				< 3.10E-02	1.40E-01	< -2.70E-02	2.00E-01	-2.35E-02	1.53E-01	-6.50E-03
Sr-90	1.88E+00	3.44E-01	1.46E+00	2.71E-01	1.00E+00	2.50E-01	2.20E+00	4.20E-01			1.64E+00
Tc-99											
U (total)	2.14E-01	7.60E-02	3.54E-01	1.17E-01	1.20E-01	6.20E-02	2.30E-01	7.40E-02			2.30E-01
Zn-65	-		6.50E-02	4.80E-02	< -1.50E-03	3.60E-02			-2.07E-02	4.95E-02	1.43E-02
Zr-95	1.28E-01	1.03E-01	7.60E-02	7.40E-02	< -2.50E-02	2.70E-02	< 2.40E-03	4.10E-02	6.48E-03	5.31E-02	3.76E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g) (cont.)
Location 2E-SE

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< -2.20E-02	1.80E-02	< 9.30E-03	2.30E-02	1.01E-02	8.18E-02	-8.67E-04
Ce-144					< 5.90E-02	6.10E-02			-8.94E-03	1.06E-01	2.50E-02
Co-58	-				< -6.90E-03	9.60E-03			5.69E-03	2.48E-02	-6.05E-04
Co-60	3.60E-02	2.40E-02			1.30E-02	9.70E-03			-1.79E-03	1.90E-02	1.57E-02
Cs-134	5.40E-02	4.40E-02	7.80E-02	3.40E-02	4.70E-02	1.40E-02	< -6.70E-02	1.80E-02	1.11E-03	1.46E-02	2.26E-02
Cs-137	6.30E-02	5.20E-02	1.66E-01	4.30E-02	1.20E-01	2.00E-02	1.00E-01	2.40E-02	1.34E+00	1.46E-01	3.58E-01
Eu-152	-		1.03E-01	9.20E-02	< 4.10E-02	4.70E-02	< 3.70E-02	8.10E-02	1.50E-01	7.30E-02	8.28E-02
Eu-154	-				< 5.60E-03	3.70E-02	< -1.80E-02	5.50E-02	3.77E-02	5.39E-02	8.43E-03
Eu-155	-				< 2.40E-02	3.30E-02	< 3.60E-02	5.10E-02	6.49E-02	5.46E-02	4.16E-02
I-129											
K-40									1.51E+01	1.68E+00	1.51E+01
Mn-54	-				< -9.10E-04	9.90E-03	< 1.20E-02	1.50E-02	3.85E-03	1.70E-02	4.98E-03
Nb-95	-								-5.54E-02	6.50E-02	-5.54E-02
Pb-212									7.48E-01	8.57E-02	7.48E-01
Pb-214									6.14E-01	8.48E-02	6.14E-01
Pu-238	4.00E-04	3.00E-04	3.00E-04	3.00E-04	< -3.10E-06	8.50E-05	< 1.80E-04	1.90E-04			2.19E-04
Pu-239	2.00E-03	1.00E-03	1.00E-03	1.00E-03	1.50E-03	4.20E-04	1.90E-03	5.50E-04			1.60E-03
Ru-106	-		2.60E-01	2.07E-01	< -3.20E-02	7.90E-02	< -2.30E-02	1.30E-01	6.05E-02	1.49E-01	6.64E-02
Sr-90	1.56E+00	2.90E-01	4.83E-01	9.50E-02	3.50E-01	9.00E-02	3.80E-01	7.40E-02			6.93E-01
Tc-99											
U (total)	3.62E-01	1.19E-01	3.14E-01	1.04E-01	2.40E-01	1.20E-01	2.90E-01	9.30E-02			3.02E-01
Zn-65	-				< -2.50E-02	2.90E-02			-7.47E-02	4.79E-02	-4.99E-02
Zr-95	-				< 1.00E-02	2.00E-02	< 1.20E-02	2.80E-02	2.49E-02	5.22E-02	1.56E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g) (cont.)
Location A-TF-E1

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< -1.60E-02	3.20E-02	< -1.10E-03	2.50E-02	-5.66E-02	9.96E-02	-2.46E-02
Ce-144					< -2.00E-02	1.10E-01			-6.39E-02	1.17E-01	-4.20E-02
Co-58	-				< -2.60E-03	1.70E-02			3.04E-02	2.79E-02	1.39E-02
Co-60	-				< -1.20E-02	1.60E-02			1.10E-02	1.92E-02	-5.00E-04
Cs-134	-		4.10E-02	2.90E-02	3.70E-02	2.50E-02	< -2.00E-03	1.40E-02	4.29E-03	1.88E-02	2.01E-02
Cs-137	9.60E-01	1.35E-01	2.44E+00	2.70E-01	2.10E+00	2.20E-01	3.70E+00	3.80E-01	2.79E+00	2.94E-01	2.40E+00
Eu-152	-		2.30E-01	1.17E-01	8.40E-02	8.20E-02	8.30E-02	6.90E-02	2.55E-02	9.47E-02	1.06E-01
Eu-154	-				< 4.00E-02	4.80E-02	< -3.20E-02	4.60E-02	3.32E-02	5.92E-02	1.37E-02
Eu-155	-				< 5.30E-02	6.30E-02	8.20E-02	5.50E-02	1.84E-02	5.98E-02	5.11E-02
I-129											
K-40									1.21E+01	1.43E+00	1.21E+01
Mn-54	-				< 3.70E-03	1.60E-02	< 4.80E-04	1.30E-02	5.05E-03	1.84E-02	3.08E-03
Nb-95	-								-4.77E-02	7.27E-02	-4.77E-02
Pb-212									4.82E-01	6.83E-02	4.82E-01
Pb-214									5.01E-01	8.14E-02	5.01E-01
Pu-238	-		1.40E-03	7.00E-04	< -1.00E-05	7.70E-05	< 7.50E-05	1.10E-04			4.88E-04
Pu-239	2.00E-03	1.00E-03	3.00E-03	1.00E-03	< 6.10E-05	9.10E-05	3.10E-03	6.20E-04			2.04E-03
Ru-106	-				< 1.30E-01	1.60E-01	< -1.70E-02	1.20E-01	1.49E-01	1.91E-01	8.73E-02
Sr-90	3.63E-01	7.10E-02	3.98E-01	7.90E-02	4.80E-01	1.20E-01	4.70E-01	9.10E-02			4.28E-01
Tc-99											
U (total)	2.57E-01	8.90E-02	2.10E-01	8.70E-02	2.80E-01	1.30E-01	1.40E-01	5.00E-02			2.22E-01
Zn-65	-				< -5.70E-02	4.80E-02			-4.80E-02	5.29E-02	-5.25E-02
Zr-95	-				< 3.00E-02	3.00E-02	< -6.10E-03	2.60E-02	-9.53E-03	6.06E-02	4.79E-03

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g) (cont.)
Location A-TF-E2

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< 7.30E-03	3.70E-02	< 8.40E-04	3.00E-02	4.05E-02	9.52E-02	1.62E-02
Ce-144					< 4.50E-03	1.30E-01			-4.02E-02	1.24E-01	-1.79E-02
Co-58	-		4.70E-02	2.50E-02	< 2.80E-04	1.50E-02			1.88E-02	2.76E-02	2.20E-02
Co-60	-				1.80E-02	1.20E-02			-5.44E-03	1.75E-02	6.28E-03
Cs-134	-		4.20E-02	2.40E-02	8.00E-02	2.20E-02	2.50E-02	1.60E-02	3.42E-03	1.88E-02	3.76E-02
Cs-137	4.57E+00	3.52E-01	1.26E+01	1.28E+00	1.10E+01	1.10E+00	4.20E+00	4.40E-01	4.08E+00	4.18E-01	7.29E+00
Eu-152	-				1.00E-01	6.30E-02	1.10E-01	6.70E-02	7.50E-02	7.45E-02	9.50E-02
Eu-154	-				5.10E-02	4.50E-02	< -5.20E-02	5.40E-02	-5.44E-02	5.44E-02	-1.85E-02
Eu-155	-				7.30E-02	6.40E-02	< 3.90E-02	6.00E-02	5.23E-02	5.41E-02	5.48E-02
I-129											
K-40									1.39E+01	1.55E+00	1.39E+01
Mn-54	6.40E-02	3.50E-02	2.20E-02	1.90E-02	< -1.50E-03	1.60E-02	< 1.20E-03	1.60E-02	1.58E-02	1.90E-02	2.03E-02
Nb-95	1.11E-01	7.40E-02							-5.21E-02	6.66E-02	2.95E-02
Pb-212									6.68E-01	7.96E-02	6.68E-01
Pb-214									5.27E-01	7.55E-02	5.27E-01
Pu-238	-		5.00E-04	5.00E-04	9.00E-04	4.30E-04	< 1.10E-04	1.90E-04			5.03E-04
Pu-239	1.00E-03	1.00E-03	4.00E-03	1.00E-03	7.60E-03	1.40E-03	3.70E-03	1.10E-03			4.08E-03
Ru-106	-				< -5.20E-02	1.70E-01	1.70E-01	1.50E-01	1.31E-01	1.89E-01	8.30E-02
Sr-90	1.17E+00	2.16E-01	2.41E+00	4.44E-01	4.30E+00	1.10E+00	7.20E-01	1.40E-01			2.15E+00
Tc-99											
U (total)	2.66E-01	9.20E-02	5.52E-01	1.83E-01	3.10E-01	1.40E-01	3.20E-01	9.90E-02			3.62E-01
Zn-65	-				< -3.10E-02	4.00E-02			-3.27E-03	4.57E-02	-1.71E-02
Zr-95	1.43E-01	1.02E-01			< 1.00E-02	2.80E-02	< 1.00E-03	2.80E-02	9.31E-04	5.67E-02	3.87E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g(cont.)
Location A-TF-E3

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< 2.70E-03	3.80E-02	< 2.60E+00	7.30E+00	-8.41E-02	1.11E-01	8.40E-01
Ce-144					< 2.50E-02	1.30E-01			-8.47E-02	1.48E-01	-2.99E-02
Co-58	-				< -2.90E-03	1.30E-02			5.98E-03	2.61E-02	1.54E-03
Co-60	4.50E-02	2.60E-02			< 7.00E-03	1.50E-02			-2.49E-02	1.89E-02	9.03E-03
Cs-134	5.50E-02	3.70E-02	1.19E-01	3.40E-02	8.50E-02	2.40E-02	< 9.10E-03	2.20E-02	1.36E-02	2.20E-02	5.63E-02
Cs-137	5.36E+00	3.97E-01	1.51E+01	1.52E+00	1.10E+01	1.10E+01	1.30E+01	1.30E+00	7.09E+00	7.22E-01	1.03E+01
Eu-152	-		8.50E-02	6.90E-02	< 4.60E-02	6.10E-02	< 6.00E-02	7.70E-02	6.16E-02	7.50E-02	6.32E-02
Eu-154	-				7.10E-02	4.80E-02	< -2.10E-02	5.40E-02	4.52E-02	4.69E-02	3.17E-02
Eu-155	-				< 1.20E-02	7.10E-02	< 6.80E-02	8.30E-02	2.79E-02	8.32E-02	3.60E-02
I-129											
K-40									1.51E+01	1.72E+00	1.51E+01
Mn-54	-		2.50E-02	1.60E-02	< 9.00E-03	1.30E-02	< 2.10E-02	2.70E-02	3.65E-02	2.84E-02	2.29E-02
Nb-95	-								-8.16E-02	6.65E-02	-8.16E-02
Pb-212									7.07E-01	9.03E-02	7.07E-01
Pb-214									5.00E-01	8.93E-02	5.00E-01
Pu-238	-		4.00E-04	4.00E-04	< -5.90E-05	1.30E-04	2.90E-04	1.60E-04			2.10E-04
Pu-239	3.00E-03	1.00E-03	3.00E-03	1.00E-03	1.40E-03	5.40E-04	4.30E-03	7.30E-04			2.93E-03
Ru-106	-		6.96E-01	3.30E-01	< 1.40E-01	1.90E-01	< 6.30E-02	2.90E-01	7.74E-02	2.40E-01	2.44E-01
Sr-90	8.32E-01	1.55E-01	5.25E+00	9.60E-01	1.60E+00	3.90E-01	2.10E+00	3.90E-01			2.45E+00
Tc-99											
U (total)	3.25E-01	1.09E-01	2.34E-01	7.80E-02	1.70E-01	1.00E-01	2.90E-01	9.00E-02			2.55E-01
Zn-65	8.20E-02	4.80E-02			< -3.20E-02	4.00E-02			1.37E-02	4.50E-02	2.12E-02
Zr-95	-				< -2.10E-02	2.70E-02	< -1.70E-01	4.10E-01	-2.28E-02	5.91E-02	-7.13E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g) (cont.)
Location A-TF-E4

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< -5.30E-02	7.00E-02	< -4.30E-03	3.70E-02	5.17E-02	8.31E-02	-1.87E-03
Ce-144					< -8.60E-03	2.30E-01			-7.31E-03	1.07E-01	-7.96E-03
Co-58			4.60E-02	3.00E-02	< 8.90E-03	1.40E-02			-5.50E-03	2.27E-02	1.65E-02
Co-60					< -9.20E-03	2.00E-02			-2.66E-03	1.36E-02	-5.93E-03
Cs-134					3.60E-02	2.10E-02	< -5.90E-02	2.50E-02	-8.95E-03	1.43E-02	-1.07E-02
Cs-137			9.04E+01	9.06E+00	4.20E+01	4.20E+00	1.00E+01	1.00E+00	4.37E+00	4.46E-01	3.67E+01
Eu-152					1.20E-01	6.30E-02	9.90E-02	8.00E-02	-6.92E-03	6.99E-02	7.07E-02
Eu-154			9.00E-02	4.90E-02	< 2.00E-02	5.40E-02	< -8.70E-03	6.00E-02	1.15E-02	5.07E-02	2.82E-02
Eu-155			2.34E-01	1.86E-01	< 6.10E-02	1.30E-01	< 5.80E-04	8.00E-02	3.73E-02	5.26E-02	8.32E-02
I-129											
K-40									1.29E+01	1.43E+00	1.29E+01
Mn-54					< 1.10E-02	1.50E-02	< 1.40E-02	1.50E-02	3.33E-03	1.53E-02	9.44E-03
Nb-95									-2.98E-02	5.57E-02	-2.98E-02
Pb-212									6.06E-01	7.17E-02	6.06E-01
Pb-214									5.25E-01	7.54E-02	5.25E-01
Pu-238			9.00E-04	5.00E-04	8.60E-04	7.60E-04	3.20E-04	1.70E-04			6.93E-04
Pu-239			1.40E-02	2.00E-03	8.20E-03	2.10E-03	8.60E-03	1.20E-03			1.03E-02
Ru-106					< -1.50E-02	3.80E-01	< 1.30E-01	2.00E-01	3.67E-02	1.45E-01	5.06E-02
Sr-90			7.66E+00	1.40E+00	4.90E+00	1.20E+00	4.10E+00	7.70E-01			5.55E+00
Tc-99											
U (total)			3.91E-01	1.27E-01	1.70E-01	1.00E-01	3.00E-01	9.50E-02			2.87E-01
Zn-65					< -1.30E-02	4.60E-02			-1.71E-02	3.70E-02	-1.51E-02
Zr-95					< -1.20E-03	3.40E-02	< 2.60E-02	2.80E-02	1.15E-02	4.75E-02	1.21E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g) (cont.)
Location A-TF-W1

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< -2.00E-02	3.70E-02	< -3.50E-02	2.70E-02	-1.02E-01	1.33E-01	-5.23E-02
Ce-144					< -7.50E-02	1.20E-01			9.25E-02	1.59E-01	8.75E-03
Co-58	-				2.10E-02	1.50E-02			-1.79E-02	3.96E-02	1.55E-03
Co-60	-				3.00E-02	1.70E-02			6.26E-03	2.16E-02	1.81E-02
Cs-134	-		2.90E-02	2.70E-02	7.50E-02	2.70E-02	< -5.00E-02	1.90E-02	-1.03E-02	2.25E-02	1.09E-02
Cs-137	6.76E-01	9.30E-02	2.89E+00	3.07E-01	3.70E+00	3.80E-01	1.90E+00	2.00E-01	2.02E+00	2.22E-01	2.24E+00
Eu-152	-				1.10E-01	7.60E-02	8.10E-02	7.10E-02	7.88E-02	1.14E-01	8.99E-02
Eu-154	1.21E-01	9.80E-02			< 9.20E-03	4.70E-02	< -3.40E-02	5.40E-02	1.10E-02	7.22E-02	2.68E-02
Eu-155	-				< 1.40E-02	7.50E-02	< 2.00E-02	6.50E-02	5.74E-02	8.75E-02	3.05E-02
I-129											
K-40									1.49E+01	1.77E+00	1.49E+01
Mn-54	-				< -1.50E-02	2.00E-02	2.20E-02	1.60E-02	1.22E-02	2.43E-02	6.40E-03
Nb-95	-								-4.25E-02	8.78E-02	-4.25E-02
Pb-212									6.41E-01	9.38E-02	6.41E-01
Pb-214									5.96E-01	9.92E-02	5.96E-01
Pu-238	-				< 1.80E-04	2.40E-04	1.80E-04	1.40E-04			1.80E-04
Pu-239	1.00E-03	1.00E-03	3.00E-03	1.00E-03	5.10E-03	1.30E-03	3.40E-03	6.60E-04			3.13E-03
Ru-106	-				< -1.60E-01	1.80E-01	1.80E-01	1.40E-01	1.13E-01	2.24E-01	4.43E-02
Sr-90	6.62E-01	1.23E-01	1.02E+00	1.90E-01	1.80E+00	4.40E-01	9.50E-01	1.80E-01			1.11E+00
Tc-99											
U (total)	2.75E-01	9.50E-02	3.18E-01	1.06E-01	2.70E-01	1.30E-01	1.90E-01	6.40E-02			2.63E-01
Zn-65	-				< -2.40E-02	4.10E-02			-4.76E-02	6.89E-02	-3.58E-02
Zr-95	-				4.40E-02	3.20E-02	< 1.70E-02	2.60E-02	1.20E-02	8.00E-02	2.43E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g) (cont.)
Location A-TF-W2

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< 1.90E-02	2.50E-02	< 1.50E-03	3.90E-02	-6.55E-02	1.00E-01	-1.50E-02
Ce-144					< 2.10E-02	8.40E-02			-4.79E-02	1.32E-01	-1.35E-02
Co-58	-				< 1.70E-03	1.30E-02			-3.25E-02	3.36E-02	-1.54E-02
Co-60	-				< 5.90E-03	1.40E-02			5.30E-03	2.17E-02	5.60E-03
Cs-134	-		3.50E-02	3.20E-02	2.60E-02	1.80E-02	< -1.60E-02	2.60E-02	5.47E-03	1.69E-02	1.26E-02
Cs-137	1.69E+00	1.70E-01	8.31E-01	1.09E-01	1.70E+00	1.80E-01	1.20E+01	1.20E+00	3.19E-01	4.87E-02	3.31E+00
Eu-152	-				< 3.90E-02	6.10E-02	9.10E-02	7.20E-02	2.45E-02	9.71E-02	5.15E-02
Eu-154	-				< 2.00E-02	4.40E-02	< 3.40E-02	5.50E-02	-8.79E-02	6.81E-02	-1.13E-02
Eu-155	-				< 4.70E-02	5.00E-02	< 3.40E-02	9.20E-02	6.67E-02	7.42E-02	4.92E-02
I-129											
K-40									1.55E+01	1.77E+00	1.55E+01
Mn-54	-				< 2.20E-04	1.30E-02	2.40E-02	1.70E-02	3.40E-03	2.28E-02	9.21E-03
Nb-95	-								-1.52E-01	7.54E-02	-1.52E-01
Pb-212									9.38E-01	1.08E-01	9.38E-01
Pb-214									8.16E-01	1.06E-01	8.16E-01
Pu-238	-		3.00E-04	2.00E-04	< 1.60E-04	2.20E-04	2.30E-04	1.50E-04			2.30E-04
Pu-239	2.00E-03	1.00E-03	1.00E-03	1.00E-03	1.30E-03	5.50E-04	3.30E-03	6.10E-04			1.90E-03
Ru-106	-				< -6.20E-02	1.20E-01	< 3.40E-02	2.60E-01	1.74E-01	1.87E-01	4.87E-02
Sr-90	2.45E+00	4.40E-01	7.64E-01	1.45E-01	1.10E+00	2.70E-01	7.60E+00	1.40E+00			2.98E+00
Tc-99											
U (total)	2.90E-01	9.80E-02	5.10E-01	1.67E-01	2.20E-01	1.10E-01	2.40E-01	7.80E-02			3.15E-01
Zn-65	-				< 1.80E-02	3.50E-02			-1.02E-01	7.19E-02	-4.20E-02
Zr-95	-				3.30E-02	2.30E-02	< 2.80E-02	3.20E-02	5.20E-02	6.63E-02	3.77E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g) (cont.)
Location AW-TF-E

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< 2.70E-03	2.00E-02	< -2.00E-02	4.20E-02			-8.65E-03
Ce-144					< 5.30E-04	6.80E-02					5.30E-04
Co-58	-				< -1.30E-02	1.40E-02					-1.30E-02
Co-60	-		3.60E-02	1.80E-02	< -1.40E-02	1.30E-02					1.10E-02
Cs-134	6.30E-02	5.30E-02	7.10E-02	2.50E-02	4.30E-02	1.40E-02	< -2.30E-02	2.80E-02			3.85E-02
Cs-137	9.30E-02	5.00E-02	2.16E-01	4.30E-02	3.10E-01	4.10E-02	6.90E-01	9.50E-02			3.27E-01
Eu-152	-				< 4.70E-02	5.10E-02	< -8.20E-03	1.40E-01			1.94E-02
Eu-154	-				< 1.20E-02	4.10E-02	< -1.90E-02	8.30E-02			-3.50E-03
Eu-155	-				< 5.80E-03	3.70E-02	< -1.30E-02	1.00E-01			-3.60E-03
I-129											
K-40											
Mn-54	5.70E-02	4.00E-02			< 4.80E-03	1.10E-02	< 1.10E-02	2.40E-02			2.43E-02
Nb-95	1.05E-01	7.70E-02									1.05E-01
Pb-212											
Pb-214											
Pu-238	2.20E-03	7.00E-04			3.30E-04	2.30E-04	2.80E-04	1.70E-04			9.37E-04
Pu-239	7.10E-02	7.00E-03	1.00E-03	1.00E-03	5.20E-03	9.80E-04	4.20E-03	7.40E-04			2.04E-02
Ru-106	4.39E-01	4.38E-01			< -6.10E-02	1.00E-01	< -1.90E-01	2.60E-01			6.27E-02
Sr-90	3.40E-02	1.90E-02	3.66E-01	7.30E-02	1.60E-01	4.00E-02	6.10E-01	1.20E-01			2.93E-01
Tc-99											
U (total)	2.72E-01	9.30E-02	4.38E-01	1.43E-01	5.10E-01	2.80E-01	3.10E-01	9.80E-02			3.83E-01
Zn-65	-				< 1.10E-02	3.10E-02					1.10E-02
Zr-95	-				< 5.60E-03	1.90E-02	< -2.00E-03	5.20E-02			1.80E-03

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g) (cont.)
Location C-TF-NE

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< 1.00E-02	9.40E-02	< 6.30E-03	3.40E-02	2.27E-02	1.65E-01	1.30E-02
Ce-144					< 1.50E-01	3.20E-01			6.36E-03	2.00E-01	7.82E-02
Co-58	3.90E-02	2.40E-02			< 6.30E-03	1.90E-02			-3.93E-03	3.42E-02	1.38E-02
Co-60	-				3.00E-02	1.60E-02			-2.50E-03	2.18E-02	1.38E-02
Cs-134	4.60E-02	4.40E-02	5.10E-02	3.30E-02	6.50E-02	2.60E-02	< 1.60E-02	1.80E-02	-2.79E-02	2.92E-02	3.00E-02
Cs-137	3.25E+00	2.74E-01	4.62E+00	4.88E-01	8.20E+01	8.20E+00	1.00E+01	1.00E+00	1.75E+01	1.76E+00	2.35E+01
Eu-152	-				< 6.80E-02	8.40E-02	< 2.70E-02	6.60E-02	6.01E-02	1.04E-01	5.17E-02
Eu-154	1.35E-01	7.80E-02	1.69E-01	8.50E-02	< 1.70E-02	5.20E-02	< -7.90E-03	4.50E-02	1.17E-02	6.53E-02	6.50E-02
Eu-155	-				< 2.20E-02	1.80E-01	< 6.70E-02	6.90E-02	6.78E-02	8.75E-02	5.23E-02
I-129											
K-40									1.45E+01	1.70E+00	1.45E+01
Mn-54	-				< -3.30E-03	2.00E-02	< 6.70E-03	1.40E-02	8.29E-03	2.38E-02	3.90E-03
Nb-95	-		1.88E-01	1.17E-01					-5.48E-02	9.35E-02	6.66E-02
Pb-212									7.40E-01	9.95E-02	7.40E-01
Pb-214									6.57E-01	1.17E-01	6.57E-01
Pu-238	-		1.00E-03	5.00E-04	< 3.90E-04	6.30E-04	2.40E-04	1.60E-04			5.43E-04
Pu-239	1.00E-03	1.00E-03	3.40E-02	4.00E-03	2.20E-02	4.10E-03	1.60E-02	2.00E-03			1.83E-02
Ru-106	-				< -5.90E-02	5.10E-01	< 5.50E-02	1.70E-01	-2.46E-01	3.14E-01	-8.33E-02
Sr-90	4.74E+00	8.75E-01	3.63E+00	6.67E-01	1.10E+01	2.60E+00	2.80E+00	5.30E-01			5.54E+00
Tc-99											
U (total)	2.70E-01	9.30E-02	3.63E-01	1.19E-01	2.70E-01	1.30E-01	4.40E-01	1.30E-01			3.36E-01
Zn-65	7.90E-02	7.00E-02			< -7.70E-03	3.80E-02			-2.55E-02	5.45E-02	1.53E-02
Zr-95	-				< 5.80E-03	3.30E-02	< 6.70E-03	2.90E-02	-2.52E-02	7.46E-02	-4.23E-03

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g) (cont.)
Location C-TF-SE

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141					< 4.90E-03	5.40E-02	< -2.60E-02	2.80E-02	1.27E-02	2.56E-01	-2.80E-03
Ce-144					< -2.50E-02	1.90E-01			-1.32E-01	3.20E-01	-7.85E-02
Co-58					< -1.10E-02	1.70E-02			5.39E-03	3.23E-02	-2.81E-03
Co-60					2.20E-02	1.50E-02			1.91E-02	2.06E-02	2.06E-02
Cs-134					6.90E-02	2.40E-02	< -5.90E-02	2.00E-02	-5.76E-02	4.60E-02	-1.59E-02
Cs-137			3.90E+01		2.30E+01	2.30E+00	3.70E+00	3.80E-01	6.20E+01	6.21E+00	3.19E+01
Eu-152					9.50E-02	6.80E-02	9.60E-02	6.10E-02	3.37E-02	9.79E-02	7.49E-02
Eu-154					< -1.00E-02	6.20E-02	< 1.80E-02	5.40E-02	1.52E-03	6.05E-02	3.17E-03
Eu-155					< -3.20E-02	1.00E-01	6.90E-02	6.30E-02	1.06E-01	1.53E-01	4.77E-02
I-129											
K-40									1.56E+01	1.79E+00	1.56E+01
Mn-54					< 2.00E-03	1.60E-02	< -4.30E-04	1.50E-02	4.42E-03	2.19E-02	2.00E-03
Nb-95									-8.14E-02	8.43E-02	-8.14E-02
Pb-212									6.19E-01	1.18E-01	6.19E-01
Pb-214									5.56E-01	1.39E-01	5.56E-01
Pu-238					7.50E-04	6.40E-04	7.50E-04	2.60E-04			7.50E-04
Pu-239					1.50E-02	2.90E-03	4.60E-03	7.50E-04			9.80E-03
Ru-106					< 2.50E-01	2.50E-01	< 2.00E-03	1.40E-01	-3.05E-01	4.58E-01	-1.77E-02
Sr-90			3.20E+01		1.50E+01	3.50E+00	3.40E+00	6.40E-01			1.68E+01
Tc-99											
U (total)					2.70E-01	1.30E-01	2.40E-01	7.80E-02			2.55E-01
Zn-65					< -1.60E-02	4.00E-02			-2.20E-02	5.19E-02	-1.90E-02
Zr-95					< 0.00E+00	2.80E-02	< 1.50E-02	2.70E-02	7.82E-02	6.41E-02	3.11E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

Table A-2.3. Results of Grid Site Vegetation Sampling (pCi/g).

Location 2E11

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Be-7											
Ce-141							< -1.80E-02	8.30E-02			< -1.80E-02
Co-60	-						< 1.10E-03	2.10E-02			< 1.10E-03
Cs-134			8.81E-02	4.44E-02			b				8.81E-02
Cs-137	3.23E-01	3.14E-02	3.92E-01	6.68E-02			1.40E-01	3.10E-02			2.85E-01
Eu-152	7.00E-02	6.10E-02					< 4.70E-02	9.70E-02			5.85E-02
Eu-154	-		2.23E-01	1.40E-01			< -4.10E-02	7.10E-02			9.10E-02
Eu-155			1.13E-01	1.07E-01			< -1.80E-04	5.80E-02			5.64E-02
I-129							a				
K-40											
Nb-95							< -5.60E-02	5.40E-02			< -5.60E-02
Pb-212							9.30E-01				9.30E-01
Pb-214							2.00E+00				2.00E+00
Pu-238	-						a				
Pu-239	-						a				
Ru-103	-						a				
Ru-106	-						b				
Sr-90	-						a				
Tc-99											
Zr-95	-		1.38E-01	1.02E-01			< 4.20E-02	4.50E-02			< 4.20E-02

Negative values indicate concentrations at or near background levels of radioactivity.

Shaded areas indicate a positive detection, the result is larger than the error.

A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows; Co-60 = 3.0E-02, Sr-90 = 5.0E-03, Nb-95 = 5.0E-02, Zr-95 = 5.0E-02, Ru-103 = 3.0E-02, Ru-106 = 2.6E-01, Cs-137 = 3.0E-02, Eu-152 = 1.7E-01, Eu-154 = 8.0E-02, Eu-155 = 7.0E-02, Pu-238 = 6.0E-04, and Pu-239 = 6.0E-04

(a) Not analyzed for this radionuclide

(b) Not routinely reported

Table A-2.3. Results of Grid Site Vegetation Sampling (pCi/g).

Location 2E12

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Be-7									1.85E+00	3.19E-01	1.85E+00
Ce-141							< 1.40E-04	5.90E-02	2.78E-03	2.65E-02	1.46E-03
Co-60	-				1.80E-02	1.50E-02	7.70E-03	1.50E-02	2.45E-03	2.15E-02	9.38E-03
Cs-134			1.79E-01	4.25E-02	3.20E-02	1.80E-02	b				1.06E-01
Cs-137	3.31E-01	3.51E-02	4.28E-01	6.52E-02	2.70E-01	3.70E-02	3.60E-01	4.40E-02	2.27E-01	3.69E-02	3.23E-01
Eu-152	-		1.44E-01	6.94E-02	5.30E-02	5.80E-02	-6.40E-02	6.80E-02	-4.68E-02	8.90E-02	2.16E-02
Eu-154	-				2.00E-03	4.90E-02	1.20E-02	5.00E-02	2.56E-02	6.14E-02	1.32E-02
Eu-155	-				-3.20E-02	4.30E-02	-6.80E-04	3.70E-02	1.60E-02	5.72E-02	-5.56E-03
I-129					a		a		6.08E-02	3.19E-01	6.08E-02
K-40									1.06E+01	1.30E+00	1.06E+01
Nb-95	-				< 1.40E-02	2.10E-02	-4.00E-02	5.30E-02	-2.49E-03	2.30E-02	-9.50E-03
Pb-212									2.78E-02	3.42E-02	2.78E-02
Pb-214									4.11E-02	3.52E-02	4.11E-02
Pu-238	-				a		a		3.03E-04	2.23E-04	3.03E-04
Pu-239	-				a		a		1.08E-03	3.99E-04	1.08E-03
Ru-103	-		1.13E-01	7.04E-02							1.13E-01
Ru-106	-				b		b				
Sr-90	-				a		3.40E+00	6.60E-01	1.06E-01	2.11E-02	1.75E+00
Tc-99					a		a		7.38E-01	1.15E+00	7.38E-01
Zr-95	-				< 1.70E-02	2.90E-02	3.70E-02	4.60E-02	-1.06E-02	3.73E-02	1.45E-02

Negative values indicate concentrations at or near background levels of radioactivity.

Shaded areas indicate a positive detection, the result is larger than the error.

A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows; Co-60 = 3.0E-02, Sr-90 = 5.0E-03, Nb-95 = 5.0E-02, Zr-95 = 5.0E-02, Ru-103 = 3.0E-02, Ru-106 = 2.6E-01, Cs-137 = 3.0E-02, Eu-152 = 1.7E-01, Eu-154 = 8.0E-02, Eu-155 = 7.0E-02, Pu-238 = 6.0E-04, and Pu-239 = 6.0E-04

(a) Not analyzed for this radionuclide

(b) Not routinely reported

Table A-2.3. Results of Grid Site Vegetation Sampling (pCi/g).

Location 2E17

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Be-7									2.64E+00	3.71E-01	2.64E+00
Ce-141							-2.20E-02	6.20E-02	5.19E-03	2.06E-02	-8.41E-03
Co-60	3.71E-02	1.92E-02			1.70E-02	1.30E-02	1.80E-02	1.70E-02	1.27E-02	1.68E-02	2.12E-02
Cs-134			4.50E-01	8.66E-02	4.20E-02	1.80E-02	b				2.46E-01
Cs-137	1.16E+00	7.93E-02	1.04E+00	1.34E-01	5.40E-01	6.40E-02	3.50E-01	4.50E-02	3.07E-01	4.34E-02	6.79E-01
Eu-152	-				2.80E-02	6.30E-02	-2.80E-02	6.90E-02	6.96E-03	7.05E-02	2.32E-03
Eu-154	2.15E-01	5.81E-02			-2.40E-02	5.10E-02	2.20E-02	5.20E-02	3.41E-02	4.87E-02	6.18E-02
Eu-155	2.95E-01	6.37E-02			4.00E-02	5.00E-02	1.80E-02	4.10E-02	4.03E-02	3.84E-02	9.83E-02
I-129					a		9.20E-03	2.90E-01	-5.51E-02	2.67E-01	-2.30E-02
K-40									1.39E+01	1.57E+00	1.39E+01
Nb-95	-		1.29E-01	9.82E-02	-1.20E-02	2.30E-02	-5.60E-02	5.40E-02	-1.07E-02	1.77E-02	1.26E-02
Pb-212									7.77E-02	3.41E-02	7.77E-02
Pb-214									8.68E-02	3.97E-02	8.68E-02
Pu-238	4.30E-03	9.00E-04	7.00E-04	5.00E-04	3.30E-04	2.10E-04	4.10E-04	2.50E-04	5.85E-04	3.42E-04	1.27E-03
Pu-239	1.43E-02	1.90E-03	2.00E-03	9.00E-04	2.10E-03	5.70E-04	1.10E-02	1.70E-03	3.38E-03	9.07E-04	6.56E-03
Ru-103	-		4.85E-01	1.17E-01	a						4.85E-01
Ru-106	5.49E-01	1.38E-01	9.01E-01	3.86E-01	b		b				7.25E-01
Sr-90	2.73E+01	5.42E+00	9.43E+00	1.74E+00	1.00E+01	2.40E+00	7.20E+00	1.50E+00	5.81E+00	1.15E+00	1.19E+01
Tc-99					a		2.70E+00	3.00E+00	8.15E-01	1.16E+00	1.76E+00
Zr-95	2.54E-02	2.48E-02		<	1.70E-02	2.80E-02	4.20E-02	4.50E-02	-1.47E-02	3.06E-02	1.74E-02

Negative values indicate concentrations at or near background levels of radioactivity.

Shaded areas indicate a positive detection, the result is larger than the error.

A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows; Co-60 = 3.0E-02, Sr-90 = 5.0E-03, Nb-95 = 5.0E-02, Zr-95 = 5.0E-02, Ru-103 = 3.0E-02, Ru-106 = 2.6E-01, Cs-137 = 3.0E-02, Eu-152 = 1.7E-01, Eu-154 = 8.0E-02, Eu-155 = 7.0E-02, Pu-238 = 6.0E-04, and Pu-239 = 6.0E-04

(a) Not analyzed for this radionuclide

(b) Not routinely reported

Table A-2.3. Results of Grid Site Vegetation Sampling (pCi/g).

Location 2E18

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Be-7									2.63E+00	3.80E-01	2.63E+00
Ce-141							-3.30E-02	6.20E-02	-6.82E-03	2.15E-02	-1.99E-02
Co-60	-				< 4.30E-03	2.10E-02	4.80E-03	1.40E-02	1.08E-02	1.88E-02	6.63E-03
Cs-134			2.23E-01	5.48E-02	7.60E-02	2.80E-02	b				1.50E-01
Cs-137	5.28E-01	4.17E-02	1.85E+00	2.13E-01	9.10E-01	1.10E-01	7.00E-01	7.90E-02	4.73E-01	6.02E-02	9.83E-01
Eu-152	-		1.92E-01	9.24E-02	2.60E-02	9.10E-02	0.00E+00	6.40E-02	-1.27E-02	8.80E-02	5.13E-02
Eu-154	-				-3.50E-02	6.90E-02	-1.20E-02	4.70E-02	8.42E-03	6.78E-02	-1.29E-02
Eu-155	-				3.70E-02	6.10E-02	3.20E-02	3.70E-02	1.40E-02	4.50E-02	2.77E-02
I-129					a		3.50E-01	2.50E-01	2.02E-01	2.30E-01	2.76E-01
K-40									1.45E+01	1.64E+00	1.45E+01
Nb-95	-				< 1.00E-02	2.90E-02	-1.90E-02	4.60E-02	6.32E-03	2.17E-02	-8.93E-04
Pb-212									5.86E-02	3.03E-02	5.86E-02
Pb-214									8.79E-02	3.47E-02	8.79E-02
Pu-238	-				4.50E-04	2.70E-04	2.50E-04	2.00E-04	1.17E-04	1.31E-04	2.72E-04
Pu-239	-				1.90E-03	5.70E-04	2.00E-03	6.20E-04	1.00E-03	4.06E-04	1.63E-03
Ru-103	-		2.16E-01	1.18E-01							2.16E-01
Ru-106	3.23E-01	1.20E-01			b		b				3.23E-01
Sr-90	-				2.10E-01	5.40E-02	1.10E+00	2.10E-01	5.18E-01	1.04E-01	6.09E-01
Tc-99					a		2.40E+00	3.00E+00	3.26E-01	1.12E+00	1.36E+00
Zr-95	-				5.60E-02	4.30E-02	3.80E-02	4.30E-02	-4.72E-03	2.94E-02	2.98E-02

Negative values indicate concentrations at or near background levels of radioactivity.

Shaded areas indicate a positive detection, the result is larger than the error.

A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows; Co-60 = 3.0E-02, Sr-90 = 5.0E-03, Nb-95 = 5.0E-02, Zr-95 = 5.0E-02, Ru-103 = 3.0E-02, Ru-106 = 2.6E-01, Cs-137 = 3.0E-02, Eu-152 = 1.7E-01, Eu-154 = 8.0E-02, Eu-155 = 7.0E-02, Pu-238 = 6.0E-04, and Pu-239 = 6.0E-04

(a) Not analyzed for this radionuclide

(b) Not routinely reported

Table A-2.3. Results of Grid Site Vegetation Sampling (pCi/g).

Loction 2E23

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Be-7											
Ce-141							2.10E-02	7.70E-02			2.10E-02
Co-60	-				< -1.70E-02	2.30E-02	-5.40E-03	2.20E-02			-1.12E-02
Cs-134			7.80E-02	3.31E-02	b		b				7.80E-02
Cs-137	1.53E-01	3.02E-02	2.02E-01	4.16E-02	1.10E-01	3.30E-02	1.40E-01	2.90E-02			1.51E-01
Eu-152	-				-8.70E-02	9.70E-02	2.50E-02	8.10E-02			-3.10E-02
Eu-154	-				-3.80E-03	7.00E-02	-1.70E-02	7.20E-02			-1.04E-02
Eu-155	-				-1.70E-02	6.30E-02	-2.50E-02	5.30E-02			-2.10E-02
I-129							-3.80E-01	4.10E-01			-3.80E-01
K-40											
Nb-95	-				< -3.40E-03	3.60E-02	-4.40E-02	6.50E-02			-2.37E-02
Pb-212											
Pb-214											
Pu-238	4.00E-04	2.00E-04			8.60E-05	1.70E-04	9.60E-05	1.30E-04			1.94E-04
Pu-239	4.10E-03	8.00E-04	6.00E-04	5.00E-04	2.90E-03	1.10E-03	2.20E-03	6.10E-04			2.45E-03
Ru-103	1.43E-01	4.19E-02	8.81E-01	1.47E-01							5.12E-01
Ru-106	9.45E-01	2.83E-01	8.46E+00	1.02E+00	b		3.40E-01	2.00E-01			3.25E+00
Sr-90	1.39E+00	2.80E-01	1.69E-01	4.57E-02	3.50E-02	1.20E-02	1.40E-01	2.90E-02			4.34E-01
Tc-99					a		1.10E+00	2.90E+00			1.10E+00
Zr-95	-				< -5.20E-03	4.90E-02	-3.60E-02	6.10E-02			-2.06E-02

Negative values indicate concentrations at or near background levels of radioactivity.

Shaded areas indicate a positive detection, the result is larger than the error.

A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows; Co-60 = 3.0E-02, Sr-90 = 5.0E-03, Nb-95 = 5.0E-02, Zr-95 = 5.0E-02, Ru-103 = 3.0E-02, Ru-106 = 2.6E-01, Cs-137 = 3.0E-02, Eu-152 = 1.7E-01, Eu-154 = 8.0E-02, Eu-155 = 7.0E-02, Pu-238 = 6.0E-04, and Pu-239 = 6.0E-04

(a) Not analyzed for this radionuclide

(b) Not routinely reported

Table A-2.3. Results of Grid Site Vegetation Sampling (pCi/g).

Location 2E24

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Be-7									3.23E+00	4.34E-01	3.23E+00
Ce-141							2.30E-02	8.80E-02	-1.92E-02	2.87E-02	1.90E-03
Co-60	7.21E-02	4.77E-02			3.90E-03	1.40E-02	9.70E-03	1.90E-02	2.41E-02	1.84E-02	2.75E-02
Cs-134			1.97E-01	3.95E-02	5.50E-02	1.80E-02	b				1.26E-01
Cs-137	3.51E-01	7.66E-02	1.24E+00	1.40E-01	1.50E+00	1.60E-01	1.30E+00	1.40E-01	1.09E+00	1.21E-01	1.10E+00
Eu-152	-		7.31E-02	5.95E-02	1.30E-02	6.70E-02	2.70E-02	8.50E-02	-7.86E-02	1.01E-01	8.63E-03
Eu-154	-				5.10E-02	4.70E-02	5.50E-02	6.20E-02	2.29E-02	5.96E-02	4.30E-02
Eu-155	-				-3.30E-02	4.00E-02	2.60E-02	5.00E-02	8.13E-04	6.03E-02	-2.06E-03
I-129					-3.90E-01	4.10E-01	1.50E-01	2.60E-01	2.48E-01	2.91E-01	2.67E-03
K-40									1.30E+01	1.49E+00	1.30E+01
Nb-95	-				-6.60E-03	2.00E-02	-1.40E-02	7.10E-02	-4.73E-03	2.18E-02	-8.44E-03
Pb-212									5.13E-02	3.59E-02	5.13E-02
Pb-214									9.76E-02	4.52E-02	9.76E-02
Pu-238	1.40E-03	1.20E-03			7.80E-05	1.60E-04	1.90E-04	2.50E-04	8.90E-04	5.04E-04	6.40E-04
Pu-239	9.50E-03	3.10E-03	9.00E-03	1.70E-03	5.90E-03	1.20E-03	1.20E-02	2.10E-03	8.09E-03	1.80E-03	8.90E-03
Ru-103	1.67E-01	1.01E-01	3.46E-01	9.68E-02							2.57E-01
Ru-106	6.67E-01	4.46E-01	1.66E+00	3.18E-01	b		b		4.42E+00	5.42E-01	2.25E+00
Sr-90	2.51E+00	5.04E-01	4.28E-01	8.72E-02	3.80E-01	9.70E-02	8.90E-01	1.70E-01	7.79E-01	1.49E-01	9.97E-01
Tc-99					2.00E-01	8.40E-01	2.30E+00	3.00E+00	1.48E+00	1.26E+00	1.33E+00
Zr-95	-				-1.80E-02	2.70E-02	2.80E-02	6.80E-02	-1.68E-02	3.27E-02	-2.27E-03

Negative values indicate concentrations at or near background levels of radioactivity.

Shaded areas indicate a positive detection, the result is larger than the error.

A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows; Co-60 = 3.0E-02, Sr-90 = 5.0E-03, Nb-95 = 5.0E-02, Zr-95 = 5.0E-02, Ru-103 = 3.0E-02, Ru-106 = 2.6E-01, Cs-137 = 3.0E-02, Eu-152 = 1.7E-01, Eu-154 = 8.0E-02, Eu-155 = 7.0E-02, Pu-238 = 6.0E-04, and Pu-239 = 6.0E-04

(a) Not analyzed for this radionuclide

(b) Not routinely reported

Draft A

Table A-2.3. Results of Grid Site Vegetation Sampling (pCi/g).

Location 2E29

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Be-7									2.01E+00	3.33E-01	2.01E+00
Ce-141							< -5.20E-02	7.40E-02	-2.07E-02	2.37E-02	-3.64E-02
Co-60	-		2.63E-02	2.40E-02			< 1.20E-02	2.10E-02	8.53E-03	1.87E-02	1.56E-02
Cs-134			1.16E-01	3.39E-02			b				1.16E-01
Cs-137	-		2.49E-01	4.83E-02			7.60E-02	3.10E-02	4.52E-02	2.26E-02	1.23E-01
Eu-152	-		-				< -3.10E-02	8.70E-02	-8.29E-02	9.26E-02	-5.70E-02
Eu-154	-		-				< 4.40E-02	6.20E-02	-2.53E-02	5.36E-02	9.35E-03
Eu-155	-		-				< -2.50E-02	4.60E-02	3.59E-03	3.70E-02	-1.07E-02
I-129									0.00E+00	1.94E-01	0.00E+00
K-40									1.49E+01	1.71E+00	1.49E+01
Nb-95	-						< -3.00E-02	7.00E-02	1.42E-03	2.12E-02	-1.43E-02
Pb-212									1.98E-02	2.96E-02	1.98E-02
Pb-214									3.28E-02	2.96E-02	3.28E-02
Pu-238	-		4.00E-04	4.00E-04			a		9.47E-05	1.35E-04	2.47E-04
Pu-239	9.00E-04	6.00E-04	1.70E-03	7.00E-04			a		9.24E-04	3.50E-04	1.17E-03
Ru-103	-	-	5.38E-01	1.17E-01							5.38E-01
Ru-106	4.52E-01	3.43E-01	6.21E+00	7.83E-01			b				3.33E+00
Sr-90	2.01E-01	5.41E-02	1.42E-01	3.53E-02			1.90E-01	3.80E-02	1.10E-01	2.20E-02	1.61E-01
Tc-99							a		1.11E+00	1.23E+00	1.11E+00
Zr-95	-						< 1.70E-02	6.40E-02	1.16E-02	3.25E-02	1.43E-02

Negative values indicate concentrations at or near background levels of radioactivity.

Shaded areas indicate a positive detection, the result is larger than the error.

A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows; Co-60 = 3.0E-02, Sr-90 = 5.0E-03, Nb-95 = 5.0E-02, Zr-95 = 5.0E-02, Ru-103 = 3.0E-02, Ru-106 = 2.6E-01, Cs-137 = 3.0E-02, Eu-152 = 1.7E-01, Eu-154 = 8.0E-02, Eu-155 = 7.0E-02, Pu-238 = 6.0E-04, and Pu-239 = 6.0E-04

(a) Not analyzed for this radionuclide

(b) Not routinely reported

Table A-2.3. Results of Grid Site Vegetation Sampling (pCi/g).

Location 2E30

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Be-7									1.50E+00	2.50E-01	1.50E+00
Ce-141							< 2.10E-02	7.20E-02	-1.49E-02	1.94E-02	3.05E-03
Co-60							< 1.00E-02	1.50E-02	1.87E-03	1.44E-02	5.94E-03
Cs-134							b	b			
Cs-137							3.90E-01	4.80E-02	7.68E-02	2.31E-02	2.33E-01
Eu-152							< 1.80E-02	6.30E-02	-4.89E-02	7.49E-02	-1.55E-02
Eu-154							< -2.30E-02	4.80E-02	-2.38E-02	4.71E-02	-2.34E-02
Eu-155							< -2.50E-03	4.00E-02	1.97E-02	3.19E-02	8.60E-03
I-129									7.35E-02	2.49E-01	7.35E-02
K-40									1.09E+01	1.25E+00	1.09E+01
Nb-95							< 1.40E-02	4.90E-02	-2.01E-02	1.96E-02	-3.05E-03
Pb-212									7.60E-02	3.18E-02	7.60E-02
Pb-214									7.13E-02	2.78E-02	7.13E-02
Pu-238							a		5.30E-04	3.70E-04	5.30E-04
Pu-239							a		4.67E-03	1.15E-03	4.67E-03
Ru-103											
Ru-106							2.80E+00	3.60E-01	6.62E-01	1.75E-01	1.73E+00
Sr-90							4.70E-01	9.00E-02	5.69E-01	1.06E-01	5.20E-01
Tc-99							a		5.78E-01	1.19E+00	5.78E-01
Zr-95							< 4.30E-02	4.70E-02	5.86E-03	2.69E-02	2.44E-02

Negative values indicate concentrations at or near background levels of radioactivity.

Shaded areas indicate a positive detection, the result is larger than the error.

A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows; Co-60 = 3.0E-02, Sr-90 = 5.0E-03, Nb-95 = 5.0E-02, Zr-95 = 5.0E-02, Ru-103 = 3.0E-02, Ru-106 = 2.6E-01, Cs-137 = 3.0E-02, Eu-152 = 1.7E-01, Eu-154 = 8.0E-02, Eu-155 = 7.0E-02, Pu-238 = 6.0E-04, and Pu-239 = 6.0E-04

(a) Not analyzed for this radionuclide

(b) Not routinely reported

Table A-2.3. Results of Grid Site Vegetation Sampling (pCi/g).

Location 2ED

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Be-7											
Ce-141							-9.50E-02	9.60E-02			-9.50E-02
Co-60	-				1.90E-02	1.80E-02	-1.40E-03	2.00E-02			8.80E-03
Cs-134			2.50E-01	6.93E-02	6.80E-02	2.40E-02	3.80E-02	2.00E-02			1.19E-01
Cs-137	2.43E-01	7.05E-02	1.95E+00	2.30E-01	3.00E-01	4.40E-02	6.40E-01	7.50E-02			7.83E-01
Eu-152	-				0.00E+00	8.40E-02	3.00E-02	8.60E-02			1.50E-02
Eu-154	-				-1.90E-02	6.00E-02	-1.10E-01	6.70E-02			-6.45E-02
Eu-155	-				1.40E-03	4.50E-02	3.40E-02	5.10E-02			1.77E-02
I-129					-2.80E-01	3.10E-01	3.40E-01	8.40E-01			3.00E-02
K-40											
Nb-95	-		2.10E-01	1.25E-01	-2.30E-02	3.30E-02	2.10E-02	7.00E-02			6.93E-02
Pb-212											
Pb-214											
Pu-238	-				3.10E-05	6.50E-05	1.50E-04	1.50E-04			9.05E-05
Pu-239	-				8.00E-03	1.30E-03	1.50E-02	2.10E-03			1.15E-02
Ru-103	-		2.36E-01	1.51E-01							2.36E-01
Ru-106	-				b		1.10E+00	2.70E-01			1.10E+00
Sr-90	-				3.70E-01	9.40E-02	3.00E-01	5.70E-02			3.35E-01
Tc-99					3.80E-01	8.50E-01	1.40E+00	3.00E+00			8.90E-01
Zr-95	-		1.23E-01	1.15E-01	4.90E-03	3.90E-02	6.90E-02	6.60E-02			6.56E-02

Negative values indicate concentrations at or near background levels of radioactivity.

Shaded areas indicate a positive detection, the result is larger than the error.

A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows; Co-60 = 3.0E-02, Sr-90 = 5.0E-03, Nb-95 = 5.0E-02, Zr-95 = 5.0E-02, Ru-103 = 3.0E-02, Ru-106 = 2.6E-01, Cs-137 = 3.0E-02, Eu-152 = 1.7E-01, Eu-154 = 8.0E-02, Eu-155 = 7.0E-02, Pu-238 = 6.0E-04, and Pu-239 = 6.0E-04

(a) Not analyzed for this radionuclide

(b) Not routinely reported

Table A-2.3. Results of Grid Site Vegetation Sampling (pCi/g).

Location 2EDB

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Be-7											
Ce-141											
Co-60					< 1.40E-02	1.60E-02					1.40E-02
Cs-134					5.20E-02	2.10E-02					5.20E-02
Cs-137					2.80E-01	3.90E-02					2.80E-01
Eu-152					< 4.80E-02	6.40E-02					4.80E-02
Eu-154					< -2.90E-02	4.90E-02					-2.90E-02
Eu-155					< 1.40E-02	3.80E-02					1.40E-02
I-129					< -1.40E-01	3.70E-01					-1.40E-01
K-40											
Nb-95					< 1.80E-02	2.90E-02					1.80E-02
Pb-212											
Pb-214											
Pu-238					< 8.90E-05	1.30E-04					8.90E-05
Pu-239					8.00E-03	1.50E-03					8.00E-03
Ru-103											
Ru-106					b						
Sr-90					3.30E-01	8.40E-02					3.30E-01
Tc-99					9.60E-01	8.80E-01					9.60E-01
Zr-95					< 8.90E-03	3.90E-02					8.90E-03

Negative values indicate concentrations at or near background levels of radioactivity.

Shaded areas indicate a positive detection, the result is larger than the error.

A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows; Co-60 = 3.0E-02, Sr-90 = 5.0E-03, Nb-95 = 5.0E-02, Zr-95 = 5.0E-02, Ru-103 = 3.0E-02, Ru-106 = 2.6E-01, Cs-137 = 3.0E-02, Eu-152 = 1.7E-01, Eu-154 = 8.0E-02, Eu-155 = 7.0E-02, Pu-238 = 6.0E-04, and Pu-239 = 6.0E-04

(a) Not analyzed for this radionuclide

(b) Not routinely reported

Table A-2.3. Results of Grid Site Vegetation Sampling (pCi/g).

Location 2EDC

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Be-7									2.98E+00	4.80E-01	2.98E+00
Ce-141									-2.25E-02	3.41E-02	-2.25E-02
Co-60									6.69E-03	2.04E-02	6.69E-03
Cs-134											
Cs-137									4.27E+00	4.37E-01	4.27E+00
Eu-152									6.64E-02	7.72E-02	6.64E-02
Eu-154									6.04E-02	5.72E-02	6.04E-02
Eu-155									2.10E-02	5.15E-02	2.10E-02
I-129									-5.80E-02	2.86E-01	-5.80E-02
K-40									1.32E+01	1.49E+00	1.32E+01
Nb-95									7.19E-03	2.58E-02	7.19E-03
Pb-212									1.06E-01	3.57E-02	1.06E-01
Pb-214									9.76E-02	4.39E-02	9.76E-02
Pu-238									4.83E-04	2.94E-04	4.83E-04
Pu-239									1.60E-02	2.43E-03	1.60E-02
Ru-103											
Ru-106									5.09E-01	1.80E-01	5.09E-01
Sr-90									4.19E-01	8.42E-02	4.19E-01
Tc-99									7.47E-01	1.10E+00	7.47E-01
Zr-95									2.16E-02	3.53E-02	2.16E-02

Negative values indicate concentrations at or near background levels of radioactivity.

Shaded areas indicate a positive detection, the result is larger than the error.

A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows; Co-60 = 3.0E-02, Sr-90 = 5.0E-03, Nb-95 = 5.0E-02, Zr-95 = 5.0E-02, Ru-103 = 3.0E-02, Ru-106 = 2.6E-01, Cs-137 = 3.0E-02, Eu-152 = 1.7E-01, Eu-154 = 8.0E-02, Eu-155 = 7.0E-02, Pu-238 = 6.0E-04, and Pu-239 = 6.0E-04

(a) Not analyzed for this radionuclide

(b) Not routinely reported

Table A-2.3. Results of Grid Site Vegetation Sampling (pCi/g).

Location GRT1

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Be-7									3.00E+00	4.75E-01	3.00E+00
Ce-141							-7.50E-03	1.40E-02	-1.93E-02	4.76E-02	-1.34E-02
Co-60					< 5.50E-03	1.70E-02	-1.60E-03	1.40E-02	0.00E+00	2.24E-02	1.30E-03
Cs-134					6.10E-02	2.20E-02	b				6.10E-02
Cs-137					3.60E-01	4.90E-02	3.40E-01	4.30E-02	1.03E+00	1.19E-01	5.77E-01
Eu-152					6.90E-02	6.70E-02	3.80E-03	4.70E-02	8.00E-02	9.64E-02	5.09E-02
Eu-154					< -5.80E-02	5.90E-02	7.60E-03	4.10E-02	7.66E-03	7.02E-02	-1.42E-02
Eu-155					< -2.50E-02	4.30E-02	7.20E-03	3.40E-02	-6.40E-03	5.45E-02	-8.07E-03
I-129					< -3.50E-01	3.00E-01	3.30E-01	2.10E-01	-1.23E-01	2.79E-01	-4.77E-02
K-40									1.18E+01	1.46E+00	1.18E+01
Nb-95					< -1.10E-02	2.80E-02	7.60E-03	1.20E-02	-1.51E-02	3.07E-02	-6.17E-03
Pb-212									9.51E-02	3.75E-02	9.51E-02
Pb-214									3.71E-02	4.51E-02	3.71E-02
Pu-238					3.20E-04	2.60E-04	9.60E-05	1.90E-04	1.59E-04	1.82E-04	1.92E-04
Pu-239					6.00E-03	1.30E-03	6.30E-03	1.30E-03	7.04E-03	1.24E-03	6.45E-03
Ru-103											
Ru-106					b		1.50E+00	2.30E-01	5.97E-01	2.70E-01	1.05E+00
Sr-90					2.20E-01	5.70E-02	2.70E-01	5.10E-02	4.56E-01	8.47E-02	3.15E-01
Tc-99					a		2.40E+00	3.10E+00	5.59E-01	1.08E+00	1.48E+00
Zr-95					< 1.40E-02	4.20E-02	3.50E-03	2.10E-02	4.70E-03	4.51E-02	7.40E-03

Negative values indicate concentrations at or near background levels of radioactivity.

Shaded areas indicate a positive detection, the result is larger than the error.

A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows; Co-60 = 3.0E-02, Sr-90 = 5.0E-03, Nb-95 = 5.0E-02, Zr-95 = 5.0E-02, Ru-103 = 3.0E-02, Ru-106 = 2.6E-01, Cs-137 = 3.0E-02, Eu-152 = 1.7E-01, Eu-154 = 8.0E-02, Eu-155 = 7.0E-02, Pu-238 = 6.0E-04, and Pu-239 = 6.0E-04

(a) Not analyzed for this radionuclide

(b) Not routinely reported

Table A-2.3. Results of Grid Site Vegetation Sampling (pCi/g).

Location GRT2

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Be-7									2.61E+00	4.09E-01	2.61E+00
Ce-141							< -1.50E-03	1.90E-02	-4.05E-03	3.18E-02	-2.78E-03
Co-60					3.40E-02	2.50E-02	-1.60E-02	1.90E-02	-1.91E-02	1.97E-02	-3.67E-04
Cs-134					8.30E-02	3.00E-02	b				8.30E-02
Cs-137					3.60E-01	5.00E-02	1.70E-01	3.70E-02	2.03E+00	2.15E-01	8.53E-01
Eu-152				<	7.50E-02	9.20E-02	1.20E-02	8.10E-02	3.94E-02	8.52E-02	4.21E-02
Eu-154				<	2.70E-02	7.70E-02	6.40E-02	5.50E-02	-1.52E-02	6.52E-02	2.53E-02
Eu-155				<	2.00E-02	6.10E-02	1.30E-03	4.30E-02	-1.06E-02	4.78E-02	3.57E-03
I-129				<	-1.10E-01	2.20E-01	1.30E-01	2.20E-01	-2.49E-01	2.75E-01	-7.63E-02
K-40									1.30E+01	1.48E+00	1.30E+01
Nb-95				<	7.00E-03	2.50E-02	-1.20E-02	1.70E-02	3.09E-03	2.68E-02	-6.37E-04
Pb-212									1.05E-01	3.59E-02	1.05E-01
Pb-214									1.37E-01	4.24E-02	1.37E-01
Pu-238				<	1.90E-04	2.70E-04	7.90E-05	1.50E-04	4.45E-04	3.09E-04	2.38E-04
Pu-239					2.90E-03	1.10E-03	1.60E-03	7.90E-04	6.36E-03	1.29E-03	3.62E-03
Ru-103											
Ru-106					b		2.20E-01	1.70E-01	2.85E-01	1.37E-01	2.53E-01
Sr-90					3.60E-01	9.00E-02	1.10E-01	2.40E-02	2.75E-01	5.25E-02	2.48E-01
Tc-99					4.70E+00	1.10E+00	2.50E+00	3.10E+00	5.49E-01	1.08E+00	2.58E+00
Zr-95				<	-1.30E-03	3.70E-02	1.00E-02	2.80E-02	1.70E-02	3.59E-02	8.57E-03

Negative values indicate concentrations at or near background levels of radioactivity.

Shaded areas indicate a positive detection, the result is larger than the error.

A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows; Co-60 = 3.0E-02, Sr-90 = 5.0E-03, Nb-95 = 5.0E-02, Zr-95 = 5.0E-02, Ru-103 = 3.0E-02, Ru-106 = 2.6E-01, Cs-137 = 3.0E-02, Eu-152 = 1.7E-01, Eu-154 = 8.0E-02, Eu-155 = 7.0E-02, Pu-238 = 6.0E-04, and Pu-239 = 6.0E-04

(a) Not analyzed for this radionuclide

(b) Not routinely reported

Table A-2.3. Results of Grid Site Vegetation Sampling (pCi/g).

Location GRT4

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Be-7									3.22E+00	4.44E-01	3.22E+00
Ce-141							2.30E-02	2.10E-02	1.61E-02	3.17E-02	1.96E-02
Co-60					< 1.50E-02	1.80E-02	5.30E-03	1.80E-02	6.96E-03	1.95E-02	9.09E-03
Cs-134					5.00E-02	2.20E-02	b				5.00E-02
Cs-137					4.80E-01	6.10E-02	1.80E-01	3.40E-02	4.11E-01	5.21E-02	3.57E-01
Eu-152					< 2.90E-02	7.70E-02	-2.30E-02	7.90E-02	6.38E-02	8.01E-02	2.33E-02
Eu-154					< 4.30E-02	5.30E-02	-1.20E-02	6.10E-02	-5.42E-03	6.01E-02	8.53E-03
Eu-155					< -2.40E-02	5.00E-02	-1.90E-02	5.40E-02	3.29E-02	5.02E-02	-3.37E-03
I-129					< 4.60E-02	2.80E-01	3.30E-01	3.40E-01	-4.59E-03	1.75E-01	1.24E-01
K-40									1.17E+01	1.34E+00	1.17E+01
Nb-95					< 2.60E-03	3.20E-02	4.40E-03	1.80E-02	-1.78E-02	2.57E-02	-3.60E-03
Pb-212									7.78E-02	2.91E-02	7.78E-02
Pb-214									1.15E-01	3.76E-02	1.15E-01
Pu-238					< 9.90E-05	1.40E-04	-4.90E-05	1.10E-04	4.74E-04	2.99E-04	1.75E-04
Pu-239					7.30E-03	1.50E-03	2.60E-03	8.00E-04	7.74E-03	1.42E-03	5.88E-03
Ru-103											
Ru-106					b		2.50E+00	3.90E-01	2.17E+00	3.19E-01	2.34E+00
Sr-90					3.40E-01	8.50E-02	1.90E-01	3.70E-02	1.87E-01	3.82E-02	2.39E-01
Tc-99					< 2.30E-01	8.40E-01	2.10E+00	3.00E+00	6.03E-01	1.09E+00	9.78E-01
Zr-95					< -3.60E-02	4.10E-02	-5.60E-03	3.20E-02	1.80E-02	3.48E-02	-7.87E-03

Negative values indicate concentrations at or near background levels of radioactivity.

Shaded areas indicate a positive detection, the result is larger than the error.

A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows; Co-60 = 3.0E-02, Sr-90 = 5.0E-03, Nb-95 = 5.0E-02, Zr-95 = 5.0E-02, Ru-103 = 3.0E-02, Ru-106 = 2.6E-01, Cs-137 = 3.0E-02, Eu-152 = 1.7E-01, Eu-154 = 8.0E-02, Eu-155 = 7.0E-02, Pu-238 = 6.0E-04, and Pu-239 = 6.0E-04

(a) Not analyzed for this radionuclide

(b) Not routinely reported

Table A-2.3. Results of Grid Site Vegetation Sampling (pCi/g).

Location GRT5

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Be-7									2.82E+00	4.53E-01	2.82E+00
Ce-141							8.30E-03	1.60E-02	7.36E-03	4.07E-02	7.83E-03
Co-60					< 9.70E-03	1.50E-02	-2.70E-03	1.50E-02	-1.77E-02	2.23E-02	-3.57E-03
Cs-134					8.50E-02	1.90E-02	b				8.50E-02
Cs-137					4.60E-01	5.60E-02	2.30E-01	3.30E-02	2.04E-01	3.82E-02	2.98E-01
Eu-152					< -8.20E-03	7.00E-02	-2.10E-02	5.80E-02	-1.30E-02	1.02E-01	-1.41E-02
Eu-154					< -3.30E-02	5.00E-02	-1.50E-02	4.80E-02	-2.51E-02	6.20E-02	-2.44E-02
Eu-155					< -3.20E-02	4.30E-02	2.00E-02	4.20E-02	-6.03E-02	6.44E-02	-2.41E-02
I-129					< -1.00E-01	2.80E-01	-9.20E-03	2.60E-01	6.63E-02	2.33E-01	-1.43E-02
K-40									1.29E+01	1.55E+00	1.29E+01
Nb-95					< 1.10E-02	2.10E-02	-5.50E-03	1.40E-02	4.98E-03	2.93E-02	3.49E-03
Pb-212									6.58E-02	3.42E-02	6.58E-02
Pb-214									5.77E-02	3.69E-02	5.77E-02
Pu-238					< 8.30E-05	9.80E-05	1.90E-04	2.60E-04	4.69E-04	2.84E-04	2.47E-04
Pu-239					4.00E-03	7.90E-04	2.30E-03	7.30E-04	2.42E-03	6.87E-04	2.91E-03
Ru-103											
Ru-106					b		4.60E-01	1.80E-01			4.60E-01
Sr-90					1.40E-01	3.70E-02	2.20E-01	4.20E-02	4.12E-01	7.91E-02	2.57E-01
Tc-99					< 2.10E-02	8.30E-01	2.00E+00	3.00E+00	1.74E+00	1.18E+00	1.25E+00
Zr-95					< -3.90E-03	2.90E-02	5.60E-03	2.40E-02	-2.31E-03	4.01E-02	-2.03E-04

Negative values indicate concentrations at or near background levels of radioactivity.

Shaded areas indicate a positive detection, the result is larger than the error.

A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows; Co-60 = 3.0E-02, Sr-90 = 5.0E-03, Nb-95 = 5.0E-02, Zr-95 = 5.0E-02, Ru-103 = 3.0E-02, Ru-106 = 2.6E-01, Cs-137 = 3.0E-02, Eu-152 = 1.7E-01, Eu-154 = 8.0E-02, Eu-155 = 7.0E-02, Pu-238 = 6.0E-04, and Pu-239 = 6.0E-04

(a) Not analyzed for this radionuclide

(b) Not routinely reported

Table A-2.3. Results of Grid Site Vegetation Sampling (pCi/g).

Location GRT6

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Be-7									2.09E+00	3.56E-01	2.09E+00
Ce-141							-5.10E-03	1.90E-02	4.61E-03	2.99E-02	-2.45E-04
Co-60					< 1.10E-02	1.50E-02	2.40E-03	1.70E-02	4.45E-03	1.86E-02	5.95E-03
Cs-134					8.00E-02	2.10E-02	3.10E-02	1.40E-02			5.55E-02
Cs-137					4.90E-01	5.90E-02	4.00E-01	5.10E-02	4.10E-01	5.69E-02	4.33E-01
Eu-152					< 1.00E-02	7.10E-02	-2.20E-02	7.00E-02	9.45E-02	8.75E-02	2.75E-02
Eu-154					< -3.70E-02	5.40E-02	1.40E-02	4.90E-02	-3.45E-02	6.40E-02	-1.92E-02
Eu-155					< 0.00E+00	3.80E-02	2.90E-02	4.60E-02	-7.63E-03	4.07E-02	7.12E-03
I-129					< 1.70E-01	3.70E-01	9.20E-03	2.60E-01	1.79E-01	1.68E-01	1.19E-01
K-40									1.10E+01	1.35E+00	1.10E+01
Nb-95					< 1.90E-02	2.80E-02	-1.40E-02	1.50E-02	-1.92E-02	2.85E-02	-4.73E-03
Pb-212									5.95E-02	3.52E-02	5.95E-02
Pb-214									7.84E-02	4.78E-02	7.84E-02
Pu-238					< -1.50E-06	8.10E-04	-3.90E-05	1.90E-04	1.75E-04	1.72E-04	4.48E-05
Pu-239					9.40E-03	3.50E-03	6.70E-03	1.30E-03	6.95E-03	1.33E-03	7.68E-03
Ru-103											
Ru-106					b		5.10E-01	1.70E-01	3.37E-01	1.85E-01	4.24E-01
Sr-90					2.40E-01	6.00E-02	2.70E-01	5.00E-02	5.04E-01	1.02E-01	3.38E-01
Tc-99					< 6.40E-01	8.60E-01	1.40E+00	3.00E+00	8.97E-01	1.11E+00	9.79E-01
Zr-95					< 3.70E-02	3.30E-02	-4.80E-03	2.50E-02	-1.54E-02	3.79E-02	5.60E-03

Negative values indicate concentrations at or near background levels of radioactivity.

Shaded areas indicate a positive detection, the result is larger than the error.

A dash (-) indicates that radionuclide concentration is less than detectable. The detection limits are as follows; Co-60 = 3.0E-02, Sr-90 = 5.0E-03, Nb-95 = 5.0E-02, Zr-95 = 5.0E-02, Ru-103 = 3.0E-02, Ru-106 = 2.6E-01, Cs-137 = 3.0E-02, Eu-152 = 1.7E-01, Eu-154 = 8.0E-02, Eu-155 = 7.0E-02, Pu-238 = 6.0E-04, and Pu-239 = 6.0E-04

(a) Not analyzed for this radionuclide

(b) Not routinely reported

Table A-2.4 Results of Air Monitoring (pCi/m3)
Location N006:

Radionuclide		1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Sr-90	max							2.9E-04	1.3E-04	2.92E-04	1.46E-04	2.91E-04
	min							< 5.8E-05	7.3E-05	-0.00000	8.46E-05	2.90E-05
	avg							1.5E-04	1.1E-04	1.42E-04	1.15E-04	1.46E-04
Cs-137	max							7.1E-04	5.2E-04	4.07E-04	7.68E-04	5.59E-04
	min							< 3.0E-05	6.4E-04	-1.21E-04	4.82E-04	-4.55E-05
	avg							3.8E-04	3.1E-04	1.43E-04	6.25E-04	2.62E-04
Pu-239	max							1.8E-05	9.9E-06	1.06E-05	5.00E-06	1.43E-05
	min							< 9.9E-07	1.8E-06	1.50E-06	3.48E-06	1.25E-06
	avg							6.5E-06	8.9E-06	6.05E-06	4.24E-06	6.28E-06
U (total)	max							-9.6E-07	1.9E-05	5.48E-06	2.84E-05	2.26E-06
	min							-1.2E-05	3.0E-05	3.02E-06	1.97E-05	-4.49E-06
	avg							-6.1E-06	7.4E-06	4.25E-06	2.41E-05	-9.25E-07

No readings were taken in 1985, 1986, or 1987
Shaded Areas indicate a positive detection, the result is larger than the error.

Table A-2.4 Results of Air Monitoring (pCi/m3)
Location N007:

Radionuclide		1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Sr-90	max							3.9E-04	1.5E-04	1.31E-04	9.62E-05	2.61E-04
	min							< 2.0E-05	6.9E-05	-0.00003	7.04E-05	-5.00E-06
	avg							1.9E-04	1.6E-04	4.73E-05	8.33E-05	1.19E-04
Cs-137	max							< 8.4E-04	1.1E-03	9.64E-05	4.67E-04	4.68E-04
	min							< -9.6E-05	4.0E-04	-4.97E-05	7.98E-04	-7.29E-05
	avg							2.1E-04	5.3E-04	2.33E-05	6.33E-04	1.17E-04
Pu-239	max							1.2E-05	7.9E-06	1.54E-06	2.99E-06	6.77E-06
	min							< 1.3E-06	2.6E-06	-0.00000	1.34E-06	6.50E-07
	avg							4.2E-06	6.2E-06	7.25E-07	2.17E-06	2.46E-06
U (total)	max							3.5E-05	3.3E-05	1.13E-05	2.12E-05	2.32E-05
	min							< -1.0E-05	3.0E-05	-0.00000	2.47E-05	-5.00E-06
	avg							7.9E-06	2.1E-05	5.50E-06	2.30E-05	6.70E-06

No readings were taken in 1985, 1986, or 1987
Shaded Areas indicate a positive detection, the result is larger than the error.

Table A-2.4 Results of Air Monitoring (pCi/m3)
Location N008:

Radionuclide		1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Sr-90	max							4.0E-04	1.5E-04	1.44E-04	8.85E-05	2.72E-04
	min							< 3.9E-05	1.3E-04	-0.00000	7.75E-05	1.95E-05
	avg							1.5E-04	1.7E-04	6.96E-05	8.30E-05	1.10E-04
Cs-137	max							< 2.6E-04	7.1E-04	6.03E-04	3.86E-04	4.32E-04
	min							< -3.0E-04	9.3E-04	-1.63E-04	6.05E-04	-2.32E-04
	avg							-4.9E-05	3.8E-04	2.20E-04	4.95E-04	8.55E-05
Pu-239	max							< 2.5E-06	2.8E-06	1.00E-05	4.65E-06	6.25E-06
	min							< 1.9E-07	2.8E-06	6.56E-07	2.00E-06	4.23E-07
	avg							1.5E-06	3.2E-06	5.33E-06	3.33E-06	3.42E-06
U (total)	max							< 2.4E-05	2.8E-05	5.47E-05	2.92E-05	3.94E-05
	min							< -9.3E-06	1.8E-05	7.58E-06	2.57E-05	-8.60E-07
	avg							9.4E-06	1.6E-05	3.11E-05	2.75E-05	2.03E-05

No readings were taken in 1985, 1986, or 1987
Shaded Areas indicate a positive detection, the result is larger than the error.

Table A-2.4 Results of Air Monitoring (pCi/m3)
Location N012:

Radionuclide		1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Sr-90	max							6.6E-04	2.2E-04	5.00E-05	7.26E-05	3.55E-04
	min							1.6E-04	1.3E-04	-0.00000	6.66E-05	8.00E-05
	avg							4.1E-04	5.1E-04	2.60E-05	6.41E-05	2.18E-04
Cs-137	max							< 8.9E-04	9.6E-04	7.97E-04	7.47E-04	8.44E-04
	min							5.9E-04	4.3E-04	5.44E-05	5.71E-04	3.22E-04
	avg							7.4E-04	6.1E-04	3.65E-04	6.17E-04	5.53E-04
Pu-239	max							4.5E-06	3.9E-06	3.36E-06	3.06E-06	3.93E-06
	min							< 1.5E-06	4.8E-06	-0.00000	1.35E-06	7.50E-07
	avg							3.0E-06	3.2E-06	1.97E-06	2.64E-06	2.49E-06
U (total)	max							< -4.2E-06	1.8E-05	1.93E-05	1.35E-05	7.55E-06
	min							< -5.2E-05	3.7E-05	-0.00000	1.94E-05	-2.60E-05
	avg							-2.8E-05	5.1E-05	9.88E-06	1.92E-05	-9.06E-06

No readings were taken in 1985, 1986, or 1987
Shaded Areas indicate a positive detection, the result is larger than the error.

Table A-2.4 Results of Air Monitoring (pCi/m3)
Location N158: 241-AX Tank Farm

Radionuclide		1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Sr-90	max	2.83E-03		4.19E-04		5.44E-04		6.7E-04	2.2E-04	1.24E-03	3.33E-04	1.14E-03
	min	3.00E-04		3.29E-04		1.49E-04		1.3E-04	8.9E-05	4.57E-05	8.70E-05	1.91E-04
	avg	1.57E-03	2.38E-03	3.81E-04	8.98E-05	3.55E-04	3.44E-04	3.5E-04	2.4E-04	3.78E-04	1.49E-04	6.07E-04
Cs-137	max	4.36E-03		5.57E-03		3.16E-03		1.7E-03	7.8E-04	1.93E-03	9.69E-04	3.34E-03
	min	1.29E-03		7.56E-04		2.81E-04		< 1.8E-04	5.5E-04	1.39E-04	6.71E-04	5.29E-04
	avg	2.37E-03	2.74E-03	2.42E-03	4.31E-03	1.64E-03	2.36E-03	1.2E-03	7.3E-04	9.45E-04	7.33E-04	1.72E-03
Pu-239	max	6.15E-05		1.83E-05		1.21E-05		3.0E-05	9.8E-06	2.37E-03	2.42E-04	4.98E-04
	min	2.64E-05		2.12E-06		3.56E-06		< -5.6E-07	5.0E-06	1.17E-06	2.03E-06	6.54E-06
	avg	4.64E-05	3.02E-05	9.72E-06	1.65E-05	6.56E-06	7.66E-06	1.1E-05	1.4E-05	5.95E-04	6.25E-05	1.34E-04
U (total)	max	1.64E-04		8.55E-05		3.50E-05		3.7E-05	2.7E-05	9.43E-05	3.48E-05	8.32E-05
	min	3.29E-05		2.21E-05		1.94E-05		< 4.2E-06	2.0E-05	-0.00000	1.88E-05	1.57E-05
	avg	1.03E-04	1.31E-04	4.80E-05	5.80E-05	2.63E-06	1.31E-05	1.7E-05	1.5E-05	3.85E-05	2.42E-05	4.18E-05

Shaded Areas indicate a positive detection, the result is larger than the error.

Table A-2.4 Results of Air Monitoring (pCi/m3)
Location N969: SW of PUREX Plant

Radionuclide		1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Sr-90	max	1.26E-03		7.96E-04		2.37E-04		3.0E-04	1.3E-04	1.30E-03	3.63E-04	7.79E-04
	min	1.45E-04		9.74E-05		1.28E-05		< 1.3E-05	6.5E-05	2.85E-05	6.42E-05	5.93E-05
	avg	6.06E-04	1.05E-03	3.75E-04	5.95E-04	9.22E-05	2.45E-04	1.5E-04	1.6E-04	3.78E-04	1.47E-04	3.20E-04
Cs-137	max	5.45E-04		1.54E-03		-5.06E-05		< 2.0E-04	6.9E-04	2.50E-04	5.21E-04	4.97E-04
	min	-8.10E-04		2.45E-05		-4.33E-04		< -1.0E-04	5.8E-04	-3.05E-05	6.27E-04	-2.70E-04
	avg	-3.27E-05	1.13E-03	7.06E-04	1.26E-03	-2.56E-04	3.31E-04	8.9E-05	1.8E-04	1.46E-04	6.23E-04	1.30E-04
Pu-239	max	1.57E-04		2.37E-05		9.10E-06		5.5E-05	1.2E-05	9.72E-06	5.01E-06	5.09E-05
	min	5.65E-05		6.04E-06		6.29E-07		< 1.1E-06	2.5E-06	4.64E-07	1.55E-06	1.29E-05
	avg	9.01E-05	9.13E-05	1.62E-05	1.71E-05	4.82E-06	7.19E-06	1.9E-05	2.5E-05	3.53E-06	2.80E-06	2.67E-05
U (total)	max	8.57E-04		9.79E-05		3.69E-05		5.6E-05	3.1E-05	4.44E-05	2.07E-05	2.18E-04
	min	2.91E-05		1.83E-05		4.37E-06		< -1.2E-07	1.9E-05	2.07E-06	2.05E-05	1.07E-05
	avg	2.59E-04	8.01E-04	5.94E-05	7.04E-05	2.47E-05	2.86E-05	3.3E-05	2.5E-05	2.19E-05	1.99E-05	7.96E-05

Shaded Areas indicate a positive detection, the result is larger than the error.

Table A-2.4 Results of Air Monitoring (pCi/m3)
Location N970:

Radionuclide		1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Sr-90	max	1.85E-03		2.31E-04		2.80E-04		2.5E-04	1.3E-04	9.79E-05	7.94E-05	5.42E-04
	min	9.94E-05		1.32E-04		-2.26E-05		1.1E-04	1.1E-04	-0.00003	5.70E-05	5.78E-05
	avg	6.11E-04	1.66E-03	1.81E-04	8.60E-05	8.76E-05	2.74E-04	1.7E-04	7.2E-05	5.45E-05	7.18E-05	2.21E-04
Cs-137	max	4.70E-04		4.72E-03		3.82E-04		3.9E-04	4.6E-04	4.78E-04	5.50E-04	1.29E-03
	min	-7.12E-04		5.42E-04		0.00E+00		< -3.0E-04	5.9E-04	-2.74E-04	5.85E-04	-1.49E-04
	avg	7.03E-05	1.08E-03	1.97E-03	3.92E-03	1.60E-04	3.41E-04	4.8E-05	3.3E-04	1.14E-04	6.12E-04	4.72E-04
Pu-239	max	1.71E-04		7.17E-05		1.25E-05		4.9E-05	1.2E-05	4.45E-05	1.07E-05	6.97E-05
	min	4.95E-05		5.59E-06		3.04E-06		1.3E-05	5.7E-06	1.04E-06	2.67E-06	1.44E-05
	avg	8.73E-05	1.13E-04	2.92E-05	5.87E-05	7.70E-06	8.88E-06	3.1E-05	1.5E-05	1.80E-05	5.97E-06	3.46E-05
U (total)	max	1.59E-04		3.91E-04		4.08E-05		4.0E-05	2.7E-05	4.67E-05	2.06E-05	1.36E-04
	min	4.62E-05		3.14E-05		1.07E-05		< -1.7E-06	1.9E-05	1.28E-05	2.15E-05	1.99E-05
	avg	9.27E-05	9.50E-05	1.40E-04	3.38E-04	2.28E-05	2.72E-05	2.0E-05	1.7E-05	2.94E-05	2.11E-05	6.10E-05

Shaded Areas indicate a positive detection, the result is larger than the error.

Table A-2.4 Results of Air Monitoring (pCi/m3)
Location N971:

Radionuclide		1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Sr-90	max	1.48E-02		5.44E-04		4.20E-04		2.7E-04	1.2E-04	7.50E-04	2.41E-04	3.21E-03
	min	2.81E-04		1.29E-04		2.30E-05		1.2E-04	1.1E-04	1.49E-05	6.12E-05	1.71E-04
	avg	4.18E-03	1.42E-02	3.18E-04	3.77E-04	1.35E-04	3.82E-04	1.9E-04	6.7E-05	3.03E-04	1.31E-04	9.65E-04
Cs-137	max	7.65E-04		1.41E-03		6.94E-04		7.0E-04	6.2E-04	6.35E-04	3.88E-04	5.77E-04
	min	0.00E+00		-7.63E-04		2.35E-04		< 5.8E-05	5.5E-04	-6.86E-04	5.58E-04	-1.07E-04
	avg	3.06E-04	6.52E-04	5.58E-04	1.87E-03	5.43E-04	4.16E-04	3.9E-04	3.2E-04	-6.52E-05	5.14E-04	3.59E-04
Pu-239	max	1.73E-04		1.58E-04		1.35E-05		3.1E-05	8.4E-06	1.76E-04	2.52E-05	7.52E-05
	min	7.17E-05		1.60E-05		3.57E-06		8.0E-06	4.8E-06	4.29E-07	1.66E-06	2.89E-05
	avg	1.20E-04	9.48E-05	5.55E-05	1.37E-04	6.54E-06	9.45E-06	2.2E-05	1.0E-05	4.52E-05	7.84E-06	4.08E-05
U (total)	max	1.14E-04		8.08E-05		3.02E-05		< 2.4E-05	2.5E-05	7.16E-05	2.79E-05	5.18E-05
	min	3.76E-05		1.49E-05		1.03E-05		< -7.4E-06	1.8E-05	1.01E-05	2.14E-05	1.85E-05
	avg	6.77E-05	6.96E-05	3.93E-05	5.77E-05	2.01E-05	1.66E-05	7.4E-06	1.3E-05	3.72E-05	2.34E-05	2.69E-05

Shaded Areas indicate a positive detection, the result is larger than the error.

Table A-2.4 Results of Air Monitoring (pCi/m3)
Location N976:

Radionuclide		1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Sr-90	max	6.23E-03		1.19E-01		2.98E-04		5.0E-04	2.0E-04	4.36E-04	1.74E-04	2.53E-02
	min	5.51E-04		5.20E-04		1.46E-04		1.7E-04	1.2E-04	3.56E-05	8.79E-05	2.85E-04
	avg	2.50E-03	5.30E-03	6.27E-04	1.87E-04	2.51E-04	1.41E-04	2.9E-04	1.5E-04	2.08E-04	1.16E-04	7.75E-04
Cs-137	max	5.67E-04		1.81E-03		5.54E-04		< 1.7E-04	6.0E-04	7.00E-04	6.20E-04	7.60E-04
	min	-4.59E-04		3.43E-04		2.06E-04		< -1.1E-04	5.3E-04	-2.28E-04	5.41E-04	-4.96E-05
	avg	2.04E-04	9.39E-04	7.82E-04	1.38E-03	4.07E-04	3.02E-04	-3.0E-07	1.5E-04	2.39E-04	5.51E-04	3.26E-04
Pu-239	max	2.91E-05		4.99E-06		6.83E-06		< 5.5E-07	1.6E-06	1.99E-06	2.97E-06	8.69E-06
	min	1.36E-05		6.81E-07		1.90E-06		< -1.7E-06	1.6E-06	-0.00000	3.28E-06	2.90E-06
	avg	1.94E-05	1.39E-05	3.64E-06	4.03E-06	3.88E-06	4.21E-06	-1.3E-07	1.1E-06	2.44E-07	2.25E-06	5.41E-06
U (total)	max	1.17E-04		4.83E-05		6.01E-05		< 9.9E-06	2.0E-05	2.21E-04	7.04E-05	9.13E-05
	min	1.97E-05		3.25E-05		1.65E-05		< -8.3E-07	1.9E-05	-0.00000	1.86E-05	1.36E-05
	avg	7.21E-05	8.89E-05	3.79E-05	1.43E-05	3.39E-05	3.71E-05	4.5E-06	4.7E-06	8.57E-05	3.73E-05	4.68E-05

Shaded Areas indicate a positive detection, the result is larger than the error.

Table A-2.4 Results of Air Monitoring (pCi/m3)
Location N977:

Radionuclide		1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Sr-90	max	5.88E-03		3.51E-04		2.90E-04		2.7E-04	1.4E-04	1.07E-04	9.90E-05	1.38E-03
	min	4.78E-04		2.14E-04		3.62E-05		1.1E-04	1.0E-04	-0.00003	1.07E-04	1.68E-04
	avg	2.08E-03	5.14E-03	2.86E-04	1.41E-04	1.23E-04	2.28E-04	1.9E-04	9.1E-05	2.19E-05	9.31E-05	5.40E-04
Cs-137	max	1.00E-03		8.76E-04		7.03E-04		8.5E-04	6.3E-04	3.69E-04	4.77E-04	7.60E-04
	min	1.05E-04		-3.73E-04		3.91E-04		< -1.1E-04	5.1E-04	-3.87E-04	6.14E-04	-7.48E-05
	avg	5.02E-04	8.08E-04	2.75E-04	1.23E-03	5.51E-04	2.57E-04	2.7E-04	4.7E-04	-6.22E-05	5.43E-04	3.07E-04
Pu-239	max	1.13E-04		2.39E-05		7.66E-06		4.4E-05	1.3E-05	6.83E-06	4.18E-06	3.91E-05
	min	3.20E-05		5.10E-06		5.31E-07		3.9E-06	3.2E-06	2.48E-07	1.64E-06	8.36E-06
	avg	7.29E-05	6.90E-05	1.24E-05	1.62E-05	3.56E-06	7.39E-06	1.5E-05	2.0E-05	2.61E-06	2.46E-06	2.13E-05
U (total)	max	1.61E-04		4.77E-05		4.27E-05		< 1.1E-05	2.3E-05	1.27E-04	4.35E-05	7.79E-05
	min	4.30E-05		1.20E-05		1.03E-05		< -4.3E-06	2.0E-05	9.56E-06	2.10E-05	1.41E-05
	avg	8.27E-05	1.07E-04	2.76E-05	3.31E-05	2.41E-05	2.95E-05	1.6E-06	7.6E-06	6.31E-05	3.04E-05	3.98E-05

Shaded Areas indicate a positive detection, the result is larger than the error.

Table A-2.4 Results of Air Monitoring (pCi/m3)
Location N984:

Radionuclide		1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Sr-90	max	2.71E-03		9.80E-04		7.88E-03		8.0E-04	2.6E-04	5.68E-04	2.15E-04	2.59E-03
	min	2.07E-04		2.73E-04		1.18E-04		2.7E-04	1.3E-04	2.01E-05	7.41E-05	1.78E-04
	avg	1.29E-03	2.15E-03	5.74E-04	6.95E-04	2.11E-03	7.70E-03	4.2E-04	2.6E-04	2.61E-04	1.40E-04	9.31E-04
Cs-137	max	3.79E-03		2.95E-03		3.12E-03		1.9E-03	7.8E-04	7.41E-04	4.53E-04	2.50E-03
	min	1.35E-04		-1.27E-04		4.48E-04		6.9E-04	4.8E-04	3.50E-04	7.04E-04	2.99E-04
	avg	2.32E-03	3.52E-03	1.37E-03	3.23E-03	1.58E-03	2.23E-03	1.1E-03	5.8E-04	5.89E-04	6.43E-04	1.39E-03
Pu-239	max	3.49E-05		6.60E-06		3.43E-06		5.6E-06	4.0E-06	4.17E-05	1.05E-05	1.84E-05
	min	1.51E-05		4.24E-06		6.76E-07		< 4.2E-07	2.0E-06	4.01E-06	4.34E-06	4.89E-06
	avg	2.29E-05	1.72E-05	5.24E-06	2.35E-06	2.12E-06	2.44E-06	2.6E-06	2.5E-06	1.48E-05	5.85E-06	9.53E-06
U (total)	max	1.46E-04		5.76E-05		1.51E-05		< 8.7E-07	1.9E-05	7.71E-05	3.03E-05	5.93E-05
	min	2.65E-05		2.19E-05		6.76E-06		< -5.6E-06	1.9E-05	-0.00000	2.00E-05	9.91E-06
	avg	7.93E-05	1.11E-04	3.94E-05	2.95E-05	1.11E-05	7.09E-06	-1.7E-06	2.9E-06	4.25E-05	2.58E-05	3.41E-05

Shaded Areas indicate a positive detection, the result is larger than the error.

Table A-2.4 Results of Air Monitoring (pCi/m3)
Location N985:

Radionuclide		1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Sr-90	max	1.02E-03		8.29E-04		5.48E-04		2.9E-04	1.3E-04	2.63E-04	1.16E-04	5.90E-04
	min	3.81E-04		3.37E-04		1.43E-04		< 7.5E-05	8.1E-05	-0.00002	8.00E-05	1.87E-04
	avg	6.91E-04	6.40E-04	5.71E-04	4.16E-04	3.19E-04	3.43E-04	1.5E-04	1.0E-04	1.20E-04	9.46E-05	3.70E-04
Cs-137	max	9.62E-04		1.28E-03		4.08E-04		4.4E-04	4.2E-04	5.94E-04	5.28E-04	7.37E-04
	min	7.34E-04		5.52E-04		-3.02E-04		< -8.5E-05	6.9E-04	-1.52E-04	5.22E-04	1.49E-04
	avg	8.81E-04	2.55E-04	9.44E-04	6.96E-04	6.85E-05	7.43E-04	1.4E-04	2.8E-04	1.24E-04	5.94E-04	4.32E-04
Pu-239	max	4.68E-05		2.53E-05		5.25E-06		1.0E-04	2.1E-05	4.16E-04	5.56E-05	1.19E-04
	min	2.27E-05		1.44E-06		9.41E-07		< 2.7E-06	3.8E-06	9.13E-07	1.73E-06	5.74E-06
	avg	3.70E-05	2.53E-05	1.54E-05	2.30E-05	3.15E-06	3.63E-06	3.3E-05	4.9E-05	1.05E-04	1.57E-05	3.87E-05
U (total)	max	2.20E-04		9.40E-05		3.14E-05		< 2.4E-05	2.4E-05	7.65E-05	2.83E-05	8.92E-05
	min	2.52E-05		1.75E-05		1.34E-05		< 2.4E-06	2.0E-05	2.61E-05	2.41E-05	1.69E-05
	avg	1.23E-04	1.95E-04	4.33E-05	6.88E-05	2.32E-05	1.48E-05	1.3E-05	9.7E-06	4.48E-05	2.48E-05	4.95E-05

Shaded Areas indicate a positive detection, the result is larger than the error.

Table A-2.4 Results of Air Monitoring (pCi/m3)
Location N991:

Radionuclide		1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Sr-90	max	1.56E-04		2.72E-04		1.05E-04		2.6E-04	1.2E-04	1.26E-04	8.37E-05	1.84E-04
	min	8.36E-05		1.50E-04		-8.84E-06		< 2.1E-06	9.2E-05	1.94E-05	9.59E-05	4.93E-05
	avg	1.20E-04	1.02E-04	2.05E-04	1.10E-04	5.31E-05	9.64E-05	1.3E-04	1.1E-04	7.67E-05	8.69E-05	1.17E-04
Cs-137	max	8.58E-04		7.12E-04		4.58E-04		< 6.8E-04	8.3E-04	3.97E-04	5.51E-04	6.21E-04
	min	2.73E-05		2.49E-04		-1.13E-05		< 8.7E-05	6.8E-04	-1.93E-04	4.70E-04	3.18E-05
	avg	4.43E-04	1.17E-03	4.40E-04	4.46E-04	2.55E-04	3.91E-04	2.7E-04	3.2E-04	1.09E-04	5.50E-04	3.03E-04
Pu-239	max	5.47E-05		2.70E-05		3.64E-06		1.1E-05	6.0E-06	3.94E-05	1.03E-05	2.71E-05
	min	3.31E-05		1.59E-06		4.66E-08		< 1.7E-06	2.6E-06	6.86E-07	1.50E-06	7.42E-06
	avg	4.39E-05	3.05E-05	1.24E-05	2.20E-05	1.62E-06	3.02E-06	6.3E-06	4.5E-06	1.07E-05	3.86E-06	1.50E-05
U (total)	max	2.00E-04		6.60E-05		2.84E-06		< 1.1E-05	2.1E-05	5.57E-05	2.25E-05	6.71E-05
	min	3.04E-05		1.54E-05		1.23E-06		< -8.7E-06	2.0E-05	8.70E-07	1.98E-05	7.84E-06
	avg	1.15E-04	2.40E-04	4.43E-05	4.44E-05	1.35E-05	2.24E-05	1.5E-06	8.3E-06	2.41E-05	1.97E-05	3.97E-05

Shaded Areas indicate a positive detection, the result is larger than the error.

Table A-2.4 Results of Air Monitoring (pCi/m3)
Location N992:

Radionuclide		1985 *		1986		1987		1988		1989		Average
		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result
Sr-90	max	2.78E-04		2.78E-04		1.33E-04				6.02E-04	2.07E-04	2.58E-04
	min	2.78E-04		5.04E-05		3.79E-05				-0.00003	6.14E-05	7.33E-05
	avg	2.78E-04	2.50E-04	1.60E-04	1.86E-04	8.52E-05	8.78E-05	2.7E-04	1.5E-04	1.52E-04	1.03E-04	1.89E-04
Cs-137	max	-7.08E-04		1.15E-03		8.88E-04				4.09E-04	4.70E-04	3.48E-04
	min	-7.08E-04		-1.88E-04		-7.54E-04				-6.66E-05	4.73E-04	-3.43E-04
	avg	-7.08E-04	9.87E-04	5.06E-04	1.21E-03	1.87E-04	1.64E-03	< 4.5E-04	5.4E-04	1.73E-04	4.77E-04	1.22E-04
Pu-239	max	0.00E+00		9.23E-06		3.65E-06				8.20E-07	1.77E-06	2.74E-06
	min	0.00E+00		1.04E-06		7.38E-07				-0.00000	2.26E-06	3.56E-07
	avg	0.00E+00	3.80E-06	6.29E-06	7.64E-06	2.10E-06	2.64E-06	< 5.4E-07	1.8E-06	-0.00000	1.66E-06	1.79E-06
U (total)	max	2.03E-05		6.71E-05		2.06E-05				3.39E-05	1.66E-05	2.84E-05
	min	2.03E-05		1.67E-05		-1.77E-05				-0.00000	1.90E-05	3.86E-06
	avg	2.03E-05	3.36E-05	4.23E-05	4.40E-05	8.62E-06	3.57E-05	< 1.3E-05	2.5E-05	2.09E-05	1.85E-05	2.10E-05

* *Sites sampled one quarter only show the overall counting error rather than the standard deviation of the mean of quarterly composites. Only one reading was taken in 1988.*

Shaded Areas indicate a positive detection, the result is larger than the error.

Table A-2.4 Results of Air Monitoring (pCi/m3)
Location N993:

Radionuclide		1985 *		1986		1987		1988		1989		Average Result
		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sr-90	max	1.05E-04		4.33E-04		1.66E-04		3.2E-04	1.4E-04	3.71E-04	1.45E-04	2.79E-04
	min	1.05E-04		1.38E-04		4.28E-05		< 2.6E-05	9.5E-05	1.84E-05	7.23E-05	6.60E-05
	avg	1.05E-04	1.89E-04	3.04E-04	2.46E-04	1.02E-04	1.19E-04	1.7E-04	1.3E-04	1.33E-04	9.73E-05	1.63E-04
Cs-137	max	-5.45E-05		5.15E-03		1.28E-03		7.1E-04	6.3E-04	7.53E-04	5.89E-04	1.57E-03
	min	-5.45E-05		3.47E-04		-4.92E-05		< -9.7E-05	5.2E-04	-2.96E-04	5.75E-04	-2.99E-05
	avg	-5.45E-05	1.12E-03	2.31E-03	4.19E-03	8.65E-04	1.23E-03	3.2E-04	3.4E-04	2.76E-04	5.53E-04	7.43E-04
Pu-239	max	9.82E-07		3.26E-05		7.48E-06		8.0E-06	5.1E-06	4.19E-06	3.25E-06	1.07E-05
	min	9.82E-07		6.61E-06		3.05E-06		< 1.5E-06	2.6E-06	1.29E-06	2.38E-06	2.69E-06
	avg	9.82E-07	1.97E-06	2.26E-05	2.36E-05	5.48E-06	4.53E-06	4.1E-06	3.2E-06	2.39E-06	2.58E-06	7.11E-06
U (total)	max	2.64E-05		2.16E-04		1.42E-04		4.5E-05	2.9E-05	9.30E-05	3.31E-05	1.04E-04
	min	2.64E-05		2.62E-05		2.46E-05		< 9.9E-06	2.0E-05	7.65E-06	2.05E-05	1.90E-05
	avg	2.64E-05	3.45E-05	9.76E-05	1.69E-04	6.05E-05	1.10E-04	2.0E-05	1.8E-05	4.31E-05	2.43E-05	4.95E-05

* *Sites sampled one quarter only show the overall counting error rather than the standard deviation of the mean of quarterly composites.*
Shaded Areas indicate a positive detection, the result is larger than the error.

Table A-2.4 Results of Air Monitoring (pCi/m3)
Location N996:

Radionuclide		1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Sr-90	max			1.39E-04		8.43E-04		4.7E-04	1.7E-04	2.81E-04	2.09E-04	4.33E-04
	min			1.39E-04		1.89E-05		< 7.8E-05	1.1E-04	4.76E-05	9.69E-05	7.09E-05
	avg			1.39E-04	2.44E-12	2.72E-04	7.67E-04	2.3E-04	2.0E-04	1.59E-04	1.40E-04	2.00E-04
Cs-137	max			6.41E-04		4.64E-04		6.2E-04	5.0E-04	1.80E-04	5.99E-04	4.76E-04
	min			2.74E-04		-3.25E-04		< -5.3E-04	6.5E-04	-4.45E-04	9.45E-04	-2.57E-04
	avg			4.58E-04	5.19E-04	9.02E-05	8.03E-04	2.4E-04	5.3E-04	-8.53E-05	7.01E-04	1.76E-04
Pu-239	max			2.40E-05		1.95E-05		7.3E-06	6.9E-06	2.65E-06	5.49E-06	1.34E-05
	min			1.73E-05		1.98E-06		< -5.6E-07	1.7E-06	-0.00000	2.23E-06	4.68E-06
	avg			2.06E-05	9.48E-06	7.26E-06	1.66E-05	2.6E-06	4.2E-06	1.20E-06	3.33E-06	7.92E-06
U (total)	max			6.42E-05		7.40E-05		< 1.0E-05	2.4E-05	7.99E-05	3.62E-05	5.70E-05
	min			4.08E-05		2.45E-05		< 3.3E-06	2.0E-05	2.71E-05	2.73E-05	2.39E-05
	avg			5.25E-05	3.31E-05	4.14E-05	4.58E-05	6.7E-06	3.5E-06	4.59E-05	3.07E-05	3.66E-05

No readings were taken in 1985
Shaded Areas indicate a positive detection, the result is larger than the error.

Table A-2.4 Results of Air Monitoring (pCi/m3)
Location N997:

Radionuclide		1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Sr-90	max			1.35E-03		7.17E-04		2.2E-04	1.1E-04	1.41E-04	1.27E-04	6.07E-04
	min			6.48E-04		4.77E-05		< 1.5E-05	7.2E-05	-0.00008	1.60E-04	1.78E-04
	avg			9.99E-04	9.93E-04	2.51E-04	6.25E-04	1.4E-04	9.7E-05	3.79E-05	2.77E-04	3.57E-04
Cs-137	max			2.31E-03		1.23E-03		< 5.9E-04	6.9E-04	2.53E-03	3.27E-03	1.67E-03
	min			1.78E-03		-2.64E-04		< 2.9E-04	4.7E-04	-3.69E-05	6.68E-04	4.42E-04
	avg			2.04E-03	7.50E-04	3.31E-04	1.30E-03	4.9E-04	1.7E-04	1.01E-03	1.66E-03	9.68E-04
Pu-239	max			3.09E-05		3.70E-05		< 3.1E-06	3.3E-06	5.52E-06	3.99E-06	1.91E-05
	min			4.29E-06		1.44E-06		< -5.6E-07	2.8E-06	-0.00000	1.47E-05	1.29E-06
	avg			1.76E-05	3.76E-05	1.47E-05	3.22E-05	1.2E-06	2.2E-06	5.51E-07	7.47E-06	8.51E-06
U (total)	max			1.18E-04		2.51E-05		< 3.5E-06	2.1E-05	1.61E-04	8.87E-05	7.69E-05
	min			2.40E-05		2.04E-06		< -5.1E-06	2.0E-05	-0.00001	6.01E-05	5.24E-06
	avg			7.10E-05	1.33E-04	1.31E-05	2.10E-05	-2.0E-06	4.9E-06	4.46E-05	5.69E-05	3.17E-05

No readings were taken in 1985
Shaded Areas indicate a positive detection, the result is larger than the error.

APPENDIX B

HEALTH AND SAFETY PLAN

9 2 1 2 6 5 0 7 7 3

CONTENTS

Page

1.0 GENERAL CONSIDERATIONS AND REQUIREMENTS B-1
1.1 INTRODUCTION B-1
1.2 DESIGNATED SAFETY PERSONNEL B-1
1.3 MEDICAL SURVEILLANCE B-3
1.4 TRAINING B-3
1.5 TRAINING FOR VISITORS B-4
1.6 RADIATION DOSIMETRY B-4
1.7 REQUIREMENTS FOR THE USE OF RESPIRATORY PROTECTION . . . B-4

2.0 GENERAL PROCEDURES B-5
2.1 GENERAL WORK SAFETY PRACTICES B-5
2.1.1 Work Practices B-5
2.1.2 Personal Protective Equipment B-7
2.1.3 Personal Decontamination B-7
2.1.4 Emergency Preparation B-8
2.2 CONFINED SPACE/TEST PIT ENTRY PROCEDURES B-8

3.0 SITE BACKGROUND B-9

4.0 SCOPE OF WORK AND POTENTIAL HAZARDS B-10
4.1 WORK TASKS B-10
4.2 POTENTIAL HAZARDS B-10
4.3 ASSESSMENT AND MITIGATION OF POTENTIAL HAZARDS B-11

5.0 ENVIRONMENTAL AND PERSONAL MONITORING B-11
5.1 AIRBORNE RADIOACTIVE AND RADIATION MONITORING B-12

6.0 PERSONAL PROTECTIVE EQUIPMENT B-13

7.0 SITE CONTROL B-13

8.0 DECONTAMINATION PROCEDURES B-14

9.0 CONTINGENCY AND EMERGENCY RESPONSE PLANS B-14

10.0 REFERENCES B-14

ACRONYMS AND ABBREVIATIONS

AAMS	aggregate area management study
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
EII	Environmental Investigations Instructions
HEHF	Hanford Environmental Health Foundation
HSP	Health and Safety Plan
HWOP	Hazardous Waste Operations Permit
JSA	Job Safety Analysis
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
RCRA	Resource Conservation and Recovery Act
RWP	radiation work permit
SCBA	self-contained breathing apparatus
WISHA	Washington Industrial Safety and Health Act

1.0 GENERAL CONSIDERATIONS AND REQUIREMENTS

1.1 INTRODUCTION

The purpose of this Health and Safety Plan (HSP) is to outline standard health and safety procedures for Westinghouse Hanford employees and contractors engaged in investigation activities for the B Plant Aggregate Area Management Study (AAMS). These activities will include surface investigation, drilling and sampling boreholes, and environmental sampling in areas of known chemical and radiological contamination. Appropriate site-specific safety documents (e.g., Hazardous Waste Operations Permit [HWOP] or Job Safety Analysis [JSA]) will be written for each task or group of tasks. A more complete discussion of Westinghouse Hanford environmental safety procedures is presented in the Westinghouse Hanford manual *Health and Safety for Hazardous Waste Field Operations*, WHC-CM-4-3 Vol. 4 (WHC 1992).

All employees of Westinghouse Hanford or any other contractors who are participating in onsite activities for the B Plant AAMS shall read the site-specific safety document and attend a pre-job safety or tailgate meeting to review and discuss the task.

1.2 DESIGNATED SAFETY PERSONNEL

The field team leader and site safety officer are responsible for site safety and health. Specific individuals will be assigned on a task-by-task basis by project management, and their names will be properly recorded before the task is initiated.

All activities onsite must be cleared through the field team leader. The field team leader has responsibility for the following:

- Allocating and administering resources to successfully comply with all technical and health and safety requirements

- Verifying that all permits, supporting documentation, and clearances are in place (e.g., electrical outage requests, welding permits, excavation permits, HWOP or JSA, sampling plan, radiation work permits [RWPs], and onsite/offsite radiation shipping records)

- Providing technical advice during routine operations and emergencies

- Informing the appropriate site management and safety personnel of the activities to be performed each day

- Coordinating resolution of any conflicts that may arise between RWPs and the implementation of the HWOP or JSA with health physics

- Handling emergency response situations as may be required

- Conducting pre-job and daily tailgate safety meetings

- Interacting with adjacent building occupants and/or inquisitive public.

The site safety officer is responsible for implementing the HWOP at the site. The site safety officer shall do the following:

- Monitor chemical, physical, and (in conjunction with the health physics technician) radiation hazards to assess the degree of hazard present; monitoring shall specifically include organic vapor detection, radiation screening, and confined space evaluation where appropriate.

- Determine protection levels, clothing, and equipment needed to ensure the safety of personnel in conjunction with the health physics department.

- Monitor the performance of all personnel to ensure that the required safety procedures are followed.

- Halt operations immediately, if necessary, due to safety or health concerns.

- Conduct safety briefings as necessary.

- Assist the field team leader in conducting safety briefings as necessary.

The health physics technician is responsible for ensuring that all radiological monitoring and protection procedures are being followed as specified in the Radiation Protection Manual and in the appropriate RWP. Westinghouse Hanford Industrial Safety and Fire Protection personnel will provide safety overview during drilling operations consistent with Westinghouse Hanford policy and, as requested, will provide technical advice. Also, downwind sampling for hazardous materials and radiological contaminants and other analyses may be requested from appropriate contractor personnel as required.

The ultimate responsibility and authority for employee's health and safety lies with the employee and the employee's colleagues. Each employee is responsible for exercising the utmost care and good judgment in protecting his or her personal health and safety and that of fellow employees. Should any employee observe a potentially unsafe condition or situation, it is the responsibility of that employee to immediately bring the observed condition to the attention of the appropriate health and safety personnel, as designated previously. In the event of an immediately dangerous or life-threatening situation, the employee automatically has temporary "stop work" authority and the responsibility to immediately notify the field team leader or site safety officer. When work is temporarily halted because of a safety or health concern, personnel will exit the exclusion zone and meet at a predetermined place in the support zone. The field team leader, site safety officer, and health physics technician will determine the next course of action.

1.3 MEDICAL SURVEILLANCE

All field team members engaged in operable unit activities at sites governed by an HWOP must have baseline physical examinations and be participants in Westinghouse Hanford (or an equivalent) hazardous waste worker medical surveillance program.

Medical examinations will be designed to identify any pre-existing conditions that may place an employee at high risk, and will verify that each worker is physically able to perform the work required by this plan without undue risk to personal health. The physician shall determine the existence of conditions that may reduce the effectiveness or prevent the employee's use of respiratory protection. The physician shall also determine the presence of conditions that may pose undue risk to the employee while performing the physical tasks of this work plan using level B personal protection equipment. This would include any condition that increases the employee's susceptibility to heat stress.

The examining physician's report will not include any nonoccupational diagnoses unless directly applicable to the employee's fitness for the work required.

1.4 TRAINING

Before engaging in any onsite activities, each team member is required to have received 40 hours of health and safety training related to hazardous waste site operations and at least 8 hours of refresher training each year thereafter as specified in 29 Code of Federal Regulations (CFR) 1910.120. In addition, each inexperienced employee (never having performed site characterization) will be directly supervised by a trained/experienced person for a minimum of 24 hours of field experience.

The field team leader and the site safety officer shall receive an additional 8 hours of training (in addition to the refresher training previously discussed).

1.5 TRAINING FOR VISITORS

For the purposes of this plan, a visitor is defined as any person visiting the Hanford Site, who is not a Westinghouse Hanford employee or a Westinghouse Hanford contractor directly involved in the Resource Conservation and Recovery Act (RCRA)/Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) facility investigation activities, including but not limited to those engaged in surveillance, inspection, or observation activities.

Visitors who must, for whatever reason, enter a controlled (either contamination reduction or exclusion) zone, shall be subject to all of the applicable training, respirator fit testing, and medical surveillance requirements discussed in Westinghouse Hanford Environmental Investigations Instructions (EII) 1.1 and Appendix B to EII 1.1 (WHC 1991).

All visitors shall be informed of potential hazards and emergency procedures by their escorts and shall conform to EII 1.1 (WHC 1991).

1.6 RADIATION DOSIMETRY

All personnel engaged in onsite activities shall be assigned dosimeters according to the requirements of the RWP applicable to that activity. All visitors shall be assigned basic dosimeters, as a minimum, that will be exchanged annually.

1.7 REQUIREMENTS FOR THE USE OF RESPIRATORY PROTECTION

All employees of Westinghouse Hanford and subcontractors who may be required to use air-purifying or air-supplied respirators must be included in the medical surveillance program and be approved for the use of respiratory protection by the Hanford Environmental Health Foundation (HEHF) or other licensed physician. Each team member must be trained in the selection, limitations, and proper use and maintenance of respiratory protection (existing respiratory protection training may be applicable towards the 40-hour training requirement).

Before using a negative pressure respirator, each employee must have been fit-tested (within the previous year) for the specific make, model, and size according to Westinghouse

Hanford fit-testing procedures. Beards (including a few days' growth), large sideburns, or moustaches that may interfere with a proper respirator seal are not permitted.

Subcontractors must provide evidence to Westinghouse Hanford that personnel are participants in a medical surveillance and respiratory protection program that complies with 29 CFR 1910.120 and 29 CFR 1910.134, respectively.

2.0 GENERAL PROCEDURES

The following personal hygiene and work practice guidelines are intended to prevent injuries and adverse health effects. A hazardous waste site poses a multitude of health and safety concerns because of the variety and number of hazardous substances present. These guidelines represent the minimum standard procedures for reducing potential risks associated with this project and are to be followed by all job-site employees at all times.

2.1 GENERAL WORK SAFETY PRACTICES

2.1.1 Work Practices

The following work practices must be observed:

- Eating, drinking, smoking, taking certain medications, chewing gum, and similar actions are prohibited within the exclusion zone. All sanitation facilities shall be located outside the exclusion zone; decontamination is required before using such facilities.

- Personnel shall avoid direct contact with contaminated materials unless necessary for sample collecting or required observation. Remote handling of such things as casings and auger flights will be practiced whenever practical.

- While operating in the controlled zone, personnel shall use the "buddy system" where appropriate, or be in visual contact with someone outside of the controlled zone.

- The buddy system will be used where appropriate for manual lifting.

- Requirements of Westinghouse Hanford radiation protection and RWP manuals shall be followed for all work involving radioactive materials or conducted within a radiologically controlled area.

- Onsite work operations shall only be carried out during daylight hours, unless the entire control zone is adequately illuminated with artificial lighting. A new tour (shift) will operate the drilling rig after completion of each shift.

- Do not handle soil, waste samples, or any other potentially contaminated items unless wearing the protective equipment specified in the HWOP or JSA.

- Whenever possible, stand upwind of excavations, boreholes, well casings, drilling spoils, and the like, as indicated by an onsite windsock.

- Stand clear of trenches during excavation. Always approach an excavation from upwind.

- Be alert to potentially changing exposure conditions as evidenced by such indications as perceptible odors, unusual appearance of excavated soils, or oily sheen on water.

- Do not enter any test pit or trench deeper than 1.2 m (4 ft) unless in accordance with procedures specified in the HWOP.

- Do not <u>under any circumstances</u> enter or ride in or on any backhoe bucket, materials hoist, or any other similar device not specifically designed for carrying passengers.

- All drilling team members must make a conscientious effort to remain aware of their own and others' positions in regards to rotating equipment, cat heads, or u-joints. Drilling operations members must be extremely careful when assembling, lifting, and carrying flights or pipe to avoid pinch-point injuries and collisions.

- Tools and equipment will be kept off the ground whenever possible to avoid tripping hazards and the spread of contamination.

- Personnel not involved in operation of the drill rig or monitoring activities shall remain a safe distance from the rig as indicated by the field team leader.

- Follow all provisions of each site-specific hazardous work permit as addressed in the HWOP, including cutting and welding, confined space entry, and excavation.

- Catalytic converters on the underside of vehicles are sufficiently hot to ignite dry prairie grass. Team members should not drive over dry grass that is higher than the ground clearance of the vehicle and should be aware of the potential fire hazard posed by catalytic converters at all times. Never allow a running or hot vehicle to sit in a stationary location over dry grass or other combustible materials.

- Follow all provisions of each site-specific RWP.

- Team members will attempt to minimize truck tire disturbance of all stabilized sites.

2.1.2 Personal Protective Equipment

- Personal protective equipment will be selected specifically for the hazards identified in the HWOP. The site safety officer in conjunction with Westinghouse Hanford Health Physics and Industrial Hygiene and Safety is responsible for choosing the appropriate type and level of protection required for different activities at the job site.

- Levels of protection shall be appropriate to the hazard to avoid either excessive exposure or additional hazards imposed by excessive levels of protection. The HWOP will contain provisions for adjusting the level of protection as necessary. These personal protective equipment specifications must be followed at all times, as directed by the field team leader, health physics technician, and site safety officer.

- Each employee must have a hard hat, safety glasses, and substantial protective footwear available to wear as specified in the HWOP or JSA.

- The exclusion zone around drilling or other noisy operations will be posted "Hearing Protection Required" and team members will have had noise control training.

- Personnel should maintain a high level of awareness of the limitations in mobility, dexterity, and visual impairment inherent in the use of level B and level C personal protective equipment.

- Personnel should be alert to the symptoms of fatigue, heat stress, and cold stress and their effects on the normal caution and judgment of personnel.

- Rescue equipment as required by Occupational Safety and Health Administration (OSHA), Washington Industrial Safety and Health Act (WISHA), or standards for working over water will be available and used.

2.1.3 Personal Decontamination

- The HWOP will describe in detail methods of personnel decontamination, including the use of contamination control corridors and step-off pads when appropriate.

- Thoroughly wash hands and face before eating or putting anything in the mouth to avoid hand-to-mouth contamination.

- At the end of each work day or each job, disposable clothing shall be removed and placed in (chemical contamination) drums, plastic-lined boxes or other containers as appropriate. Clothing that can be cleaned may be sent to the Hanford Site laundry.

- Individuals are expected to thoroughly shower before leaving the work site or Hanford Site if directed to do so by the health physics technician, site safety officer, or field team leader.

2.1.4 Emergency Preparation

- A multipurpose dry chemical fire extinguisher, a fire shovel, a complete field first-aid kit, and a portable pressurized spray wash unit shall be available at every site where there is potential for personnel contamination.

- Prearranged hand signals or other means of emergency communication will be established when respiratory protection equipment is to be worn, because this equipment seriously impairs speech.

- The Hanford Fire Department shall be initially notified before the start of the site investigation project. This notification shall include the location and nature of the various types of field work activities as described in the work plan. A site location map shall be included in this notification.

2.2 CONFINED SPACE/TEST PIT ENTRY PROCEDURES

The following procedures apply to the entry of any confined space, which for the purpose of this document shall be defined as any space having limited egress (access to an exit) and the potential for the presence or accumulation of a toxic or explosive atmosphere. This includes manholes, certain trenches (particularly those through waste disposal areas), and all test pits greater than 1 m (4 ft) deep. If confined spaces are to be entered as part of the work operations, a hazardous work permit (filled out for confined space entry) must be obtained from Industrial Safety and Fire Protection.

The identified remedial investigation activities on the B Plant AAMS should not require confined space entry. Nevertheless, the hazards associated with confined spaces are of such severity that all employees should be familiar with the safe work discussed in the following paragraphs.

No employee shall enter any test pit or trench deeper than 1 m (4 ft) unless the sides are shored or laid back to a stable slope as specified in OSHA 29 CFR 1926.652 or equivalent state occupational health and safety regulations.

When an employee is required to enter a pit or trench 1 m (4 ft) deep or more, an adequate means of access and egress, such as a slope of at least 2:1 to the bottom of the pit or a secure ladder or steps shall be provided.

Before entering any confined space, <u>including any test pit</u>, the atmosphere will be tested for flammable gases, oxygen deficiency, and organic vapors. If other specific contamination, such as radioactive materials or other gases and vapors may be present, additional testing for those substances shall be conducted. Depending on the situation, the space may require ventilation and retesting before entry.

An employee entering a confined or partially confined space must be equipped with an appropriate level of respiratory protection in keeping with the monitoring procedures discussed previously and the action levels for airborne contaminants (see "Warnings and Action Levels" in HWOP).

No employee shall enter any test pit requiring the use of level B protection, unless a backup person also equipped with a pressure-demand self-contained breathing apparatus (SCBA) is present. No backup person shall attempt any emergency rescue unless a second backup person equipped with an SCBA is present, or the appropriate emergency response authorities have been notified and additional help is on the way.

3.0 SITE BACKGROUND

Specific details on the B Plant AAMS background and known and suspected contamination are described in Sections 2.0 through 10.0 of the plan. The B Plant Aggregate Area is situated within the 200 East Area of the U.S. Department of Energy's (DOE) Hanford Site, in the south-central portion of the state of Washington. The 200 East Area is located in Benton County in the central portion of the Hanford Site. It is adjacent to the 200 West Area, located roughly 5 km (3 mi) to the east.

The B Plant Aggregate Area at the Hanford Site was used by the U.S. Government as a chemical separations area in the process to produce plutonium for nuclear weapons. These operations resulted in the release of chemical and radioactive wastes into the soil, air, and water of the area. Each waste site in the aggregate area is described separately in this document. Close relationships between waste units, such as overflow from one to another, are also discussed.

4.0 SCOPE OF WORK AND POTENTIAL HAZARDS

While the information presented in Sections 2.0 through 10.0 of the plan are believed to be representative of the constituents and quantities of wastes at the time of discharge, the present chemical nature, location, extent, and ultimate fate of these wastes in and around the liquid disposal facilities are largely unknown. The emphasis of the investigation in the B Plant AAMS will be to characterize the nature and extent of contamination in the vadose (unsaturated subsurface soil) zone.

4.1 WORK TASKS

Work tasks are described in Section 5.0 of the plan.

4.2 POTENTIAL HAZARDS

Onsite tasks will involve noninvasive surface sampling procedures and invasive soil sampling either directly in or immediately adjacent to areas known or suspected to contain potentially hazardous chemical substances, toxic metals, and radioactive materials.

Surface radiological contamination and fugitive dust will be the potential hazards of primary concern during noninvasive mapping and sampling activities.

Existing data indicate that hazardous substances may be encountered during invasive sampling; these include radionuclides, heavy metals, and corrosives. In addition, volatile organics may also be associated with certain facilities such as the solvent storage buildings or underground storage tanks.

Potential hazards include the following:

- External radiation (gamma and to a lesser extract, beta) from radioactive materials in the soil
- Internal radiation resulting from radionuclides present in contaminated soil entering the body by ingestion or through open cuts and scratches
- Internal radiation resulting from inhalation of particulate (dust) contaminated with radioactive materials
- Inhalation of toxic vapors or gases such as volatile organics or ammonia
- Inhalation or ingestion of particulate (dust) contaminated with inorganic or organic chemicals, and toxic metals
- Dermal exposure to soil or groundwater contaminated with radionuclides
- Dermal exposure to soil or groundwater contaminated with inorganic or organic chemicals, and toxic metals
- Physical hazards such as noise, heat stress, and cold stress
- Slips, trips, falls, bumps, cuts, pinch points, falling objects, other overhead hazards, crushing injuries, and other hazards typical of a construction-related job site
- Unknown or unexpected underground utilities
- Biological hazards; snakes, spiders, etc.

4.3 ASSESSMENT AND MITIGATION OF POTENTIAL HAZARDS

The likelihood of significant exposure (100 mR/h or greater) to external radiation is remote and can be readily monitored and controlled by limiting exposure time, increasing distance, and employing shielding as required.

Internal radiation by inhalation or inadvertent ingestion of contaminated dust is a realistic concern and must be continuously evaluated by the health physics technician. Appropriate respiratory protection, protective clothing, and decontamination procedures will be implemented as necessary to reduce potential inhalation, ingestion, and dermal exposure to acceptable levels.

Dermal exposure to toxic chemical substances is not expected to pose a significant problem for the identified tasks given the use of the designated protective clothing. The appropriate level of personal protective clothing and respiratory protection will vary from work site to work site.

5.0 ENVIRONMENTAL AND PERSONAL MONITORING

The site safety officer or authorized delegate shall be present at all times during work activities which require an HWOP, and shall be in charge of all environmental/personal monitoring equipment. Industrial Hygiene and Safety shall review all activities involving or potentially involving radiological exposure or contamination control and shall prescribe the appropriate level of technical support and/or monitoring requirements. Other equipment deemed necessary by the site safety officer or Industrial Hygiene and Safety shall be obtained at their direction; work will be initiated or continued until such equipment is in place. These instruments are to be used only by persons who are trained in their usage and who understand their limitations. No work shall be done unless instrumentation is available and in proper working order.

Air sampling may be required downwind of the referenced waste sites to monitor particulates and vapors before job startup. Siting of such sampling devices will be determined by Health Physics, the site safety officer, and HEHF, if appropriate. Any time personnel exposure monitoring, other than radiological, is required to determine exposure levels, it must be done by HEHF. Discrete sampling of ambient air within the work zone and breathing zones will be conducted using a direct-reading instrument, as specified in the site-specific safety document, and other methods as deemed appropriate (e.g., pumps with tubes, O_2 meters). The following standards will be used in determining critical levels:

- "Radionuclide Concentrations in Air," in Chapter XI, DOE Order 5480.1B (DOE 1986)

- "Air Contaminants - Permissible Exposure Limits," in 29 CFR 1910.1000

- *Threshold Limit Values and Biological Exposure Indices for 1990-1991* (ACGIH 1991)

- *Occupational Safety and Health Standards*, 29 CFR 1910.1000

- *Pocket Guide to Chemical Hazards* (NIOSH 1991), which provides National Institute for Occupational Safety and Health (NIOSH)-recommended exposure limits for substances that do not have either a threshold limit value or a permissible exposure limit.

5.1 AIRBORNE RADIOACTIVE AND RADIATION MONITORING

An onsite health physics technician will monitor airborne radioactive contamination levels and external radiation levels. Action levels will be consistent with derived air concentrations and applicable guidelines as specified in the radiation protection manual WHC-CM-4-10 (WHC 1988).

Appropriate respiratory protection shall be required when conditions are such that the airborne contamination levels may exceed an 8-hour derived air concentration (e.g., the presence of high levels of uncontained, loose contamination on exposed surfaces or operations that may raise excessive levels of dust contaminated with airborne radioactive materials, such as excavation or drilling under extremely dry conditions).

Specific conditions requiring the use of respiratory protection because of radioactive materials in air will be incorporated into the RWP. If, in the judgment of the health physics technician, any of these conditions arise, work shall cease until appropriate respiratory protection is provided.

6.0 PERSONAL PROTECTIVE EQUIPMENT

The level of personal protective equipment required initially at a site will be specified in the site-specific safety document for each task or group of tasks. Personal protective

clothing and respiratory protection shall be selected to limit exposure to anticipated chemical and radiological hazards. Work practices and engineering controls may be used to control exposure.

7.0 SITE CONTROL

The field team leader, site safety officer, and health physics technician are designated to coordinate access control and security on the site. Special site control measures will be necessary to restrict public access. The zones will be clearly marked with rope and/or appropriate signs. The size and shape of the control zone will be dictated by the types of hazards expected, the climatic conditions, and specific operations required.

Control zone boundaries may be increased or decreased based on results of field monitoring, environmental changes, or work technique changes. The site RWP and the contractor's standard operating procedures for radiation protection may also dictate the boundary size and shape. All team members must be surveyed for radioactive contamination when leaving the controlled zone if in a radiation zone.

The onsite command post and staging area will be established near the upwind side of the control zone as determined by an onsite windsock. Exact location for the command post is to be determined just before start of work. Vehicle access, availability of utilities (power and telephone), wind direction, and proximity to sample locations should be considered in establishing a command post location.

8.0 DECONTAMINATION PROCEDURES

Remedial investigation activities will require entry into areas of known chemical and radiological contamination. Consequently, it is possible that personnel and equipment could be contaminated with hazardous chemical and radiological substances.

During site activities, potential sources of contamination may include airborne vapors, gases, dust, mists, and aerosols; splashes and spills; walking through contaminated areas; and handling contaminated equipment. Personnel who enter the exclusion zone will be required to go through the appropriate decontamination procedures on leaving the zone. Decontamination procedures shall be consistent with EII 5.4, "Field Decontamination of

Drilling, Well Development, and Sampling Equipment," and EII 5.5, "Decontamination of Equipment for RCRA/CERCLA Sampling" (WHC 1991), or other approved decontamination procedures.

9.0 CONTINGENCY AND EMERGENCY RESPONSE PLANS

As a general rule, in the event of an unanticipated, potentially hazardous situation indicated by instrument readings, visible contamination, unusual or excessive odors, or other indications, team members shall temporarily cease operations and move upwind to a predesignated safe area as specified in the site-specific safety documentation.

10.0 REFERENCES

ACGIH, 1991, *Threshold Limit Values and Biological Exposure Indices for 1990-1991*, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.

DOE, 1986, *Environment, Safety & Health Program for DOE Operations*, DOE Order 5480.1B, U.S. Department of Energy, Washington, D.C.

NIOSH, 1991, *Pocket Guide to Chemical Hazards, National Institute for Occupational Safety and Health*, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, Washington, D.C.

WHC, 1988, *Radiation Protection*, WHC-CM-4-10, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991, *Environmental Investigations and Site Characterization Manual*, WHC-CM-7-7, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992, *Health and Safety for Hazardous Waste Field Operations*, WHC-CM-4-3 Vol. 4, Westinghouse Hanford Company, Richland, Washington.

APPENDIX C

PROJECT MANAGEMENT PLAN

9 2 1 2 5 6 0 7 9 6

CONTENTS

Page

1.0 INTRODUCTION C-1

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES C-1
2.1 INTERFACE OF REGULATORY AUTHORITIES AND THE U.S. DEPARTMENT OF ENERGY C-1
2.2 PROJECT ORGANIZATION AND RESPONSIBILITIES C-1
2.2.1 Project Managers C-1
2.2.2 Unit Managers C-2
2.2.3 Quality Assurance Lead C-2
2.2.4 Health and Safety Officer (Environmental Division/Environmental Field Services) C-2
2.2.5 Technical Lead C-3
2.2.6 Remedial Investigation/Feasibility Study Coordinators C-3
2.2.7 Resource Conservation and Recovery Act Facility Investigation/ Corrective Measures Study Contractors C-3
2.2.8 Hanford Site Technical Resources C-3

3.0 DOCUMENTATION AND RECORDS C-4

4.0 FINANCIAL AND PROJECT TRACKING REQUIREMENTS C-4
4.1 MANAGEMENT CONTROL C-4
4.2 MEETINGS AND PROGRESS REPORTS C-5

5.0 REFERENCES C-6

CONTENTS (cont.)

Page

FIGURES:

C-1 Project Organization for the B Plant Aggregate Area Project CF-1
C-2 Example Project Organization for the B Plant Aggregate Area CF-2
C-3 The Hanford Site Soil Sampling Team CF-3
C-4 The Hanford Site Biological Sampling Team CF-4
C-5 The Hanford Site Physical and Geophysical Survey Team CF-5
C-6 Drilling, Sampling, and Well-Development Team CF-6

TABLE:

C-1 Hanford Site RI/FS Technical Resources CT-1

ACRONYMS AND ABBREVIATIONS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FS	feasibility study
MCS	Management Control System
PMP	Project Management Plan
PNL	Pacific Northwest Laboratory
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order

9 2 1 2 5 6 1 7 2 9

THIS PAGE INTENTIONALLY
LEFT BLANK

1.0 INTRODUCTION

This Project Management Plan (PMP) defines the administrative and institutional tasks necessary to support the B Plant Aggregate Area investigations at the Hanford Site. Also, this PMP defines the responsibilities of the various participants, the organizational structure, and the project tracking and reporting procedures. This PMP is in accordance with the provisions of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) dated August 1990 (Ecology et al. 1990). Any revisions to the Tri-Party Agreement that would result in changes to the project management requirements would supersede the provisions of this chapter.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 INTERFACE OF REGULATORY AUTHORITIES AND THE U.S. DEPARTMENT OF ENERGY

The B Plant Aggregate Area consists of active and inactive waste management units to be remedied under either the Resource Conservation and Recovery Act (RCRA) or the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). The U.S. Department of Ecology (Ecology) has been designated as the lead regulatory agency, as defined in the Tri-Party Agreement. Accordingly, Ecology is responsible for overseeing remedial action activity at this aggregate area and ensuring that the applicable authorities of both the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) are applied. The specific responsibilities of EPA, Ecology, and DOE are detailed in the Tri-Party Agreement.

2.2 PROJECT ORGANIZATION AND RESPONSIBILITIES

The project organization for implementing remedial activities at the B Plant Aggregate Area is shown in Figure C-1. The following sections describe the responsibilities of the individuals shown in Figure C-1.

2.2.1 Project Managers

The EPA, DOE, and Ecology have each designated one individual as project manager for remedial activities at the Hanford Site. These project managers will serve as the primary point of contact for all activities to be carried out under the Tri-Party Agreement. The responsibilities of the project managers are given in Section 4.1 of the Tri-Party Agreement.

2.2.2 Unit Managers

As shown in Figure C-1, EPA, DOE, and Ecology will each designate an individual as a unit manager for the B Plant Aggregate Area.

The unit manager from Ecology will serve as the lead unit manager. The Ecology unit manager will be responsible for regulatory oversight of all activities required for the B Plant Aggregate Area.

The unit manager from EPA will be responsible for making decisions related to issues for which the supporting regulatory agency maintains authority. All such decisions will be made in consideration of recommendations made by the Ecology unit manager.

The unit manager from DOE will be responsible for maintaining and controlling the schedule and budget and keeping the EPA and Ecology unit managers informed as to the status of the activities at the B Plant Aggregate Area, particularly the status of agreements and commitments.

2.2.3 Quality Assurance Lead

The quality assurance lead will be a designated person within the Westinghouse Hanford Quality Assurance Organization. This designated person will be responsible for monitoring overall environmental restoration activities for this project. The designated personnel shall have the necessary organizational independence and authority to identify conditions adverse to quality and to systematically seek corrective action.

This individual is responsible for the preplanned survellance and audit activities for this project. A quality assurance report shall be provided to the technical lead, annually as a minimum, for inclusion in the project final report generated by the technical organization. The quality assurance report shall summarize the surveillance and audit activities as well as associated corrective actions that may have been taken during the interval.

2.2.4 Health and Safety Officer (Environmental Division/Environmental Field Services)

The health and safety officer is responsible for monitoring all potential health and safety hazards, including those associated with radioactive, volatile, and/or toxic compounds during sample handling and sampling decontamination activities. The health and safety officer has the responsibility and authority to halt field activities resulting from unacceptable health and safety hazards.

2.2.5 Technical Lead

The technical lead will be a designated person within the Westinghouse Hanford Environmental Engineering Group. The responsibilities of the technical lead will be to plan, authorize, and control work so that it can be completed on schedule and within budget, and to ensure that all planning and work performance activities are technically sound.

2.2.6 Remedial Investigation/Feasibility Study Coordinators

The remedial investigation (RI) and feasibility study (FS) coordinators will be responsible for coordinating all activities related to the RI and FS, respectively, including data collection, analysis, and reporting. The RI and FS coordinators will be responsible for keeping the technical lead informed as to the RI and FS work status and any problems that may arise.

2.2.7 Resource Conservation and Recovery Act Facility Investigation/Corrective Measures Study Contractor

Figure C-1 shows the organizational relationship of an offsite contractor. Assuming a contractor is used to perform the RI/FS for the B Plant Aggregate Area, the contractor would assume responsibilities of the RI and FS coordinators, as described above. In this instance, the contractor will be directly responsible for planning data collection activities and for analyzing and reporting the results of the data-gathering in the RI and FS reports. However, the Westinghouse Hanford coordinator would retain the responsibility for securing and managing the field sampling efforts of the Hanford Site technical resource teams, described below. Figure C-2 shows a sample organizational structure for an RI/FS contractor team.

2.2.8 Hanford Site Technical Resources

The various technical resources available on the Hanford Site for performing the field studies are shown in Table C-1. These resources will be responsible for performing data collection activities and analyses, and for reporting the results of specific technical activities. Figures C-3 through C-6 show the detailed organizational structure of specific technical teams. Internal and external work orders and subcontractor task orders will be written by the Westinghouse Hanford technical lead to use these technical resources, which are under the control of the technical lead. Statements of work will be provided to the technical teams and will include a discussion of authority and responsibility, a schedule with clearly defined milestones, and a task description including specific requirements. Each technical team will keep the coordinator informed of the work status performed by that group and any problems that may arise.

3.0 DOCUMENTATION AND RECORDS

All plans and reports will be categorized as either primary or secondary documents as described by Section 9.1 of the Tri-Party Agreement. The process for document review and comment will be as described in Section 9.2 of the Tri-Party Agreement. Revisions, should they become necessary after finalization of any document, will be in accordance with Section 9.3 of the Tri-Party Agreement. Changes in the work schedule, as well as minor field changes, can be made without having to process a formal revision. The process for making these changes will be as stated in Section 12.0 of the Tri-Party Agreement. Administrative records, which must be maintained to support the Hanford Site activities, will be in accordance with Section 9.4 of the Tri-Party Agreement.

4.0 FINANCIAL AND PROJECT TRACKING REQUIREMENTS

4.1 MANAGEMENT CONTROL

Westinghouse Hanford will have the overall responsibility for planning and controlling the investigation activities, and providing effective technical, cost, and schedule baseline management. If a contractor is used, the contractor will assume the direct day-to-day responsibilities for these management functions. The management control system used for this project must meet the requirements of DOE Order 4700.1, Project Management System

and DOE Order 2250.1C, Cost and Schedule Control Systems Criteria. The Westinghouse Hanford Management Control System (MCS) meets these requirements. The primary goals of the Westinghouse Hanford MCS are to provide methods for planning, authorizing, and controlling work so that it can be completed on schedule and within budget, and to ensure that all planning and work performance activities are technically sound and in conformance with management and quality requirements.

The schedule developed for the B Plant Aggregate Area will be updated at least annually, to expand the new current fiscal year and the follow-on year. In addition, any approved schedule changes (see Section 12.0 of the Tri-Party Agreement for the formal change control system) would be incorporated at this time, if not previously incorporated. This update will be performed in the fourth quarter of the previous fiscal year (e.g., July to September) for the upcoming current fiscal year. The work schedule can be revised at any time during the year if the need arises, but the changes would be restricted to major changes that would not be suitable for the change control process.

4.2 MEETINGS AND PROGRESS REPORTS

Both project and unit managers must meet periodically to discuss progress, review plans, and address any issues that have arisen. The project managers' meeting will take place at least quarterly, and is discussed in Section 8.1 of the Tri-Party Agreement.

Unit managers shall meet monthly to discuss progress, address issues, and review near-term plans pertaining to their respective operable units and/or treatment, storage, and disposal groups/units. The meetings shall be technical in nature, with emphasis on technical issues and work progress. The assigned DOE unit manager for the B Plant Aggregate Area will be responsible for preparing revisions to the aggregate area schedule prior to the meeting. The schedule shall address all ongoing activities associated with the B Plant Aggregate Area, including actions on specific source units (e.g., sampling). This schedule will be provided to all parties and reviewed at the meeting. Any agreements and commitments (within the unit manager's level of authority) resulting from the meeting will be prepared and signed by all parties as soon as possible after the meeting. Meeting minutes will be issued by the DOE unit manager and will summarize the discussion at the meeting, with information copies given to the project managers. The minutes will be issued within five working days following the meeting. The minutes will include, at a minimum, the following information:

- Status of previous agreements and commitments
- Any new agreements and commitments

- Schedules (with current status noted)

- Any approved changes signed off at the meeting in accordance with Section 12.1 of the Tri-Party Agreement.

Project coordinators for each operable unit also will meet on a monthly basis to share information and to discuss progress and problems.

The DOE shall issue a quarterly progress report for the Hanford Site within 45 days following the end of each quarter. Quarters end on March 31, June 30, September 30, and December 31. The quarterly progress reports will be placed in the public information repositories as discussed in Section 10.2 of the Tri-Party Agreement. The report shall include the following:

- Highlights of significant progress and problems.

- Technical progress with supporting information, as appropriate.

- Problem areas with recommended solutions. This will include any anticipated delays in meeting schedules, the reason(s) for the potential delay, and actions to prevent or minimize the delay.

- Significant activities planned for the next quarter.

- Work schedules (with current status noted).

5.0 REFERENCES

Ecology, EPA, and DOE, 1990, *Hanford Federal Facility Agreement and Consent Order*, (First Amendment), 89-10, Rev.1, Olympia, Washington.

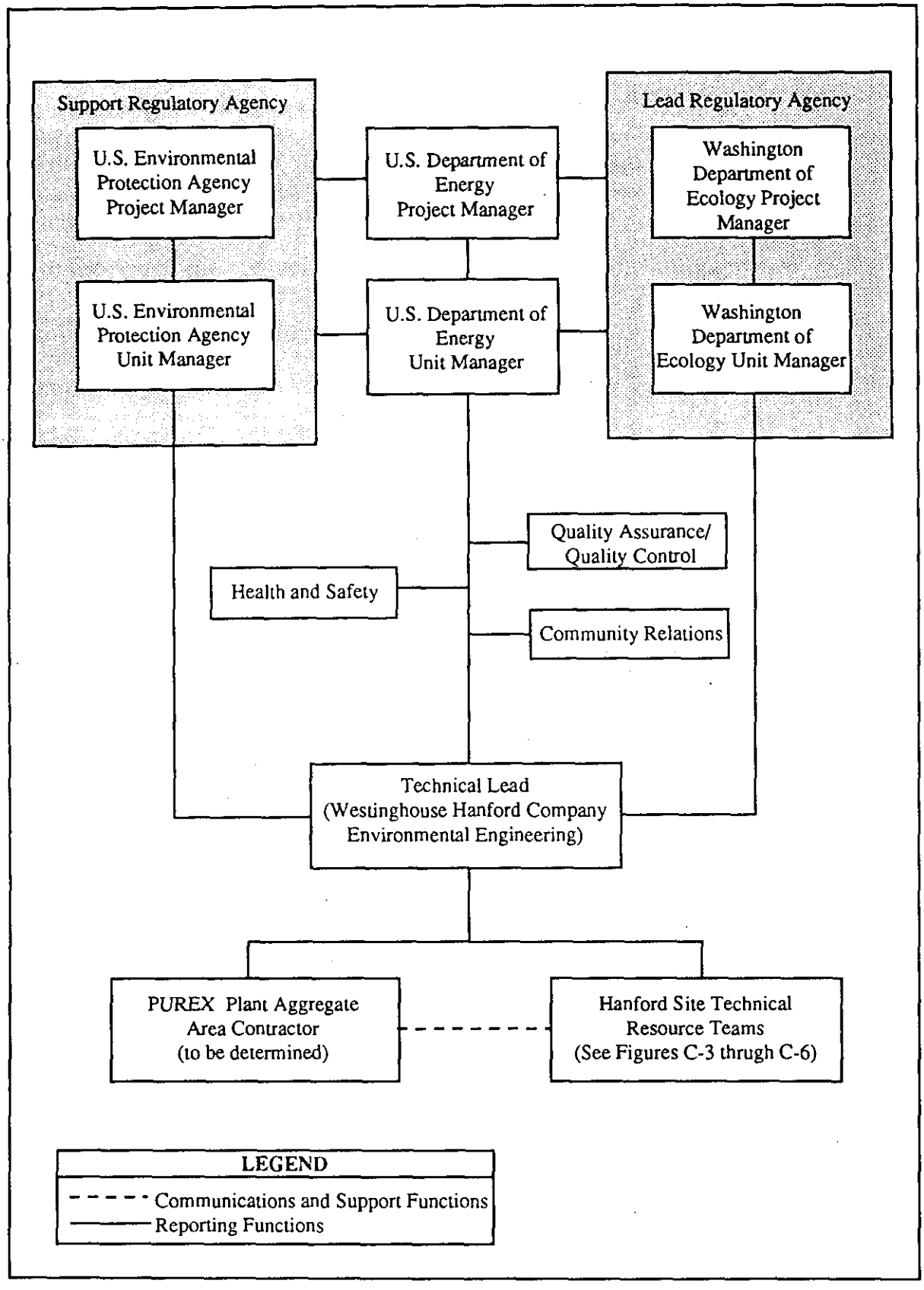


Figure C-1. Project Organization for the PUREX Plant Aggregate Area Project.

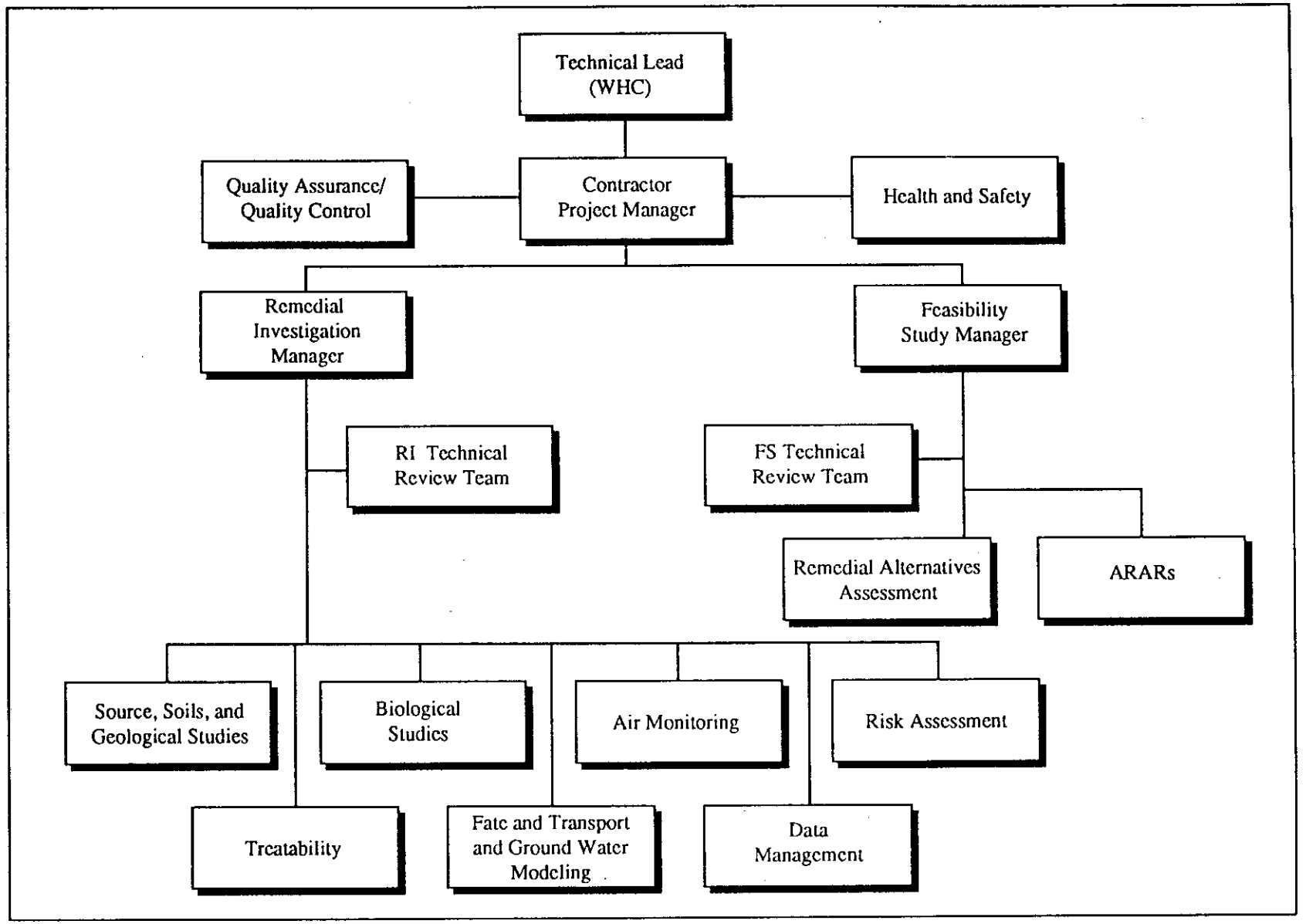


Figure C-2. Example Project Organization for the PUREX Plant Aggregate Area

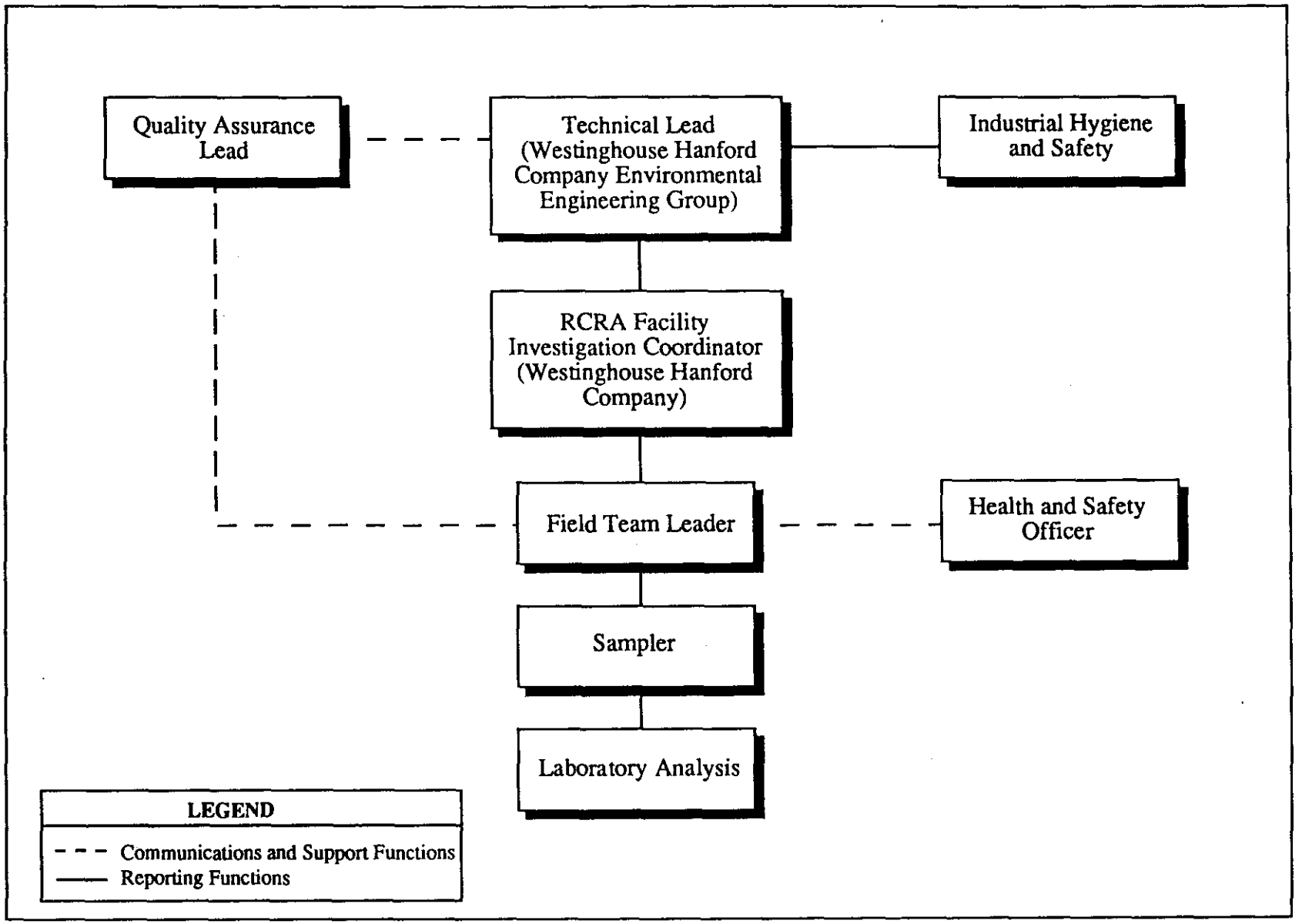


Figure C-3. The Hanford Site Soil Sampling Team.

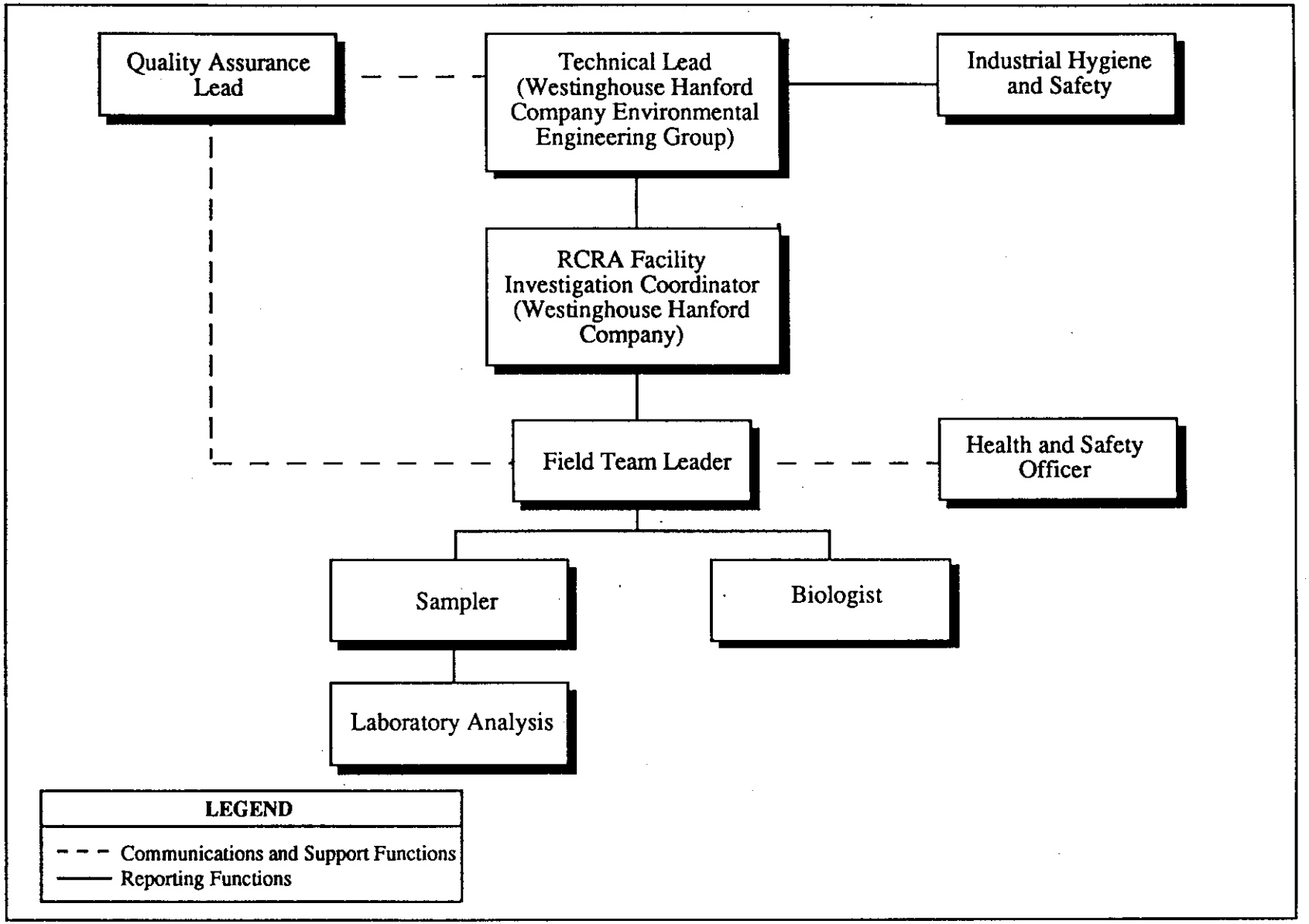


Figure C-4. The Hanford Site Biological Sampling Team.

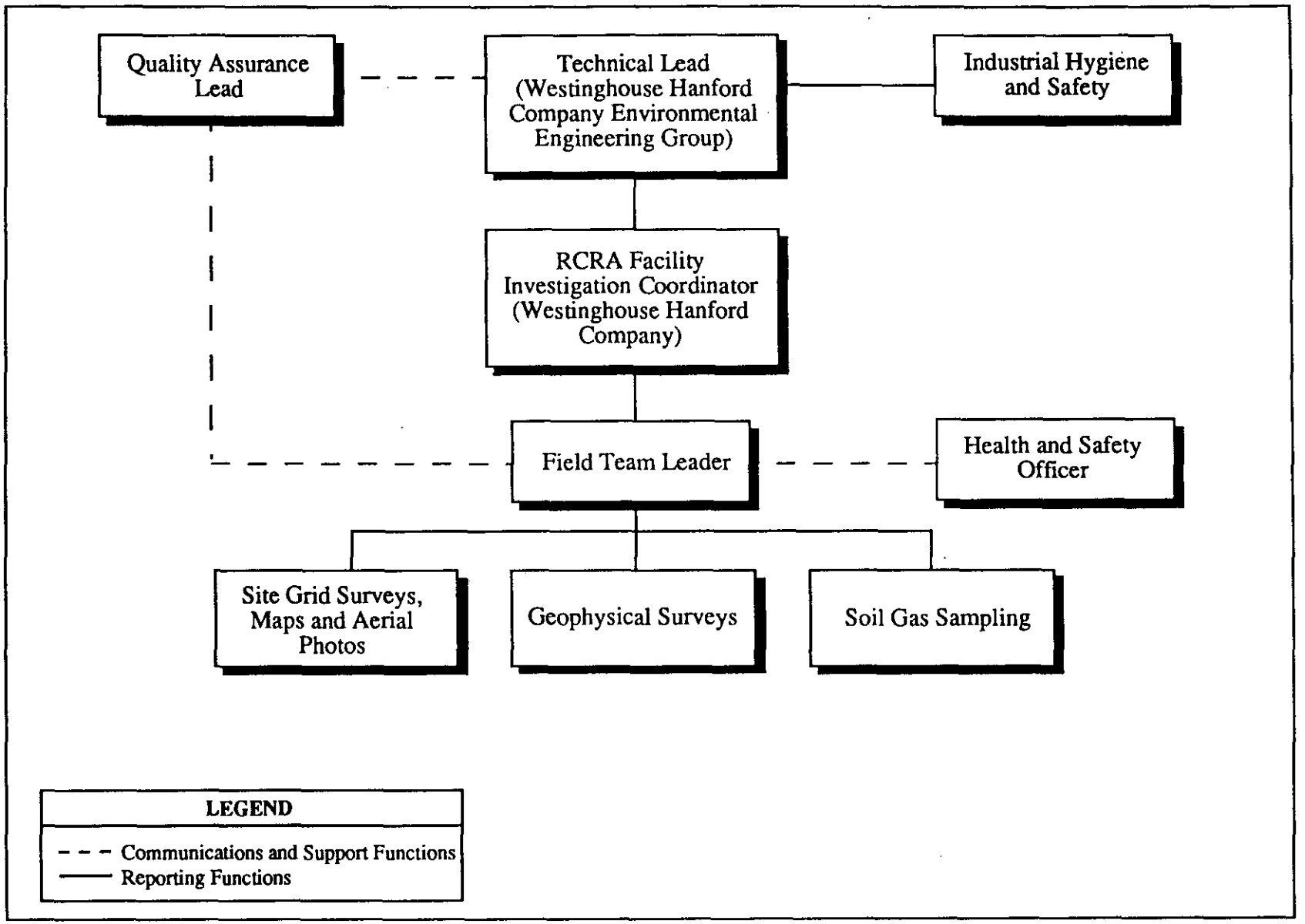


Figure C-5. The Hanford Site Physical and Geophysical Survey Team.

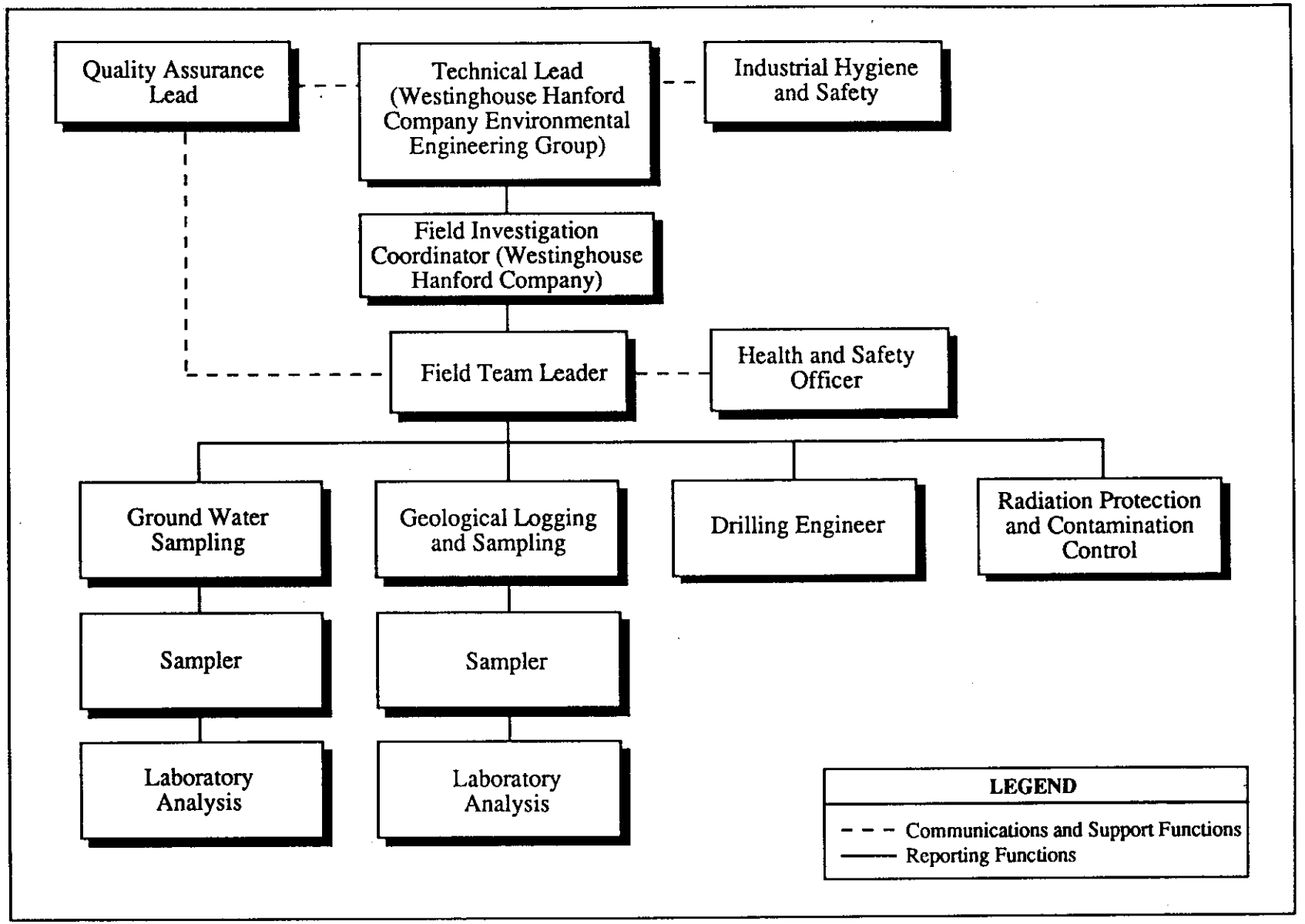


Figure C-6. Drilling, Sampling, and Well-Development Team.

Table C-1. Hanford Site RI/FS Technical Resources. Page 1 of 2

Subject/Activity	Technical Resources	
	RI	FS
Hydrology and geology	Westinghouse Hanford/Geosciences PNL/Earth and Environmental Sciences Center	Westinghouse Hanford/Geosciences
Toxicology and risk/endangerment assessment	Westinghouse Hanford/Environmental Technology PNL/Earth and Environmental Sciences Center PNL/Life Sciences Center	Westinghouse Hanford/ Environmental Technology
Environmental chemistry	Westinghouse Hanford/Geosciences PNL/Earth and Environmental Sciences Center	Westinghouse Hanford/Geosciences
Geotechnical and civil engineering	Westinghouse Hanford/Geosciences (Planning) Environmental Field Services	NA
Geotechnical and civil engineering	NA	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Groundwater treatment engineering	NA	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Waste stabilization and treatment	NA	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Surveying	Kaiser Engineers Hanford	NA

9 2 1 2 5 6 0 3 1 2

Table C-1. Hanford Site RI/FS Technical Resources.

Subject/Activity	Technical Resources	
	RI	FS
Soil and water sampling and analysis	Westinghouse Hanford/Environmental Engineering Westinghouse Office of Sampling Management PNL/Earth and Environmental Sciences Center PNL/Materials and Chemical Sciences Center	NA
Drilling and well installation	Westinghouse Hanford/Geosciences Environmental Field Services Kaiser Engineers	NA
Radiation monitoring	Westinghouse Hanford/Operational Health Physics	NA

NA = Not applicable.

9 2 1 2 6 0 8 1 3

APPENDIX D

INFORMATION MANAGEMENT OVERVIEW

9 2 1 2 5 5 0 8 1 4

THIS PAGE INTENTIONALLY
LEFT BLANK

CONTENTS

Page

1.0 INTRODUCTION AND OBJECTIVES D-1
1.1 INTRODUCTION D-1
1.2 OBJECTIVES D-1

2.0 TYPES OF DATA D-2
2.1 TYPES OF DATA D-2
2.2 DATA COLLECTION D-2
2.3 DATA STORAGE AND ACCESS D-3
2.4 DATA QUANTITY D-4

3.0 DATA MANAGEMENT D-4
3.1 OBJECTIVE D-4
3.2 ORGANIZATIONS CONTROLLING DATA D-4
3.2.1 Environmental Engineering Group D-4
3.2.2 Office of Sample Management D-4
3.2.3 Environmental Data Management Center D-5
3.2.4 Information Resource Management D-5
3.2.5 Hanford Environmental Health Foundation D-5
3.2.6 Environmental Health and Pesticide Services Section D-5
3.2.7 Technical Training Records and Scheduling Section D-6
3.2.8 Pacific Northwest Laboratory D-6
3.3 DATABASES D-6
3.3.1 Meteorological Data D-6
3.3.2 Nonradiological Exposure and Medical Records D-6
3.3.3 Radiological Exposure Records D-7
3.3.4 Training Records D-7
3.3.5 Environmental Information/Administrative Record D-7
3.3.6 Sample Status Tracking D-7

4.0 ENVIRONMENTAL INFORMATION AND RECORDS MANAGEMENT PLAN D-8
4.1 ENVIRONMENTAL INFORMATION MANAGEMENT PLAN D-8
4.2 ENVIRONMENTAL RESTORATION REMEDIAL ACTION PROGRAM RECORDS MANAGEMENT PLAN D-9

5.0 HANFORD ENVIRONMENTAL INFORMATION SYSTEM D-10
5.1 OBJECTIVE D-10
5.2 STATUS OF THE HANFORD ENVIRONMENTAL INFORMATION SYSTEM D-11

6.0 REFERENCES D-11

CONTENTS (cont.)

Page

FIGURE:

D-1 Environmental Engineering, Technology, and Permitting Data Management Model DF-1

TABLE:

D-1 Types of Related Administrative Data DT-1

9 2 1 2 5 1 6 0 3 1 6

ACRONYMS AND ABBREVIATIONS

AR	administrative record
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CMS	Corrective Measures Study
DOE	U.S. Department of Energy
DOE/RL	U.S. Department of Energy, Richland Operations Office
Ecology	Washington Department of Ecology
EDMC	Environmental Data Management Center
EHPSS	Environmental Health and Pesticide Services Section
EII	Environmental Investigations Instructions
EIMP	Environmental Information Management Plan
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
ERRA	Environmental Restoration Remedial Action
FOMP	Field Office Management Plan
FS	feasibility study
GIS	geographic information system
HEHF	Hanford Environmental Health Foundation
HEIS	Hanford Environmental Information System
HLAN	Hanford Local Area Network
HMS	Hanford Meteorological Station
IMO	Information Management Overview
KEH	Kaiser Engineers Hanford
OSM	Office of Sample Management
PNL	Pacific Northwest Laboratory
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RFI	RCRA Facility Investigation
RI	remedial investigation
ROD	record of decision
TR	training records
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
TSD	treatment, storage, and disposal
Westinghouse Hanford	Westinghouse Hanford Company

9 2 1 2 5 . 5 0 8 1 7

DEFINITIONS OF TERMS

Action Plan. Action plan for implementation of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1990). A negotiation between the U.S. Environmental Protection (EPA), the U.S. Department of Energy (DOE), and the State of Washington Department of Ecology (Ecology). The Action Plan defines the methods and processes by which hazardous waste permits will be obtained, and by which closure and post-closure actions under the Resource Conservation and Recovery Act of 1976 (RCRA) and by which remedial actions under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) will be conducted on the Hanford Site.

Administrative Record (AR). In CERCLA, the official file that contains all information that was considered or relied on by the regulatory agency in arriving at a final remedial action decision, as well as all documentation of public participation throughout the process. In RCRA, the official file that contains all documents to support a final RCRA permit determination.

Administrative Record File. The assemblage of documents compiled and maintained by an agency pertaining to a proposed project of administrative action and designated as AR or that are candidates for inclusion in the AR once a record of decision (ROD) is attained.

Data Management. The planning and control of activities affecting data.

Data Quality. The totality of features and characteristics of data that bears on its ability to satisfy a given purpose. The characteristics of major importance are accuracy, precision, completeness, representativeness, and comparability.

Data Validation. The process whereby data are accepted or rejected based on a set of criteria. This aspect of quality assurance involves establishing specified criteria for data validation. The quality assurance project plan (QAPP) must indicate the specified criteria that will be used for data validation.

ENCORE. The name given to the combination of hardware, software, and administrative subsystems that serve to integrate the management of the Hanford Site environmental data.

Environmental Data Management Center (EDMC). The central facility and services that provide a files management system for processing environmental information.

Environmental Information. Data related to the protection or improvement of the Hanford Site environment, including data required to satisfy environmental statutes, applicable DOE orders, or the Tri-Party Agreement.

Field File Custodian. An individual who is responsible for receipt, validation, storage, maintenance, control, and disposition of information or other records generated in support of Environmental Division activities.

Hanford Environmental Information System (HEIS). A computer-based information system under development as a resource for the storage, analysis, and display of investigative data collected for use in site characterization and remediation activities. Subject areas currently being developed include geophysics/soil gas, vadose zone soil (geologic), atmospherics, and biota.

Information System. Collection of components relate to the management of data and reporting of information. Information systems typically include computer hardware, computer software, operating systems, utilities, procedures, and data.

Lead Agency. The regulatory agency (EPA or Ecology) that is assigned the primary administrative and technical responsibility with respect to actions at a particular operable unit.

Nonrecord Material. Copies of material that are maintained for information, reference, and operating convenience and for which another office has primary responsibility.

Operable Unit. An operable unit at the Hanford Site is a group of land disposal and groundwater sites placed together for the purposes of doing a remedial investigation/ feasibility study. The primary criteria for placement of a site into an operable unit are geographic proximity, similarity of waste characteristics and site types, and the possibility for economies of scale.

Primary Document. A document that contains information on which key decisions are made with respect to the remedial action or permitting process. Primary documents are subject to dispute resolution and are part of the administrative record file.

Project Manager. The individual responsible for implementing the terms and conditions of the Action Plan on behalf of his respective party. The EPA, DOE, and Ecology will each designate one project manager.

Quality Affecting Record. Information contained on any media, including but not limited to, hard copy, sample material, photo copy, and electronic systems, that is complete in

terms of appropriate content and that furnishes evidence of the quality of items and/or activities affecting quality.

Quality Assurance. The systematic actions necessary to provide adequate confidence that a material, component, system, process, or facility performs satisfactorily or as planned in service.

Quality Assured Data. Data developed under an integrated program for assurance of the reliability of data.

Raw Data. Unprocessed or unanalyzed information.

Record Validation. A review to determine that records are complete, legible, and meet records requirements. Documents are considered valid records only after the validation process has been completed.

Retention Period. The length of time records must be held before they can be disposed of. The time is usually expressed in years from the date of the record, but may also be expressed as contingent on the occurrence of an event.

Secondary Document. A document providing information that does not, in itself, reflect or support key decisions. A secondary document is subject to review by the regulatory agencies and may be part of the administrative record field. It is not subject to dispute resolution.

Validated Data. Data that meet criteria contained in an approved company procedure.

Verified Data. Data that have been checked for accuracy and consistency following a transfer action (e.g., from manual log to computer, or from distributed database to centralized data repository).

1.0 INTRODUCTION AND OBJECTIVES

1.1 INTRODUCTION

An extensive amount of data will be generated over the next several years in connection with the activities planned for the B Plant Aggregate Area. The quality of these data are extremely important to the full remediation of the aggregate area as agreed on by the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA) the Washington Department of Ecology (Ecology), and interested parties.

The Information Management Overview (IMO) provides an overview of the data management activities at the operable unit level. It identifies the type and quantity of data to be collected and references the procedures which control the collection and handling of data. It provides guidance for the data collector, aggregate area investigator, project manager, and reviewer to fulfill their respective roles.

This IMO addresses handling of data generated from activities associated with the aggregate area activities. All data collected will be in accordance with the Environmental Investigations Instructions (EII) contained in the Westinghouse Hanford Company's (Westinghouse Hanford) *Environmental Investigations and Site Characterization Manual* (WHC 1991a).

Development of a comprehensive plan for the management of all environmental data generated at the Hanford Site is under way. The *Environmental Information Management Plan* (EIMP) (Steward et al. 1989), released in March 1989, described activities in the Environmental Data Management Center (EDMC) and long-range goals for management of scientific and technical data. The scientific and technical data part of the EIMP was reviewed, revised, and expanded in fiscal year 1990 (Michael et al. 1990). An *Environmental Restoration Remedial Action Program Records Management Plan* (WHC 1991b) issued in July 1991, enables the program office to identify, control, and maintain the quality assurance (QA), decisional, or regulatory prescribed records generated and used in support of the Environmental Restoration Remedial Action (ERRA) Program.

1.2 OBJECTIVES

This IMO describes the process for the collection and control procedures for validated data, records, documents, correspondence, and other information associated with this aggregate area. This IMO addresses the following:

- Types of data to be collected

- Plans for managing data
- Organizations controlling data
- Databases used to store the data
- EIMP
- Hanford Environmental Information System (HEIS).

2.0 TYPES OF DATA

2.1 TYPES OF DATA

The general types of technical data to be collected and the associated controlling procedures are as follows:

Type of data	Procedure
Historical reports	EII 1.6
Aerial photos	EII 1.6
Chart recordings	EII 1.6
Technical memos	EII 1.6
Validated samples analyses	EII 1.6
Reports	EII 1.6
Logbooks	EII 1.5
Chain-of-custody forms	EII 5.1
Sample quality assurance/ quality control (QA/QC)	Office of Sample Management (OSM)

All such data are submitted to the EDMC for entry into the administrative record (AR).

General types of related administrative data is shown in Table D-1, which is organized in terms of general types of personnel and compliance/regulatory data. Table D-1 references the appropriate procedures and the record custodians. Data associated with aggregate area investigations will be submitted to the EDMC for entry into the AR, as appropriate.

2.2 DATA COLLECTION

Data will be collected according to the aggregate area sampling and analysis plans and the Quality Assurance Project Plan (QAPP). Section 2.1 listed the controlling procedures for data collection and handling before turnover to the organization responsible for data storage.

All procedures for data collection shall be approved in compliance with the Westinghouse Hanford *Environmental Investigations and Site Characterization Manual* (WHC 1991a).

2.3 DATA STORAGE AND ACCESS

Data will be handled and stored according to procedures approved in compliance with applicable Westinghouse Hanford procedures (WHC 1988). The EDMC is the central files manager and process facility. All data entering the EDMC will be indexed, recorded, and placed into safe and secure storage. Data designated for placement into the AR will be copied, placed into the Hanford Site AR file, and distributed by the EDMC to the user community. The hard copy files are the primary sources of information; the various electronic data bases are secondary sources.

Normal access to data is through EDMC which is responsible for the AR. The Administrative Record Public Access Room is located in the 345 Hills Street Facility in Richland, Washington. This facility includes AR file documents (including identified guidance documents and technical literature).

Project participants may access data that are not in the AR by requesting it at the monthly unit managers' meeting for the operable unit of concern. As the project moves to completion, it is expected that all of the relevant data will be contained in the AR and the need to access data will be minimal.

The following types of data will be accessed from and reside in locations other than the EDMC:

Data Type	Data location
• QA/QC laboratory data	OSM (Westinghouse Hanford)
• Sample status	OSM (Westinghouse Hanford)
• Archived samples	Laboratory performing analyses
• Training records	Technical Training Support Section (Westinghouse Hanford)
• Meteorological data	Hanford Meteorological Station (HMS) (Pacific Northwest Laboratory [PNL])

• Health and safety records	Hanford Environmental Health Foundation (HEHF)
• Personal protective fitting	Environmental Health and Pesticide Services Section (Westinghouse Hanford)
• Radiological exposure	Pacific Northwest Laboratory.

2.4 DATA QUANTITY

Data quantities for the investigative activities will be estimated based on the sampling and analysis plans developed for investigation of sites within the aggregate area.

3.0 DATA MANAGEMENT

3.1 OBJECTIVE

A considerable amount of data will be generated through the implementation of the aggregate area sampling and analysis plans. The QAPP will provide the specific procedural direction and control for obtaining and analyzing samples in conformance with requirements to ensure quality data results. The sampling and analysis plans will provide the basis for selecting the location, depth, frequency of collection, etc., of media to be sampled and methods to be employed to obtain samples of selected media for cataloging, shipment, and analysis. Figure D-1 displays the general data management model for data generated through work plan activities.

3.2 ORGANIZATIONS CONTROLLING DATA

This section addresses the organizations that will receive data generated from aggregate area activities.

3.2.1 Environmental Engineering Group

The Westinghouse Hanford Environmental Engineering Group provides the operable unit technical coordinator. The technical coordinator is responsible for maintaining and transmitting data to the designated storage facility.

3.2.2 Office of Sample Management

The Westinghouse Hanford OSM will validate all analytical data packages received from the laboratory. Validated summary data (sample results and copies of chain-of-custody forms) will be forwarded to the technical coordinator. Nonvalidated data will be forwarded to the technical coordinator on request. Preliminary data will be clearly labeled as such. The OSM will maintain raw sample data, QA/QC laboratory data, and the archived sample index.

3.2.3 Environmental Data Management Center

The EDMC is the Westinghouse Hanford Environmental Division's central facility and service that provides a file management system for processing environmental information. The EDMC manages and controls the AR and Administrative Record Public Access Room at the Hanford Site. Part 1 of the EIMP (Michael et al. 1990) describes the central file system and services provided by the EDMC. The following procedures address data transmittal to the EDMC:

- EII 1.6, Records Management (WHC 1991a)
- EII 1.11, Technical Data Management (WHC 1991a)
- TPA-MP-02, Information Transmittals and Receipt Controls (DOE/RL 1990)
- TPA-MP-07, Administrative Record Collection and Management (DOE/RL 1990)

3.2.4 Information Resource Management

Information Resource Management is the designated records custodian (permanent storage) for Westinghouse Hanford. The procedural link from the EDMC to the Information Resource Management is currently under development.

3.2.5 Hanford Environmental Health Foundation

The HEHF performs the analyses on the nonradiological health and exposure data (Section 3.3.2) and forwards summary reports to the Fire and Protection Group and the Environmental Health and Pesticide Services Section within the Westinghouse Hanford Environmental Division. Nonradiological and health exposure data are maintained also for other Hanford Site contractors (PNL and Kaiser Engineers Hanford [KEH]) associated with aggregate area activities. The HEHF provides summary data to the appropriate site contractor. EII 2.1, Preparation of Hazardous Waste Operations Permits, and EII 2.2,

Occupational Health Monitoring (WHC 1991a) address the preparation of health and safety plans and occupational health monitoring, respectively.

3.2.6 Environmental Health and Pesticide Services Section

The Westinghouse Hanford Environmental Health and Pesticide Services Section maintains personal protective equipment fitting records and maintains nonradiological health field exposure and exposure summary reports provided by HEHF for Westinghouse Hanford Environmental Division and subcontractor personnel.

3.2.7 Technical Training Records and Scheduling Section

The Westinghouse Hanford Technical Training Records and Scheduling Section provides training and maintains training records (Section 3.3.4).

3.2.8 Pacific Northwest Laboratory

The PNL operates the HMS and collects and maintains meteorological data (Section 3.3.1). Data management is discussed in Andrews (1988).

The PNL collects and maintains radiation exposure data (Section 3.3.3).

3.3 DATABASES

This section addresses databases that will receive data generated from the aggregate area activities. These and other databases are described in the EIMP (Michael et al. 1990). All of these databases exist independently of this aggregate area and serve other site functions. Data pertinent to the operable unit, housed in these databases, will be submitted to the AR.

3.3.1 Meteorological Data

The HMS collects and maintains meteorological data. Their database contains meteorological data from 1943 to the present, and Andrews (1988) is the document containing meteorological data management information.

3.3.2 Nonradiological Exposure and Medical Records

The HEHF collects and maintains data for all nonradiological exposure records and medical records.

3.3.3 Radiological Exposure Records

The PNL collects and maintains data on occupational radiation exposure. This database contains respiratory personal protective equipment fitting records, work restrictions, and radiation exposure information.

3.3.4 Training Records

Training records for Westinghouse Hanford and subcontractor personnel are managed by the Westinghouse Hanford Technical Training Support Section. Other Hanford Site contractors (PNL and KEH) maintain their own personnel training records. Training records for non-Westinghouse personnel are entered into the Westinghouse (soft reporting) database to document compliance.

Training records include:

- Initial 40-h hazardous waste worker training
- Annual 8-h hazardous waste worker training update
- Hazardous waste generator training
- Hazardous waste site specific training
- Radiation safety training
- Cardiopulmonary resuscitation
- Scott air pack
- Fire extinguisher
- Noise control
- Mask fit.

3.3.5 Environmental Information/Administrative Record

Environmental information and the AR are managed by Westinghouse Hanford EDMC personnel. They provide an index and key information on all data transmitted to the EDMC. This database is used to assist in data retrieval and to produce index lists as required.

3.3.6 Sample Status Tracking

The OSM maintains the sample status tracking database. This database contains information about each sample. Information maintained includes sample number, ship date, receipt date, and laboratory identification.

4.0 ENVIRONMENTAL INFORMATION AND RECORDS MANAGEMENT PLAN

This section briefly discusses the EIMP (Michael et al. 1990) that was developed to provide an overview of an integrated approach to managing Hanford Site environmental data, and the *Environmental Restoration Remedial Action Program Records Management Plan* (WHC 1991b).

4.1 ENVIRONMENTAL INFORMATION MANAGEMENT PLAN

The EIMP provides an overview of how information is managed throughout the lifetime of Hanford Site environmental programs.

The Environmental Division of Westinghouse Hanford is responsible for the protection and improvement of the Hanford Site environment. To fulfill responsibility, the Environmental Division has assumed a management role with respect to Hanford Site environmental information. This management role includes (1) establishing standards for how data are validated and controlled, (2) developing and maintaining a supporting computer-based environment, and (3) sustaining a centralized file management system.

Hanford Site environmental information is defined as data related to the protection or improvement of the Hanford Site environment, including data required to satisfy environmental statutes, applicable DOE orders, or the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1990), (Tri-Party Agreement).

Environmental information falls into several overlapping categories, such as administrative versus technical and electronic versus manual or hard copy. A considerable amount of data are recorded in documents, which are governed by company-wide document and records control practices. Other data are collected or generated by computer and, therefore, exist in electronic form. The name ENCORE has been given to the combination of administrative, hardware, and software systems that serve to integrate the management of this electronic data.

Administrative information (e.g., budgets and schedules) is subject to accounting and other standard business practices. Scientific and technical data are subject to a different set of legal, classification, release, and engineering requirements.

Superimposed over these categories is the files management system for environmental information. This management system, has been developed to meet a number of Environmental Division needs, including requirements for compilation of AR files. The AR files are compilations of all material related to environmental restoration and remedial action records of decision (ROD) for each operable unit and treatment, storage, and disposal (TSD) group described in the Tri-Party Agreement.

Data in electronic form flows from information systems in the ENCORE realm to both scientific/technical and administrative documents. Environmental documents distributed within the Hanford Site and from regulatory agencies are received by the EDMC for storage and future processing.

Part I of the EIMP describes the overall Westinghouse Hanford systems that are generally applied to documents and records. Part I also describes, in greater detail, the files management system developed to manage the AR file information. The EDMC compiles the AR files and provides controlled distribution of specified information to the AR files held by DOE, Ecology, and the EPA. The EDMC also provides controlled distribution of specified community relations information to regional information repositories.

Part II addresses computer-based information, with an emphasis on scientific and technical data. The long-term nature of environmental programs and the complex interrelationships of environmental data require that the data be preserved, retrievable, traceable, and sufficient for future use. To ensure data availability for response to regulatory and agency requirements, the plan is directed toward optimizing the use of automated techniques for managing data. The current processing environment and the proposed ENCORE realm are described, and the plans for implementation of ENCORE are addressed.

4.2 ENVIRONMENTAL RESTORATION REMEDIAL ACTION PROGRAM RECORDS MANAGEMENT PLAN

The ERRA Program records management plan was developed to fulfill the requirements of the U.S. Department of Energy, Richland Operations Office (DOE/RL) *Environmental Restoration Field Office Management Plan* (FOMP) (DOE/RL 1989). The FOMP describes the plans, organization, and control systems to be used for management of the Hanford Site ERRA Program. The Westinghouse Hanford ERRA Program Office has developed this ERRA Program records management plan to fulfill the requirements of the FOMP. This records management plan will enable the program office to identify, control,

and maintain the quality assurance, decisional, or regulatory prescribed records generated and used in support of the ERRA Program.

The ERRA Program records management plan describes how the applicable records management requirements will be implemented for the ERRA Program. The plan also develops the criteria for identifying the appropriate requirements for each individual piece of information related to ERRA work activities.

This records management plan applies to all ERRA Program records and documents generated, used, or maintained in support of ERRA-funded work activities on the Hanford Site. The terms, information, documents, nonrecord material, records, record material, and QA records used throughout the ERRA records management plan are interpreted as ERRA information, ERRA documents, ERRA nonrecord material, ERRA records, ERRA record material, and ERRA QA records.

5.0 HANFORD ENVIRONMENTAL INFORMATION SYSTEM

5.1 OBJECTIVE

The Hanford Environmental Information System (HEIS) has been developed by PNL for Westinghouse Hanford as a primary resource for computerized storage, retrieval, and analysis of quality-assured technical data associated with Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) remedial investigation/ feasibility study (RI/FS) activities and RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) activities being undertaken at the Hanford Site. The HEIS will provide a means of interactive access to data sets extracted from other databases relevant to implementation of the Tri-Party Agreement (Ecology et al. 1990). The HEIS will support graphics analysis, including a geographic information system. Implementation of HEIS will serve to ensure that data consistency, quality, traceability, and security are achieved through incorporation of all environmental data within a single controlled database.

The following is a list of data subjects proposed to be entered into HEIS:

- Geologic
- Geophysics
- Atmospheric
- Biotic
- Site characterization
- Soil gas

- Waste site information
- Surface monitoring
- Groundwater.

5.2 STATUS OF THE HANFORD ENVIRONMENTAL INFORMATION SYSTEM

The HEIS, a computerized database containing technical data and information used to support the Hanford environmental restoration (ER) activities, is operational. The data for the Hanford groundwater wells and groundwater samples is currently accessible via the Hanford Local Area Network (HLAN) to local users and to offsite users via a modem link to the HEIS database computer. Additional data, including geologic, biota, and other pertinent environmental sample results, are being entered into the HEIS database.

The *Hanford Environmental Information System (HEIS) User's Manual* (WHC 1990) was issued in October 1990. An operator manual is being prepared and is expected to be issued in 1992.

The HEIS geographic information system (GIS) will display detailed maps for the Hanford restoration sites including data from the HEIS database. Such spatially related data will be used to support analysis of waste site technical issues and restoration options. The combination of the HEIS for data and the GIS spatial displays offers some powerful tools for many users to analyze and collectively evaluate the environmental data from the ER and site-wide monitoring programs.

6.0 REFERENCES

Andrews, G. L., 1988, *The Hanford Meteorological Data Collection System and Data Base,* PNL-6509, Pacific Northwest Laboratory, Richland, Washington.

DOE/RL, 1989, *Environmental Restoration Field Office Management Plan,* DOE/RL-89-29, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL, 1990, *Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Handbook,* RL-TPA-90-0001, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, and DOE/RL, 1990, *Hanford Federal Facility Agreement and Consent Order,* First amendment, Two Volumes, 89-10 Revision 1, Washington Department of Ecology, Olympia, Washington, U.S. Environmental Protection Agency, Region X, Seattle, Washington, and U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Michael, L. E., G. C. Main, and E. J. See, 1990, *Environmental Information Management Plan,* WHC-EP-0219, Revision 1, Westinghouse Hanford Company, Richland, Washington.

Steward, J. C., G. C. Main, and E. J. See, 1989, *Environmental Information Management Plan,* WHC-EP-0219, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988, *Quality Assurance Manual*, WHC-CM-4-2, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991a, *Environmental Investigations and Site Characterization Manual,* WHC-CM-7-7, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991b, *Environmental Restoration Remedial Action Program Records Arrangement Plan,* WHC-EP-0430, Westinghouse Hanford Company, Richland, Washington.

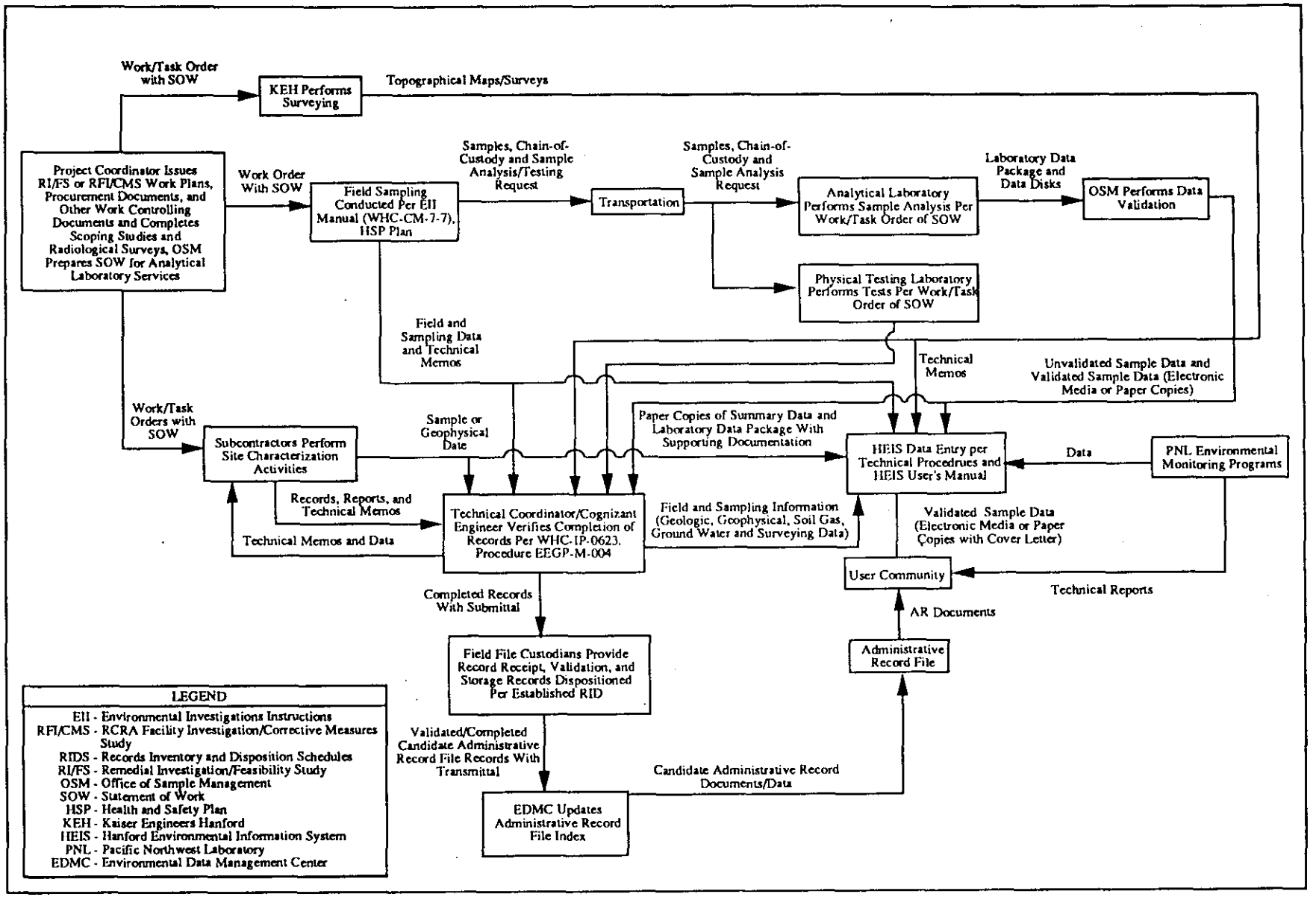
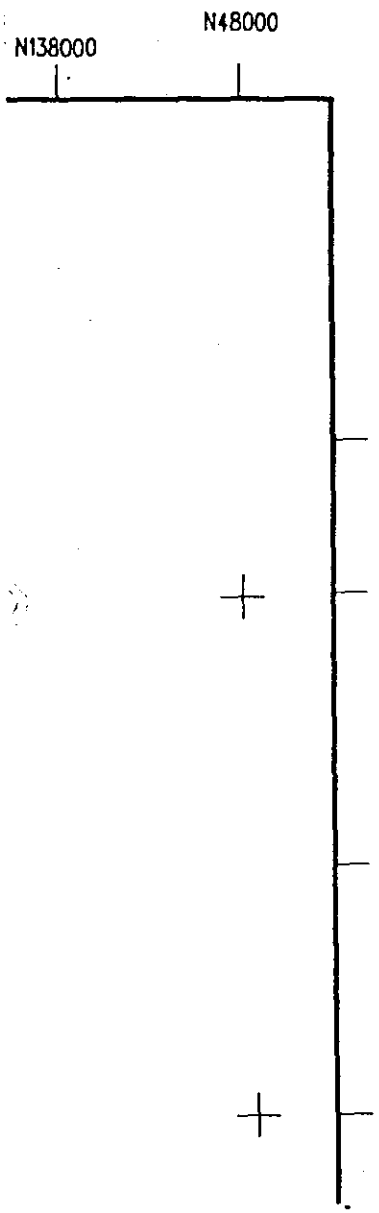


Figure D-1. Environmental Engineering, Technology and Permitting Data Management Model.

Table D-1. Types of Related Administrative Data.

Type of Data	Controlling document/procedure	Record Custodians				
		TR	HEHF	PNL	EDMC	EHPSS
Personnel						
Personnel training and qualifications	EII 1.7[a/]	X				
Occupational exposure records (nonradiological)	EII 2.2[a/]		X			X
Radiological exposure records				X		
Respiratory protection fitting						X
Personnel health and safety records	EII 2.1[a/]		X			X
Compliance/regulatory						
Action-specific requirements/screening levels	EII 1.6[a/]				X	
Guidance document tracking	EII 1.6[a/]				X	
Compliance issues	EII 1.6[a/]				X	
Problem resolution	EII 1.6[a/]				X	
Administrative record	TPA-MP-11[b/]				X	

[a/] WHC 1991a, *Environmental Investigations and Site Characterization Manual.*
[b/] DOE/RL 1990, *Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Handbook.*
EDMC = Environmental Data Management Center (Westinghouse Hanford Company).
EHPSS = Environmental Health and Pesticide Services Section (Westinghouse Hanford Company).
EII = Environmental Investigations Instructions.
HEHF = Hanford Environmental Health Foundation.
TR = training records (Westinghouse Hanford Company, Pacific Northwest Laboratory [PNL], Kaiser Engineers Hanford [KEH]).

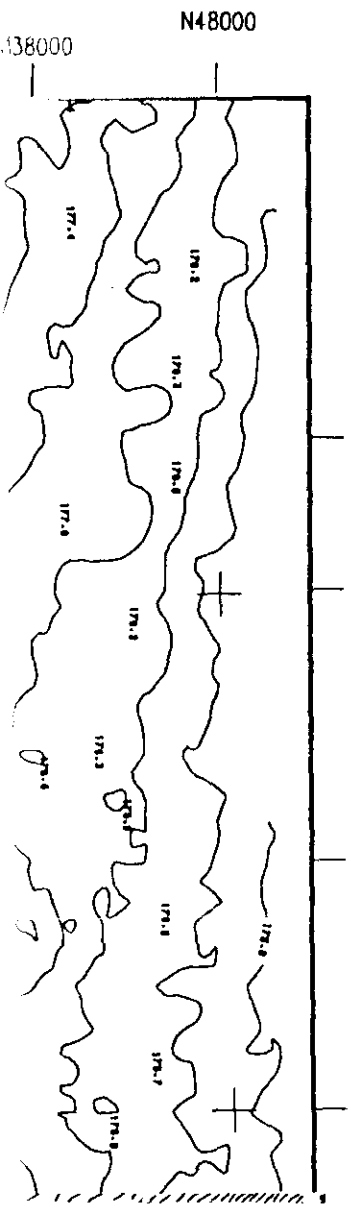


DRAFT

Westinghouse Hanford Company
Aggregate Area Management Studies

PUREX AGGREGATE AREA
PLATE 1 - Facilities, Sites, & Unplanned Releases

9 2 1 2 5 1 6 0 8 3 5

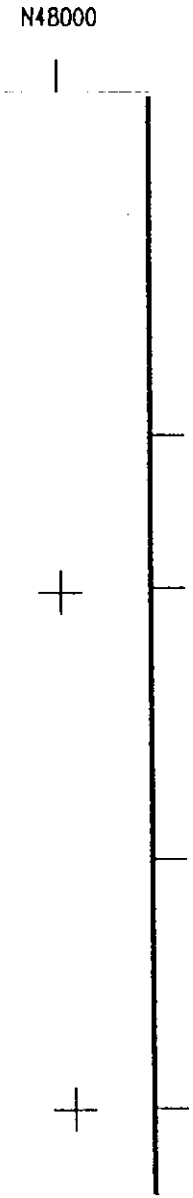


DRAFT

Westinghouse Hanford Company
Aggregate Area Management Studies

PUREX AGGREGATE AREA
PLATE 2 - Topography

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



DRAFT

Westinghouse Hanford Company
Aggregate Area Management Studies

PUREX AGGREGATE AREA
PLATE 3 - Monitor Wells & Sample Locations

9 2 1 2 5 1 6 0 8 3 7

DRAFT

Westinghouse Hanford Company
Aggregate Area Management Studies

PUREX AGGREGATE AREA
PLATE 4 - TANK FARMS ENLARGEMENT

9 2 1 2 5 1 6 0 9 2 8