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RCRA FACILITY INVESTIGATION REPORT FOR SWMU 9

NAVAL STATION ROOSEVELT ROADS
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TABLE OF CONTENTS

Page

LIST OF ACRONYMS AND ABBREVIATIONS ..... **xiv**

EXECUTIVE SUMMARY **ES-1**

1.0 INTRODUCTION **1-1**
- 1.1 SWMU 9 Investigation History 1-1
- 1.2 Scope and Objectives 1-3
- 1.3 Report Organization 1-3

2.0 FACILITY BACKGROUND **2-1**
- 2.1 Facility Description 2-1
- 2.2 SWMU 9 - Tanks 212-217 2-1
- 2.3 Summary of Previous Investigations 2-2
  - 2.3.1 Initial Assessment Study 2-2
  - 2.3.2 Confirmation Study 2-3

3.0 FACILITY INVESTIGATION **3-1**
- 3.1 RFI Facility History 3-1
  - 3.1.1 Phase I RFI 3-1
  - 3.1.2 Phase II RFI 3-1
  - 3.1.3 Phase III RFI 3-3
- 3.2 Geophysical Investigation 3-6
- 3.3 Sampling Activities at SWMU 9 - Tanks 212-217 3-7
  - 3.3.1 Area A – Tanks 212–213 3-8
  - 3.3.2 Area B – Tanks 214-215 3-14
  - 3.3.3 Area C – Tanks 216-217 3-17
- 3.4 Background Sampling Activities 3-20
  - 3.4.1 Background Surface Soil Investigation 3-20
  - 3.4.2 Background Subsurface Soil Investigation 3-21
  - 3.4.3 Background Groundwater Investigation 3-21
  - 3.4.4 Background Sediment and Surface Water Investigation 3-22
- 3.5 Soil Sampling Procedures 3-22
  - 3.5.1 Drilling Procedures 3-22
  - 3.5.2 Surface Soil Sampling Procedures 3-24
  - 3.5.3 Subsurface Soil Sampling Procedures 3-25
  - 3.5.4 Test Pit Procedures 3-25
- 3.6 Groundwater Investigation Procedures 3-26
  - 3.6.1 Monitoring Well Installation Procedures 3-26
  - 3.6.2 Monitoring Well Abandonment Procedures 3-27
  - 3.6.3 Well Development Procedures 3-28
  - 3.6.4 Groundwater Sampling Procedures 3-28
  - 3.6.5 Wellhead Testing Procedures 3-29
- 3.7 Surface Water and Sediment Sampling 3-29
  - 3.7.1 Surface Water Sampling Procedures 3-30
  - 3.7.2 Sediment Sampling Procedures 3-30

TABLE OF CONTENTS
(Continued)

Page

3.8 Quality Assurance/Quality Control Sampling Procedures 3-30
3.9 Decontamination Procedures 3-31

4.0 PHYSICAL CHARACTERISTICS OF STUDY AREA 4-1
4.1 Climatology 4-1
4.2 Topography 4-2
4.3 Geology 4-3
4.3.1 Soils 4-3
4.3.2 Regional Geology 4-4
4.3.3 Site Geology SWMU 9 - Tanks 212-217 (Areas A, B and C) 4-5
4.4 Hydrology 4-7
4.4.1 Regional Hydrology 4-7
4.4.2 SWMU 9 Hydrogeology 4-9

5.0 NATURE AND EXTENT OF CONTAMINATION 5-1
5.1 Background Conditions 5-2
5.1.1 Background Surface Soil 5-3
5.1.2 Background Subsurface Soil 5-3
5.1.3 Background Groundwater 5-3
5.1.4 Background Surface Water 5-4
5.1.5 Background Sediment 5-5
5.1.6 Background Summary 5-5
5.2 SWMU 9 - Tanks 212-217 5-7
5.2.1 SWMU 9 Area A – Tanks 212-213 5-8
5.2.2 Area B - Tanks 214 – 215 5-17
5.2.3 Area C - Tanks 216 – 217 5-24
5.3 Quality Assurance/Quality Control Sample Results 5-30
5.3.1 Phase I - QA/QC Sample Results 5-30
5.3.2 Phase II - QA/QC Sample Results 5-31
5.3.3 Phase III - QA/QC Sample Results 5-32
5.4 Data Validation 5-33

6.0 HUMAN HEALTH RISK ASSESSMENT 6-1
6.1 Identification of Chemicals of Potential Concern 6-1
6.1.1 Data Evaluation 6-1
6.1.2 COPC Selection Criteria 6-2
6.1.3 Selection of COPCs 6-3
6.2 Exposure Assessment 6-5
6.2.1 Fate and Transport 6-6
6.2.2 Potential Human Receptors and Exposure Pathways 6-7
6.2.3 Conceptual Site Model 6-9
6.2.4 Quantification of Exposure 6-10

TABLE OF CONTENTS
(Continued)

Page

6.3 Toxicity Assessment 6-16
6.3.1 Reference Doses 6-16
6.3.2 Carcinogenic Slope Factors 6-17
6.3.3 Dermal Absorption Efficiency 6-17
6.4 Risk Characterization 6-18
6.4.1 Carcinogenic Compounds 6-18
6.4.2 Noncarcinogenic Compounds 6-19
6.4.3 Potential Human Health Effects 6-20
6.5 Sources of Uncertainty 6-23
6.5.1 Sampling and Analysis 6-24
6.5.2 Selection of COPCs 6-25
6.5.3 Exposure Assessment 6-26
6.5.4 Toxicological Assessment 6-27
6.6 Summary of Risk Assessment Results 6-29
6.6.1 Summary of Results of the Baseline Human Health Risk Assessment 6-29

7.0 SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT 7-1
7.1 Screening-Level Problem Formulation 7-3
7.1.1 Environmental Setting 7-3
7.1.2 Available Analytical Data 7-7
7.1.3 Fate and Transport of Detected Chemicals 7-8
7.1.4 Identification of Potential Exposure Pathways 7-8
7.1.5 Selection of Ecological Receptors 7-12
7.1.6 Assessment Endpoints and Measurement Endpoints 7-14
7.2 Screening-Level Ecological Effects Evaluation 7-15
7.2.1 Threshold Screening Values for Sediment-Associated Biota 7-15
7.2.2 Threshold Screening Values for Saltwater Aquatic Life 7-19
7.2.3 Threshold Screening Values for Soil Organisms 7-22
7.2.4 Threshold Screening Values for Avian Dietary Intake Exposures 7-22
7.3 Screening-Level Exposure Estimate 7-23
7.3.1 Exposure Point Concentrations 7-24
7.3.2 Avian Dietary Exposure Models 7-27
7.4 Screening-Level Risk Calculation 7-32
7.4.1 Screening-Level Risk Calculation for Areas A, B, and C 7-33
7.5 Screening-Level Uncertainty Analysis 7-37
7.5.1 Threshold Screening Values 7-37
7.5.2 Ecological Receptors 7-39
7.5.3 Dietary Intake Models 7-40
7.5.4 Sampling and Analytical Program 7-40
7.6 Screening-Level Conclusions 7-41

TABLE OF CONTENTS
(Continued)

Page

7.7 Refinement of Conservative Exposure Assumptions and Recalculation of Risk Estimates 7-42
7.7.1 Refinement of Exposure Assumptions 7-43
7.7.2 Recalculation of Risk Estimates Using Refined Exposure Assumptions 7-44
7.7.3 Uncertainty Analysis Related to Refinement of Exposure Assumptions and Recalculation of Risk Estimates 7-48
7.7.4 Conclusions from the Refinement of Exposure Assumptions and Recalculation of Risk Estimates 7-49

8.0 CONCLUSIONS AND RECOMMENDATIONS 8-1
8.1 Introduction 8-1
8.2 Conclusions by Area 8-1
8.2.1 Area A 8-1
8.2.2 Area B 8-4
8.2.3 Area C 8-7
8.3 Recommendations by Area 8-10
8.3.1 Area A 8-10
8.3.2 Area B 8-11
8.3.3 Area 8-11

9.0 REFERENCES 9-1

LIST OF APPENDICES

A Geophysical Investigation Report
B Test Pit Records (Phase I and II)
C Test Boring and Well Construction Records
D Chain-of-Custody Records
E Well Development Records
F Wellhead Test Data (Slug Tests)
G Geotechnical Test Results
H Analytical Laboratory Results
I Quality Assurance/Quality Control Results
J Exposure Parameters
K Statistics
L Human Health Risk Assessment Calculations
M Dermal Absorption Factors
N Screening Level Dietary Intake Calculations
O Refined Dietary Intake Calculations
P Screening Level and Refinement HQ and HI Values

LIST OF TABLES

1-1 SWMU 9 Investigations and Reporting Summary

3-1 Summary of Sampling and Analytical Program – Area A
3-2 Summary of Sampling and Analytical Program – Area B
3-3 Summary of Sampling and Analytical Program – Area C
3-4 Summary of Sampling and Analytical Program – Background
3-5 Method Performance Limits Appendix IX Compound List and Contract Required Quantitaion Limits (CRQL)
3-6 Method Performance Limits RCRA Metals Compound List and Contract Required Quantitaion Limits (CRQL)
3-7 Method of Chemical Analysis Water Quality Parameters
3-8 Summary of Soil Boring and Well Construction Details
3-9 Summary of Sampling and Analytical Program – QA/QC

4-1 Summary of Corrective Measures Samples
4-2 Summary of Groundwater Elevations – May 10, 1996
4-3 Summary of Hydraulic Conductivity Estimates – SWMU 9
4-4 Summary of Hydraulic Conductivity Estimates – Areas A and B

5-1 Summary of Inorganic Detections in Surface Soil – SWMU 09 Background
5-2 Summary of Inorganic Detections in Subsurface Soil – SWMU 09 Background
5-3 Summary of Organic Detections in Groundwater – SWMU 09 Background
5-4 Summary of Inorganic (Total) Detections in Groundwater – SWMU 09 Background
5-5 Summary of Inorganic (Dissolved) Detections in Groundwater – SWMU 09 Background

LIST OF TABLES
(Continued)

5-6 Summary of Inorganic (Total) Detections in Surface Water – SWMU 09 Background
5-7 Summary of Organic Detections in Sediment – SWMU 09 Background
5-8 Summary of Inorganic Detections in Sediment – SWMU 09 Background
5-9 Summary of Organic Detections in Surface Soil – Area A
5-10 Summary of Inorganic Detections in Surface Soil – Area A
5-11 Summary of Organic Detections in Subsurface Soil – Area A
5-12 Summary of Inorganic Detections in Subsurface Soil – Area A
5-13 Summary of Organic Detections in Groundwater – Area A
5-14 Summary of Organic Detections in Groundwater – Area A – Onsite Laboratory
5-15 Summary of Inorganic (Total) Detections in Groundwater – Area A
5-16 Summary of Inorganic (Dissolved) Detections in Groundwater – Area A
5-17 Summary of Water Quality Detections in Groundwater – Area A
5-18 Summary of Inorganic (Total) Detections in Surface Water – Area A
5-19 Summary of Organic Detections in Sediment – Area A
5-20 Summary of Inorganic Detections in Sediment – Area A
5-21 Summary of Organic Detections in Surface Soil – Area B
5-22 Summary of Inorganic Detections in Surface Soil – Area B
5-23 Summary of Organic Detections in Subsurface Soil – Area B
5-24 Summary of Inorganic Detections in Subsurface Soil – Area B
5-25 Summary of Organic Detections in Groundwater – Area B – Onsite Laboratory
5-26 Summary of Organic Detections in Groundwater – Area B
5-27 Summary of Inorganic (Total) Detections in Groundwater – Area B
5-28 Summary of Inorganic (Dissolved) Detections in Groundwater – Area B
5-29 Summary of Water Quality Detections in Groundwater – Area B
5-30 Summary of Organic Detections in Surface Water – Area B
5-31 Summary of Inorganic (Total) Detections in Surface Water – Area B
5-32 Summary of Organic Detections in Sediment – Area B
5-33 Summary of Inorganic Detections in Sediment – Area B
5-34 Summary of Organic Detections in Surface Soil – Area C
5-35 Summary of Inorganic Detections in Surface Soil – Area C
5-36 Summary of Organic Detections in Subsurface Soil – Area C
5-37 Summary of Inorganic Detections in Subsurface Soil – Area C
5-38 Summary of Organic Detections in Groundwater – Area C
5-39 Summary of Inorganic (Total) Detections in Groundwater – Area C
5-40 Summary of Inorganic (Dissolved) Detections in Groundwater – Area C
5-41 Summary of Water Quality Detections in Groundwater – Area C
5-42 Summary of Organic Detections in Surface Water – Area C
5-43 Summary of Inorganic (Total) Detections in Surface Water – Area C
5-44 Summary of Organic Detections in Sediment – Area C
5-45 Summary of Inorganic Detections in Sediment – Area C
5-46 Summary of QA/QC Positive Detections – Phase I
5-47 Summary of QA/QC Positive Detections – Phase II
5-48 Summary of QA/QC Positive Detections – Phase III

LIST OF TABLES
(Continued)

6-1 Comparison of Maximum Concentrations for Inorganic Analytes Detected in Surface Soil 2x Average Detected Background Concentrations – Area A (Tanks 212-213)

6-2 Comparison of Maximum Concentrations for Inorganic Analytes Detected in Subsurface Soil to 2x Average Detected Background Concentrations – Area A (Tanks 212-213)

6-3 Comparison of Maximum Concentrations for Total Inorganic Analytes Detected in Groundwater Samples to 2x Average Detected Background Concentrations – Area A (Tanks 212-213)

6-4 Comparison of Maximum Concentrations for dissolved Inorganic analytes Detected in Groundwater Samples to 2x Average Detected Background Concentrations – Area A (Tanks 212-213)

6-5 Comparison of Maximum Concentrations for Inorganic Analytes Detected in Surface Soil to 2x Average Detected Background Concentrations – Area B (Tanks 214-215)

6-6 Comparison of Maximum Concentrations for Inorganic Analytes Detected in Subsurface Soil to 2x Average Detected Background Concentrations – Area B (Tanks 214-215)

6-7 Comparison of Maximum Concentrations for Total Inorganic Analytes Detected in Groundwater Samples to 2 x Average Detected Background Concentrations – Area B (Tanks 214-215

6-8 Comparison of Maximum Concentrations for Dissolved Inorganic Analytes Detected in Groundwater to 2x Average Detected Background Concentrations Area B (Tanks 214-215)

6-9 Comparison of Maximum Concentrations for Inorganic Analytes Detected in Surface Soil to 2x Average Detected Background Concentrations – Area C (Tanks 216-217)

6-10 Comparison of Maximum Concentrations for Inorganic Analytes Detected in Subsurface Soil to 2x Average Detected Background Concentrations – Area C (Tanks 216-217)

6-11 Comparison of Maximum Concentrations for Total Inorganic Analytes Detected in Groundwater to 2x Average Detected Background – Area C (Tanks 216-217)

6-12 Comparison of Maximum Concentrations for Dissolved Inorganic Analytes Detected in Groundwater to 2x Average Detected Background Concentrations – Area C (Tanks 216-217)

6-13 Comparison of Maximum Concentrations for Inorganic Analytes Detected in Surface Soil to EPA Region III RBC Concentrations – Area A (Tanks 212-213)

6-14 Comparison of Maximum Concentrations for Organic Analytes Detected in Surface Soil to EPA Region III RBC Concentrations – Area A (Tanks 212-213)

6-15 Comparison of Maximum Concentrations for Inorganic Analytes Detected in Subsurface Soil to EPA Region III RBC Concentrations – Area A (Tanks 212-213)

6-16 Comparison of Maximum Concentrations for Organic Analytes Detected in Subsurface Soil to EPA Region III RBC Concentrations – Area A (Tanks 212-213)

6-17 Comparison of Maximum Concentrations for Total Inorganic Analytes Detected in Groundwater Samples to EPA Region III RBC Concentrations – Area A (Tanks 212-213)

6-18 Comparison of Maximum Concentrations for Dissolved Inorganic Analytes Detected in Groundwater Samples to EPA Region III RBC Concentrations – Area A (Tanks 212-213)

6-19 Comparison of Maximum Concentrations for Organic Analytes Detected in Groundwater Samples to EPA Region III RBC Concentrations – Area A (Tanks 212-213)

6-20 Comparison of Maximum Concentrations for Inorganic Analytes Detected in Sediment Samples to EPA Region III RBC Concentrations – Area A (Tanks 212-213)

6-21 Comparison of Maximum Concentrations for Organic Analytes Detected in Sediment Samples to EPA Region III RBC Concentrations – Area A (Tanks 212-213)

LIST OF TABLES
(Continued)

6-22 Comparison of Maximum Concentrations for Total Inorganic Analytes Detected in Surface Water Samples to EPA Region III RBC Concentration – Area A (Tanks 212-213)
6-23 Comparison of Maximum Concentrations for Inorganic Analytes Detected in Surface Soil Samples to EPA Region III RBC Concentrations – Area B (Tanks 214-215)
6-24 Comparison of Maximum Concentrations for Organic Analytes Detected in Surface Soil Samples to EPA Region III RBC Concentrations – Area B (Tanks 214-215)
6-25 Comparison of Maximum Concentrations for Inorganic Analytes Detected in Subsurface Soil Samples to EPA Region III RBC Concentrations – Area B (Tanks 214-215)
6-26 Comparison of Maximum Concentrations for Organic Analytes Detected in Subsurface Soil Samples to EPA Region III RBC Concentrations – Area B (Tanks 214-215)
6-27 Comparison of Maximum Concentrations for Organic Analytes Detected in Groundwater Samples to EPA Region III RBC Concentrations – Area B (Tanks 214-215)
6-28 Comparison of Maximum Concentrations for Inorganic Analytes Detected in Sediment Samples to EPA Region III RBC Concentrations – Area B (Tanks 214-215)
6-29 Comparison of Maximum Concentrations for Organic Analytes Detected in Sediment Samples to EPA Region III RBC Concentrations – Area B (Tanks 214-215)
6-30 Comparison of Maximum Concentrations for Inorganic Analytes Detected in Surface Water Samples to EPA Region III RBC Concentrations – Area B (Tanks 214-215)
6-31 Comparison of Maximum Concentrations for Organic Analytes Detected in Surface Water Samples to EPA Region III RBC Concentrations – Area B (Tanks 214-215)
6-32 Comparison of Maximum Concentrations for Inorganic Analytes Detected in Surface Soil Samples to EPA Region III RBC Concentrations – Area C (Tanks 216-217)
6-33 Comparison of Maximum Concentrations for Organic Analytes Detected in Surface Soil Samples to EPA Region III RBC Concentrations – Area C (Tanks 216-217)
6-34 Comparison of Maximum Concentrations for Inorganic Analytes Detected in Subsurface Soil Samples to EPA Region III RBC Concentrations – Area C (Tanks 216-217)
6-35 Comparison of Maximum Concentrations for Organic Analytes Detected in Subsurface Soil Samples to EPA Region III RBC Concentrations – Area C (Tanks 216-217)
6-36 Comparison of Maximum Concentrations for Organic Analytes Detected in Groundwater Samples to EPA Region III RBC Concentrations – Area C (Tanks 216-217)
6-37 Comparison of Maximum Concentrations for Inorganic Analytes Detected in Sediment Samples to EPA Region III RBC Concentrations – Area C (Tanks 216-217)
6-38 Comparison of Maximum Concentrations for Organic Analytes Detected in Sediment Samples to EPA Region III RBC Concentrations – Area C (Tanks 216-217)
6-39 Comparison of Maximum Concentrations for Inorganic Analytes Detected in Surface Water Samples to EPA Region III RBC Concentrations – Area C (Tanks 216-217)
6-40 Comparison of Maximum Concentrations for Organic Analytes Detected in Surface Water Samples to EPA Region III RBC Concentrations – Area C (Tanks 216-217)
6-41 Summary of Inorganic Analytes that Exceeded 2x Average Detected Background Concentrations for Areas A, B, C – Tanks 212-217)
6-42 Summary of PCOCs for Areas A, B, and C Identified by Screening with EPA Region III RBC Concentrations – (Tanks 212-217)
6-43 Shapiro Wilkes Test Results and Identification of the Exposure Point Concentration – Area A

LIST OF TABLES
(Continued)

6-44 Shapiro Wilkes Test Results and Identification of the Exposure Point Concentration – Area B
6-45 Shapiro Wilkes Test Results and Identification of the Exposure Point Concentration – Area C
6-46 Future and Current Exposures to Environmental Media at SWMU 9
6-47 Noncarcinogenic Toxicity Data – Area A
6-48 Carcinogenic Toxicity Data – Oral/Dermal – Area A
6-49 Noncarcinogenic Toxicity Data – Inhalation – Area B
6-50 Carcinogenic Toxicity Data – Oral/Dermal – Area B
6-51 Noncarcinogenic Toxicity Data – Oral/Dermal – Area C
6-52 Carcinogenic Toxicity Data – Oral/Dermal – Area C
6-53 Incremental Lifetime Cancer Risks (ILCRs) and Hazard Indices (HIs) for Future Military Adult and Young Child Residents – RME – Area A
6-54 Incremental Lifetime Cancer Risks (ILCRs) and Hazard Indices (HIs) for Current On-Site Workers – Area A
6-55 Incremental Lifetime Cancer Risks (ILCRs) and Hazard Indices (HIs) for Future Construction Workers – Area A
6-56 Incremental Lifetime Cancer Risks (ILCRs) and Hazard Indices (HIs) for Future Military Adult and Young Child Residents – RME – Area B
6-57 Incremental lifetime Cancer Risks (ILCRs) and Hazard Indices (HIs) for Current On-Site Workers – Area B
6-58 Incremental Lifetime Cancer Risks (ILCRs) and Hazard Indices (HIs) for Future Construction Workers – Area B
6-59 Incremental Lifetime Cancer Risks (ILCRs) and Hazard Indices (HIs) for Future Military Adult and Young Child Residents – RME – Area C
6-60 Incremental Lifetime Cancer Risks (ILCRs) and Hazard Indices (HIs) for Current On-Site Workers – Area C
6-61 Incremental Lifetime Cancer Risks (ILCRs) and Hazard Indices (HIs) for Future Construction Workers – Area C

7-1 Summary of SWMU 9 (Area A, B, and C) Sediment Analytical Data: Frequency of Detection, Maximum Positive Detections, and Arithmatic Mean Concentrations
7-2 Summary of SWMU 9 (Area A, B, and C) Surface Water Analytical Data: Frequency of Detection, Maximum Positive Detections, and Arithmatic Mean Concentrations
7-3 Summary of SWMU 9 (Area A, B, and C) Surface Soil Analytical Data: Frequency of Detection, Maximum Positive Detections, and Arithmatic Mean Concentrations
7-4 Summary of Background Surface Water, Sediment, and Surface Soil Analytical Data: Frequency of Detection, Maximum Positive Detections, and Arithmatic Mean Concentrations
7-5 Assessment Endpoints, Risk Hypothesis, Measurement Endpoints and Receptors
7-6 Sediment Threshold Screening Values for Chemicals Detected in SWMU 9 and Background Sediment Samples
7-7 EPA Saltwater National Ambient Water Quality Criteria for Metals Detected in SWMU 9 and Background Surface Water Samples

LIST OF TABLES
(Continued)

7-8 Acquire Database Toxicity Test Data for Constituents Detected in SWMU 9 and Background Surface Water Samples that Lack Established EPA Saltwater National Ambient Water Quality Criteria

7-9 Earthworm and Plant Surface Soil Threshold Screening Values for Chemicals Detected in SWMU 9 and Background Surface Soil Samples

7-10 Literature-Derived No Observed Effect Level and Lowest Observed Effect Level Threshold Screening Values for Avian Dietary Intake Exposures

7-11 Bioconcentration/Bioaccumulation Factors Used in the Avian Dietary Intake Models

7-12 Conservative life History Parameters for the Avian Dietary Intake Models

7-13 Sediment Hazard Quotient and Hazard Index Values for Sediment-Associated Biota - Area (Tanks 212-213)

7-14 Surface Water Hazard Quotient and Hazard Index Values for Saltwater Aquatic Life - Area (Tanks 212-213)

7-15 Surface Soil Hazard Quotient and Hazard Index Values for Earthworms and Plants - Area A (Tanks 212-213)

7-16 Dietary Intake Hazard Quotient and Hazard Index Values for Avian Receptors - Area A (Tanks 212-213)

7-17 Sediment Hazard Quotient and Hazard Index Values for Sediment-Associated Biota - Area B (Tanks 214-215)

7-18 Surface Water Hazard Quotient and Hazard Index Values for Saltwater Aquatic Life - Area B (Tanks 214-215)

7-19 Surface Soil Hazard Quotient and Hazard Index Values for Earthworms and Plants - Area B (Tanks 214-215)

7-20 Dietary Intake Hazard Quotient and Hazard Index Values for Avian Receptors - Area B (Tanks 214-215)

7-21 Sediment Hazard Quotient and Hazard Index Values for Sediment-Associated Biota - Area C (Tanks 216-217)

7-22 SWMU 9, Area C Surface Water Hazard Quotient and Hazard Index Values for Saltwater Aquatic Life - Area C (Tanks 216-217)

7-23 Surface Soil Hazard Quotient and Hazard Index Values for Earthworms and Plants - Area C (Tanks 216-217)

7-24 Dietary Intake Hazard Quotient and Hazard Index Values for Avian Receptors - Area C (Tanks 216-217)

7-25 Background Sediment Hazard Quotient and Hazard Index Values for Sediment–Associated Biota

7-26 Background Surface Water Hazard Quotient and Hazard Index Values

7-27 Background Surface Soil Hazard Quotient and Hazard Index Values for Earthworms and Plants

7-28 Background Dietary Intake Hazard Quotient and Hazard Index Values for Avian Receptors Values for Avian Receptors

7-29 Ecological COPCs Identified by the Screening-Level Ecological Risk Assessment

7-30 Less Conservative Bioaccumulation Factors Used in the American Robin and Red-Tailed Hawk Dietary Intake Models

7-31 Less Conservative Life History Parameters for the Avian Dietary Intake Models

LIST OF TABLES
(Continued)

7-32 Sediment Hazard Quotient and Hazard Index Values for Sediment-Associated Biota Following the Refinement of Exposure Assumptions - Area A (Tanks 212-213)

7-33 Surface Water Hazard Quotient and Hazard Index Values for Saltwater Aquatic Life Following the Refinement of Exposure Assumptions - Area A (Tanks 212-213)

7-34 Surface Soil Hazard Quotient and Hazard Index Values for Earthworms and Plants Following the Refinement of Exposure, Assumptions - Area A (Tanks 212-213)

7-35 Dietary Intake Hazard Quotient and Hazard Index Values for Avian Receptors Following the Refinement of Exposure Assumptions - Area A (Tanks 212-213)

7-36 Sediment Hazard Quotient and Hazard Index Values for Sediment-Associated Biota Following the Refinement of Exposure Assumptions - Area B (Tanks 214-215)

7-37 Surface Water Hazard Quotient and Hazard Index Values for Saltwater Aquatic Life Following the Refinement of Exposure Assumptions - Area B (Tanks 214-215)

7-38 Surface Soil Hazard Quotient and Hazard Index Values for Earthworms and Plants Following the Refinement of Exposure Assumptions - Area B (Tanks 214-215)

7-39 Dietary Intake Hazard Quotient and Hazard Index Values for Avian Receptors Following the Refinement of Exposure Assumptions - Area B (Tanks 214-215)

7-40 Sediment Hazard Quotient and Hazard Index Values for Sediment-Associated Biota Following the Refinement of Exposure Assumptions - Area C (Tanks 216-217)

7-41 Surface Water Hazard Quotient and Hazard Index Values for Saltwater Aquatic Life Following the Refinement of Exposure Assumptions - Area C (Tanks 216-217)

7-42 Surface Soil Hazard Quotient and Hazard Index Values for Earthworms and Plants Following the Refinement of Exposure Assumptions - Area C (Tanks 216-217)

7-43 Dietary Intake Hazard Quotient and Hazard Index Values for Avian Receptors Following the Refinement of Exposure Assumptions - Area C (Tanks 216-217)

7-44 Background Sediment Hazard Quotient and Hazard Index Values for Sediment-Associated Biota Following the Refinement of Exposure Assumptions

7-45 Background Surface Water Hazard Quotient and Hazard Index Values for Saltwater Aquatic Life Following the Refinement of Exposure Assumptions

7-46 Background Surface Soil Hazard Quotient and Hazard Index Values for Earthworms and Plants Following the Refinement of Exposure Assumptions

7-47 Background Dietary Intake Hazard Quotient and Hazard Index Values for Avian Receptors Following the Refinement of Exposure Assumptions

7-48 Comparison of SWMU 9, Area A, B, and C Hazard Quotient and Hazard Index Values to Background Hazard Quotient and Hazard Index Values Following the Refinement of Exposure Assumptions: Sediment-Associated Biota

7-49 Comparison of SWMU 9, Area A, B, and C Hazard Quotient and Hazard Index Values to Background Hazard Quotient and Hazard Index Values Following the Refinement of Exposure Assumptions: Saltwater Aquatic Life

7-50 Comparison of SWMU 9, Area A, B, and C Hazard Quotient and Hazard Index Values to Background Hazard Quotient and Hazard Index Values Following the Refinement of Exposure Assumptions: Earthworms and Plants

7-51 Comparison of SWMU 9, Area A Hazard Quotient and Hazard Index Values to Background Hazard Index and Hazard Quotient Values Following the Refinement of Exposure Assumptions: Avian Receptors

LIST OF TABLES
(Continued)

7-52 Comparison of SWMU 9, Area B Hazard Quotient and Hazard Index Values to Background Hazard Index and Hazard Quotient Values Following the Refinement of Exposure Assumptions: Avian Receptors

7-53 Comparison of SWMU 9, Area C Hazard Quotient and Hazard Index Values to Background Hazard Index and Hazard Quotient Values Following the Refinement of Exposure Assumptions: Avian Receptors

LIST OF FIGURES

1-1 SWMU/AOC Location Map

2-1 Regional Location Map
2-2 Current Conditions, SWMU 9 – Areas A and B, Tanks 212-215
2-3 Current Conditions, SWMU 9 – Area C, Tanks 216-217

3-1 Sampling Locations, SWMU 9 – Area A, Tanks 212-213
3-2 Sampling Locations, SWMU 9 – Area B, Tanks 214-215
3-3 Sampling Locations, SWMU 9 – Area C, Tanks 216-217
3-4 Surface Water and Sediment Sampling Locations, SWMU 9 – Areas A and B, Tanks 212-215

4-1 Location of Hydrogeologic Cross-Sections, SWMU 9 – Areas A and B, Tanks 212-215
4-2 Hydrogeologic Cross-Section A-A', SWMU 9 – Area A, Tanks 212-213
4-3 Hydrogeologic Cross-Section B-B', SWMU 9 – Areas A and B, Tanks 212-215
4-4 Groundwater Contour Map – May 10, 1996, SWMU 9 – Areas A and B, Tanks 212-215
4-5 Groundwater Contour Map – May 10, 1996, SWMU 9 – Area C, Tanks 216-217

5-1 Surface Soil Detections Above Screening Criteria, SWMU 9 – Background
5-2 Surface Soil Detections Above Screening Criteria, SWMU 9 – Background
5-3 Subsurface Soil Detections Above Screening Criteria, SWMU 9 – Background
5-4 Subsurface Soil Detections Above Screening Criteria, SWMU 9 – Background
5-5 Groundwater Detections Above Screening Criteria, SWMU 9 – Background
5-6 Groundwater Detections Above Screening Criteria, SWMU 9 – Areas A and B, Background
5-7 Sediment Detections Above Screening Criteria, SWMU 9 – Areas A and B, Background
5-8 Surface Soil Detections Above Screening Criteria, SWMU 9 – Area A, Tanks 212-213
5-9 Subsurface Soil Detections Above Screening Criteria, SWMU 9 – Area A, Tanks 212-213
5-10 Groundwater Organic Detections Above Screening Criteria, SWMU 9 – Area A, Tanks 212-213
5-11 Distribution of Total BTEX in Groundwater, SWMU 9 – Area A, Tanks 212-213
5-12 Groundwater Inorganic Detections Above Screening Criteria, SWMU 9 – Area A, Tanks 212-213
5-13 Surface Water Detections Above Screening Criteria, SWMU 9 – Areas A and B, Tanks 212-215

LIST OF FIGURES
(Continued)

5-14 Sediment Detections Above Screening Criteria, SWMU 9 – Areas A and B, Tanks 212-215
5-15 Surface Soil Detections Above Screening Criteria, SWMU 9 – Area B, Tanks 214-215
5-16 Subsurface Soil Detections Above Screening Criteria, SWMU 9 – Area B, Tanks 214-215
5-17 Groundwater Detections Above Screening Criteria, SWMU 9 – Area B, Tanks 214-215
5-18 Water Quality Detections Above Screening Criteria, SWMU 9 – Area B, Tanks 214-215
5-19 Surface Water Detections Above Screening Criteria, SWMU 9 – Area B, Tanks 214-215
5-20 Sediment Detections Above Screening Criteria, SWMU 9 – Area B, Tanks 214-215
5-21 Distribution of Arsenic in Subsurface Soil (5-10' BGS), SWMU 9 – Area B, Tanks 214-215
5-22 Distribution of Total BTEX in Groundwater, SWMU 9 – Area B, Tanks 214-215
5-23 Surface Soil Detections Above Screening Criteria, SWMU 9 – Area C, Tanks 216-217
5-24 Subsurface Soil Detections Above Screening Criteria, SWMU 9 – Area C, Tanks 216-217
5-25 Groundwater Detections Above Screening Criteria, SWMU 9 – Area C, Tanks 216-217
5-26 Water Quality Detections Above Screening Criteria, SWMU 9 – Area C, Tanks 216-217
5-27 Surface Water Detections Above Screening Criteria, SWMU 9 – Area C, Tanks 216-217
5-28 Sediment Detections Above Screening Criteria, SWMU 9 – Area C, Tanks 216-217

6-1 Conceptual Site Model, SWMU 9 - Tanks 212-217

7-1 Screening–Level EPA Preliminary Conceptual Model for SWMU 9 – Areas A, B, and C

LIST OF ACRONYMS AND ABBREVIATIONS

ABS	Absorbance Factor
AET	Apparent Effects Threshold
AF	Adherence Factor
AOC	Area of Concern
AQUIRE	Aquatic Toxicity Information Retrieval
ASTM	American Society of Testing Materials
At	Averaging Time
AVGAS	Aviation Gasoline
b	saturated thickness
BAF	Bioaccumulation Factor
bgs	Below Ground Surface
Baker	Baker Environmental, Inc.
BCF	Bioconcentration Factor
BFI	Browning Ferris Industries
BTEX	benzene, toluene, ethylbenzene, and xylene
BW	Body Weight
C	Centigrade
Ca	Chemical Concentration in Air
CAP	Corrective Action Plan
CCC	Criteria Continuous Concentration
CDI	Chronic Daily Intake
CERCLA	Comprehensive Environmental Recovery, Compensation, and Liabilities Act
CF	Conversion Factor
CLEAN	Comprehensive Long-Term Environmental Action Navy
cm^2	Centimeter squared
cm^3	Centimeter cubed
CMC	Criteria Maximum Concentration
CMS	Corrective Measures Study
CNO	Chief of Naval Operations
COC	Chemical of Concern
COPC	Chemical of Potential Concern
CRAVE	Carcinogen Risk Assessment Verification Endeavor
CRQL	Contract Required Quantitation Limit
C_s	Chemical Concentration in Soil
CS	Confirmation Study
CSF	Carcinogen Slope Factor
CTO	Contract Task Order
DAD	Dermally Absorbed Dose
DMMP	Dredged Material Management Program
DoN's	Department of the Navy's
DRMO	Defense Reutilization and Marketing Office

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

ED	Exposure Duration
EF	Exposure Frequency
Eh	Oxidation Reduction Potential
EM	Electromagnetic
ESE	Environmental Science and Engineering
ERA	Ecological Risk Assessment
ER-L	Effects Range-Low
ER-M	Effects Range-Median
ET	Exposure Time
FCM	Food Chain Multiplier
FI	Fraction Ingested
GPM	gallons per minute
GPR	Ground Penetrating Radar
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
HQ	Hazard Quotient
HSWA	Hazardous and Solid Waste Amendments
HHRA	Human health Risk Assessment
IAS	Initial Assessment Study
ID	Inside Diameter
IDW	Investigation Derived Waste
ILCR	Incremental Lifetime Cancer Risk
IR	Ingestion Rate
IRIS	Integrated Risk Information System
K	hydraulic conductivity
Kg	Kilogram
Koc	Octanol-Carbon Partitioning Coefficient
Kow	Octanol-Water Partitioning Coefficient
L	Liter
LANTDIV	Naval Facilities Engineering Command, Atlantic Division
L/day	Liter per Day
LOAEL	Lowest Observed Adverse Effect Level
LOEC	Lowest Observed Effect Concentration
m^3	Cubic Meter
MATC	Maximum Acceptable Toxicant Concentration
MCL	Maximum Contaminant Level
MF	Modifying Factor

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

μg/kg	Microgram per Kilogram
μg/L	Microgram per Liter
mg	Milligram
mgd	million gallons per day
mg/kg	Milligram per Kilogram
mg/kg/day	Milligram per Kilogram per Day
mg/L	Milligram per Liter
MI	Mobility Index
ml	Milliliter
NACIP	Navy Assessment and Control of Installation Pollutants
NAWQC	National Ambient Water Quality Criteria
ND	Not Detected
NOAEL	No Observable Adverse Effect Level
NOEC	No Observed Effect Concentration
NSRR	Naval Station Roosevelt Roads
OD	outside diameter
ORNL	Oak Ridge National Laboratory
OU	Operable Unit
PAH	Polynuclear Aromatic Hydrocarbons
PEL	Probable Effects Level
PC	Permeability Constant
PCB	polychlorinated biphenyls
PEF	Particulate Emission Factor
pH	Minus the log of the hydrogen ion concentration
PID	Photoionization Detector
ppm	parts per million
PREQB	Puerto Rico Environmental Quality Board
PVC	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
RAGS	Risk Assessment Guidance for Superfund
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RfC	Reference Concentration
RfD	Reference Dose
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RME	Reasonable Maximum Exposure

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

RPD	Relative Percent Difference
RR	Respiration Rate
S	Water Solubility
SA	Surface area of exposed skin
SCCRBS	Selecting Exposure Routes and Contaminants of Concern by Risk-based Screening
SOP	Standard Operating Procedures
SOW	Statement of Work
SQL	Sample Quantitation Limit
SRC	Syracuse Research Corporation
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
T	Transmissivity
TAL	Target Analyte List
TCL	Target Compound List
TEL	Threshold Effects Level
TPH	Total Petroleum Hydrocarbon
UCL	Upper Confidence Limit
UF	uncertainty factor
USACE	U.S. Army Corp of Engineers
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USGS	Unified Soil Classification System
UST	Underground Storage Tank
VOC	Volatile Organic Compound
VP	Vapor Pressure

EXECUTIVE SUMMARY

INTRODUCTION

This Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) evaluates the nature and extent of potential threats to the public health and the environment posed by the release or threatened release of hazardous substances, pollutants, or contaminants at Solid Waste Management Unit (SWMU) 9, Naval Station Roosevelt Roads (NSRR), Ceiba, Puerto Rico.

This report pertains to SWMU 9 - Tanks 212-217, a fuel management area within Operable Unit (OU) 2. The scope of the RFI included completion of three phases of field investigation at Areas A, B, and C within SWMU 9 to assess the environmental impact of operations at the site. This document presents the results of the sampling conducted during the three phases of field investigation. The objective of the RFI is to summarize the results of the data gathered, evaluate potential human health and ecological risks within each area, and provide conclusions regarding the analytical results and corresponding risks as well as recommendations for SWMU 9.

INVESTIGATION ACTIVITIES

The RFI at SWMU 9 was conducted as a series of three phases of investigation, Phase I was conducted on April 1996; Phase II in September/October 1997; and Phase III in June 1999. The first phase RFI field activities (April 1996) included a geophysical investigation, test pit excavations, surface and subsurface soil sampling, monitoring well installation, groundwater sampling, wellhead testing, and surveying. The second phase RFI field activities (September/October 1997) were conducted to address EPA comments on the first phase RFI Report and consisted of test pit excavations at Areas A and B and the installation of additional monitoring wells, including soil and groundwater sampling. The third phase RFI field activities (June 1999) were conducted to address EPA comments on the second phase RFI Report and included specific areas of additional soil and groundwater investigation, surface water, sediment, and background sampling, and the completion of an ecological study.

FINDINGS OF THE INVESTIGATIONS

Each phase of investigation presented various analytical results from the different areas within SWMU 9. The investigation findings from each area were grouped together in this report to provide one set of conclusions and recommendations by area. The following provides a summary of the investigation findings.

Area A

Evidence of the impact of past site operations on surface soil is limited. A few organic and inorganic compounds were detected at low concentrations below screening criteria in sample locations scattered in the vicinity of Tanks 212 and 213. None of these compounds are associated with diesel fuel and unleaded gasoline.

There is evidence of the impact of past site operations on subsurface soils. Benzene, toluene, ethylbenzene, and xylene (BTEX) and total petroleum hydrocarbon (TPH) constituents were detected in several subsurface soil samples. However, only one detection exceeded the screening criteria. The locations of BTEX and TPH detections are consistent with spills and leaks related to tank operations. BTEX constituents as well as TPH gasoline and diesel range organics were detected in test pits located immediately down slope of Tank 212 and the suspected sludge disposal pit location. BTEX constituents and TPH gasoline range organics were detected down slope from Tank 213. Primarily TPH gasoline range organics and BTEX constituents were detected in borings located in the vicinity of the fuel pipeline valve pit were the fuel lines from the Tank 212-213 area merge with the fuel lines from the Tank 214-215 area. TPH diesel range organics were detected in borings located farther away from this junction. Several other organic compounds were detected, including acetone and phthalate compounds. These detections were below screening criteria and are not associated with diesel fuel and unleaded gasoline.

Several inorganic compounds were detected above background screening criteria in subsurface soil samples scattered throughout Area A. However, none of the inorganic compounds are associated with diesel fuel and unleaded gasoline. Only Arsenic was detected in excess of RBCs. Arsenic appears to be naturally occurring in concentrations exceeding RBCs. It should be noted that lead was detected

above background criteria in association with BTEX and gasoline range TPH contamination. While not conclusive, it suggests that leaded gasoline may have been stored in Area A tanks.

There is evidence of the impact of past site operations on groundwater. BTEX compounds were detected in several of the temporary and permanent monitoring wells located in the vicinity of Tank 212. A BTEX plume is evident downgradient of Tank 212, between the tank and the mangrove swamp. The location of the plume is consistent with past leaks or spills during the operation of Tank 212. Additionally, the plume is coincident with detections of BTEX and TPH constituents in subsurface soil. A second BTEX plume is evident in the vicinity of well 9-MW02R. The plume appears to extend radially from the valve pit. Again, the location of the plume is consistent with past leaks or spills related to the valve pit. The location of the maximum BTEX concentration is located near the possible source (the valve pit). This suggests that the spills or leaks may have occurred relatively recently. Benzene was detected above the Federal Maximum Contaminant Level (MCL) and EPA Region III Risk-Based Concentration (RBC) for Tap Water in both plume locations.

Arsenic, cadmium, chromium, lead, and mercury were detected in groundwater samples above the Federal MCL and/or tap water RBC. However, a majority of the detections were below the background screening criteria. Additionally, none of these inorganic compounds are associated with diesel fuel or unleaded gasoline. Thus, it is unlikely that the detections of inorganic constituents in this area are associated with fuel storage operations. It should be noted that cadmium was detected above screening criteria in groundwater in at least four scattered locations. The detections are scattered and not in a pattern related to tank or valve pit leaks or spills.

The comparison of water quality parameters to federal standards shows several exceedences that suggest that untreated groundwater is not suitable for human use because of odor, color, and staining problems.

There is limited evidence of the impact of past site operations on surface water and sediment. Many inorganic compounds were detected in surface water and sediment, and several exceeded the background screening criteria. However, most of the inorganic compounds are not associated with fuel storage operations. Lead is typically associated with fuel storage operations, and was detected in sediment above background screening criteria.

The Human Health Risk Assessment (HHRA) did not identify an incremental lifetime cancer risk greater than the acceptable EPA limits in Area A. Noncarcinogenic risk may exist for future young child military residents. Almost forty-percent of the risk can be attributed to exposures to chromium in groundwater. Benzene is the second leading contaminant driving an increase in risk at Area A, contributing forty-three percent of the risk from ingestion and dermal contact with groundwater.

Future construction workers in Area A may potentially be at risk. This Hazard Index (HI) is primarily the result of exposures to chromium (evaluated as Cr VI) in subsurface soil and groundwater and benzene in groundwater.

The screening-level ERA indicated that the assessment endpoints for Area A were not met. As such, the results of the screening-level ERA are not sufficient to conclude that risks to the ecological receptors at the Area A are negligible. For all receptor species, there were multiple chemicals with HQ values greater than 1.0. In addition, many chemicals could not be evaluated due to the lack of threshold screening values. The conservative exposure assumptions utilized in the screening-level ERA were refined and HQ values for Area A were recalculated using the same conceptual site model that was developed for the screening-level ERA (i.e., same exposure pathways and receptors). With the exception of the red-tailed hawk, one or more chemicals was shown to present a risk to each technological receptor following the refinement of exposure assumptions. As such, it cannot be concluded that risks to ecological receptors at Area A following the refinement of exposure assumptions is negligible.

Area A HQ values for individual receptors following the refinement of exposure assumptions are summarized below. The chemicals listed in italicized print are those with site HQ values that are less than background HA values. The risks presented by these chemicals are not considered to be site related.

Sediment-Associated Biota	Copper (HQ = 3.37) and Vanadium (HQ = 3.16)
Aquatic Life	Arsenic (HQ = 1.06)
Earthworms	*Chromium (HQ = 39.3)*
Plants	*Chromium (HQ = 15.7)*

Belted Kingfisher	Chromium (HQ = 1.05), Selenium (HQ = 16.1), and Vanadium (HQ = 1.38)
Great Blue Heron	Selenium (HQ = 5.68)
American Robin	*Chromium (HQ = 1.38)* and Lead (HQ = 1.05)
Red-Tailed Hawk	None

Area B

There is some evidence of the impact of past site operations on subsurface soil. TPH (diesel and gasoline range organics) were detected in a test pit up-slope of Tank 214, approximately 40 feet from the valve pit and a test pit 9TP02 immediately down-slope of Tank 215. The semivolatile organic compound (SVOC) detections are limited, do not exceed RBCs, and are not associated with fuel storage operations. The inorganics detected in subsurface soil samples above background screening criteria are not associated with fuel operations. Lead is associated with gasoline, however lead exceeded background screening criteria in only one sample located up-slope of Tank 215. The distribution pattern of arsenic in subsurface soil shows the highest concentrations north of Tank 215 with lesser concentrations east and south of Tank 215. The other inorganics in Area B, while in some instances exceeding the background comparison criteria, generally appear in concentrations similar to those in Area A.

There is evidence of the impact of past site operations on groundwater. BTEX compounds were detected in several of the temporary monitoring wells located downgradient of Tanks 214 and 215. A BTEX plume is evident downgradient of Tank 214, between the tank and the mangrove swamp. The location of the plume is consistent with past leaks or spills during the operation of Tank 214. The location of the maximum BTEX concentration is approximately 100 feet downgradient of the tank. This suggests that the spills or leaks have not recently occurred. A much smaller plume with lower concentrations is located southwest of Tank 215. Again, its location is consistent with past leaks or spills during the operation of Tank 215. TPH gasoline range compounds were also detected in two permanent monitoring wells, (13GW04 and 13GW05). These locations are consistent with the locations of the BTEX plumes. Other organic compounds were detected in groundwater, but are not associated with fuel storage operations. Cadmium was detected in groundwater in excess of the Tap Water MCL, but not background screening criteria. Cadmium is not associated with fuel storage operations.

The comparison of water quality parameters to federal standards shows several exceedences. These exceedences include several metals, as well as sulfate, color, and total dissolved solids (TDS). This suggests that untreated groundwater is not suitable for human use because of odor, color, and staining problems.

There is limited evidence of the impact of past site operations on surface water and sediment. Several volatile organic compounds (VOCs) were detected in sediments, but all were below screening criteria. Many inorganic compounds were detected in surface water and sediment, and many exceeded the background screening criteria. However, most of the inorganic compounds are not associated with fuel storage operations. Lead is typically associated with fuel storage operations, and was detected in surface water and sediment above screening criteria.

The HHRA did not identify an incremental lifetime cancer risk greater than the acceptable EPA limits in Area B. There were no unacceptable noncarcinogenic risks associated with exposures to contaminants detected in Area B as estimated in the HHRA.

The screening-level ERA indicated that the assessment endpoints for Area B were not met. As such, the results of the screening-level ERA are not sufficient to conclude that risks to the ecological receptors at the Area B are negligible. For all receptor species, there were multiple chemicals with HQ values greater than 1.0. In addition, many chemicals could not be evaluated due to the lack of threshold screening values. The conservative exposure assumptions utilized in the screening-level ERA were refined and HQ values were recalculated using the same conceptual site model that was developed for the screening-level ERA (i.e., same exposure pathways and receptors). With the exception of the great blue heron, one or more chemicals was shown to present a risk to each ecological receptor following the refinement of exposure assumptions. As such, it cannot be concluded that risks to ecological receptors at Area B following the refinement of exposure assumptions are negligible.

HQ values for individual receptors following the refinement of exposure assumptions are summarized below. The chemicals listed in italicized print are those with site HQ values that are less than background HQ values. The risks presented by these chemicals are not considered to be site related.

Sediment-Associated Biota	Copper (HQ = 5.35) and Vanadium (2.75)
Aquatic Life	Copper (HQ = 11.4) and Cyanide (5.40)
Earthworms	*Chromium (HQ = 26.8)*
Plants	*Chromium (HQ = 10.7)* and Lead (HQ = 2.02)
Belted kingfisher	Chromium (HQ = 1.30), Lead (HQ = 1.19), and Vanadium (HQ = 1.31)
Great Blue Heron	None
American Robin	Lead (HQ = 8.05)
Red-Tailed Hawk	Lead (HQ = 1.61)

Area C

Evidence of the impact of past site operations on surface soil is limited. Four SVOCs were detected in only one surface soil sample located down slope of Tanks 216 and 217. However, detected concentrations were below RBCs. These SVOCs are typically associated with tars, greases, heavy oils, and poorly refined fuels. Their presence may be related to site operations, but are limited in extent and concentration. Lead concentrations exceeded background-screening criteria in only one sample and low levels of TPH gasoline-range organics were also detected in the same sample.

There is also limited evidence of the impact of past site operations on subsurface soil. Lead concentrations exceeded background-screening criteria but did not exceed either the residential or industrial RBCs. Lead can be associated with leaded gasoline and its presence can be attributable to former site operations. Silver concentrations exceeded background-screening criteria but did not exceed either the residential or industrial RBCs. Silver is not associated with fuel storage operations and may be related to ambient soil conditions. Organic compound detections in subsurface soils are limited and do not exceed RBCs.

There is no evidence of the impact of past site operations on groundwater. Detection of organic compounds is sporadic, both temporally and spatially. Additionally, the organic compounds were detected at low levels. In terms of inorganic compounds, only barium and cadmium were detected. Cadmium exceeded only the Federal MCL, and is not typically associated with fuel storage operations.

The comparison of water quality parameters to federal standards shows several exceedences. These exceedences include several metals, as well as sulfate, color, and TDS. This suggests that untreated groundwater is not suitable for human use because of odor, color, and staining problems.

There is limited evidence of the impact of past site operations on surface water and sediment. Several VOCs were detected, but all were below screening criteria. Most inorganic analytes were detected in surface water and sediment, and many exceeded screening criteria. However, most of the inorganic compounds are not associated with fuel storage operations. Lead can be associated with fuel storage operations (leaded gasoline). Lead was detected in both surface water and sediment above screening criteria.

The HHRA did not identify an incremental lifetime cancer risk greater than the acceptable EPA limits in Area C.

Future young child military residents in Area C may also potentially be at risk. In Area C contaminants in groundwater contribute less than one percent of the noncarcinogenic risk. Chromium (evaluated as Cr VI) and vanadium in surface water and sediment drive ninety-four percent of the risk (thirty-eight percent chromium, and fifty-six percent vanadium). Similar to observance made in Area A, assuming total chromium may have overestimated the noncarcinogenic risk.

No other unacceptable noncarcinogenic risk associated with exposures to contaminants detected in Area C were estimated in the HHRA. The HHRA concludes that a minimal noncarcinogenic risk may potentially exist for future young child military resident in Area C.

The screening-level ERA indicated that the assessment endpoints for Area C were not met. As such, the results of the screening-level ERA are not sufficient to conclude that risks to the ecological receptors at the Area C are negligible. For all receptor species, there were multiple chemicals with HQ values greater than 1.0. In addition, many chemicals could not be evaluated due to the lack of threshold screening values. The conservative exposure assumptions utilized in the screening-level ERA were refined and HQ values were recalculated using the same conceptual site model that was developed for the screening-level ERA (i.e., same exposure pathways and receptors). With the exception of the great blue heron, one or more chemicals was shown to present a risk to each

ecological receptor following the refinement of exposure assumptions. As such, it cannot be concluded that risks to ecological receptors at Area C following the refinement of exposure assumptions are negligible.

HQ values for individual receptors following the refinement of exposure assumptions are summarized below. The chemicals listed in italicized print are those with site HQ values that are less than background HA values. The risks presented by these chemicals are not considered to be site related.

Sediment-Associated Biota	Barium (HQ = 1.14), Cobalt (HQ = 1.48), *Copper (HQ = 2.06)*, and Vanadium (2.16)
Aquatic Life: Chromium	(HQ = 2.56), Copper (HQ = 102), Lead (HQ = 12.4), Nickel (HQ = 7.05), and Zinc (HQ = 3.93)
Earthworms	Chromium (HQ = 61.0)
Plants	Chromium (HQ = 24.4)
Belted kingfisher	Cadmium (HQ = 1.76), Chromium (HQ = 1.19), Copper (HQ = 1.21), Lead (HQ = 2.77), Mercury (HQ = 1,200), Vanadium (HQ = 6.35), and Zinc (HQ = 11.3)
Great Blue Heron	Mercury (HQ = 419), Vanadium (HQ = 2.24), and Zinc (HQ = 3.98)
American Robin	Chromium (HQ = 2.15) and Lead (2.49)
Red-Tailed Hawk	None

The calculated risk presented by mercury to the belted kingfisher and great blue heron at Area C, as well as Area B, can be attributed to conservative exposure assumptions that were still applied to the "refined" risk calculation. The BCF value (27,900 L/kg) and NOAEL value (0.0064 mg/kg/day) used in the avian piscivore dietary intake models are based on an organometallic (methylated) form. If methylated mercury is not present in the surface water adjacent to Area C, use of a BCF value and NOAEL for inorganic mercury (2,998 L/kg and 0.45 mg/kg/day, respectively) would be more appropriate for the determination of potential risks. Use of a BCF value and NOAEL for inorganic mercury would reduce the calculated risks to these receptors by three orders of magnitude. This ERA also assumes that 100 percent of the mercury, as well as 100 percent of all chemicals detected in site

media, are bioavailable. In this assumption, total recoverable mercury data were used to estimate the tissue concentration of mercury in the prey of the belted kingfisher and great blue heron. Use of the biologically available fraction (i.e., dissolved fraction) would provide a more realistic estimation of fish tissue concentrations, and, therefore, a more realistic estimation of dietary intakes. It is noted that dissolved metals data were not available for use in the refinement of conservative exposure assumptions.

RECOMMENDATIONS

The following provides the recommendations separately for Areas A, B, and C.

Area A

It is recommended that a minimum of three additional surface water samples be collected from the adjacent Mangrove forest in the vicinity of Area A. These samples will be analyzed for total recoverable and dissolved metals. In addition, analyses are recommended to determine if methylated forms of mercury and selenium are present. These analyses will assist in further refinement of exposure assumptions for aquatic life and avian piscivores at Area A. It is also recommended that three additional background samples be collected for the same analyses. The background data will be used to determine if calculated risks at Area A are site related.

Area B

It is recommended that a minimum of three additional surface water samples be collected from the adjacent Mangrove forest in the vicinity of Area B. These samples will be analyzed for total recoverable and dissolved metals. In addition, analyses are recommended to determine if methylated forms of mercury and selenium are present. These analyses will assist in further refinement of exposure assumptions for aquatic life and avian piscivores at Area B. It is also recommended that three additional background samples be collected for the same analyses. The background data will be used to determine if calculated risks at Area B are site related.

Area C

It is recommended that a minimum of three additional surface water samples be collected from the adjacent Mangrove forest in the vicinity of Area C. These samples will be analyzed for total recoverable and dissolved metals. In addition, analyses are recommended to determine if methylated forms of mercury and selenium are present. These analyses will assist in further refinement of exposure assumptions for aquatic life and avian piscivores at Area C. It is also recommended that three additional background samples be collected for the same analyses. The background data will be used to determine if calculated risks at Area C are site related.

1.0 INTRODUCTION

This document presents results from the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI), for Solid Waste Management Unit (SWMU) 9, Operable Unit 2, Naval Station Roosevelt Roads (NSRR), Ceiba, Puerto Rico. This report is prepared under the Corrective Action provisions of the NSRR's RCRA Permit No. PR2170027203 and includes the results for three different phases of investigation as described in Section 1.1. This report has been prepared by Baker Environmental, Inc. (Baker) under contract to the Atlantic Division, Naval Facilities Engineering Command (LANTDIV) Contract Number N62470-95-D-6007, Contract Task Order (CTO) 099.

1.1 SWMU 9 Investigation History

On October 20, 1994, a Final RCRA Part B permit was issued by the United States Environmental Protection Agency (EPA) Region II to NSRR. This permit contains requirements for RFI activities at 24 SWMUs and three areas of concern (AOC). Prior to 1993, environmental activities at NSRR, exclusive of underground storage tanks (USTs), were conducted in compliance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulations under the Department of the Navy's (DoN's) Installation Restoration (IR) Program. The RCRA Part B permit, issued for the Defense Reutilization and Marketing Office (DRMO) at NSRR, included provisions for corrective action under the Hazardous and Solid Waste Amendments (HSWA) provisions of RCRA.

The various SWMUs and AOCs at NSRR have been grouped together into Operable Units (OUs) based on similarity of investigation scope, geography, or similarity of contaminants potentially released (Figure 1-1). This report pertains to SWMU 9 - Tanks 212-217, a fuel management area within OU 2. OU 2 consists of SWMU 7 and 8, Tow Way Fuel Farm and SWMU 9, Tanks 212-217. Originally, SWMU 9 was included in the OU 2 RFI report since, along with SWMUs 7 and 8, OU 2 encompassed the fuel farms at NSRR. A draft RFI report was submitted to which revisions were required based on the complexity of SWMUs 7 and 8, which comprise the Tow Way Fuel Farm. SWMU 9 was separated from SWMUs 7 and 8 to limit confusion between the areas and allow the specific problems at the Tow Way to be addressed individually.

The following provides a description of the three phases of field activities at SWMU 9 leading to the development of this Revised Draft RFI Report. Table 1-1 provides a summary of the investigations conducted and reports prepared for SWMU 9.

- The RCRA Part B permit required a full RFI for SWMU 9. RFI Work Plans (Baker 1995) were developed for NSRR which included SWMU 9. The field investigation for the work under this work plan is designated the Phase I investigation in this report.

- The field investigation for Phase I of the RFI for Operable Unit 2, including SWMU 9, was conducted during April 1996 and resulted in the development of the Draft RCRA Facility Investigation Report for Operable Unit 2, Naval Station Roosevelt Roads, Ceiba, Puerto Rico, September 1996 (Baker 1996).

- The EPA Region II reviewed the document and provided comments in a March 4, 1997 letter. A Work Plan Addendum (Baker 1997) was developed to perform additional field work to address EPA comments. This additional work is described as the Phase II investigation in this report.

- The Phase II field investigation took place during the fall (September/October) 1997 following EPA comments on the Draft RFI Report for Operable Unit 2, Naval Station Roosevelt Roads, Ceiba, Puerto Rico. The Phase II field activities led to the development of the Draft RCRA Facility Investigation Report for SWMU 9, Naval Station Roosevelt Roads, Ceiba, Puerto Rico, March 1998 (Baker 1998).

- The EPA Region II reviewed the document and provided comments in a June 15, 1998 letter. A Work Plan (Baker 1998) was developed to address these comments. This additional work is described as the Phase III investigation in this report.

- The Phase III investigatory work was conducted during June 1999 and led to the development of this report.

Each of the three phases of field investigation were conducted following the procedures outlined in site-specific work plans, which were submitted to, and approved by, the EPA. The Phase II and III work plans contained work elements designed to address comments received on the draft reports. The results from the three phases of investigations at SWMU 9 are provided and analyzed in this report.

1.2 Scope and Objectives

The scope of the RFI included completion of three phases of field investigation at Areas A, B, and C within SWMU 9 to assess the environmental impact of operations at the site. This document presents the results of the sampling conducted during the three phases of field investigation. The objective of the RFI is to summarize the results of the data gathered, evaluate potential human health and ecological risks within each area, and provide conclusions regarding the analytical results and corresponding risks as well as recommendations for SWMU 9.

1.3 Report Organization

Section 1.0 of this document includes this introduction and the scope and objectives of this RFI Report. Section 2.0 provides a description of the facility and historical background. Section 3.0 describes the field activities undertaken during the RFI at SWMU 9. It also describes the purpose of the study of individual media, sampling procedures, sampling locations for all media and quality control (QC) conducted during sampling activities. Section 4.0 provides a description of the physical characteristics (such as, geology and hydrology) of SWMU 9. Section 5.0 discusses the nature and extent of contamination detected in the environmental samples from each media sampled. Section 6.0 presents the human health risk assessment conducted for this SWMU. An ecological risk assessment is presented in Section 7.0. A summary of findings and conclusions are presented in Section 8.0 along with recommendations for SWMU 9. The report references are listed in Section 9.0.

SECTION 1.0
TABLES

TABLE 1-1

SWMU 9
INVESTIGATIONS AND REPORTING SUMMARY
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

WORK PLANS	INVESTIGATION	REPORT	EPA COMMENTS	GENERAL COMMENTS
RFI Work Plans for OU2 (Baker, 1995)	Phase I (April 1996): • Geophysical Investigation • Test Pit Excavations • Surface and Subsurface Soil Sampling • Monitoring Well Installation • Groundwater Sampling • Wellhead Testing • Surveying	Draft RFI Report for Operable Unit 2, Naval Station Roosevelt Roads, Ceiba, Puerto Rico, September 1996 (Baker 1996)	March 4, 1997 comments recommended additional work at Areas A and B, including: • Test Pit Excavation • Monitoring Well Installation	The RFI Work Plan Addendum was developed (Baker, 1997).
RFI Work Plan Addendum (Baker, 1997)	Phase II (September/October 1997) • Test Pit Excavations • Subsurface Soil Sampling • Monitoring Well Installation • Groundwater Sampling • Monitoring Well Abandonment • Surveying	Draft RFI Report for SWMU 9, Naval Station Roosevelt Roads, Ceiba, Puerto Rico, March 6, 1998 (Baker 1998)	June 15, 1998 comments recommended the following: • Background Sampling • Soil Boring and Groundwater Program (e.g. disposal pits, contaminated wells) to determine the extent of contamination • Ecological Risk Assessment ➢ sediment and surface water sampling to assist with the assessment	The RFI Work Plan Additional Investigations was developed (Baker, 1998).
RFI Work Plan Additional Investigations at SWMU 9 (Baker, 1998)	Phase III (June 1999) • Surface and Subsurface Soil Sampling • Temporary Piezometer Installation • Groundwater Sampling • Surface Water and Sediment Sampling • Background Sampling • Surveying	Revised Draft RFI Report for SWMU 9, Naval Station Roosevelt Roads, Ceiba, Puerto Rico, March 10, 2000 (This Document)		

SECTION 1.0
FIGURES

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LEGEND

1 – SWMUs

9 AREA A – INVESTIGATION AREA

AOC D – AOCs

SOURCE: LANTDIV, FEB. 1992/1997

2500 0 1250 2500

1 inch = 2500 ft.

FIGURE 1-1
SWMU/AOC LOCATION MAP

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

00779L01Y

2.0 FACILITY BACKGROUND

This section contains a description of the physical layout of the facility, Roosevelt Roads background history, and a summary of previous investigations.

2.1 Facility Description

NSRR occupies over 33,500 acres on the northern side of the east coast of Puerto Rico, along Vieques Passage with Vieques Island lying to the east about 10 miles off the harbor entrance. The north entrance to NSRR is about 35 miles east along the coast road (Route 3) from San Juan. The closest large town is Fajardo (population approximately 37,000), which is about 10 miles north of NSRR off Route 3. Ceiba (population approximately 17,000) adjoins the west boundary of NSRR (see Figure 2-1).

NSRR was commissioned in 1943 as a Naval Operations Base, and redesignated a Naval Station in 1957. The current primary mission of NSRR is provision of full support for Atlantic Fleet weapons training and development activities. NSRR has administrative and command responsibilities for some operations separated from the main base on Vieques Island.

2.2 SWMU 9 - Tanks 212-217

SWMU 9 is comprised of a series of six, concrete USTs located in three separate areas as shown on Figures 2-2 and 2-3. These areas include:

- Area A - Tanks 212 and 213
- Area B - Tanks 214 and 215
- Area C - Tanks 216 and 217

Areas A and B (Figure 2-2) are located north of Forrestal Drive along Manila Bay Street. Area C (Figure 2-3) is located approximately 4,000 feet southeast of Areas A and B, north of Forrestal Drive along Antienam Road. Previous reports indicate that these tanks were constructed in 1948 for the storage of aviation gasoline (AVGAS), and that the tanks were cleaned about every five years until 1978. According to base personnel, Tanks 212 and 213 are now used for the storage of diesel fuel and

unleaded gasoline, respectively. Tanks 214 and 215 were later changed from AVGAS storage to marine diesel fuel and are currently out of service. Tank 216 was most recently used for the storage of unleaded gasoline but is currently out of service. With regard to Tank 217, it is not clear if the tank was used for the storage of any fuel other than AVGAS. Previous investigations indicate that Tank 217 was used for the storage of marine diesel fuel and JP-5. This tank is also currently out of service.

Previous reports also indicate that these tanks were cleaned of sludge material approximately every five years until 1978. Reportedly, tank cleaning resulted in the removal of 800 to 1,250 gallons of sludge per tank, which was disposed in excavated pits adjacent to the individual tanks. An estimated 30,000 to 50,000 gallons of sludge material could have been disposed of over a 40-year period. Since 1978 sludge materials have been removed and disposed off-site by a licensed contractor.

2.3 Summary of Previous Investigations

This section summarizes the findings of previous environmental investigations conducted at SWMU 9.

2.3.1 Initial Assessment Study

As part of the Navy-wide program to manage past disposal sites through the Navy Assessment and Control of Installation Pollutants (NACIP), NSRR was designated for an Initial Assessment Study (IAS) in 1982. Conducted in 1983 and 1984 by Greenleaf/Telesca Planners, Engineers, Architects (Miami, Florida) and Ecology and Environment (Buffalo, New York), the IAS consisted of a records search at various government agencies, national and regional archives, and USGS; an on-site survey; and personnel interviews. The IAS identified 16 sites that warranted further study under the NACIP including SWMU 9.

2.3.2 Confirmation Study

In May 1986, a Confirmation Study (CS) was performed by Environmental Science and Engineering (ESE) of Gainesville, Florida. Fifteen of the 16 sites identified in the IAS were investigated as part of this study including SWMU 9. The CS consisted of two rounds of sample collection from the 15 sites. Completed in April 1988, the CS (ESE, 1988) indicated 14 sites, including SWMU 9, required additional investigation. The quality of data obtained during the CS is questionable due to the unknown level of laboratory data quality objectives and the apparent lack of independent, third party data validation; therefore, no conclusions regarding conditions at any of the sites investigated can be drawn on the basis of the CS information.

SECTION 2.0
FIGURES

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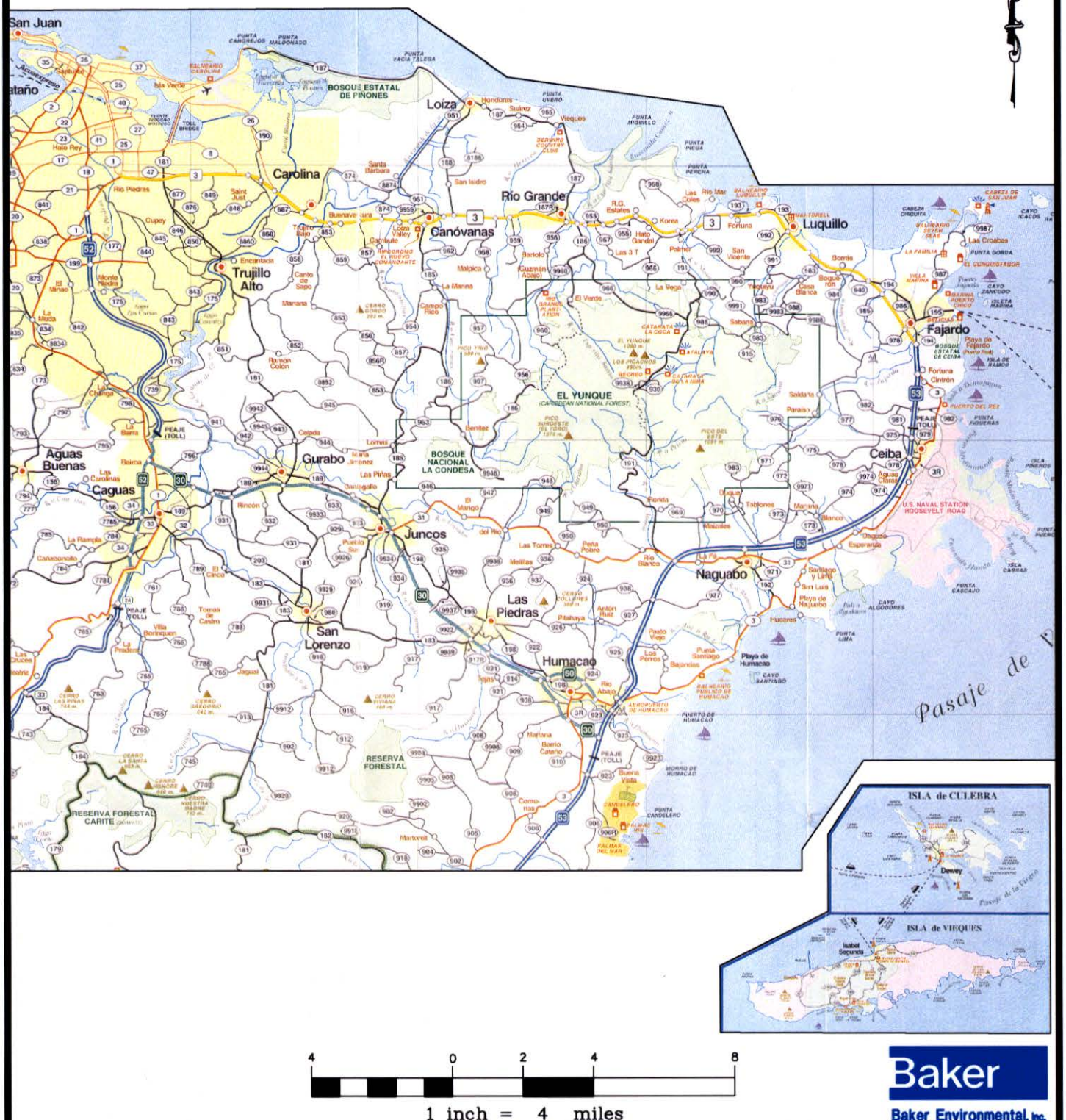


4 0 2 4 8

1 inch = 4 miles

Baker

Baker Environmental, Inc.

FIGURE 2-1
REGIONAL LOCATION MAP

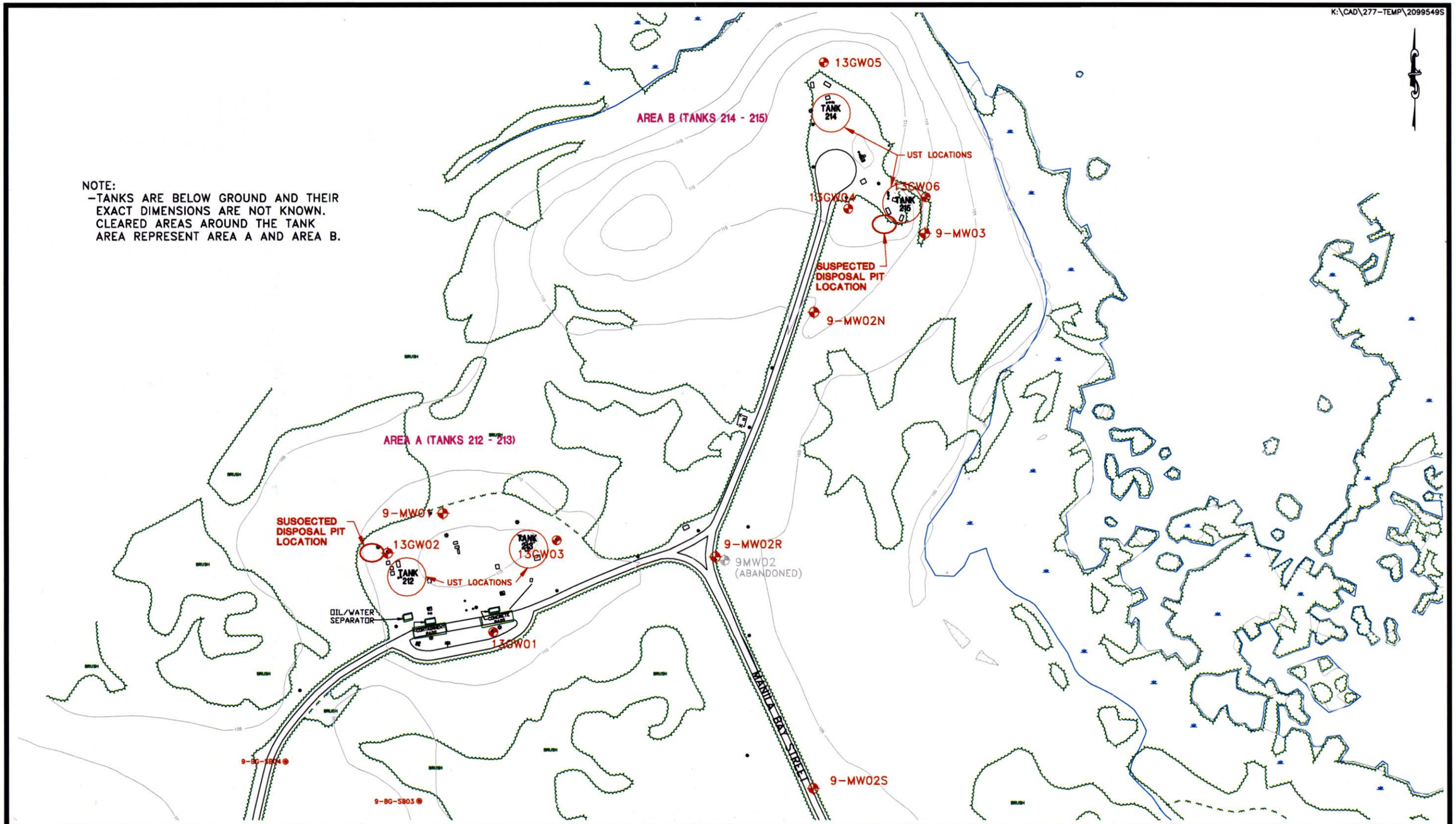
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SOURCE: METRODATA, INC., 1999.

00779 | R2Y

K:\CAD\277-TEMP\2099549S

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA A AND AREA B.



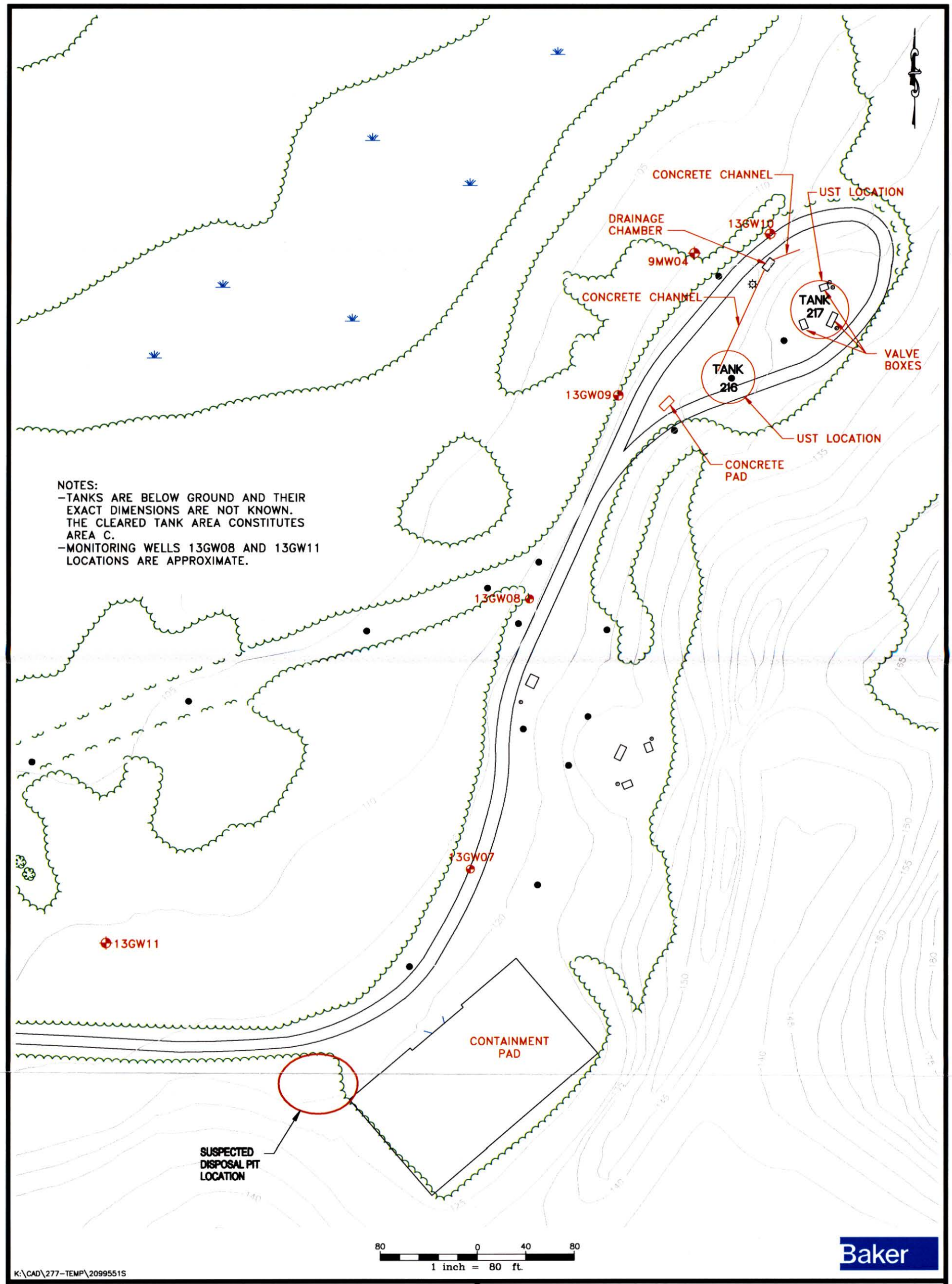
LEGEND

- EXISTING MONITORING WELL LOCATION
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- VALVE PITS
- TELEPHONE POLE

180 0 90 180
1 inch = 180 ft.

Baker

FIGURE 2-2
CURRENT CONDITIONS
SWMU 9 - AREAS A AND B
TANKS 212 - 215
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



LEGEND

- EXISTING MONITORING WELL LOCATION
- SURFACE ELEVATION CONTOUR
- TELEPHONE POLE
- SUSPECTED LOCATION OF DISPOSAL PIT

FIGURE 2-3
CURRENT CONDITIONS
SWMU 9 – AREA C
TANKS 216 – 217

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

3.0 FACILITY INVESTIGATION

The following sections present a description of the environmental field investigation activities conducted at SWMU 9. All investigations performed and the methodologies used were in accordance with the approved RFI Work Plans (Baker, 1995, 1997, and 1998).

3.1 RFI Facility History

The RFI at SWMU 9 was conducted as a series of three phases of investigation phase I was conducted on April 1996; Phase II in September/October 1997; and Phase III in June 1999.

3.1.1 Phase I RFI

The first phase RFI field activities (April 1996) included a geophysical investigation, test pit excavations, surface and subsurface soil sampling, monitoring well installation, groundwater sampling, wellhead testing, and surveying in accordance with the RFI Work Plans. This initial field investigation was conducted to fulfill the EPA RCRA Part B permit requirement for a full RFI for the fuel storage and disposal activities at SWMU 9. The results of this investigation were reported in the Draft RCRA Facility Investigation Report for Operable Unit 2, Naval Station Roosevelt Roads, Ceiba, Puerto Rico, September 1996 (Baker 1996).

3.1.2 Phase II RFI

The second phase RFI field activities (September/October 1997) were conducted to address comments dated (March 4, 1997) submitted by the USEPA Region II on the Draft RCRA Facility Investigation Report for Operable Unit 2, Naval Station Roosevelt Roads, Ceiba, Puerto Rico, September 1996 (Baker 1996). The EPA comments indicated the need for two additional items: test pit excavations at Areas A and B to further substantiate potential fuel related contaminated from fuel storage and suspected sludge disposal practices. Installation of additional monitoring wells, including soil and groundwater sampling to provide site related background information.

3.1.2.1 Phase II Test Pits

Five investigatory test pit excavations were included in the Phase II field activities to address the EPA comments. Three of the test pits were located in Area A (9TP07A, 9TP07B, and 9TP09A) as presented on Figure 3-1, and two were placed in Area B (9TP01A and 9TP02A) as shown on Figure 3-2.

Phase II Area A Test Pits

Three test pits were excavated in Area A during the second phase of the investigation.

- Test pits 9TP07A and 9TP07B were located west and north of the suspected fuel disposal pit that is northwest of Tank Area 212. These were situated to ensure that any release from the suspected disposal pit can be identified; based on surrounding topography, contaminants from tank bottom sludges could be expected to migrate to the west and north.

- Test pit 9TP09, excavated during Phase I to locate a suspected disposal pit associated with Tank Area 213 did not substantiate the suspected disposal pit area. Therefore, test pit 9TP09A was excavated on a southwest-northeast axis 100 feet north of 9TP09 in an attempt to locate a suspected disposal pit associated with Tank Area 213.

Phase II Area B Test Pits

Two test pits were excavated in Area B during the second phase of the investigation.

- Test Pit 9TP01A was excavated in a further attempt to locate the suspected disposal pit adjacent to Tank Area 215. This test pit was located adjacent to the south side of the suspect disposal pit.

- Test Pit 9TP02A was excavated in a further attempt to locate the suspected disposal pit adjacent to Tank Area 215. This test pit was excavated on a southeast-northwest axis in perpendicular to the first test pit, 9TP02.

3.1.2.2 Phase II Groundwater Investigation

EPA comments requested background investigation of groundwater in the area of monitoring well 9MW02. Well 9MW02 was installed during the Phase I investigations just off the access road to Areas A and B at a point remote to each operational area. The location should have been free of effect from site operations. The well was installed with the intent to have the well screen straddle the water table which would allow any light non-aqueous phase liquid (LNAPL) to freely enter the well. Final equilibrated water levels were found to be significantly higher than the apparent occurrence of water in the boring would have indicated. This resulted in complete inundation of the well screen. As part of the Phase II groundwater investigation three new monitoring wells were located within Areas A and B of SWMU 9 along Manila Bay Street. This also included the abandonment and replacement of monitoring well 9MW02.

The results of this investigation were reported in the Draft RCRA Facility Investigation Report for SWMU 9, Naval Station Roosevelt Roads, Ceiba, Puerto Rico, March 6, 1998 (Baker 1998).

3.1.3 Phase III RFI

The third phase RFI field activities (June 1999) were conducted to address comments submitted by the USEPA Region II regarding the Draft RCRA Facility Investigation Report for SWMU 9, Naval Station Roosevelt Roads, Ceiba, Puerto Rico, March 6, 1998 (Baker 1998).

EPA comments also requested a number of additional activities within Areas A, B, and C. The following is a summary of these comments and the actions taken during the third phase of the investigation.

3.1.3.1 Phase III Area A

- Well 9MW02R was originally intended to be a background sampling point for Areas A and B. During drilling, a petroleum odor was noted and groundwater sampling confirmed the presence of significant levels of benzene and toluene. The extent of the benzene and toluene plume in the area of 9MW02R was investigated through a boring program during which soil and groundwater samples were obtained in concentric rings around 9MW02R.

- The potential usability of the uppermost aquifer as a drinking water source was to be established. The general quality of the uppermost aquifer in terms of its usability as a potable water source was established by analyzing certain groundwater samples for the National Secondary Drinking Water Regulations (40CFR, Part 143) parameters.

- Metals concentrations in soil and groundwater were found to exceed the background values established at the Base perimeter. Site-specific background sampling of soil and groundwater was conducted at the perimeter of SWMU 9. This provided a comparison data set for onsite sampling results.

- Groundwater at well 13GW02 indicated the presence of benzene above MCLs and the extent of the contamination was investigated. This was accomplished through a boring program during which soil and groundwater samples were obtained and analyzed from borings placed at varying distances downgradient of 13GW02.

3.1.3.2 Phase III Area B

- The metals in groundwater and soils exceeded the concentrations in the Base background data set. Site-specific background sampling of soil and groundwater was conducted at the perimeter of SWMU 9. This provided a comparison data set for onsite sampling results.

- Sampling results at 13GW05 indicated the presence of benzene above MCLs. The extent of the contamination was investigated through a boring program during which soil and groundwater samples were obtained and analyzed from borings placed at varying distances downgradient of 13GW05.

- Sampling results at 9TP02 and nearby well 13GW06 indicated the presence of volatile organics at significant levels. Also in the general area of these two sampling points, a suspected disposal pit was identified. The extent of contamination around 9TP02 and 13GW06 was investigated downgradient of 9TP02 and 13GW06. This was accomplished through a boring program during which soil and groundwater samples were obtained and analyzed from locations progressively downgradient of the test pit and monitoring well. Also, the area of the disposal pit was directly investigated by placing a boring directly through the area.

Phase III Area C

- Two organic constituents were detected, one each in widely separated wells. The extent of these occurrences was to be verified through resampling of the wells.

- Cadmium in groundwater at one location was above values established in the background data set. Site-specific background sampling of soil and groundwater was conducted at the perimeter of SWMU 9. This provided a comparison data set for onsite sampling results.

Finally, the potential ecological risks were established and included in this report. This was accomplished by:

- Collecting sediment and surface water samples
- Identifying potential receptors, and
- Performing an Ecological Risk Assessment.

3.2 Geophysical Investigation

A geophysical investigation was conducted at SWMU 9 during the first phase of field investigation by GeoPhex, Ltd. to provide information regarding the locations of former fuel sludge disposal pits. This investigation used a combination of both electromagnetic (EM) terrain conductivity and ground penetrating radar (GPR) surveys. The geophysical report prepared by GeoPhex, Ltd. is provided as Appendix A.

Prior to collecting geophysical data, an initial 50-foot grid was established at SWMU 9. Locations of the geophysical survey are provided in Appendix A. GPR data was acquired within the mowed areas of the SWMU and transects cut into the vegetation for access. GPR data was collected using two systems; a 500 MHz monostatic (transmitter and receiver housed together) antenna, and a 100 MHz bistatic (transmitter and receiver housed separately) antenna. Data collected using the 500 MHz antenna indicated that the pulse was severely attenuated by the surface and subsurface soil resulting in poor penetration of the radar signal. The radar signal rarely penetrated deeper than 30 inches and was unpredictable. Due to this poor signal bistatic radar was utilized. The bistatic radar (100 MHz) typically increases the reflectivity of planar targets in the subsurface over the 500 MHz antenna. This method detected penetration depths of as much as 60 inches, however, the resolving power of near surface targets decreased.

SWMU 9 soil consisted of densely compacted silty clay and weathered gabbro bedrock. Gabbros are characteristically high in mafic minerals such as olivine, pyroxines, amphiboles, and mica. These minerals are predominantly iron, magnesium, and titanium in content. The high reflective nature of the mineral content in the surface and subsurface soil masked (or attenuated) the GPR signal thus preventing the detection of any sludge disposal pits.

Due to the lack of useable GPR data, EM data (using the GEM-2, at 1,530 Hz and 7,290 Hz frequencies) was collected. The high frequency anomalous features detected in the field were all correlated to surficial features (e.g., concrete vaults) or known location of underground piping or conduits. Additionally, the close proximity of cultural features such as overhead power lines within SWMU 9, greatly affected the conductivity data. As a result, there were no fuel sludge disposal pits identified by the EM data.

During the performance of the field investigation, the EPA was kept fully apprised of the problems associated with the geophysics. The change to full EM coverage with bistatic radar used only at EM anomalies was discussed with, and approved by, EPA representatives prior to changing the approach in the field.

3.3 Sampling Activities at SWMU 9 - Tanks 212-217

The field sampling activities at SWMU 9 during the three phases of investigation consisted of collecting:

- Surface soil samples at specific identified locations and during monitoring well installations

- Subsurface soil samples during the installation of shallow monitoring wells, test pits, and Geoprobe® activities

- Groundwater samples from the monitoring wells and temporary wells installed during the Geoprobe® activities

- Sediment and surface water samples at specific identified locations

Environmental sampling locations within Areas A, B, and C are presented on Figures 3-1, 3-2, and 3-3 and described in the following subsections. The surface water and sediment sample locations for Areas A and B are depicted on Figure 3-4. Also, included in this report is a description of the procedures employed during sampling.

Tables 3-1 through 3-4 present a listing of samples collected from Areas A, B, C, and the background locations, including the associated analytical parameters. Tables 3-5, 3-6, and 3-8 present individual parameters included in the Appendix IX and RCRA Metals compound list and water quality parameters.

3.3.1 Area A – Tanks 212–213

During the three phases of field investigations within SWMU 9 Area A there were surface and subsurface soil samples, sediment, surface water, and groundwater samples collected. The following subsections identify the type, number, and sample analysis parameters for the Area A investigations. These sampling locations are identified on Figures 3-1 (soil and ground water sample locations) and Figure 3-4 (sediment and surface water sample locations). The sample information including sample depth, date of collection, and analytical parameters are identified in Table 3-1.

3.3.1.1 Area A - Surface Soil Investigation

A total of four surface soil samples were collected from the Area A tank pads during the Phase I investigation. The surface soil sample locations were based on visual observations of stained areas, areas overlying identified pits, or low areas where surface drainage would collect. Two locations were for surface soil sample collection only (9SS01 and 9SS02); the other two surface soil samples were collected during the installation of two monitoring wells (9MW01 and 9MW02) (Figure 3-1). A description of the soil sampling procedures employed is provided in Section 3.5. The first phase

SWMU 9 surface soil samples were submitted to the laboratory for analysis of Appendix IX volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), RCRA Metals and total petroleum hydrocarbons (TPH) (diesel range organics and gasoline range organics) as shown in Table 3-1.

There were no surface soil samples collected within Area A during the second and third phase of the RFI investigation in accordance with the EPA approved RFI Work Plans.

3.3.1.2 Area A - Subsurface Soil Investigation

A total of 10 subsurface soil samples were obtained during the Phase I activities within Area A (Figure 3-1). The subsurface soils were collected from suspected disposal pit locations and test pit excavations. Five of these subsurface soil samples were collected during the installation of two Area A monitoring wells (9MW01 and 9MW02). This series of subsurface soil samples was collected to assess the subsurface media for potential petroleum hydrocarbon contamination. Two soil samples were collected from boring 9MW01; one was collected immediately above the water table and one was collected from an interval between the ground surface and the water table based on visual observations. Three soil samples were collected from soil boring 9MW02; one was collected directly above the water table and two were collected at intervals between the ground surface and the water table based on visual observations.

The other five Phase I subsurface soil samples were collected during test pit excavation activities within Area A. A total of 5 exploratory test pits, 9TP07 through 9TP10 and 9TP18 were excavated during the first phase of investigation and subsurface soil samples were collected from each of these test pits directly above the water table. These test pits were excavated to locate sludge disposal pits associated with the fuel storage tanks 212 and 213. The Area A Phase I test pit locations are identified on Figure 3-1. The Phase I subsurface soil samples were submitted to the laboratory for analysis of Appendix IX VOCs and SVOCs, RCRA Metals and TPH (diesel range organics and gasoline range organics) as shown in Table 3-1. Copies of the Test Pit Records are provided as Appendix B.

During the second phase of investigation a total of ten subsurface soil samples were collected in Area A (Figure 3-1). These subsurface soils samples were collected during the monitoring well installations to characterize the soil. Four of the Phase II subsurface soil samples were collected during the installation of three shallow monitoring wells (9MW02R, 9MW02S, and 9MW02N). One subsurface soil sample was collected from each well boring; an additional soil sample was collected from well boring 9-MW02R based on evidence of visual, and instrumental (Photo Ionizing Detector [PID]) contamination detection.

The other six Phase II Area A subsurface soil samples were collected from three test pits (9TP07A, 9TP07B, and 9TP09A). These test pits were excavated to locate reported sludge disposal pits associated with the fuel storage. Two subsurface soil samples were collected from each of the three test pits. The test pit locations and dimensions are shown on Figure 3-1. Each test pit sample was analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX), TPH (gasoline range organics and diesel range organics), and RCRA metals (Table 3-1). Subsurface soil sampling procedures are described in Section 3.5. Test pit specifics, including dimensions, PID readings, location, orientation, and sample identification numbers are presented on the Test Pit Records provided as Appendix B.

During the Phase III Area A investigation a total of 14 subsurface soil samples including two duplicate samples were collected (Figure 3-1). These samples were collected at 12 Geoprobe® boring locations (9-02R-HP01 through 9-02R-HP12) in the vicinity of monitoring well 9-MW02R. Well 9MW02R was originally intended to be a background sampling point for Areas A and B. During drilling, a petroleum odor was noted and groundwater sampling confirmed the presence of significant levels of benzene and toluene. The subsurface soil samples were collected in concentric rings around 9-MW02R to establish the extent of contamination. One sample was collected from each of the 12 Geoprobe® boring locations along with two duplicate samples. Each of the 12 subsurface soil samples collected were analyzed for BTEX and TPH (gasoline range organics and diesel range organics) (Table 3-1).

3.3.1.3 Area A - Groundwater Investigation

The first phase of groundwater investigation at Area A involved sampling three existing monitoring wells (13GW01 through 13GW03) in addition to sampling two newly installed wells (9MW01 and

9MW02) (Figure 3-1). This monitoring well network provided upgradient and downgradient monitoring to provide groundwater characterization at Tank Areas 212 and 213. Each Area A monitoring well was sampled and analyzed for VOCs, SVOCs, polychlorinated biphenyls (PCBs), and TPH (diesel range organics and gasoline range organics). The two newly installed wells were also analyzed for RCRA Metals (total and dissolved). Sampling procedures and monitoring well installation are discussed in Section 3.6. Upon completion of the groundwater sampling, all wells at SWMU 9 (existing and new) were slug tested to assess the hydraulic conductivity of the formation adjacent to the monitoring well. The slug test procedures are discussed in Section 3.6.5.

The second phase groundwater investigation at Area A included the installation, development, and sampling of three new monitoring wells and the abandonment of one previously installed monitoring well (9MW02). Well 9MW02 was installed during the Phase I investigations just off the access road to Areas A and B at a point remote to each operational area. The location was anticipated to be free of effect from site operations. The well was installed with the intent to have the well screen straddle the water table which would allow any light non-aqueous phase liquid (LNAPL) to freely enter the well. Final equilibrated water levels were found to be significantly higher than the apparent occurrence of water in the boring would have indicated. This resulted in complete inundation of the well screen.

Well 9MW02R, Figure 3-1, was installed during the second phase of investigations to remedy the situation. The replacement well (hence the "R" designation) was installed in approximately the same location as well 9MW02 which was abandoned by overdrilling leaving only the replacement well (9MW02R) operable.

In addition to 9MW02R, two other new monitoring wells were installed along the East Side of the access road into SWMU 9 (Manila Bay Street). One well within Area A was placed approximately 450 feet south-southeast of 9MW02 along Manila Bay Street and designated 9MW02S and another well was installed adjacent to 9MW02 and designated 9MW02R (Figure 3-1). Another new monitoring well, although part of the Area A investigation, was placed within Area B, approximately 480 feet north-northeast of 9MW02 along the access road to Area B, designated 9MW02N (Figure 3-2).

These three new monitoring wells were installed to delineate groundwater contamination in the area of 9MW02. Groundwater samples were obtained from each of these monitoring wells and analyzed for BTEX, TPH (gasoline range organics and diesel range organics), and RCRA metals (total and dissolved). Sampling procedures and monitoring well installation procedures are discussed in Section 3.6.

The Phase III groundwater investigation at Area A involved the collection of 23 groundwater samples, including four duplicates. These groundwater samples were collected to delineate contamination for two areas of concern found to be present after the first two phases of investigatory work. These areas include the vicinity of monitoring well 13GW02 and 9MW02 (abandoned). An area of elevated benzene concentration was noted in the vicinity of monitoring well 13GW02 upon receipt of the validated data. The EPA requested additional characterization in the area of 13GW02 to delineate the extent of the benzene occurrence.

Well 9-MW02R was sampled during the recent phase of investigations. A petroleum odor was noted during drilling and benzene and toluene were found in the groundwater at levels significantly above the Federal MCLs. The EPA also requested additional investigations in the area of 9-MW02R to delineate the extent of benzene and toluene groundwater contamination.

The groundwater samples were acquired from 17 Geoprobe® boring/temporary piezometer locations and two existing monitoring wells (13GW02 and 9-MW02R) as shown on Figure 3-1. Five Geoprobe® groundwater samples were collected around Area A monitoring well 13GW02. The initial two Geoprobe® groundwater samples were collected 50 feet to the west and north of 13GW02 (borings 9-A02HP01 and 9-02HP02). Based on the on-site laboratory results from these initial two samples an additional three Geoprobe® borings (9-A02HP03 through 9-A02HP05) were located at a distance of 150 feet from the well as shown on Figure 3-1. The outermost ring of Geoprobe® borings/samples (200 feet away) were not required to further delineate the extent of contamination due to the nearness of the surface water at this distance.

There were 12 Geoprobe® groundwater samples collected in the vicinity of Area A monitoring well 9-MW02R as described below.

- Three Geoprobe® sampling points (temporary piezometers) were placed 50 feet from the well (9-A02R-HP01 through 9-A02R-HP03)

- Three Geoprobe® sampling points were placed at 100 feet from the well (9-A02R-HP04 through 9-A02R-HP06)

- Three Geoprobe® sampling points were placed at 150 feet from the well (9-A02R-HP07 through 9-A02R-HP09)

- Three additional Geoprobe® sampling points were established at 200 feet from the well because of onsite laboratory detection results of the initial nine samples and to determine the extent of contamination (9-A02R-HP10 through 9-A02R-HP12)

Each of the Geoprobe® groundwater samples was analyzed at an on-site laboratory for BTEX; 10 of these samples were also analyzed for TPH (gasoline range organics and diesel range organics) in the on-site laboratory. One of the groundwater samples that tested positive for some of the BTEX parameters was sent to an off-site laboratory for confirmation. The two samples collected from the monitoring wells were also sent off site and analyzed for water quality parameters provided in Table 3-8.

3.3.1.4 Area A – Sediment and Surface Water Investigation

There were no sediment or surface water samples collected for Area A during the first and second phases of the RFI investigation in accordance with the EPA approved RFI Work Plans.

One sediment sample and one surface water sample were collected during the Phase III investigation at Area A: 9SD02 and 9SW02. The data from these samples was used in assessing potential ecological risks. The Area A Phase III investigation sediment and surface water sample location is identified on Figure 3-4. The sediment sample was submitted to the laboratory for analysis of Appendix IX VOCs, SVOCs, Sulfide, Metalloids (Arsenic and Cyanide) and Appendix IX Inorganics. The surface water sample was submitted to the laboratory for analysis of Appendix IX VOCs, SVOCs, Total Metalloids (Arsenic and Cyanide) and Appendix IX Total Inorganics.

3.3.2 Area B – Tanks 214-215

During the three phases of the field investigation within Area B there were surface and subsurface soil, sediment, surface water, and groundwater samples collected. The following subsections identify the type, number, and sample analysis parameters for the Area B investigation. The sampling locations are identified on Figure 3-2 (soil and ground water sample locations) and Figure 3-4 (sediment and surface water sample locations); the analytical parameters are identified in Table 3-2.

3.3.2.1 Area B - Surface Soil Investigation

A total of three surface soil samples were collected from the Area B tank pads during the Phase I investigation. Two locations were for surface soil sample collection only (9SS03 and 9SS04) and based on proximity to test pits and anticipated disposal pits. The third surface soil sample was collected during the installation of monitoring well 9MW03 (Figure 3-2). A description of the soil sampling procedures employed is provided in Section 3.5. The Phase I Area B surface soil samples were submitted to the laboratory for analysis of Appendix IX VOCs, SVOCs, RCRA Metals and TPH (diesel range organics and gasoline range organics) as shown in Table 3-2.

There were no surface soil samples collected within Area B during the second and third phases of investigation in accordance with the EPA approved RFI Work Plans.

3.3.2.2 Area B - Subsurface Soil Investigation

A total of seven subsurface soil samples were obtained during the Phase I (Figure 3-2). The subsurface soils were collected from suspect disposal pit locations and test pit excavations. Two of these subsurface soil samples were collected during the installation of monitoring well (9MW03). One subsurface soil sample was collected immediately above the water table and the other was collected from an interval between the ground surface and the water table.

The other five Phase I subsurface soil samples were collected during test pit activities. These test pits were excavated to locate sludge disposal pits associated with Fuel Tanks 214 and 215. A total of six exploratory test pits, 9TP01 through 9TP06 were excavated during the Phase I investigation and one

subsurface soil sample was collected above the water table from 9TP02 through 9TP06. There was no sample collected from 9TP01 because no visible evident signs of contamination were present. The Area B Phase I test pit locations are identified on Figure 3-2. The Phase I subsurface samples were submitted to the laboratory for analysis of Appendix IX VOCs, SVOCs, RCRA Metals and TPH (diesel range organics and gasoline range organics) as shown in Table 3-2. Copies of the test pit records are provided as Appendix B.

During the second phase of investigation a total of four subsurface soil samples were collected in Area B. These test pits were excavated to locate reported sludge disposal pits associated with the fuel storage. These four subsurface soil samples were collected from two test pits (9TP01A and 9TP02A). Two subsurface soil samples were collected from each test pit. The test pit locations and dimensions are shown on Figure 3-2. Each sample was analyzed for BTEX, TPH (gasoline range organics and diesel range organics), and RCRA Metals (Table 3-2). Subsurface soil sampling procedures are described in Section 3.5. Test pit specifics, including dimensions, PID readings, location, orientation, and sample identification numbers are located on the Test Pit Records provided as Appendix B.

During the third phase of investigation, two subsurface soil samples were collected at Geoprobe® location 9-B06-HP04, (9-B06-HP04-01 and 9-B06-HP04-02) (Figure 3-2). These samples were used to assist in determining the extent of contamination from monitoring well 13GW06. Both Geoprobe® subsurface soil samples were analyzed for Appendix IX VOCs.

3.3.2.3 Area B - Groundwater Investigation

The Phase I groundwater investigation at Area B included sampling three existing monitoring wells (13GW04, 13GW05, and 13GW06) and one newly installed well (9MW03) (Figure 3-2). This monitoring well network provided upgradient and downgradient monitoring to provide groundwater characterization at Tank Area 214 and 215. The Area B monitoring well samples were analyzed for Appendix IX VOCs, SVOCs, PCBs, and TPH (diesel range organics and gasoline range organics) (Table 3-2). The newly installed well was also analyzed for RCRA Metals (total and dissolved). Sampling and monitoring well installation procedures are discussed in Section 3.6. Upon completion of the groundwater sampling, all wells at SWMU 9 (existing and new) were slug tested to assess the

hydraulic conductivity of the formation adjacent to the monitoring well. The slug test procedures are discussed in Section 3.6.5.

There were no groundwater samples collected from Area B during the second phase of investigation in accordance with the EPA approved RFI Work Plan Addendum.

The Phase III groundwater investigation at Area B involved the collection of 13 groundwater samples including one duplicate. These groundwater sample were collected to delineate contamination for two areas of concern within Area B. This includes the area around 13GW05 where benzene was detected in groundwater and the area around 9TP02 and 13GW06 where VOCs were found in the groundwater. The samples were collected from 10 Geoprobe® boring/temporary piezometer locations and two existing monitoring wells (13GW05 and 13GW06). Five Geoprobe® groundwater samples were collected around Area B monitoring well 13GW05. The two initial sampling locations (9-B05-HP01 and 9-B05-HP02) were placed 50 feet downgradient of 13GW05 (based on the previous groundwater investigations and the site topography), and designed to detect contamination migrating away from the well. Geoprobe® borings were installed and used to construct temporary piezometers for groundwater sampling. Based on the onsite laboratory results from these two samples an additional three Geoprobe® borings/temporary piezometers (9-B05-HP03 through 9-B05-HP05) were located at a distance of 100 feet from the well as shown on Figure 3-2. The outermost ring (150 feet away) of Geoprobe® groundwater samples were not required to further delineate the extent of contamination due to the presence of surface water at this distance.

Five Geoprobe® groundwater samples were also collected around Area B monitoring well 13GW06. The initial four Geoprobe® boring/temporary piezometer locations (9-B06-HP-01 through 9-B06-HP04) were selected to monitor groundwater flow downgradient of BGW06 (based on previous groundwater information and the topography of the site). Geoprobe® borings were installed and used to construct temporary piezometers for groundwater samples. Based on the onsite laboratory results from the four samples, one additional Geoprobe® boring/tempory piezometer (9-B05-HP-05) was installed at a distance of approximately 110 feet west of the well as shown on Figure 3-2.

Each of the Geoprobe® groundwater samples were analyzed on site for BTEX. One groundwater sample that tested positive for benzene from on-site analysis was sent to an off-site laboratory for confirmation. The two monitoring well groundwater samples were also sent off site and analyzed for the water quality parameters provided in Table 3-8.

3.3.2.4 Area B – Sediment and Surface Water Investigation

There were no sediment or surface water samples collected for Area B during the first and second phases of investigation in accordance with the EPA approved RFI Work Plans.

There were four sediment samples (9SD01, 9SD01D, 9SD03, and 9SD04) including one duplicate and four surface water samples (9SW01, 9SW01D, 9SW03, and 9SW04) including one duplicate collected for Area B during the Phase III investigation. The data from the samples was used in assessing potential ecological risks. The Area B sediment and surface water sample locations are identified on Figure 3-4. The sediment samples were submitted to an off-site laboratory for analysis of Appendix IX VOCs, SVOCs, sulfide, arsenic, cyanide, and Appendix IX inorganics. The surface water samples were submitted to the laboratory for analysis of Appendix IX VOCs, SVOCs, arsenic, cyanide, and Appendix IX total inorganics.

3.3.3 Area C – Tanks 216-217

Samples were collected within SWMU 9 Area C during the first and third phases of investigation. There were surface and subsurface soil samples and groundwater samples collected during the Phase I investigation. Only groundwater, sediment, and surface water samples were collected during the Phase III investigation. There were no samples collected in Area C during the Phase II investigation. The following subsections identify the type, number, and analysis parameters for the Area C investigations. The sampling locations are identified on Figure 3-3 and the analytical parameters are identified in Table 3-3.

3.3.3.1 Area C - Surface Soil Investigation

A total of three surface soil samples were collected from the Area C tank pads during the first phase of investigation. The surface soil samples were based on visual observations, areas overlying identified pits, or low areas where surface drainage would collect. Two surface soil samples were collected at locations 9SS05 and 9SS06 and the other surface soil sample was collected during the installation of monitoring well 9MW04 (Figure 3-3). A description of the soil sampling procedures employed is provided in Section 3.5. The Phase I investigation surface soil samples were submitted to an off-site laboratory for analysis of Appendix IX VOCs, SVOCs, RCRA Metals and TPH (diesel range organics and gasoline range organics) as shown in Table 3-3.

There were no surface soil samples collected within Area C during the second and third phases of investigation in accordance with the EPA approved RFI work plan addendums.

3.3.3.2 Area C - Subsurface Soil Investigation

A total of ten subsurface soil samples including two duplicates were obtained during the Phase I investigation (Figure 3-3). The subsurface soils were collected from suspected disposal pit locations and test pit excavations. Two of these subsurface soil samples were collected during the installation of monitoring well 9MW04. One subsurface soil sample was collected immediately above the water table and the other was collected from an interval between the ground surface and the water table.

The other eight Phase I subsurface soil samples including two duplicates were collected during test pit activities. These test pits were excavated to locate sludge disposal pits associated with Fuel Tanks 216 and 217. A total of seven exploratory test pits, 9TP11 through 9TP17, were excavated during the first phase of investigation and subsurface soil samples were collected from six of these test pits. There was no sample collected from 9TP12 because no visible indications of contamination were evident. The Area C test pit locations are identified on Figure 3-3. The Phase I subsurface soil samples were submitted to the laboratory for analysis of Appendix IX VOCs, SVOCs, RCRA Metals and TPH (diesel range organics and gasoline range organics) as shown in Table 3-3. Copies of the test pit records are provided as Appendix B.

There were no subsurface soil samples collected within Area C during the second and third phases of investigation in accordance with the EPA approved RFI work plan addendums.

3.3.3.3 Area C - Groundwater Investigation

The first phase of groundwater investigation at Area C included sampling five existing monitoring wells (13GW07 through 13GW11) and one newly installed well (9MW04) (Figure 3-3). This monitoring well network provided upgradient and downgradient monitoring to provide groundwater characterization at Tank Areas 216 and 217. The Area C groundwater samples were analyzed for Appendix IX VOCs, SVOCs, PCBs, and TPH (diesel range organics and gasoline range organics). The newly installed well was also analyzed for RCRA Metals (total and dissolved). Sampling and monitoring well installation procedures are discussed in Section 3.6. Upon completion of the groundwater sampling, all wells at SWMU 9 (existing and new) were slug tested to assess the hydraulic conductivity of the formation adjacent to the monitoring well. The slug test procedures are discussed in Section 3.6.5.

The first phase work plans originally had two wells scheduled to be installed in Area C adjacent to Tank 217 (9MW03 and 9MW04). Because bedrock was encountered at 26 feet below ground surface (bgs) at the location east of Tank 217, without encountering groundwater, it was abandoned and designated 9SB01. An environmental sample was not collected from 9SB01. This well was then relocated to a point east of Tank 215 in Area B (Figure 3-2) and designated 9MW03. The fourth well, 9MW04, was installed in Area C to the west of Tank 217 (Figure 3-3).

There were no groundwater samples collected from Area C during the second phase of investigation in accordance with the EPA approved RFI work plan addendum.

The third phase of groundwater investigation at Area C included sampling three monitoring wells (13GW10, 13GW11, and 9MW04). These wells were resampled to obtain additional groundwater data for this area. Monitoring well 13GW10 sample and duplicate were analyzed for SVOCs. Monitoring well 13GW11 sample was analyzed for VOCs. Monitoring well 9MW04 sample was analyzed for cadmium (Table 3-3). All three of the monitoring wells were additionally sampled and analyzed for the water quality parameters listed in Table 3-8.

3.3.3.4 Area C – Sediment and Surface Water Investigation

There were no sediment or surface water samples collected for Area C during the first and second phases of investigation in accordance with the EPA approved RFI work plans.

There were two sediment samples (9SD06 and 9SD07) and two surface water samples (9SW06 and 9SW07) collected during the third phase of investigation (Figure 3-3). The data from these samples was used in assessing potential ecological risks. The sediment samples were submitted to the laboratory for analysis of Appendix IX VOCs, SVOCs, sulfide, arsenic, cyanide, and Appendix IX inorganics. The surface water samples were submitted to the laboratory for analysis of Appendix IX VOCs, SVOCs, sulfide, arsenic, cyanide, and Appendix IX total inorganics.

3.4 Background Sampling Activities

Background samples were collected for SWMU 9 during only the third phase of investigation. There were background surface and subsurface soil samples, groundwater samples, and one sediment and one surface water sample collected during the third phase of investigation. The background data was compared with the concentrations reported from SWMU 9 to identify chemicals of potential concern (COPCs). The following subsections identify the type, number, and sample analysis parameters for the background sampling activities. These sampling locations are identified on Figures 3-1 through 3-4 and the analytical parameters are identified in Table 3-4.

3.4.1 Background Surface Soil Investigation

There were no background surface soil samples collected during the first and second phases of investigation in accordance with the EPA approved RFI Work Plans.

During the third phase of investigation a total of six surface soil samples, including one duplicate were collected from five locations (9-BG-SB01 [Figure 3-2], 9-BG-SB02 through 9-BG-SB04 [Figure 3-1], and 9-BG-SB05, [Figure 3-4]). These background samples were analyzed for sulfide, arsenic, cyanide, and Appendix IX inorganics. Each background sample media, designation, depth and analytical parameter is presented in Table 3-4.

3.4.2 Background Subsurface Soil Investigation

There were no background subsurface soil samples collected during the first and second phases of investigation in accordance with the EPA approved RFI Work Plans.

During the third phase of investigation a total of six subsurface soil samples were collected from five Geoprobe® boring locations (9-BG-SB01 [Figure 3-2], 9-BG-SB02 through 9-BG-SB04 [Figure 3-1], and 9-BG-SB05, [Figure 3-4]). Two samples were collected at 9-BG-SB05. The background samples were analyzed for sulfide, arsenic, cyanide, and Appendix IX inorganics. Background sample media, designations, depths and analytical parameters are presented in Table 3-4.

3.4.3 Background Groundwater Investigation

There were no background groundwater samples collected during the first and second phases of investigation in accordance with the approved RFI Work Plans.

The third phase of groundwater investigation included collecting six background samples, including two duplicates, from four Geoprobe® borings (9-BG-GW01 [Figure 3-2] and 9-BG-GW02 through 9-BG-GW04 [Figure 3-1]). Groundwater flow is radial in Area A. As such, upgradient is located between Tanks 212 and 213. That is an unreasonable location for background groundwater because of the close proximity to known contamination. Background groundwater sampling locations were chosen based on different rationale:

- The background samples were located as far as practical from tanks and pipelines, yet within the SWMU area to provide site-specific background.

- Based on Phase I and II information, the background samples were located in areas unaffected by groundwater contamination.

The analytical parameters for these samples varied and included at least two or more of the following parameter: Appendix IX VOCs, SVOCs, total sulfide, total and dissolved metalloids and cyanide, and total and dissolved Appendix IX Inorganics. Each background sample media, designation, date collected, and analytical parameter is presented in Table 3-4.

3.4.4 Background Sediment and Surface Water Investigation

There were no background sediment nor surface water samples collected during the first and second phases of investigation in accordance with the EPA approved RFI Work Plans.

One background surface water sample and one sediment sample were collected during the third phase of investigation at location 9SD05/9SW05 (Figure 3-4). The sediment samples were submitted to the laboratory for analysis of Appendix IX VOCs, SVOCs, sulfide, arsenic, cyanide, and Appendix IX Inorganics. The surface water samples were submitted to the laboratory for analysis of Appendix IX VOCs, SVOCs, arsenic, cyanide, and Appendix IX Total Inorganics. Each background sample media, designation, date collected, and analytical parameter is presented in Table 3-4.

3.5 Soil Sampling Procedures

The following subsections present a description of the surface and subsurface sampling procedures used during drilling and test pitting activities performed during the three phases of the investigation.

3.5.1 Drilling Procedures

The drilling procedures used during the three phases of investigation are described in the following subsections.

3.5.1.1 Phase I

Overburden drilling and sampling were accomplished using 3-1/4 inch inside diameter (ID) hollow-stem augers and 3-inch, nominal diameter, split-spoons advanced in accordance with American Society of Testing Materials (ASTM) Method D-1586. Subsurface samples were collected continuously beginning at a depth of two feet bgs. Once the borehole was advanced to its target depth at the monitoring well location, the borehole was reamed with 6-1/4 inch ID hollow-stem augers to allow for the placement of well screen and riser and backfill materials (i.e., sand and bentonite). A PVC bottom plug or 6-inch center bit was used during reaming to prevent soil cuttings from entering

the augers. In some cases these measures did not prevent cuttings from entering the augers which necessitated removing and cleaning the augers and redrilling.

Borehole information pertaining to soil classification, environmental sampling depths, and depth to groundwater measurements were recorded on Soil Boring and Well Construction Records (Appendix C). Soil cuttings, discarded split-spoon samples, and rock cuttings were placed in 55-gallon drums, removed from the boring location, and staged adjacent to Building 38. Soil cuttings and decontamination fluids generated during the investigation were characterized and containerized by Baker, and disposed by BFI.

3.5.1.2 Phase II

The Phase II drilling operations were performed using a Mobile B-90 truck mounted drill rig. The soil borings were advanced using 3-1/4 inch ID, hollow-stem, augers and 3-inch, nominal diameter split spoons. The auguring and sampling were performed in general accordance with procedures outlined in ASTM Method D1586. Soil samples were collected continuously (at 2-foot intervals) from the ground surface to the watertable. Once the watertable was encountered, samples were collected at five-foot intervals, or at intervals selected by the Baker Field Geologist. Sample intervals are shown on the Test Boring and Well Construction Records that are presented as Appendix C. The drilling and soil sampling activities were performed in Level D personal protective equipment. Soil cuttings and decontamination fluids generated during the investigation were characterized and containerized by Baker, and disposed by BFI.

3.5.1.3 Phase III

The Phase III subsurface soil sampling was conducted using direct push technology (DPT). Two separate Geoprobe® DPT rigs were used during the Phase III investigation. The Geoprobe® is a truck-mounted, hydraulically powered probing machine that uses static and percussive force to advance small diameter sampling probes.

The probes used for soil sampling vary in length and diameter. A macro core sampler and a large-bore sampler were used during the Phase III investigation. The macro core sampler is typically 1.25-inch inside diameter (ID) and 4 feet long. The large-bore sampler is typically 0.75-inch ID and 2 feet long. Both probes are hollow, stainless steel tubes split along the long axis. One end of the probe is threaded to fit driving rods used to advance the sampler. The other end of the probe is also threaded to fit a "drive shoe". The drive shoe is a tapered hollow stainless steel fitting threaded onto the leading end of the probe to facilitate pushing the tube through subsurface materials. The tubes are fitted with inner, clear acetate liners that hold the soil core. The specific procedures used during the subsurface soil sampling are presented below in Section 3.5.3.

Temporary polyvinyl chloride (PVC) slotted well screen and solid riser were installed in select Geoprobe® boreholes for groundwater elevation measurement and sample collection. The wells were constructed of 2-inch nominal inside diameter (ID) PVC riser and screen. The screens were 10 feet long with 10-slot (0.010-inch) size. The well screens and risers were removed following sample collection.

The soil cuttings generated during subsurface sampling were replaced in the boreholes upon completion and disposable or pre-decontaminated equipment was used for the sampling activities avoiding generation of investigation derived waste.

3.5.2 Surface Soil Sampling Procedures

Surface soil samples were only collected during the first and third phase of the investigation. Samples were collected using decontaminated stainless steel spoons. Prior to sample collection, vegetation (grass and roots) was removed from the location. Surface soil samples were collected to a depth of one foot as required by EPA Region II guidelines. Soil collected for VOC analysis was placed directly into the laboratory prepared container without homogenizing to prevent volatilization. Soil collected for other analyses was placed in aluminum pie pans, homogenized and placed in their respective containers beginning with SVOCs followed by pesticides/PCBs, TPH, and finally inorganic analyses (metals, sulfides, and cyanide). Samples were kept in coolers on ice and under strict chain-of-custody until delivered to the laboratory. Chain-of-custody forms for environmental media samples are provided as Appendix D.

3.5.3 Subsurface Soil Sampling Procedures

Subsurface soil samples were collected during all three phases of investigation from soil sampling and monitoring well boreholes and Geoprobe® borings. Soil samples from the soil sampling and monitoring well boreholes were collected using nominal three-inch ID split-spoons during the Phase I and II investigations. After the split-spoons were removed from the borehole, they were opened and immediately screened using a PID. Each soil sample was then tightly wrapped in aluminum foil until sampling operations were completed. The samples selected for analysis (based on the criteria contained within the approved work plans) were opened and representative portions placed directly into the container for VOCs using decontaminated stainless steel spoons. The remaining sample was then homogenized in the aluminum foil and placed into containers beginning with the organic analyses and ending with the inorganic analyses. Samples were kept in coolers on ice and under strict chain-of-custody until delivered to the laboratory. Chain-of-custody forms for environmental media samples were provided as Appendix D.

3.5.4 Test Pit Procedures

The test pit procedures used during the first and second phases of the investigation are described in the following two subsections. Note that there were no test pits excavated during the third phase of investigation.

3.5.4.1 Phase I - Test Pits

The test pits excavated during the first phase of the investigation were excavated using a rubber-tired backhoe with a 24-inch wide bucket. Pit dimensions varied between locations with the average length being approximately 20 feet and depths ranging from four feet to 12 feet bgs. Test pit excavation records are provided as Appendix B.

The first phase sampling scheme devised for the test pits included the collection of any disposed sludge and one sample from a point approximately two feet below the disposed sludge. A third subsurface soil sample was to be collected just above the water table, if encountered. A similar scheme was devised for the test trenches except that any disposed sludge would be sampled at ten foot

intervals along the trench axis for a maximum of two sludge samples per trench. Additionally, a cross trench would be excavated with disposed sludge samples collected at ten foot intervals.

3.5.4.2 Phase II - Test Pits

The test pits excavated during the second phase of the investigation were excavated using a rubber-tired backhoe with a 36-inch wide bucket. The test pit dimensions extended to 22 to 25.5 feet in length and to a depth of 12 feet bgs.

The second phase sampling scheme for the test pits included one sample collected of the disposed sludge/or other apparent contamination encountered and a second sample from the soil underlying the sludge material (just above the water table). If no contamination was apparent then two representative samples of the material near the bottom were collected. Each test pit was excavated to a depth of 12 to 14 feet bgs unless groundwater or bedrock was encountered beforehand. Test pit logs containing test pit dimensions, sampling depths, and sample identification numbers are provided as in Appendix B.

Soil samples obtained during these test pit activities were collected from the excavated soil stockpiles. The soil was placed in sample containers using decontaminated stainless steel spoons.

3.6 Groundwater Investigation Procedures

The groundwater investigation for the first phase of the investigation included the installation, development, and sampling of four new monitoring wells along with the sampling of existing wells, performance of wellhead tests, and limited pumping tests. Each of these activities is discussed in the following subsections.

3.6.1 Monitoring Well Installation Procedures

Figures 3-1 through 3-3 illustrate the locations of the monitoring wells installed during the RFI field activities at SWMU 9. There were four monitoring wells installed during the first phase of investigation and three monitoring wells installed during the second phase of investigation at SWMU

9 to facilitate groundwater sample collection from areas that may have been impacted by past site activities and to characterize the nature and extent of possible groundwater contamination. The monitoring wells provide secure, fixed groundwater sampling locations from which future samples may be acquired, and from which critical hydrogeologic data such as hydraulic conductivity, groundwater depths, flow directions, and gradients can be ascertained.

The monitoring wells were screened across the watertable (i.e., a portion of the monitoring well screen is above the level of the groundwater surface) to facilitate monitoring of the upper zone of the uppermost aquifer. Monitoring wells were constructed of 2-inch nominal inside diameter, Schedule 40, flush-joint and threaded PVC casing, screen, and a threaded bottom cap. Screen lengths varied between locations depending on borehole depth and thickness of the water-bearing zone. The well screens utilized were 10 foot sections of 0.010 inch slots. A sand pack was placed in the annulus between the screen/riser and the borehole wall from the bottom of the well to approximately two feet above the top of the screen. A bentonite seal of one to two feet thick was placed above the sand pack and then hydrated using potable water. Above the bentonite seal, the annular space was filled with cement-bentonite grout to the ground surface. The PVC riser was terminated approximately 2 feet above the level of the surrounding ground surface and an above ground steel protective well cover with a concrete pad were installed. Additionally, four 5-foot long steel posts were installed within the concrete pad near the corners to prevent damage to the well and protective casing. The posts and pads were painted a bright yellow color to enhance visibility. Table 3-8 presents a summary of the soil boring and well construction details.

3.6.2 Monitoring Well Abandonment Procedures

Monitoring well 9MW02 was abandoned in accordance with the additional investigation work plans (Baker, 1997). The abandonment procedures included breaking the monitoring well concrete pad apart with a sledge hammer. The steel protective casing was removed using the drill rig winch. The PVC riser was removed from the ground with the aid of the drill rig winch. The concrete fragments, protective casing, and PVC piping were collected and discarded off-site by the drilling company. The four 5-foot long steel posts installed around the pad to prevent damage to the well and protective casing were removed and reused during a subsequent well installation.

A grout mixture consisting of Type II Portland cement and water was pumped through a tremie pipe into the monitoring well location until grout was observed flowing at the ground surface. After the grout was observed at the surface, pumping was terminated. The grout was permitted to settle and additional grout was added in increments until the level of the grout stabilized near the ground surface.

3.6.3 Well Development Procedures

Following the monitoring well construction and curing of the bentonite/grout seals (24 hour minimum), each newly installed monitoring well was developed to remove fine-grained material from the screen and to establish a good hydraulic connection between the sand pack and the formation. The monitoring wells were developed using disposable polyethylene bailers and clean rope dedicated to each well.

Prior to monitoring well development, water levels from each well were measured along with the total well depth. The water level measurements, total depth, and well diameter were used to calculate the volume of water in each well. Total borehole volumes also were estimated using similar procedures. These volume estimates were used to gauge the total amount of water to be removed during the development process. During development, measurements of pH, temperature, and specific conductance were recorded in field log books and later transferred to Well Development Forms. These forms are provided as Appendix E. The water generated during development operations was temporarily stored in secure 55-gallon steel drums. The water was subsequently tested for appropriate disposal criteria and removed from the site and disposed by BFI.

3.6.4 Groundwater Sampling Procedures

Prior to groundwater sampling, water level and total depth measurements were collected from the well in order to calculate well volumes. A minimum of three to five well volumes were purged from each well using a disposable bailer and clean rope prior to sampling. Measurements of pH, temperature, and specific conductance were made prior to purging and after each well volume to ensure the parameters stabilized before sampling. Purging was considered complete when three successive measurements were within 10 percent of each other or a total of five well volumes ere purged from the well.

Groundwater samples were introduced into laboratory-prepared containers directly from the sampling device. Sample bottles for the VOC analysis were filled first, followed by SVOC, and finally the inorganic analyses. Samples analyzed for dissolved metals were collected in laboratory-prepared containers and filtered prior to placement in preserved containers. Samples were filtered and preserved in the field using a peristaltic pump and 45 micron in-line filter. Groundwater samples were kept in coolers on ice and under strict chain-of-custody until delivered to the laboratory.

3.6.5 Wellhead Testing Procedures

Each of the four monitoring wells sampled during the 1996 first phase investigation at SWMU 9 had in-situ hydraulic conductivity tests ("slug tests") performed after groundwater samples had been collected. These tests allowed for the approximation of aquifer hydraulic conductivities in the vicinity immediately surrounding the wells. Each test was conducted by installing a pressure transducer, attached to an electronic recording device (Hermit™ data logger), into the well to record the water level data. The first part of the test (falling head) involved introducing a PVC slug into the groundwater column and recording the water level returned to its original elevation. Once the static water level in the well stabilized, the slug was removed and the rising head test initiated. The rising head test consisted of recording the recovery of the static water level to near its original elevation after removing the slug. Data was recorded in the data logger and later downloaded, in the field, to a personal computer. The slug test data is presented as Appendix F. Results of the slug tests are discussed in further detail in Section 4.5.

3.7 Surface Water and Sediment Sampling

Surface water and sediment sampling programs were conducted during the third phase of investigation to assess ecological risks posed by SWMU 9. Seven sediment samples (9SD01 through 9SD07) and seven surface water samples (9SW01 through 9SW07) were collected during the Phase III activities. The sample locations are shown on Figures 3-3 and 3-4 and were distributed as follows:

- One sampling location north of Area A (9SD02 and 9SW02) (Figure 3-4)
- One location northwest of Area B (9SD01 and 9SW01) (Figure 3-4)
- One location northeast of Area B (9SD03 and 9SW03) (Figure 3-4)

- One location east of Area B (9SD04 and 9SW04) (Figure 3-4)
- One location to the southeast of Areas B and A (9SD05 and 9SW05) (Figure 3-4)
- One location west of Area C (9SD06 and 9SW06) (Figure 3-3)
- One location northwest of Area C (9SD07 and 9SW07) (Figure 3-3)

3.7.1 Surface Water Sampling Procedures

Samples of the surface water were obtained directly from the surface water body. Each sample location was demarcated along the shoreline with a wooden stake labeled with the sample identification. Samples analyzed for VOA were obtained first, by using a clean unpreserved laboratory glass container to fill the VOA container without allowing the preservative to escape. The remaining surface water analytical fractions were collected by dipping the laboratory containers directly into the water at each designated area.

3.7.2 Sediment Sampling Procedures

The corresponding sediment samples were collected subsequent to the surface water samples to minimize sediment suspension in the surface water sample. Sediment samples were collected from the shoreline water bed to approximately six inches using a stainless steel sampling spoon. Volatile fractions were collected first while the remaining sample portion was thoroughly homogenized, and then placed into the appropriate sample containers.

3.8 Quality Assurance/Quality Control Sampling Procedures

Extensive field Quality Assurance/Quality Control (QA/QC) samples were collected during the sampling program (Table 3-9). These samples were obtained to: (1) ensure that decontamination procedures were properly implemented (i.e., equipment rinsate blanks); (2) evaluate field methodology (i.e., duplicate samples); (3) establish field background conditions (i.e., field blanks); and, (4) evaluate whether cross-contamination occurred during sampling and/or shipping (i.e., trip blanks).

Several types of field QA/QC samples were collected and analyzed including duplicate samples, equipment rinsate samples, field blanks, and trip blanks. These QA/QC samples are defined below:

- Duplicate Sample (D): Two samples collected simultaneously into separate containers from the same source under identical conditions. One duplicate sample was collected for every 10 environmental samples collected for each media type.

- Equipment Rinsate Sample (ER/RB): Sample obtained by running laboratory supplied deionized water over/through sample collection equipment after it was decontaminated. These samples were used to determine if decontamination procedures were adequate.

- Field Blank (FB): Sample obtained from each water source utilized during the field program. The water sources used during the field program included: laboratory supplied deionized water utilized to collect rinsate blanks; store bought distilled water utilized for decontamination, and potable water utilized for decontamination.

- Trip Blank (TB): Trip blanks were prepared at the laboratory and shipped with the sample containers. Trip blanks were packaged for shipment with the other VOC samples and sent for analysis. At no time after their preparation were the trip blank sample containers opened before they reached the laboratory. At least one trip blank per shipping cooler containing samples requiring VOC analysis was sent to the laboratory for VOC analysis.

3.9 Decontamination Procedures

Decontamination procedures performed in the field were conducted in accordance with EPA Region II guidelines.

For routine sample collection equipment, the following steps were implemented:

- Clean with potable water and low-phosphate detergent
- Tap water rinse
- 10 percent nitric acid solution rinse
- Tap water rinse
- Methanol followed by a hexane or an acetone rinse
- Analyte-free deionized water rinse
- Air dry
- Wrap in aluminum foil, shiny side out, for storage or transport

This decontamination procedure was performed on stainless steel sampling spoons and the split-spoon samplers used in drilling operations in accordance with Baker's standard operating procedure (SOP) F502. Decontamination of heavy equipment (i.e., hollow-stem augers, drill rods, and backhoe bucket) was performed by rinsing with potable water to remove soil followed by steam cleaning, in accordance with SOP F501 as contained in the EPA approved work plan.

SECTION 3.0
TABLES

TABLE 3-1

SWMU 9 AREA A - TANKS 212-213
SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

				Analysis Requested								Analysis Requested												
				Solid Samples								Aqueous Samples												
				Stateside Laboratory								Stateside Laboratory										On-Site Lab		
Phase	Sample ID	Sample Depth (feet bgs)	Date Collected	Benzene Toluene Ethylbenzene Xylene	TPH-DRO/GRO(1)	Volatile Organic Compounds	Semivolatile Organic Compounds	Sulfide	Metalloids *	RCRA Metals(2)	Appendix IX Inorganics	Volatile Organic Compounds	Semivolatile Organic Compounds	Polychlorinated Biphenyls	Benzene Toluene Ethylbenzene Xylene	Water Quality	TPH DRO/GRO	Total RCRA Metals	Dissolved RCRA Metals	Total Metalloids *	Total Appendix IX Inorganics	Benzene Toluene Ethylbenzene Xylene	TPH 8015 (gas & diesel)	Comments
I	**SURFACE SOIL SAMPLES**																							
	9SS01	0-1	3/20/96		X	X	X			X														
	9SS02	0-1	3/20/96		X	X	X			X														
	9MW02-00	0-1	3/20/96		X	X	X			X														
	9MW01-00	0-1	3/20/96		X	X	X			X														
	SUBSURFACE SOIL SAMPLES																							
	9MW01-08	16-18	4/10/96		X	X	X			X														
	9MW01-15	30-32	4/10/96		X	X	X			X														
	9MW02-04	8-10	4/12/96		X	X	X			X														
	9MW02-06	12-14	4/12/96		X	X	X			X														
	9MW02-10	20-22	4/12/96		X	X	X			X														Test Pit
	9TP07-04	9	4/8/96		X	X	X			X														Test Pit
	9TP08-04	9	4/8/96		X	X	X			X														Test Pit
	9TP09-04	9	4/8/96		X	X	X			X														Test Pit
	9TP10-04	8	4/8/96		X	X	X			X														Test Pit
	9TP18-05	10	4/14/96		X	X	X			X														Test Pit
	GROUNDWATER SAMPLES																							
	9MW01	NA	4/15/96									X	X	X			X	X	X					Monitoring Well
	9MW02	NA	4/16/96									X	X	X			X	X	X					Monitoring Well
	13GW01	NA	3/24/96									X	X	X			X							Monitoring Well
	13GW02	NA	3/24/96									X	X	X			X							Monitoring Well
	13GW03	NA	3/24/96									X	X	X			X							Monitoring Well

Notes:

bgs - below ground surface

* - arsenic and cyanide

(1) TPH-DRO/GRO - Total Petroleum Hydrocarbon Diesel Range Organics/Gasoline Range Organics

(2) RCRA Metals - Resource Conservation and Recovery Act Metals

TABLE 3-1 (Continued)

SWMU 9 AREA A - TANKS 212-213
SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

				Analysis Requested								Analysis Requested												
				Solid Samples								Aqueous Samples												
				Stateside Laboratory								Stateside Laboratory										On-Site Lab		
Phase	Sample ID	Sample Depth (feet bgs)	Date Collected	Benzene Toluene Ethylbenzene Xylene	TPH-DRO/GRO(1)	Volatile Organic Compounds	Semivolatile Organic Compounds	Sulfide	Metalloids *	RCRA Metals(2)	Appendix IX Inorganics	Volatile Organic Compounds	Semivolatile Organic Compounds	Polychlorinated Biphenyls	Benzene Toluene Ethylbenzene Xylene	Water Quality	TPH DRO/GRO	Total RCRA Metals	Dissolved RCRA Metals	Total Metalloids *	Total Appendix IX Inorganics	Benzene Toluene Ethylbenzene Xylene	TPH 8015 (gas & diesel)	Comments
	SUBSURFACE SOIL SAMPLES																							
	9TP07A-01	8-10	10/1/97	X	X					X														Test Pit
	9TP07A-02	8-10	10/1/97	X	X					X														Test Pit
	9TP07B-01	8-10	10/1/97	X	X					X														Test Pit
	9TP07B-02	8-10	10/1/97	X	X					X														Test Pit
	9TP09A-01	8-10	10/1/97	X	X					X														Test Pit
	9TP09A-02	8-10	10/1/97	X	X					X														Test Pit
II	9MW02R-05	8-10	9/21/97	X	X					X														
	9MW02R-06	10-12	9/21/97	X	X					X														
	9MW02S-05	8-10	9/21/97	X	X					X														
	9MW02N-05	8-10	9/21/97	X	X					X														
	GROUNDWATER SAMPLES																							
	9-GW02R	NA	9/30/97												X		X	X	X					Monitoring Well
	9-GW02S	NA	9/30/97												X		X	X	X					Monitoring Well
	9-GW02N	NA	9/30/97												X		X	X	X					Monitoring Well

Notes:

bgs - below ground surface
* - arsenic and cyanide

(1) TPH-DRO/GRO - Total Petroleum Hydrocarbon Diesel Range Organics/Gasoline Range Organics
(2) RCRA Metals - Resource Conservation and Recovery Act Metals

TABLE 3-1 (Continued)

SWMU 9 AREA A - TANKS 212-213
SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

				Analysis Requested								Analysis Requested												
				Solid Samples								Aqueous Samples												
				Stateside Laboratory								Stateside Laboratory										On-Site Lab		
Phase	Sample ID	Sample Depth (feet bgs)	Date Collected	Benzene Toluene Ethylbenzene Xylene	TPH-DRO/GRO(1)	Volatile Organic Compounds	Semivolatile Organic Compounds	Sulfide	Metalloids *	RCRA Metals(2)	Appendix IX Inorganics	Volatile Organic Compounds	Semivolatile Organic Compounds	Polychlorinated Biphenyls	Benzene Toluene Ethylbenzene Xylene	Water Quality	TPH DRO/GRO	Total RCRA Metals	Dissolved RCRA Metals	Total Metalloids *	Total Appendix IX Inorganics	Benzene Toluene Ethylbenzene Xylene	TPH 8015 (gas & diesel)	Comments
	SUBSURFACE SOIL SAMPLES																							
	9-02R-HP01	11-12	6/22/99	X	X																			Geoprobe
	9-02R-HP02D	11-12	6/23/99	X	X																			Duplicate
	9-02R-HP02	11-12	6/23/99	X	X																			Geoprobe
	9-02R-HP03	10-12	6/22/99	X	X																			Geoprobe
	9-02R-HP04	10-12	6/23/99	X	X																			Geoprobe
	9-02R-HP05	10-12	6/23/99	X	X																			Geoprobe
	9-02R-HP06	10-12	6/23/99	X	X																			Geoprobe
	9-02R-HP07	10-12	6/23/99	X	X																			Geoprobe
III	9-02R-HP08	10-12	6/23/99	X	X																			Geoprobe
	9-02R-HP09	14-16	6/23/99	X	X																			Geoprobe
	9-02R-HP10-01	0-4	6/26/99	X	X																			Geoprobe
	9-02R-HP11-01	12-16	6/26/99	X	X																			Geoprobe
	9-02R-HP11-01D	12-16	6/26/99	X	X																			Duplicate
	9-02R-HP12-01	5-6	6/26/99	X	X																			Geoprobe
	SEDIMENT SAMPLE																							
	9SD02	0-0.5	6/29/99			X	X	X	X		X													
	SURFACE WATER SAMPLE																							
	9SW02	NA	6/29/99									X	X							X	X			Surface Water

Notes:

bgs - below ground surface

* - arsenic and cyanide

(1) TPH-DRO/GRO - Total Petroleum Hydrocarbon Diesel Range Organics/Gasoline Range Organics

(2) RCRA Metals - Resource Conservation and Recovery Act Metals

TABLE 3-1 (Continued)

SWMU 9 AREA A - TANKS 212-213
SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

				Analysis Requested								Analysis Requested												
				Solid Samples								Aqueous Samples												
				Stateside Laboratory								Stateside Laboratory										On-Site Lab		
Phase	Sample ID	Sample Depth (feet bgs)	Date Collected	Benzene Toluene Ethylbenzene Xylene	TPH-DRO/GRO(1)	Volatile Organic Compounds	Semivolatile Organic Compounds	Sulfide	Metalloids *	RCRA Metals(2)	Appendix IX Inorganics	Volatile Organic Compounds	Semivolatile Organic Compounds	Polychlorinated Biphenyls	Benzene Toluene Ethylbenzene Xylene	Water Quality	TPH DRO/GRO	Total RCRA Metals	Dissolved RCRA Metals	Total Metalloids *	Total Appendix IX Inorganics	Benzene Toluene Ethylbenzene Xylene	TPH 8015 (gas & diesel)	Comments
	GROUNDWATER SAMPLES																							
III	13GW02	NA	6/28/99													X						X		Monitoring Well
	9-A02-HP01	NA	6/27/99																			X		Temporary Piezometer
	9-A02-HP01D	NA	6/27/99																			X		Duplicate
	9-A02-HP02	NA	6/27/99												X							X		Temporary Piezometer
	9-A02-HP03	NA	6/26/99																			X	X	Temporary Piezometer
	9-A02-HP03D	NA	6/26/99																			X	X	Duplicate
	9-A02-HP04	NA	6/26/99																			X	X	Temporary Piezometer
	9-A02-HP05	NA	6/26/99																			X	X	Temporary Piezometer
	9-A02-HP05D	NA	6/26/99																			X	X	Duplicate

Notes:

bgs - below ground surface

* - arsenic and cyanide

(1) TPH-DRO/GRO - Total Petroleum Hydrocarbon Diesel Range Organics/Gasoline Range Organics

(2) RCRA Metals - Resource Conservation and Recovery Act Metals

TABLE 3-1 (Continued)

SWMU 9 AREA A - TANKS 212-213
SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

				Analysis Requested								Analysis Requested												
				Solid Samples								Aqueous Samples												
				Stateside Laboratory								Stateside Laboratory										On-Site Lab		
Phase	Sample ID	Sample Depth (feet bgs)	Date Collected	Benzene Toluene Ethylbenzene Xylene	TPH-DRO/GRO(1)	Volatile Organic Compounds	Semivolatile Organic Compounds	Sulfide	Metalloids *	RCRA Metals(2)	Appendix IX Inorganics	Volatile Organic Compounds	Semivolatile Organic Compounds	Polychlorinated Biphenyls	Benzene Toluene Ethylbenzene Xylene	Water Quality	TPH DRO/GRO	Total RCRA Metals	Dissolved RCRA Metals	Total Metalloids *	Total Appendix IX Inorganics	Benzene Toluene Ethylbenzene Xylene	TPH 8015 (gas & diesel)	Comments
	GROUNDWATER SAMPLES																							
	9-MW02R	NA	6/29/99													X						X		Monitoring Well
	9-A02R-GW01	NA	6/23/99																			X		Temporary Piezometer
	9-A02R-GW02	NA	6/27/99																			X		Temporary Piezometer
	9-02R-GW03	NA	6/27/99												X							X		Temporary Piezometer
	9-02R-GW04	NA	6/23/99																			X		Temporary Piezometer
	9-02R-GW05	NA	6/23/99																			X		Temporary Piezometer
III	9-02R-GW06	NA	6/23/99																			X	X	Temporary Piezometer
	9-02R-GW07	NA	6/23/99																			X		Temporary Piezometer
	9-A02R-HP08	NA	6/23/99																			X		Temporary Piezometer
	9-A02R-GW09	NA	6/23/99																			X		Temporary Piezometer
	9-02R-HP10	NA	6/23/99																			X	X	Temporary Piezometer
	9-02R-HP10D	NA	6/23/99																			X	X	Duplicate
	9-02R-HP11	NA	6/23/99																			X	X	Temporary Piezometer
	9-02R-HP12	NA	6/23/99																			X	X	Temporary Piezometer

Notes:

bgs - below ground surface

* - arsenic and cyanide

(1) TPH-DRO/GRO - Total Petroleum Hydrocarbon Diesel Range Organics/Gasoline Range Organics

(2) RCRA Metals - Resource Conservation and Recovery Act Metals

TABLE 3-2

SWMU 9 AREA B - TANKS 214-215
SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

				Analysis Requested								Analysis Requested											
				Solid Samples								Aqueous Samples											
				Stateside Laboratory								Stateside Laboratory										On-Site Lab	
Phase	Sample ID	Sample Depth (feet bgs)	Date Collected	Benzene, Toluene Ethylbenzene, Xylene	TPH-DRO/GRO(1)	Volatile Organic Compounds	Semivolatile Organic Compounds	Sulfide	Metalloids *	RCRA Metals(2)	Appendix IX Inorganics	Volatile Organic Compounds	Semivolatile Organic Compounds	Polychlorinated Biphenyls	Benzene Toluene Ethylbenzene Xylene	Water Quality	TPH DRO/GRO	Total RCRA Metals	Dissolved RCRA Metals	Total Metalloids *	Total Appendix IX Inorganics	Benzene, Toluene, Ethylbenzene, Xylene	Comments
	SURFACE SOIL SAMPLES																						
	9SS03	0-1	3/20/96		X	X	X			X													
	9SS04	0-1	3/20/96		X	X	X			X													
	9MW03-00	0-1	3/20/96		X	X	X			X													
	SUBSURFACE SOIL SAMPLES																						
	9MW03-04	8-10	4/15/96		X	X	X			X													
	9MW03-09	18-20	4/15/96		X	X	X			X													
	9TP02-06	11.5-12	4/1/96		X	X	X			X													Test Pit
I	9TP03-03	7	4/6/96		X	X	X			X													Test Pit
	9TP04-04	9	4/6/96		X	X	X			X													Test Pit
	9TP05-04	12	4/6/96		X	X	X			X													Test Pit
	9TP06-04	9	4/6/96		X	X	X			X													Test Pit
	GROUNDWATER SAMPLES																						
	9MW03	NA	4/20/96									X	X	X			X	X	X				Monitoring Well
	13GW04	NA	3/24/96									X	X	X			X						Monitoring Well
	13GW05	NA	3/24/96									X	X	X			X						Monitoring Well
	13GW06	NA	3/24/96									X	X	X			X						Monitoring Well
	SUBSURFACE SOIL SAMPLES																						
	9-TP01A-01	8-10	10/1/97	X	X					X													Test Pit
II	9-TP01A-02	8-10	10/1/97	X	X					X													Test Pit
	9-TP02A-01	8-10	10/1/97	X	X					X													Test Pit
	9-TP02A-02	8-10	10/1/97	X	X					X													Test Pit

Notes: bgs - below ground surface
* - arsenic and cyanide

(1) TPH-DRO/GRO - Total Petroleum Hydrocarbon Diesel Range Organics/Gasoline Range Organics
(2) RCRA Metals - Resource Conservation and Recovery Act Metals

TABLE 3-2 (Continued)

SWMU 9 AREA B - TANKS 214-215
SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

				Analysis Requested								Analysis Requested											
				Solid Samples								Aqueous Samples											
				Stateside Laboratory								Stateside Laboratory										On-Site Lab	
Phase	Sample ID	Sample Depth (feet bgs)	Date Collected	Benzene, Toluene Ethylbenzene, Xylene	TPH-DRO/GRO(1)	Volatile Organic Compounds	Semivolatile Organic Compounds	Sulfide	Metalloids *	RCRA Metals(2)	Appendix IX Inorganics	Volatile Organic Compounds	Semivolatile Organic Compounds	Polychlorinated Biphenyls	Benzene Toluene Ethylbenzene Xylene	Water Quality	TPH DRO/GRO	Total RCRA Metals	Dissolved RCRA Metals	Total Metalloids *	Total Appendix IX Inorganics	Benzene, Toluene, Ethylbenzene, Xylene	Comments
	SUBSURFACE SOIL SAMPLES																						
	9-B06HP04-01	12-14	6/25/99			X																	
	9-B06HP04-02	16-17	6/25/99			X																	
	SEDIMENT SAMPLES																						
	9SD01	0-0.5	6/29/99			X	X	X	X		X												
	9SD01D	0-0.5	6/29/99			X	X	X	X		X												Duplicate
III	9SD03	0-0.5	6/29/99			X	X	X	X		X												
	9SD04	0-0.5	6/29/99			X	X	X	X		X												
	SURFACE WATER SAMPLES																						
	9SW01	NA	6/29/99									X	X							X	X		
	9SW01D	NA	6/29/00									X	X							X	X		Duplicate
	9SW03	NA	6/29/99									X	X							X	X		
	9SW04	NA	6/29/99									X	X							X	X		

Notes:

bgs - below ground surface
* - arsenic and cyanide

(1) TPH-DRO/GRO - Total Petroleum Hydrocarbon Diesel Range Organics/Gasoline Range Organics
(2) RCRA Metals - Resource Conservation and Recovery Act Metals

TABLE 3-2 (Continued)

SWMU 9 AREA B - TANKS 214-215
SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

				Analysis Requested								Analysis Requested											
				Solid Samples								Aqueous Samples											
				Stateside Laboratory								Stateside Laboratory										On-Site Lab	
Phase	Sample ID	Sample Depth (feet bgs)	Date Collected	Benzene, Toluene Ethylbenzene, Xylene	TPH-DRO/GRO(1)	Volatile Organic Compounds	Semivolatile Organic Compounds	Sulfide	Metalloids *	RCRA Metals(2)	Appendix IX Inorganics	Volatile Organic Compounds	Semivolatile Organic Compounds	Polychlorinated Biphenyls	Benzene Toluene Ethylbenzene Xylene	Water Quality	TPH DRO/GRO	Total RCRA Metals	Dissolved RCRA Metals	Total Metalloids *	Total Appendix IX Inorganics	Benzene, Toluene, Ethylbenzene, Xylene	Comments
	GROUNDWATER SAMPLES																						
III	13GW05	NA	6/28/99													X						X	Monitoring Well
	9-B05-HP01	NA	6/27/99																			X	Temporary Piezometer
	9-B05-HP02	NA	6/27/99												X							X	Temporary Piezometer
	9-B05-HP03	NA	6/27/99																			X	Temporary Piezometer
	9-B05-HP04	NA	6/24/99																			X	Temporary Piezometer
	9-B05-HP05	NA	6/26/99																			X	Temporary Piezometer
	13GW06	NA	6/28/99													X						X	Monitoring Well
	13GW06D	NA	6/28/99																			X	Duplicate
	9-B06-HP01	NA	6/24/99																			X	Temporary Piezometer
	9-B06-HP02	NA	6/24/99																			X	Temporary Piezometer
	9-B06-HP03	NA	6/24/99																			X	Temporary Piezometer
	9-B06-HP04	NA	6/24/99																			X	Temporary Piezometer
	9-B06-HP05	NA	6/27/99																			X	Temporary Piezometer

Notes:

bgs - below ground surface

* - arsenic and cyanide

(1) TPH-DRO/GRO - Total Petroleum Hydrocarbon Diesel Range Organics/Gasoline Range Organics

(2) RCRA Metals - Resource Conservation and Recovery Act Metals

TABLE 3-3

SWMU 9 AREA C - TANKS 216-217
SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

				Analysis Requested								Analysis Requested											
				Solid Samples								Aqueous Samples											
				Stateside Laboratory								Stateside Laboratory											
Phase	Sample ID	Sample Depth (feet bgs)	Date Collected	Benzene Toluene Ethylbenzene Xylene	TPH-DRO/GRO(1)	Volatile Organic Compounds	Semivolatile Organic Compounds	Sulfide	Metalloids *	RCRA(2) Metals	Appendix IX Inorganics	Volatile Organic Compounds	Semivolatile Organic Compounds	Polychlorinated Biphenyls	Benzene Toluene Ethylbenzene Xylene	Water Quality	TPH DRO/GRO(1)	Cadmium	Total RCRA Metals	Total Metalloids *	Dissolved Metaloids *	Total Appendix IX Inorganics	Comments
	SURFACE SOIL SAMPLES																						
	9SS05	0-1	3/20/96		X	X	X			X													
	9SS06	0-1	3/20/96		X	X	X			X													
	9MW04-00	0-1	3/20/96		X	X	X			X													
	SUBSURFACE SOIL SAMPLES																						
	9MW04-03	6-8	4/19/96		X	X	X			X													
	9MW04-05	10-12	4/19/96		X	X	X			X													
	9TP11-05	11	4/13/96		X	X	X			X													Test Pit
	9TP13-04	9	4/13/96		X	X	X			X													Test Pit
	9TP13-04D	9	4/13/96		X	X	X			X													Duplicate
I	9TP14-05	10	4/13/96		X	X	X			X													Test Pit
	9TP14-05D	10	4/13/96		X	X	X			X													Duplicate
	9TP15-05	10	4/13/96		X	X	X			X													Test Pit
	9TP16-05	10	4/13/96		X	X	X			X													Test Pit
	9TP17-05	10	4/14/96		X	X	X			X													Test Pit
	GROUNDWATER SAMPLES																						
	9MW04	NA	4/24/96									X	X	X			X		X				Monitoring Well
	13GW07	NA	3/24/96									X	X	X			X						Monitoring Well
	13GW08	NA	3/24/96									X	X	X			X						Monitoring Well
	13GW09	NA	3/24/96									X	X	X			X						Monitoring Well
	13GW10	NA	3/24/96									X	X	X			X						Monitoring Well
	13GW11	NA	3/25/96									X	X	X			X						Monitoring Well

Notes:

bgs - below ground surface
* - arsenic and cyanide

(1) TPH-DRO/GRO - Total Petroleum Hydrocarbon Diesel Range Organics/Gasoline Range Organics
(2) RCRA Metals - Resource Conservation and Recovery Act Metals

TABLE 3-3 (Continued)

SWMU 9 AREA C - TANKS 216-217
SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

				Analysis Requested								Analysis Requested											
				Solid Samples								Aqueous Samples											
				Stateside Laboratory								Stateside Laboratory											
Phase	Sample ID	Sample Depth (feet bgs)	Date Collected	Benzene Toluene Ethylbenzene Xylene	TPH-DRO/GRO(1)	Volatile Organic Compounds	Semivolatile Organic Compounds	Sulfide	Metalloids *	RCRA(2) Metals	Appendix IX Inorganics	Volatile Organic Compounds	Semivolatile Organic Compounds	Polychlorinated Biphenyls	Benzene Toluene Ethylbenzene Xylene	Water Quality	TPH DRO/GRO(1)	Cadmium	Total RCRA Metals	Total Metalloids *	Dissolved Metaloids *	Total Appendix IX Inorganics	Comments
	SEDIMENT SAMPLES																						
	9SD06	0-0.5	6/29/99			X	X	X	X		X												
	9SD07	0-0.5	6/29/99			X	X	X	X		X												
	SURFACE WATER SAMPLES																						
	9SW06	NA	6/29/99									X	X							X		X	
III	9SW07	NA	6/29/99									X	X							X		X	
	GROUNDWATER SAMPLES																						
	9MW04	NA	6/29/99													X		X					Monitoring Well
	13GW10	NA	6/29/99										X			X							Monitoring Well
	13GW10D	NA	6/29/99										X										Duplicate
	13GW11	NA	6/29/99									X				X							Monitoring Well

Notes:

bgs - below ground surface
* - arsenic and cyanide

(1) TPH-DRO/GRO - Total Petroleum Hydrocarbon Diesel Range Organics/Gasoline Range Organics
(2) RCRA Metals - Resource Conservation and Recovery Act Metals

TABLE 3-4

SWMU 9 BACKGROUND
SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

				Analysis Requested					Analysis Requested									
				Solid Samples					Aqueous Samples									
				Stateside Laboratory					Stateside Laboratory									
Phase	Sample ID	Sample Depth (feet bgs)	Date Collected	Volatile Organic Compounds	Semivolatile Organic Compounds	Sulfide	Metalloids*	Appendix IX Inorganics	Volatile Organic Compounds	Semivolatile Organic Compounds	Total Cyanide	Total Sulfide	Total Arsenic	Dissolved Arsenic	Dissolved Cyanide	Total Appendix IX Inorganics	Dissolved App IX Inorganics	Comments
III	**SURFACE SOIL SAMPLES**																	
	9-BG-SS01	0-0.5	6/26/99			X	X	X										
	9-BG-SS01D	0-0.5	6/26/99			X	X	X										Duplicate
	9-BG-SS02	0-0.5	6/26/99			X	X	X										
	9-BG-SS03	0-0.5	6/26/99			X	X	X										
	9-BG-SS04	0-0.5	6/26/99			X	X	X										
	9-BG-SS05	0-0.5	6/27/99			X	X	X										
	SUBSURFACE SOIL SAMPLES																	
	9-BG-SB01-10-12	10-12	6/26/99			X	X	X										
	9-BG-SB02-8-10	8-10	6/26/99			X	X	X										
	9-BG-SB03-8-10	8-10	6/26/99			X	X	X										
	9-BG-SB04-10-12	10-12	6/26/99			X	X	X										
	9-BG-SB05-15-17	15-17	6/27/99			X	X	X										
	9-BG-SB05-21-23	21-23	6/27/99			X	X	X										

Notes:

bgs - below ground surface

* - Arsenic and Cyanide

TABLE 3-4 (Continued)

SWMU 9 BACKGROUND
SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

				Analysis Requested					Analysis Requested									
				Solid Samples					Aqueous Samples									
				Stateside Laboratory					Stateside Laboratory									
Phase	Sample ID	Sample Depth (feet bgs)	Date Collected	Volatile Organic Compounds	Semivolatile Organic Compounds	Sulfide	Metalloids*	Appendix IX Inorganics	Volatile Organic Compounds	Semivolatile Organic Compounds	Total Cyanide	Total Sulfide	Total Arsenic	Dissolved Arsenic	Dissolved Cyanide	Total Appendix IX Inorganics	Dissolved App IX Inorganics	Comments
	SEDIMENT SAMPLE																	
	9SD05	0-0.5	6/29/99	X	X	X	X	X										
	SURFACE WATER SAMPLE																	
	9SW05	NA	6/29/99						X	X			X			X		
	GROUNDWATER SAMPLES																	
III	9-BG-GW01	NA	6/29/99						X		X	X	X	X	X	X	X	Temporary Piezometer
	9-BG-GW01D	NA	6/29/99						X		X	X						Duplicate
	9-BG-GW02	NA	6/29/99						X	X	X	X	X	X	X	X	X	Temporary Piezometer
	9-BG-GW03	NA	6/28/99						X	X	X	X	X	X	X	X	X	Temporary Piezometer
	9-BG-GW03D	NA	6/29/99								X	X	X			X	X	Duplicate
	9-BG-GW04	NA	6/29/99						X		X		X					Temporary Piezometer

Notes:

bgs - below ground surface

* - Arsenic and Cyanide

TABLE 3-5

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)

Volatiles	Quantitation Limits*		Method Number
	Water (µg/L)	Low Soil (µg/kg)	
Acetone	100	100	8240
Acetonitrile	100	100	8240
Acrolein	5	5	8240
Acrylonitrile	5	5	8240
Methyl Chloride	100	100	8240
Benzene	5	5	8240
Bromodichloromethane	10	10	8240
Bromoform	5	5	8240
Bromomethane	10	10	8240
Carbon Disulfide	5	5	8240
Carbon Tetrachloride	5	5	8240
Chlorobenzene	5	5	8240
2-Chloro-1,3-butadiene	5	5	8240
Chloroethane	10	10	8240
Chlorodibromomethane	5	5	8240
Chloroform	5	5	8240
Chloromethane	10	10	8240
3-Chloropropene	5	5	8240
1,2-Dibromo-3-chloropropane	5	5	8240
Dibromomethane	5	5	8240
trans-1,4-Dichloro-2-butene	100	100	8240
Dichlorodifluoromethane	5	5	8240
Dibromomethane	5	5	8240
1,1-Dichloroethane	5	5	8240
1,2-Dichloroethane	5	5	8240
trans-1,2-Dichloroethylene	5	5	8240
1,1-Dichloroethylene	5	5	8240
Dichloromethane	5	5	8240
1,2-Dichloropropane	5	5	8240
cis-1,3-Dichloropropene	5	5	8240
trans-1,3-Dichloropropene	5	5	8240
1,4-Dioxane	150	150	8240
Ethyl benzene	5	5	8240

TABLE 3-5 (Continued)

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)

Volatiles	Quantitation Limits*		Method Number
	Water (µg/L)	Low Soil (µg/kg)	
Ethyl cyanide	100	100	8240
Ethyl methacrylate	5	5	8240
2-Hexanone	50	50	8240
Iodomethane	5	5	8240
Isobutyl alcohol	50	50	8240
Methacrylonitrile	100	100	8240
Methyl ethyl ketone	100	100	8240
Methyl methacrylate	5	50	8240
4-Methyl-2-pentanone	50	50	8240
Pentachloroethane	10	10	8240
Stryene	5	5	8240
1,1,1,2-Tetrachloroethane	5	5	8240
1,1,2,2-Tetrachloroethane	5	5	8240
Tetrachloroethene	5	5	8240
Toluene	5	5	8240
1,1,1-Trichloroethane	5	5	8240
1,1,2-Trichloroethane	5	5	8240
Trichloroethene	5	5	8240
Trichlorofluoromethane	5	NA	8240
1,2,3-Trichloropropane	5	5	8240
Vinyl Acetate	50	50	8240
Vinyl Chloride	10	10	8240
Xylene	5	5	8240

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.

TABLE 3-5 (Continued)

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)

Semivolatiles	Quantitation Limits*		Method Number
	Water (µg/L)	Low Soil (µg/kg)	
Acenaphthene	10	660	8270
Acenaphthylene	10	660	8270
Acetophenone	10	NA	8270
2-Acetylaminofluorene	20	NA	8270
4-Aminobiphenyl	20	NA	8270
Aniline	10	NA	8270
Anthracene	10	660	8270
Aramite	20	NA	8270
Benzo(a)anthracene	10	660	8270
Benzo(b)fluoranthene	10	660	8270
Benzo(k)fluoranthene	10	660	8270
Benzo(g,h,i)perylene	10	660	8270
Benzo(a)pyrene	10	660	8270
Benzyl alcohol	20	1,300	8270
Bis(2-chloroethoxyl)methane	10	660	8270
Bis(2-chloroethyl)ether	10	660	8270
Bis(2-chloro-1-methyl ethyl)ether	10	660	8270
Bis(2-ethylhexyl)phthalate	10	660	8270
4-Bromophenyl phenyl ether	10	660	8270
Butyl benzyl phthalate	10	660	8270
p-Chloroaniline	20	1,300	8270
Chlorobenzilate	10	NA	8270
p-Chloro-m-cresol	20	1,300	8270
2-Chloronaphthalene	10	660	8270
2-Chlorophenol	10	660	8270
4-Chlorophenyl phenyl ether	10	660	8270
Chrysene	10	660	8270
o,m,p-Cresol	10	660	8270
Diallate	10	NA	8270
Dibenzofuran	10	660	8270
Di-n-butyl phthalate	10	660	8270
Dibenzo(a,h)anthracene	10	660	8270
o-Dichlorobenzene	10	660	8270
m-Dichlorobenzene	10	660	8270

TABLE 3-5 (Continued)

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)

Semivolatiles	Quantitation Limits*		Method Number
	Water (µg/L)	Low Soil (µg/kg)	
p-Dichlorobenzene	10	660	8270
3,3'-Dichlorobenzidine	20	1,300	8270
2,4-Dichlorophenol	10	660	8270
2,6-Dichlorophenol	10	NA	8270
Diethylphthalate	10	660	8270
Dimethoate	20	NA	8270
p-(Dimethylamino)azobenzene	10	NA	8270
7,12-Dimethyl benz(a)anthracene	10	NA	8270
3,3-Dimethyl benzidine	10	NA	8270
Dimethylphenenthylamine	10	NA	8270
2,4-Dimethylphenol	10	660	8270
Dimethyl phthalate	10	660	8270
m-Dinitrobenzene	20	NA	8270
4,6-Dinitro-o-cresol	50	3,300	8270
2,4-Dinitrophenol	50	3,300	8270
2,4-Dinitrotoluene	10	660	8270
2,6-Dinitrotoluene	10	660	8270
Di-n-octylphthalate	10	660	8270
Diphenylamine	10	NA	8270
Di-n-propylnitrosamine	10	NA	8270
Ethylmethanesulfonate	20	NA	8270
Fluoranthene	10	660	8270
Fluorene	10	660	8270
Hexachlorobenzene	10	660	8270
Hexachlorobutadiene	10	660	8270
Hexachlorocyclopentadiene	10	660	8270
Hexachloroethane	10	660	8270
Hexachloropropene	10	NA	8270
Indeno(1,2,3-cd)pyrene	10	660	8270
Isodrin	20	NA	8270
Isophorone	10	660	8270
Isosafrole	10	NA	8270
Kepone	20	NA	8270
Methapyrilene	100	NA	8270

TABLE 3-5 (Continued)

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)

Semivolatiles	Quantitation Limits*		Method Number
	Water (µg/L)	Low Soil (µg/kg)	
3-Methylcholanthrene	10	NA	8270
Methyl methanesulfonate	10	NA	8270
2-Methylnaphthalene	10	660	8270
Naphthalene	10	660	8270
1,4-Naphthoquinone	10	NA	8270
1-Naphthylamine	10	NA	8270
2-Naphthylamine	10	NA	8270
o-Nitroaniline	50	3,300	8270
m-Nitroaniline	50	3,300	8270
p-Nitroaniline	20	NA	8270
Nitrobenzene	10	660	8270
o-Nitrophenol	10	660	8270
p-Nitrophenol	50	3,300	8270
4-Nitroquinoline-1-oxide	40	NA	8270
n-Nitrosodi-n-butylamine	10	NA	8270
n-Nitrosodiethylamine	20	NA	8270
n-Nitrosodimethylamine	20	NA	8270
n-Nitrosodiphenylamine	10	660	8270
n-Nitrosomethylethylamine	20	NA	8270
n-Nitrosomorpholine	10	NA	8270
n-Nitrosopiperidine	20	NA	8270
n-Nitrosopyrrolidine	40	NA	8270
5-Nitro-o-toluidine	10	NA	8270
Pentachlorobenzene	10	NA	8270
Pentachloronitrobenzene	20	NA	8270
Pentachlorophenol	50	3,300	8270
Phenacetin	20	ND	8270
Phenanthrene	10	660	8270
Phenol	10	660	8270
Phorate	10	NA	8270
p-Phenylenediamine	10	NA	8270
2-PicolinPronamidee	10	NA	8270
Pyrene	10	660	8270
Pyridine	10	NA	8270

TABLE 3-5 (Continued)

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)

Semivolatiles	Quantitation Limits*		Method Number
	Water (µg/L)	Low Soil (µg/kg)	
Safrole	10	NA	8270
1,2,4,5-Tetrachlorobenzene	10	NA	8270
2,3,4,6-Tetrachlorophenol	10	NA	8270
o-Toluidine	10	NA	8270
1,2,4-Trichlorobenzene	10	660	8270
2,4,5-Trichlorophenol	10	660	8270
2,4,6-Trichlorophenol	10	660	8270
O,O,O-Triethyl-Phosphorotrioate	10	NA	8270
sym-Trinitrobenzene	10	660	8270

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.

TABLE 3-5 (Continued)

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)

Pesticides/PCBs	Quantitation Limits(1)		Method Number
	Water (µg/L)	Low Soil (µg/kg)	
Aldrin	0.04	2.7	8080
Alpha-BHC	0.03	2	8080
beta-BHC	0.06	4	8080
delta-BHC	0.09	6	8080
Lindane	0.05	1.7	8080
Chlordane	0.14	9.4	8080
4,4'-DDT	0.12	8	8080
4,4'-DDE	0.04	2.7	8080
4,4'-DDD	0.11	7.4	8080
Dieldrin	0.02	1.3	8080
Endosulfan I	0.14	9.4	8080
Endosulfan II	0.04	2.7	8080
Endosulfan sulfate	0.66	44	8080
Endrin	0.06	4	8080
Toxaphene	2.4	160	8080
Endrin Aldehyde	0.1	3.3	8080
Heptachlor	0.03	2	8080
Heptachlor epoxide	0.83	56	8080
Methyoxychlor	1.8	120	8080
Aroclor-1016	NA	NA	8080
Aroclor-1221	NA	NA	8080
Aroclor-1232	NA	NA	8080
Aroclor-1242	0.65	44	8080
Aroclor-1248	NA	NA	8080
Aroclor-1254	NA	NA	8080
Aroclor-1260	NA	NA	8080

(1) Practical Quantitation Limits taken from "Test Methods for Evaluating Solid Wastes," USEPA, SW-846, November 1986.

NA = Not Available

TABLE 3-5 (Continued)

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)

Dioxins (SW-846 Method 8280)	Quantitation Limits		Method Number
	Water (µg/L)	Low Soil (µg/kg)	
PCDD's	0.01	NA	8280
PCDF's	0.01	NA	8280
2,3,7,8-TCDD	0.005	0.17	8280

TABLE 3-5 (Continued)

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)

Chlorinated Herbicides	Practical Quantitation Limits		Method Number
	Water (µg/L)	Soil/Sediment (µg/kg)	
2,4-Dichlorophenoxyacetic acid	12	804	8150
Dinoseb	0.7	46.9	8150
2,4,5-T	2	134	8150
Silvex	1.7	11.4	8150

TABLE 3-5 (Continued)

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)

Inorganics	Method Number	MDL (µg/L)	Method Description
Antimony	6010	32	Inductively Cupled Plasma
Arsenic	7060	1	AA Graphite Furnace
Barium	6010	2	Inductively Coupled Plasma
Beryllium	6010	0.3	Inductively Coupled Plasma
Cadmium	6010	4	Inductively Coupled Plasma
Chromium	6010	7	Inductively Coupled Plasma
Cobalt	6010	7	Inductively Coupled Plasma
Copper	6010	6	Inductively Coupled Plasma
Lead	7421	1	AA Graphite Furnace
Mercury	7470	0.2	Cold Vapor AA
Nickel	6010	40	Inductively Coupled Plasma
Selenium	7741	2	AA Graphite Furnace
Silver	6010	7	Inductively Coupled Plasma
Thallium	7841	1	AA Graphite Furnace
Tin	6010	1,000	Inductively Coupled Plasma
Vanadium	6010	8	Inductively Coupled Plasma
Cyanide	9010	5	Colorimetric
Sulfide	9030	1,000	Titrimetric, Iodine

TABLE 3-6

METHOD PERFORMANCE LIMITS
RCRA METALS COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)

Inorganics	Method Number	MDL (µg/L)	Method Description
Arsenic	7060	1	AA Graphite Furnace
Barium	6010	2	Inductively Coupled Plasma
Cadmium	6010	4	Inductively Coupled Plasma
Chromium	6010	7	Inductively Coupled Plasma
Lead	7421	1	AA Graphite Furnace
Mercury	7470	0.2	Cold Vapor AA
Selenium	7741	2	AA Graphite Furnace
Silver	6010	7	Inductively Coupled Plasma

TABLE 3-7

METHOD OF CHEMICAL ANALYSIS
WATER QUALITY PARAMETERS

Analysis	Method
Silver	7000 Series *
Copper	7000 Series *
Zinc	7000 Series *
Aluminum	7000 Series *
Iron	7000 Series *
Manganese	7000 Series *
Alkalinity (as $CaCO_3$)	130.2 **
Salinity	----------
Sulfate	9035-38 *
Chloride	9250 *
Fluoride	340.2 **
Odor	----------
Color (APHA Units)	110.1 **
Total Dissolved Solids	160.1 *

* "Methods for Chemical Analysis of Water and Wastes," USEPA, EPA 600/4-79-020. Revised March 1983.
** "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," USEPA, SW-846.

TABLE 3-8

SUMMARY OF SOIL BORING AND WELL CONSTRUCTION DETAILS
SWMU 9, AREAS A, B, AND C, TANKS 212 - 217
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Phase	Boring Number	Top of PVC Casing Elevation (ft above msl)	Ground Surface Elevation (ft above msl)	Boring Depth (ft bgs)	Depth to Bedrock (ft bgs)	Well Depth (ft bgs)	Well Depth (ft from top of PVC casing)	Screen Interval (ft bgs)	Sand Pack Interval (ft bgs)	Bentonite Interval (ft bgs)
I	9MW01	115.29	113.34	47.00	43.50	45.00	48.95	25.0-45.0	21.5-45.0	17.0-21.5
	9MW02	111.44	109.38	44.00	NA	44.00	46.06	24.0-44.0	22.0-44.0	20.0-22.0
	9MW03	111.62	108.77	47.00	NA	43.00	49.85	23.0-43.0	18.5-43.0	16.5-18.5
	9MW04	108.56	106.09	37.00	NA	35.00	39.47	15.0-35.0	12.0-35.0	10.0-12.0
II	9MW02N	111.89	109.90	22.00	NA	20.00	23.99	10.0-20.0	8.0-20.0	6.0-8.0
	9MW02R	111.68	109.81	22.00	NA	20.00	23.87	10.0-20.0	8.0-20.0	6.0-8.0
	9MW02S	112.42	109.76	22.00	NA	21.00	24.66	11.0-21.0	7.5-21.0	5.0-7.5
III	9-A02-HP01	NM	112.46	18.00	NA	18.00	NM	8.0-18.0	NA	NA
	9-A02-HP02	NM	109.76	18.00	NA	15.5	NM	5.5-15.5	NA	NA
	9-A02-HP03	NM	108.71	18.00	NA	18.00	NM	8.0-18.0	NA	NA
	9-A02-HP04	NM	106.94	16.00	NA	15.5	NM	5.5-15.5	NA	NA
	9-A02-HP05	NM	105.74	12.00	NA	10.0	NM	0.0-10.0	NA	NA
	9-A02R-HP01	NM	109.18	13.00	NA	13.0	NM	8.0-13.0	NA	NA
	9-A02R-HP02	NM	105.97	12.00	NA	12.0	NM	2.00-12.0	NA	NA
	9-A02R-HP03	NM	109.26	14.00	NA	14.0	NM	9.0-14.0	NA	NA
	9-A02R-HP04	NM	106.50	12.00	NA	12.0	NM	7.0-12.0	NA	NA
	9-A02R-HP05	NM	104.67	12.00	NA	12.0	NM	2.0-12.0	NA	NA
	9-A02R-HP06	NM	109.83	18.00	NA	18.0	NM	8.0-18.0	NA	NA
	9-A02R-HP07	NM	106.13	16.00	NA	16.0	NM	6.0-16.0	NA	NA
	9-A02R-HP08	NM	109.47	12.00	NA	NI	NA	NA	NA	NA
	9-A02R-HP09	NM	110.62	18.00	NA	18.0	NM	8.0-18.0	NA	NA
	9-A02R-HP10	NM	102.85	12.00	NA	12.0	NM	2.0-12.0	NA	NA
	9-A02R-HP11	NM	107.48	18.00	NA	18.0	NM	8.0-18.0	NA	NA
	9-A02R-HP12	NM	105.63	18.00	NA	18.0	NM	8.0-18.0	NA	NA
	9-B05-HP01	NM	107.55	12.00	NA	12.0	NM	2.0-12.0	NA	NA
	9-B05-HP02	NM	112.13	20.00	NA	16.0	NM	11.0-16.0	NA	NA

TABLE 3-8 (Continued)

SUMMARY OF SOIL BORING AND WELL CONSTRUCTION DETAILS
SWMU 9, AREAS A, B, AND C, TANKS 212 - 217
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Phase	Boring Number	Top of PVC Casing Elevation (ft above msl)	Ground Surface Elevation (ft above msl)	Boring Depth (ft bgs)	Depth to Bedrock (ft bgs)	Well Depth (ft bgs)	Well Depth (ft from top of PVC casing)	Screen Interval (ft bgs)	Sand Pack Interval (ft bgs)	Bentonite Interval (ft bgs)
III	9-B05-HP03	NM	105.87	12.00	NA	12.0	NM	2.0-12.0	NA	NA
	9-B05-HP04	NM	104.21	8.00	NA	8.0	NM	3.0-8.0	NA	NA
	9-B05-HP05	NM	116.54	NR	NR	NR	NR	NR	NA	NA
	9-B06-HP01	NM	106.31	16.00	NA	16.0	NM	11.0-16.0	NA	NA
	9-B06-HP02	NM	108.36	26.00	NA	26.0	NM	21.0-26.0	NA	NA
	9-B06-HP03	NM	106.86	12.00	NA	12.0	NM	7.0-12.0	NA	NA
	9-B06-HP04	NM	113.62	20.00	NA	19.5	NM	9.5-19.5	NA	NA
	9-B06-HP05	NM	111.12	30.00	NA	30.0	NM	15.0-30.0	NA	NA
	9-BG-SB01	NM	111.22	16.00	NA	16.0	NM	6.0-16.0	NA	NA
	9-BG-SB02	NM	106.36	16.00	NA	16.0	NM	6.0-16.0	NA	NA
	9-BG-SB03	NM	104.66	16.00	NA	16.0	NM	6.0-16.0	NA	NA
	9-BG-SB04	NM	107.73	14.00	NA	14.0	NM	4.0-14.0	NA	NA
	9-BG-SB05	NM	128.67	23.00	21.0	23.0	NM	13.0-23.0	NA	NA

Notes: NA - Not Applicable/Not Available
NM – Not Measured
NR- Not Recorded

TABLE 3-9

SWMU 9 QA/QC - TANKS 212-217
SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

		Analysis Requested										
		Aqueous Samples										
		Stateside Laboratory										
Sample ID	Date Collected	Volatile Organic Compounds	Semivolatile Organic Compounds	Pesticides/PCBs	TPH DRO	TPH GRO	Sulfide	Total RCRA Metals	Cyanide	Total Appendix IX Inorganics	Arsenic	COMMENTS
PHASE I QA/QC SAMPLES												
9RB01	04/08/96	X	X		X	X		X			X	Equipment Rinsate
9RB02	04/17/96	X	X		X	X		X			X	Equipment Rinsate
FB01	04/16/96	X	X	X				X			X	Field Blank
FB02	04/16/96	X	X	X				X			X	Field Blank
FB03	04/17/96	X	X	X		X		X			X	Field Blank
TB10	04/03/96	X										Trip Blank
TB11	04/03/96	X										Trip Blank
TB12	04/06/96	X										Trip Blank
TB13	04/08/96	X										Trip Blank
TB14	04/12/96	X										Trip Blank
TB15	04/16/96	X										Trip Blank
TB16	04/17/96	X										Trip Blank
TB17	04/19/96	X										Trip Blank
TB18	04/20/96	X										Trip Blank
TB19	04/22/96	X										Trip Blank
TB20	04/25/96	X										Trip Blank
TB21	04/27/96	X										Trip Blank
PHASE II QA/QC SAMPLES												
9ER01	10/02/97				X			X			X	Equipment Rinsate
9ER02	10/02/97				X			X			X	Equipment Rinsate
FB01	09/19/97	X			X							Field Blank
PHASE III QA/QC SAMPLES												
99-ER01	06/30/99	X	X		X	X	X		X	X	X	Equipment Rinsate
99-ER02	06/30/99	X	X		X	X	X		X	X	X	Equipment Rinsate
99-ER03	06/30/99	X	X		X	X	X		X	X	X	Equipment Rinsate
99-ER04	06/30/99	X	X				X		X	X	X	Equipment Rinsate
99FB01	06/30/99	X	X		X	X				X	X	Field Blank
99FB02	06/30/99	X	X		X	X				X	X	Field Blank
9TB01	06/24/99	X				X						Trip Blank
9TB03	06/28/99	X										Trip Blank
9TB04	06/29/99	X										Trip Blank
9TB05	06/29/99	X										Trip Blank
9TB06	06/29/99	X										Trip Blank
9TB07	06/30/99	X										Trip Blank

SECTION 3.0
FIGURES

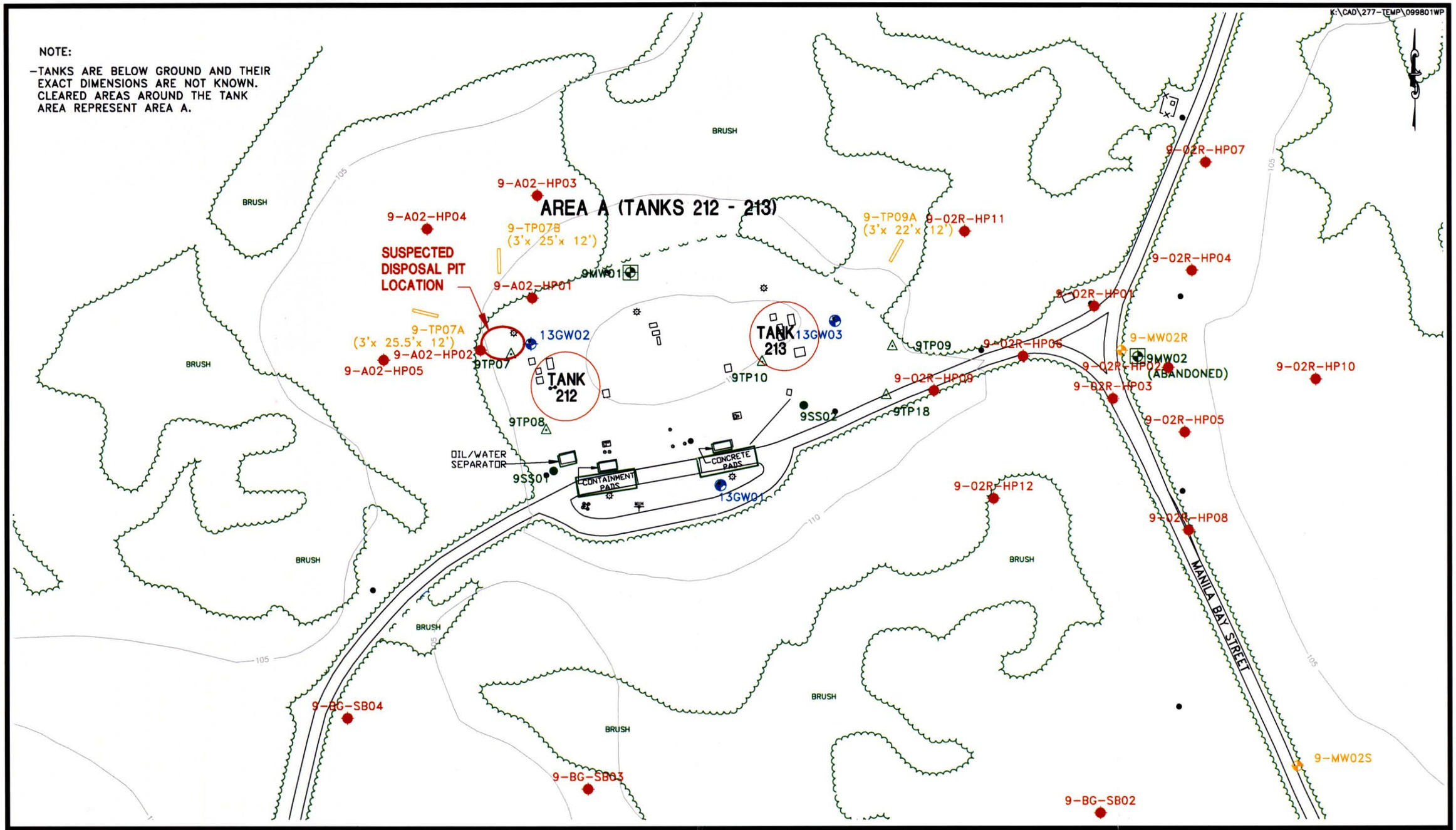
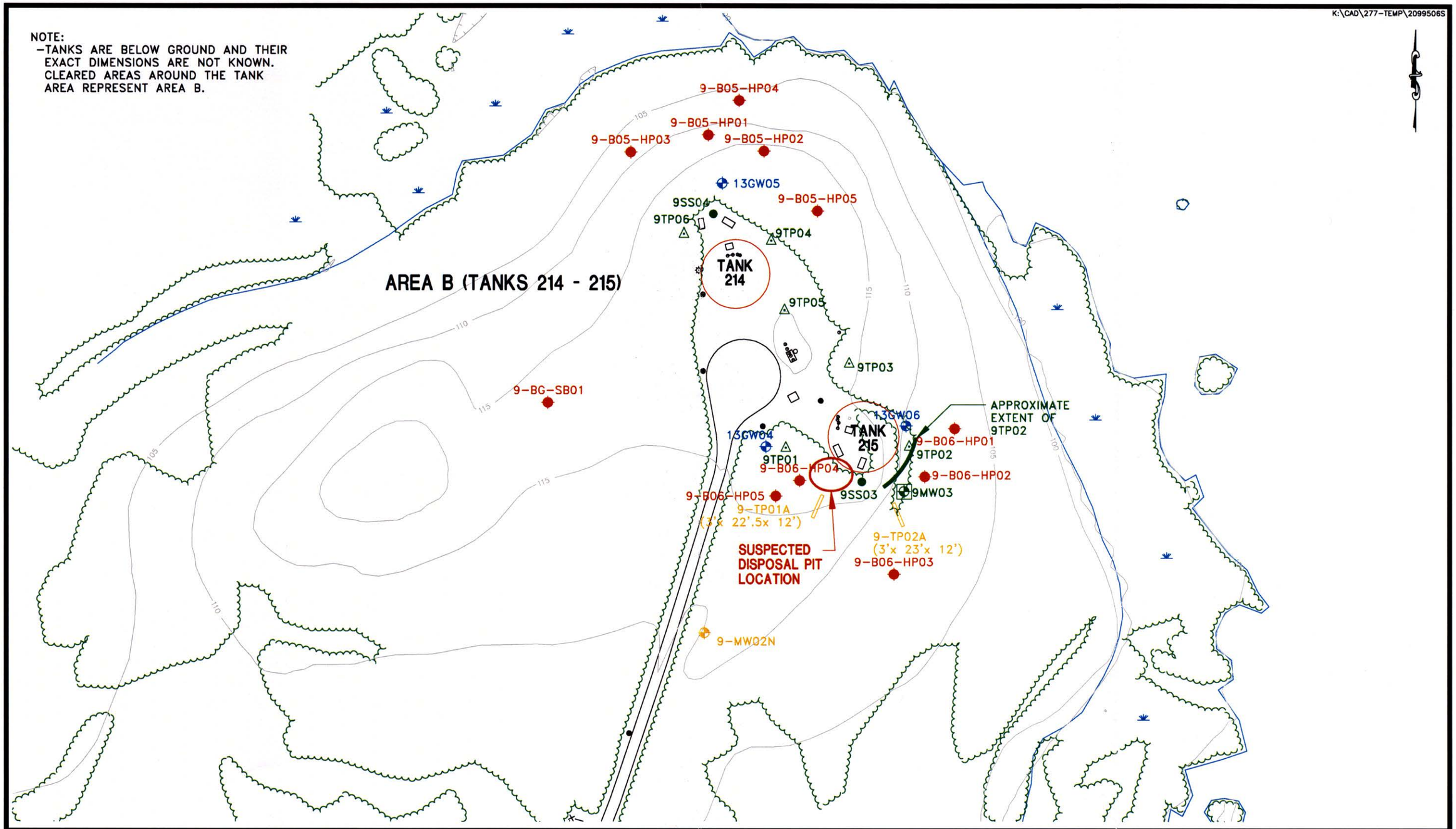


FIGURE 3-1
SAMPLING LOCATIONS
SWMU 9 - AREA A
TANKS 212 - 213
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

00779LB3Y

K:\CAD\277-TEMP\2099506S

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA B.



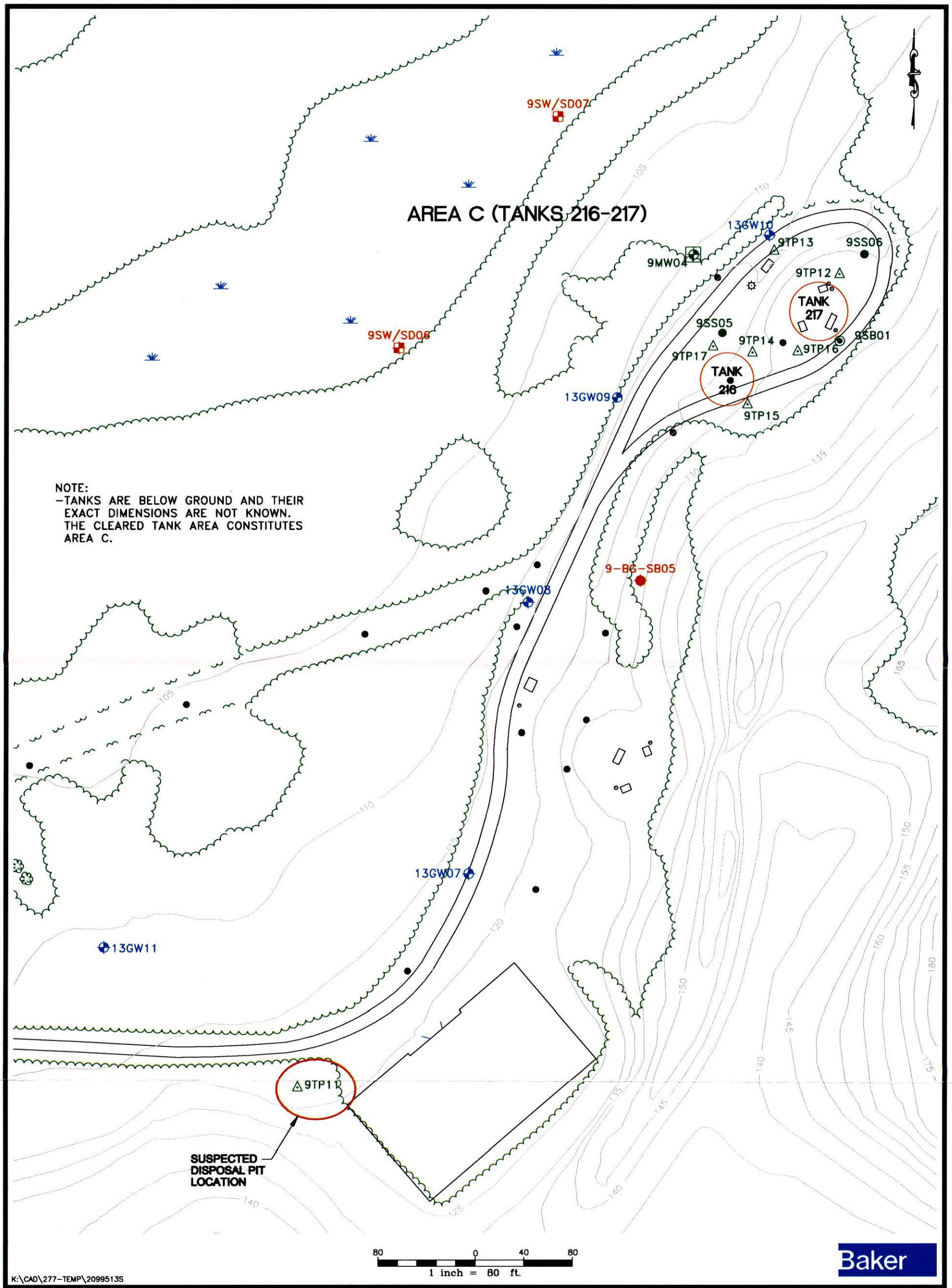
LEGEND

- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE II)
- SOIL BORING LOCATION (PHASE III)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- MONITORING WELL LOCATION (PHASE II)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

100 0 50 100
1 inch = 100 ft.

Baker

FIGURE 3-2
SAMPLING LOCATIONS
SWMU 9 - AREA B
TANKS 214 - 215
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



LEGEND

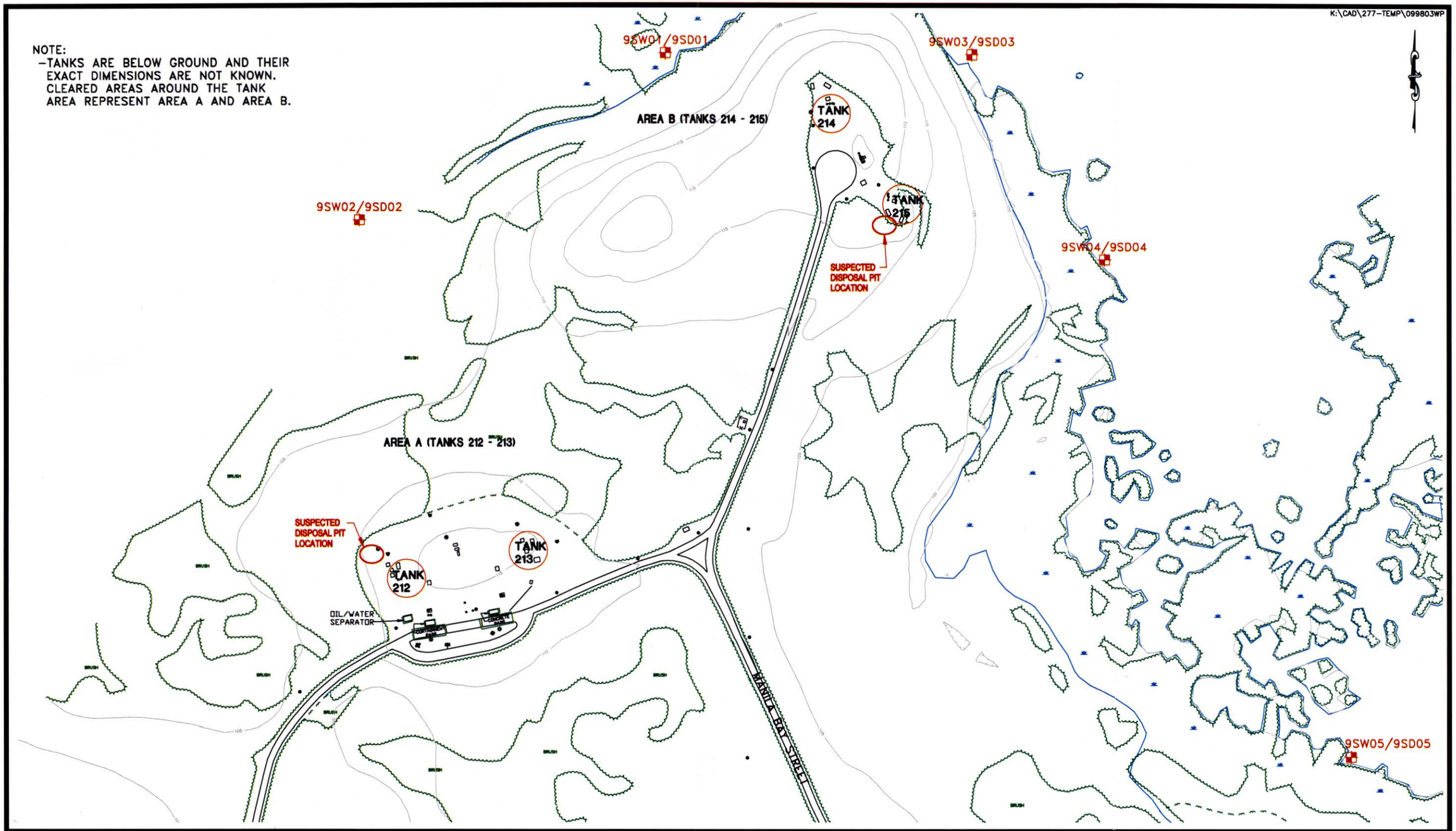
- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- SOIL BORING LOCATION (PHASE I)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- SURFACE WATER AND SEDIMENT SAMPLE LOCATION (PHASE III)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

FIGURE 3-3
SAMPLING LOCATIONS
SWMU 9 - AREA C
TANKS 216 - 217

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

K:\CAD\277-TEMP\099803WP

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA A AND AREA B.



LEGEND

- SURFACE WATER AND SEDIMENT SAMPLING LOCATION (PHASE III)
- 115 – SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

180 0 90 180
1 inch = 180 ft.

Baker

FIGURE 3-4
SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS
SWMU 9 – AREAS A AND B
TANKS 212 – 215
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

4.0 PHYSICAL CHARACTERISTICS OF STUDY AREA

The physical setting of NSRR was documented in the 1984 IAS (NEESA Document 13-051). This information is summarized below.

4.1 Climatology

The climate of the Roosevelt Roads area is characterized as warm and humid, with frequent showers occurring throughout the year. A major factor affecting the weather is the pattern of trade winds associated with the Bermuda High, the center of which is in the vicinity of 30° North, 30° West. The prevailing wind direction reflects the easterly trade winds. The area receives a surface flow varying between the northeast to the southeast about 75 percent of the year, and as much as 95 percent of the time in July when the easterly winds are strongest. The differential heating of the land and sea during the day tends to give a more northerly component to the flow on the northern side of the island and a more southerly component on the southern side. During the night, a land breeze causes a prevailing southeasterly flow in the north and a prevailing northeasterly flow over the southern coast. The mean annual wind velocity is 5.5 knots, with a minimum in November and a maximum in August. Gales associated with westward moving disturbances in the trade winds or hurricanes passing either north or south of the area have the highest probability of occurrence from June through October.

Uniform temperatures prevail, with small diurnal ranges as a result of insular exposure and the relatively small land areas. The warmest months are August and September, while the coolest are January and February. Mean annual maximum temperatures range from 82.0° in January to 88.2°F in August. The mean annual minimum temperatures vary from 64.0° in January to 73.2° in June. The highest maximum temperature recorded was 95°F, while the lowest minimum was 59°F. Rain usually occurs at least nine days in every month, with an average of 60 inches per year although a dry winter season occurs from December through April. About 22 thunderstorm-days occur per year, with maximum frequencies of three days per month from May through October.

In late summer, the mean sky cover begins a steady decrease from a monthly maximum average of 6.5-tenths coverage in September to a minimum monthly average of 4.4-tenths coverage in February. From March through August, the monthly average clouds over increases steadily from 4.5- to 6.0-tenths coverage during the period. Over the open sea, a maximum of clouds (usually broken stratocumulus) occurs during early morning, with the skies clearing or becoming scattered with cumulus by afternoon. Completely clear or overcast skies are rare during daylight hours, while clear skies frequently occur at night.

The hurricane season is from mid-June through mid-September; maximum winds exceed 95 knots during severe hurricanes. An average of two tropical storms per year occur in the study area, one of which usually reaches hurricane intensity.

4.2 Topography

The regional area of Roosevelt Roads consists of an interrupted, narrow coastal plain with small valleys extending from the Sierra de Luquillo range, which has been severely eroded by streams into valleys several hundreds of feet deep. Slopes of up to 60° are common.

In the immediate area of the station, elevations range from sea level to approximately 295 feet. Immediately to the north of the NSRR boundary, the hills rise abruptly to heights of 800 to 1,050 feet above sea level, with the tallest peak located within two kilometers of the station boundary. There is a series of three hilly areas on the station, two of which separate the southern airfield area from the Port/Industrial, Housing and Personnel Support areas. The third set of hills is in the Bundy area. These ridge lines not only separate sections of the station, but dictate the degree of allowable development. The ridge line south of the airfield provides an excellent barrier which effectively decreases the aircraft-generated noise which reaches the Unaccompanied Enlisted Personnel Housing areas to an acceptable level. Relief is low along the shoreline. Lagoons and mangrove swamps are common.

4.3 Geology

The following subsections present a description of the general geology at NSRR and site-specific geologic information obtained at SWMU 9.

4.3.1 Soils

The soil associations found at NSRR are predominantly of two types typical of humid areas, namely the Swamps-Marshes Association and the Mabi-Rio-Arriba-Cayagua Association, as well as the Descalabrado-Guayama Association, which is typical of dry areas. In addition, isolated areas of the Caguabo-Mucara-Naranjito Association, the Coloso-Toa-Bajura Association, and the Jacana-Amelia-Fraternidad Association are found at NSRR.

The Swamps-Marshes and Mabi-Rio-Arriba-Cayagua associations cover over one half of NSRR's surface area and are equally distributed. The remaining area is covered primarily by the Descalabrado-Guayama and Caguabo-Mucara-Naranjito associations.

The Swamps-Marshes Association consists of deep, very poorly drained soils. This association is found in level or nearly level areas that are slightly above sea level but are wet, and when the tide is high, are covered or affected by saltwater or brackish water. The soils are sandy or clayey, and contain organic materials from decaying mangrove trees. They are underlain by coral, shells and marl at varying depths. The high concentration of salt inhibits the growth of all vegetation except mangrove trees, and in small scattered patches, other salt-tolerant plants.

The Mabi-Rio-Arriba-Cayagua Association consists generally of deep, somewhat poorly drained and moderately well-drained, nearly level to moderately steep soils found on foot and side slopes, terraces and alluvial fans. Soils of this association at NSRR are basically clayey.

The Descalabrado-Guayama Association generally consists of shallow, well-drained, strongly sloping to very steep soils on volcanic uplands. Soils of this association are found primarily in the hilly areas located directly inland and adjacent to the soils of the Swamps-Marshes Association.

The Caguabo-Mucara-Naranjito Association consists generally of shallow and moderately deep, well-drained, sloping to very steep soils on volcanic uplands. This association consists of soils which formed in residual material that weathered from volcanic rocks. This association is represented at the station by soils of the Sabana series, which are found on the side slopes and the hilly terrain west of Langley Drive in the Fort Bundy area. These soils are suited for pasture and woodland. Steep slopes, susceptibility to erosion and depth to bedrock are the main limitations for farming, and for recreation and urban areas.

The Coloso-Toa-Bajura Association consists of deep, moderately well drained to poorly drained, nearly level soils found on floodplains. This soil association extends along the western boundary of NSRR and around the airfield. The soils of this association formed in fine-textured and moderately fine-textured sediment of mixed origin on floodplains. The Coloso soils are deep and somewhat poorly drained; the Toa soils are deep and moderately well drained; and the Bajura soils and Maunabo soils are deep and poorly drained. The Reilly soils, also part of this association, are shallow sand and gravel and are excessively drained; they lie adjacent to streams. The minor soils are Talante, Vivi, Fortuna, Vega Alta and Vega Baja. The Talante, Vivi, Fortuna and Vega Baja soils are found on floodplains, while the Vega Alta soils occupy slightly higher positions on terraces.

The Jacana-Amelia-Fraternidad Association consists generally of moderately deep and deep, well-drained and moderately well-drained, nearly level to strongly sloping soils on terraces, alluvial fans and foot slopes. This association is represented at NSRR by soils of the Jacana series, which consist of moderately deep, well-drained soils found on the foot slopes and low rolling hills along Langley Drive and just east of the airfield. These soils formed in fine-textured sediment and residuum derived from basic volcanic rocks.

4.3.2 Regional Geology

The underlying geology of NSRR area is predominantly volcanic (composed of lava and tuff), as well as sedimentary (rocks derived from discontinuous beds of limestone). These rocks all range in age from early Cretaceous to middle Eocene. The volcanic rocks and interbedded limestones have been complexly faulted, folded, metamorphosed and variously intruded by dioritic rocks. This complex geological structuring occurred sometime after the deposition of the limestone during the middle

Tertiary, when Puerto Rico was separated from the other major Antillean Islands by block faulting, and was arched, uplifted and tilted to the northeast. Culebra, Vieques, and the Virgin Islands are part of the Puerto Rican block; they are separated from the main island simply because of the drowning that resulted from the tilting.

In addition to the predominant volcanic and sedimentary rock, the northwestern and western sectors of the base are underlain by unconsolidated alluvial and older deposits from the Quaternary period.

The primary geologic formations on and near NSRR are various beach deposits, alluvium, quartz diorite and granodiorite, quartz keratophyre, the Daguao Formation, and the Figuera Lava. NSRR is traversed by the Peña Pobre fault zone.

4.3.3 Site Geology SWMU 9 - Tanks 212-217 (Areas A, B and C)

Overburden soil encountered at SWMU 9 was mainly comprised of residual fine grained silts and clays with varying amounts of rock fragments. Two hydrogeologic cross-sections where developed from monitoring wells and temporary piezometers installed within Areas A and B during Phase I, II and III (Figure 4-1). The two hydrogeologic cross-sections depicting representative subsurface soil conditions and water elevations are shown on Figures 4-2 and 4-3.

The subsurface material at SWMU 9 consists of varying amounts of clay and silt with occasional rock fragments, and sand. Cross-section A-A' includes monitoring wells 9MW01 and 9MW02 within Area A and Geoprobe® boring locations/temporary piezometers 9-A02-HP01, 9-A02-HP04 and 9-A02-HP06 (Figure 4-1). Cross-section A-A' is presented on Figure 4-2. The soil within Area A is typically a brown to gray, firm to hard clay to clayey silt. A brown sand and rock fragment layer was encountered from a depth of 37 feet to 43.5 feet bgs during Phases I and II. This sand zone rested directly above weathered bedrock. Within Area B (well 9MW03) the soil becomes a mottled green, white, and red silty clay and silt with little to some rock fragments. Soil encountered at 9MW04 and 9SB01 within Area C was observed to be light brown to brown containing a higher silt content than noted at Areas A and B. This silt zone continued to a depth of eight feet. Below this zone, and continuing to the base of the boring, is a layer of brown, rock fragments, some silty sand, trace clay. A sample from 8 to 10 feet bgs was submitted for grain size analysis where it was classified as a GC

(poorly sorted gravel, sand, and silt mixture) according to the Unified Soil Classification System (USCS) (Table 4-1). The Grain Size Distribution Test Report for 9MW04 is provided as Appendix G. Relative densities of the subsurface soils throughout SWMU 9, based on standard penetration tests range from medium stiff to hard. The more granular soils showed a relative density ranging from dense to very dense.

The soil at 9-BG-SB05 was a lean, firm clay from surface to 21 ft. bgs. Weathered bedrock was present from 21 ft. to the boring termination depth at 23 ft. bgs.

Cross-section B-B' includes monitoring wells 9MW02N, 9MW02R, and 9MW02S within Areas A and B (Figure 4-1). The hydrogeologic cross-section of Areas A and B subsurface conditions is shown on Figure 4-3. Monitoring well 9MW02R replaced the original monitoring well 9MW02. Cross section B-B' runs approximately north to south across the site. The boring logs used to generate this cross section identified suspected fill soil consisting of rocks with fine grain sand and some clay in the first several feet below ground surface. This soil overlies a mottled reddish brown, light brown gray clay with varying amounts of silt. This material occasionally contains black staining along planar surfaces possibly attributed to insitu chemical weathering of iron and manganese. Further south along B-B' in Area A, the soil was a white clay with red/brown iron staining.

Bedrock, defined by auger refusal, was encountered at only two locations during Phases I and II, 9MW01 in Area A and 9SB01 in Area C. At 9MW01 auger refusal was encountered at a depth of 47 feet while bedrock was encountered at a depth of 24.4 feet bgs at 9SB01. Drilling operations were terminated above bedrock at the remaining locations because a sufficient saturated thickness of unconsolidated material existed above bedrock.

Bedrock was not encountered in any of the Geoprobe® borings installed in Areas A or B during the third phase of investigation. The Phase III borings were used to collect soil samples at the groundwater table and install temporary piezometers screened across the groundwater table within the unconsolidated zone.

4.4 Hydrology

The following sections present a description of the hydrologic conditions that exist at NSRR. Both regional conditions and site specific conditions at SWMU 9 are discussed.

4.4.1 Regional Hydrology

The surface waters that flow across the northeastern plain of Puerto Rico, where the Station is located, originate on the eastern slopes of the Sierra de Luquillo mountains. Surface runoff is channeled into various rivers and streams which eventually flow into the Caribbean Sea. The Daguao River and Quebrada Seca Stream (a tributary to Rio Daguao) collect surface waters from the hills immediately north of the station and, in periods of heavy rain, on-station flooding occurs. The Daguao-Quebrada Seca watershed comprises an area of approximately 7.6 square miles (4,900 acres), and the river falls some 700 feet from its source to sea level. Increased development in the Town of Ceiba, especially in areas adjacent to the station's northern boundary, has significantly increased the surface runoff reaching the station, causing ponding and erosion in the Boxer Drive area. Boxer Drive, for a major portion of its length, is subject to surface water flooding, as are Hangar 200 and AIMD Hangar 379 and adjacent apron areas. This condition has been alleviated by the construction of the new highway (Route 3) immediately outside the fence and the realignment of Boxer Drive both with attendant stormwater management features.

In the low-lying shore areas, seawater flooding results from storms, wind and abnormally high tides. The tidal ranges in the Roosevelt Roads area are rather small, with a maximum spring range of less than three feet. The tides are semidiurnal and have a usual range of about one foot in the main harbor of the station.

Little information exists concerning the geohydrology of NSRR. The only known potential sources of groundwater lie in lenticular beds of clay, sand and gravel, and rock fragments which occur at a depth of less than 30 meters. No wells have been developed on-base from these layers. Some wells had been developed upgradient of the station in Ceiba, some three kilometers from base headquarters, but were abandoned due to high levels of salinity.

The quality of surface waters is variable, reflecting the drainage area through which the water flows. Generally, surface waters have high turbidities and bio-organics (naturally occurring organics, such as decay products of vegetable and animal matter) due to the periodic heavy rains which can easily erode soils from steep slopes, exposed areas and disturbed stream beds.

Water from alluvial aquifers along the coast of the station is of a calcium bicarbonate type, and has high concentrations of iron and manganese. The source of these minerals is unknown, but they may be derived from buried swamp or lagoon deposits.

A seawater-freshwater interface is present in the aquifers throughout the coastal areas of Puerto Rico, usually within a short distance inland of the coastline.

The NSRR potable water treatment plant receives its raw water from the Rio Blanco through a 27 inch reinforced concrete pipe that replaced the old, open channel. The intake is located at the foot of the El Yunque rain forest. This buried raw water line traverses a distance of 14 miles from the intake to the station boundary. A raw water reservoir is located at the water treatment plant and has a 45-million gallon capacity. Additionally, there are two fire protection storage reservoirs with a total capacity of 520,000 gallons.

The base has been served for over 30 years by the present treatment facility. The plant (Building 88) has a capacity of 4.0 million gallons per day (mgd). Water flows by gravity into a 45 million gallon raw water storage basin from which the plant draws its supply at a rate of 1.3 mgd on average. Treatment consists of pre-chlorination, coagulation sedimentation, filtration and post-chlorination.

The single potable water supply system provides water to all industrial operations at the facility. The water supply is low in hardness, and, therefore, is an excellent source for industrial uses, particularly in boiler operation and maintenance.

Three hundred acres are used for pasture near Gate 1, and are irrigated as needed. Extensive sprinkling of lawns and green areas is evident throughout the base.

4.4.2 SWMU 9 Hydrogeology

Groundwater in monitoring wells installed during the Phase I field activity was encountered in predominantly clayey soil at depths ranging from 19 feet bgs at 9MW03 and 9MW04 to 32 feet bgs at 9MW01. At location 9MW01, the water bearing zone extended to the top of bedrock (47 feet bgs) for a saturated thickness of approximately 15 feet. The water bearing zone at the other well locations did not extend to the base of the boring. A saturated thickness of 22 feet was noted at 9MW02, and 9MW03 recorded a saturated thickness of 24 feet. Groundwater at location 9MW04 was observed at two different depths, separated by approximately 15 feet of silty clay. Groundwater was encountered from depths of 13 to 16 feet bgs and 30 to 32 feet bgs at 9MW04.

Groundwater elevation measurements from May 10, 1996 for Area A are presented in Table 4-2. For Area A, groundwater elevations are similar with less than a 0.7 foot variation between wells. A groundwater elevation contour map for the Areas A and B shallow aquifer on May 10, 1996 is presented on Figure 4-4. The represented groundwater surface at Area A is an elongated mound with its axis running east-west, the highest shallow groundwater elevation in this area is at well 13GW03, located in the approximate center of the groundwater mound. Taking well 13GW03 as the highest point of the mound, the hydraulic gradient measured between well 13GW03 and well 13GW02 to the west is 0.00078 ft/ft. The hydraulic gradient measured between well 13GW03 and well 9MW02 to the east is 0.0014 ft/ft. This gives an average estimated hydraulic gradient for the area of 0.0011 ft/ft.

Groundwater elevations were measured on May 10, 1996 for Area B and are presented in Table 4-2. Figure 4-4 presents the groundwater elevation contour map for Area B. The shallow groundwater in Area B is a mound with the highest elevation measured at well 13GW06. Groundwater would move away from well 13GW06 in all directions. Low marshy areas are located to the north and east of Area B, which may be discharge points for the shallow groundwater. The hydraulic gradient measured between well 13GW06 and well 9MW03 to the south is 0.021 ft/ft. The hydraulic gradient measured between well 13GW06 and well 13GW04 to the west/southwest is 0.0019 ft/ft. This gives an average estimated hydraulic gradient of 0.011 ft/ft for the area.

Groundwater level elevations at Area C are also included in Table 4-2 for May 10, 1996. Figure 4-5 presents the groundwater elevation contour map for this area. Wells 13GW07, 13GW08, 13GW09,

13GW10 and 9MW04 are all located along the road leading back to Tanks 216 and 217, at generally the same ground surface elevation. Well 13GW11 is located down slope from well 13GW07, approximately 5 feet lower in elevation. The groundwater contour map indicates there is a relatively flat groundwater surface at the higher ground elevation, with an apparent gradient towards well 13GW11. Groundwater may also flow toward the marsh area to the northwest of Area C. The hydraulic gradient measured from well 13GW07 to well 13GW11 to the west/southwest is 0.017 ft/ft. The hydraulic gradient in the northeastern area may be steeper due to the increased surface grade to the marsh area.

The hydraulic properties of the shallow aquifer were characterized by performing in situ rising and/or falling head slug tests in existing groundwater monitoring wells. The tests were performed in April 1996. An electronic data logger (In Situ Hermit Model 1000C) and pressure transducer assembly were used to record the recovery of groundwater in the monitoring wells to static level. The data was recorded in logarithmic scale to more closely monitor initial changes in groundwater elevation. The data resulting from the slug tests were converted into time (in minutes) and the corresponding change in water level displacement (in feet). Results from the slug tests were analyzed using Geraghty & Miller's AQTESOLV (ver. 2.0) computer program for performing quantitative groundwater assessments. The Bouwer and Rice solution for slug tests in unconfined aquifers was used to evaluate the test data. Table 4-3 presents a summary of slug test data obtained from the SWMU 9 wells. The input parameters and plots generated from the slug tests are contained in Appendix F. Hydraulic conductivity (K) values ranged from 0.86 ft/day in well 13GW02 in Area A to 12.53 ft/day in well 13GW08 in Area C. An estimated transmissivity value (T) can be obtained by multiplying the hydraulic conductivity by the saturated thickness (b) of the aquifer. Assuming an average saturated thickness of 20 feet, estimated T values range from 17.2 ft^2/day (129 gallons/day/ft) to 250.6 ft^2/day (1879.5 gallons/day/ft).

Slug tests were also performed in October 1997 in the three groundwater monitoring wells (9MW02N, 9MW02R and 9MW02S) installed during the second phase of field activities. Falling head tests were not conducted due to the water levels being within the screened intervals in the three monitoring wells. Falling head tests are invalid in conditions where the water level is within the screened interval. This is due to the fact that when the slug is placed in the well and the water level rises, the falling water flows into the aquifer through the screen and through the vadose zone above the original water table.

This increases the rate of fall of the water level in the borehole beyond the inflow into the aquifer, thus overestimating the K value. Results from the slug tests were analyzed using Geraghty & Miller's AQTESOLV computer program for the Bouwer and Rice solution. Table 4-4 presents the estimated hydraulic conductivity values for the monitoring wells. The input parameters and plots generated from the slug tests are provided as Appendix F. The hydraulic conductivity values ranged from 0.30 ft/day to 0.70 ft/day. Assuming a saturated thickness of 20 feet for the aquifer, estimated transmissivity values range from 6 ft^2/day (45 gallons/day/ft) to 14 ft^2/day (105 gallons/day/ft).

SECTION 4.0
TABLES

TABLE 4-1

SUMMARY OF CORRECTIVE MEASURES SAMPLES
SWMU9 , TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample Number	9MW04-04	9MW04
Depth (ft)	8.0 - 10.0	NA
Matrix	Soil	Groundwater
USCS Classification	GC	--
Percent Moisture	13.1	--
pH (s.u.)	8	6.58
TOC	0.19%	5.8 mg/L
BOD	23U mg/Kg	2U mg/L
COD	580U mg/Kg	170 mg/L
TSS	NA	330 mg/L
Oil and Grease	NA	5.4 U mg/L
Nitrogen	NA	0.2 U mg/L
Phosphorous	NA	0.05U mg/L

Note: NA - Not Analyzed
U - undetected
"--" Not Available

TABLE 4-2

SUMMARY OF GROUNDWATER ELEVATIONS
MAY 10, 1996
SWMU 9, TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Area	Well Number	Top of PVC Casing Elevation (ft. msl)	Ground Surface Elevation (ft. msl)	Depth to Water (ft. msl)	Groundwater Elevation (ft. msl)
A	13GW01	116.23	113.23	--	--
	13GW02	117.38	114.76	19.76	97.62
	13GW03	115.45	112.60	17.59	97.86
	9MW01	115.30*	113.34	17.67	97.62
	9MW02	111.44*	109.38	14.27	97.17
	9MW02R	111.68	109.81	--	--
B	13GW04	119.80	116.30	20.81	98.99
	13GW05	--	117.96	21.79	--
	13GW06	112.88*	110.09	13.61	99.26
	9MW03	111.63*	108.77	13.75	97.87
	9MW02N	111.89	109.90	--	--
	9MW92S	111.65	109.76	--	--
C	13GW07	121.59*	118.90	21.45	100.14
	13GW08	120.25*	118.00	19.98	100.27
	13GW09	120.26*	117.51	20.06	100.20
	13GW10	116.35*	114.00	16.06	100.29
	13GW11	114.51*	111.77	16.69	97.82
	9MW04	108.57*	106.09	8.54	100.02

Note: Depth to water measurements taken from top of PVC casing.
msl - mean sea level
" -- " Not Available
* Elevation of top of steel protective casing

TABLE 4-3

SUMMARY OF HYDRAULIC CONDUCTIVITY ESTIMATES
SWMU 9, TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Area	Well ID	Hydraulic Conductivity (ft/day)Average		
		Rising Head	Falling Head	Average
A	13GW01	--	6.58	--
	13GW02	--	0.86	--
	13GW03	--	0.92	--
	Max.	--	6.58	--
	Min.	--	0.86	--
	Avg.	--	2.79	--
B	13GW05	--	3.03	--
	13GW06	1.55	2.04	1.80
	Max.	1.55	3.03	2.29
	Min.	--	2.04	--
	Avg.	--	2.54	--
C	13GW07	1.32	1.42	1.37
	13GW08	--	12.53	--
	13GW09	2.35	4.08	3.22
	13GW11	5.14	6.07	5.61
	Max.	5.14	12.53	5.61
	Min.	1.32	1.42	1.37
	Avg.	2.94	6.03	3.40

Note: Results calculated using Bouwer-Rice Method.
"--" Not Available

TABLE 4-4

SUMMARY OF HYDRAULIC CONDUCTIVITY ESTIMATES
SWMU 9 , AREAS A AND B, TANKS 212-215
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

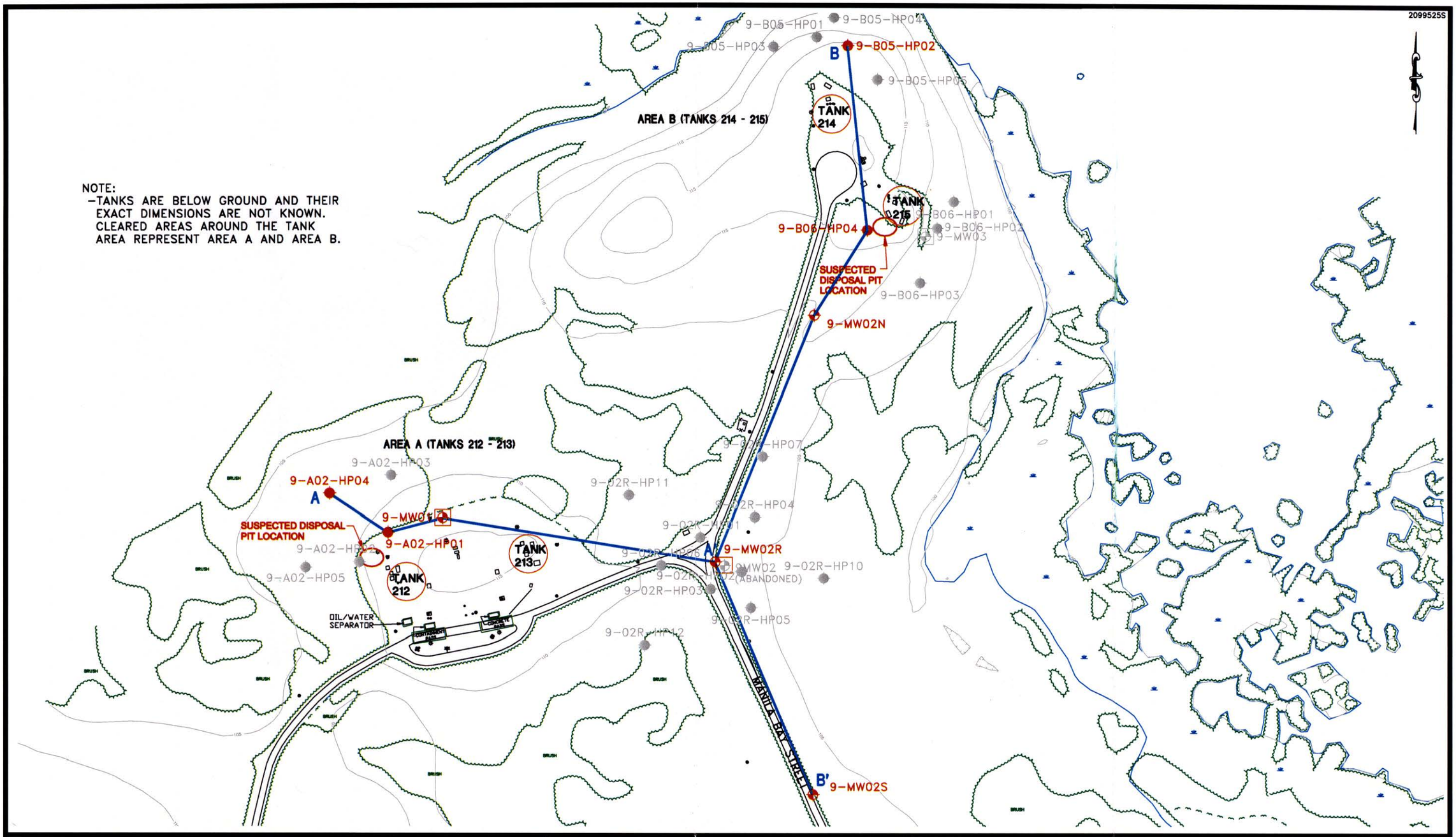
SWMU	Well ID	Hydraulic Conductivity	
		Rising Head (ft/day)	Rising Head (cm/sec)
9	9-MW02N	0.74	2.61E-04
	9-MW02R	0.46	1.62E-04
	9-MW02S	0.75	2.64E-04
	Max.	0.75	2.64E-04
	Min.	0.46	1.62E-04
	Avg.	0.65	2.29E-04

Note: Results calculated using Bouwer-Rice Mehtod

SECTION 4.0
FIGURES

2099525S

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA A AND AREA B.



LEGEND

- GEOPROBE BORING LOCATIONS/TEMPORARY PIEZOMETERS
- NEWLY INSTALLED MONITORING WELL LOCATION - PHASE II
- NEWLY INSTALLED MONITORING WELL LOCATION - PHASE I
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

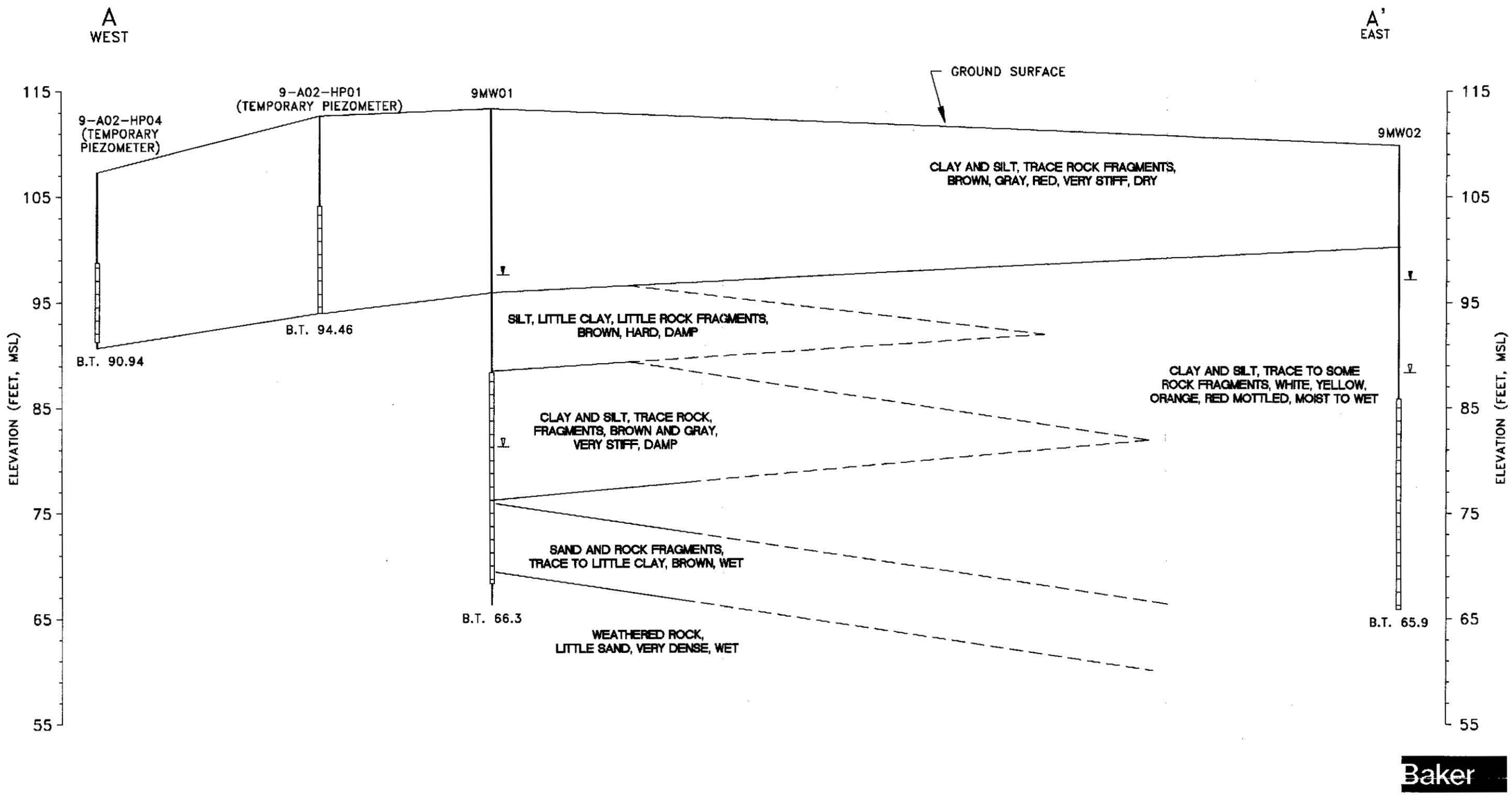
180 0 90 180
1 inch = 180 ft.

Baker

FIGURE 4-1
LOCATION OF HYDROGEOLOGIC CROSS-SECTIONS
SWMU 9 - AREAS A AND B
TANKS 212 - 215
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

00779604Y

K:\CAD\277-TEMP\2099547S



LEGEND

- GROUNDWATER ELEVATION (5/10/96)
- GROUNDWATER ENCOUNTERED DURING DRILLING
- B.T. X' — BORING TERMINATED, ELEVATION MSL
- WELL SCREEN INTERVAL
- ESTIMATED
- PROJECTED

60 0 30 60 120

Horizontal Scale: 1 inch = 60 ft.

10 0 5 10 20

Vertical Scale: 1 inch = 10 ft.

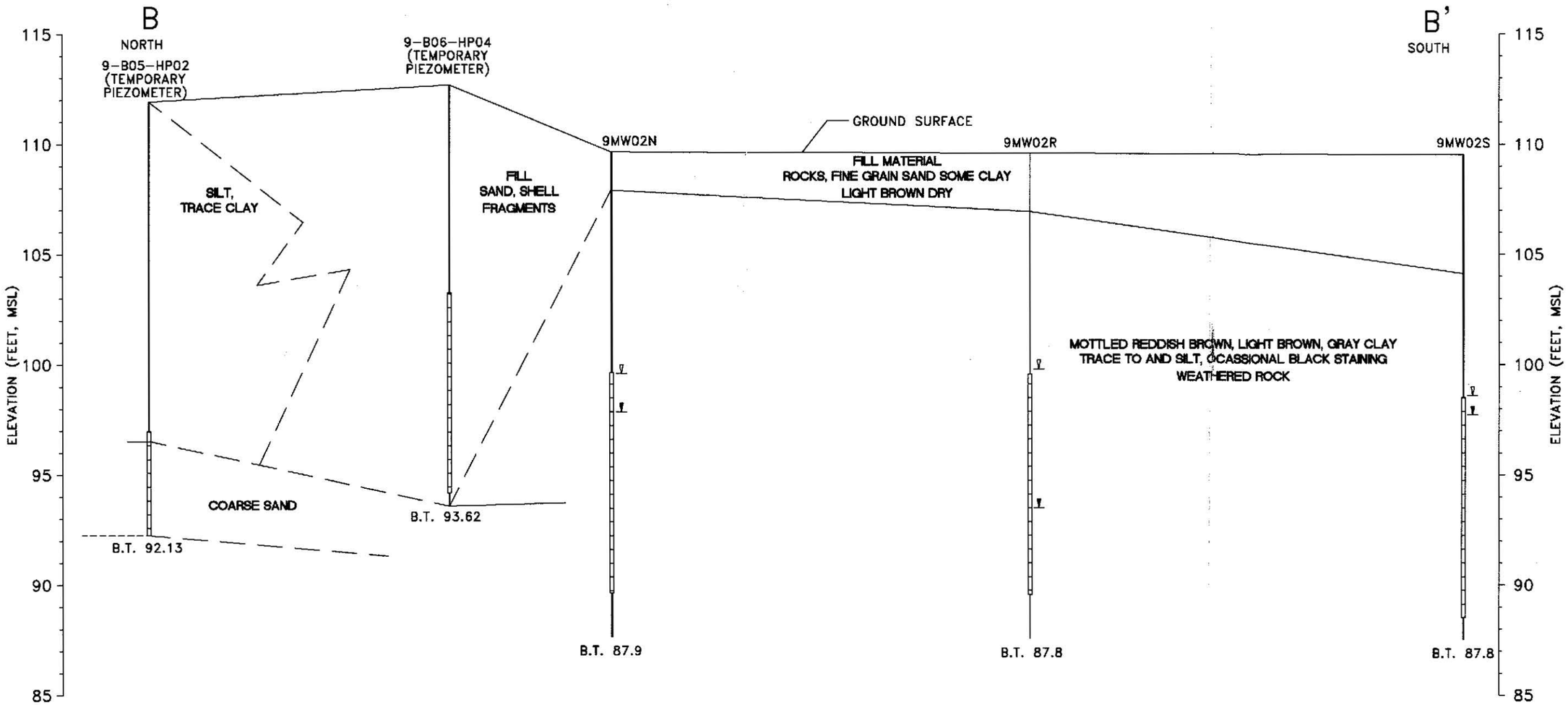
THE SOIL BORING INFORMATION IS CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS. SUBSURFACE CONDITIONS INTERPOLATED BETWEEN BORINGS ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND GEOLOGIC JUDGEMENT.

FIGURE 4-2
HYDROGEOLOGIC CROSS-SECTION A-A'
SWMU 9 - AREA A
TANKS 212-213

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

00771LB52

K:\CAD\277-TEMP\2099548S



Baker

LEGEND

- GROUNDWATER ENCOUNTERED DURING DEVELOPMENT
- GROUNDWATER ENCOUNTERED DURING DRILLING
- B.T. X' — BORING TERMINATED, ELEVATION MSL
- WELL SCREEN INTERVAL
- ESTIMATED
- PROJECTED

120 0 60 120 240

Horizontal Scale: 1 inch = 120 ft.

5 0 2.5 5 10

Vertical Scale: 1 inch = 5 ft.

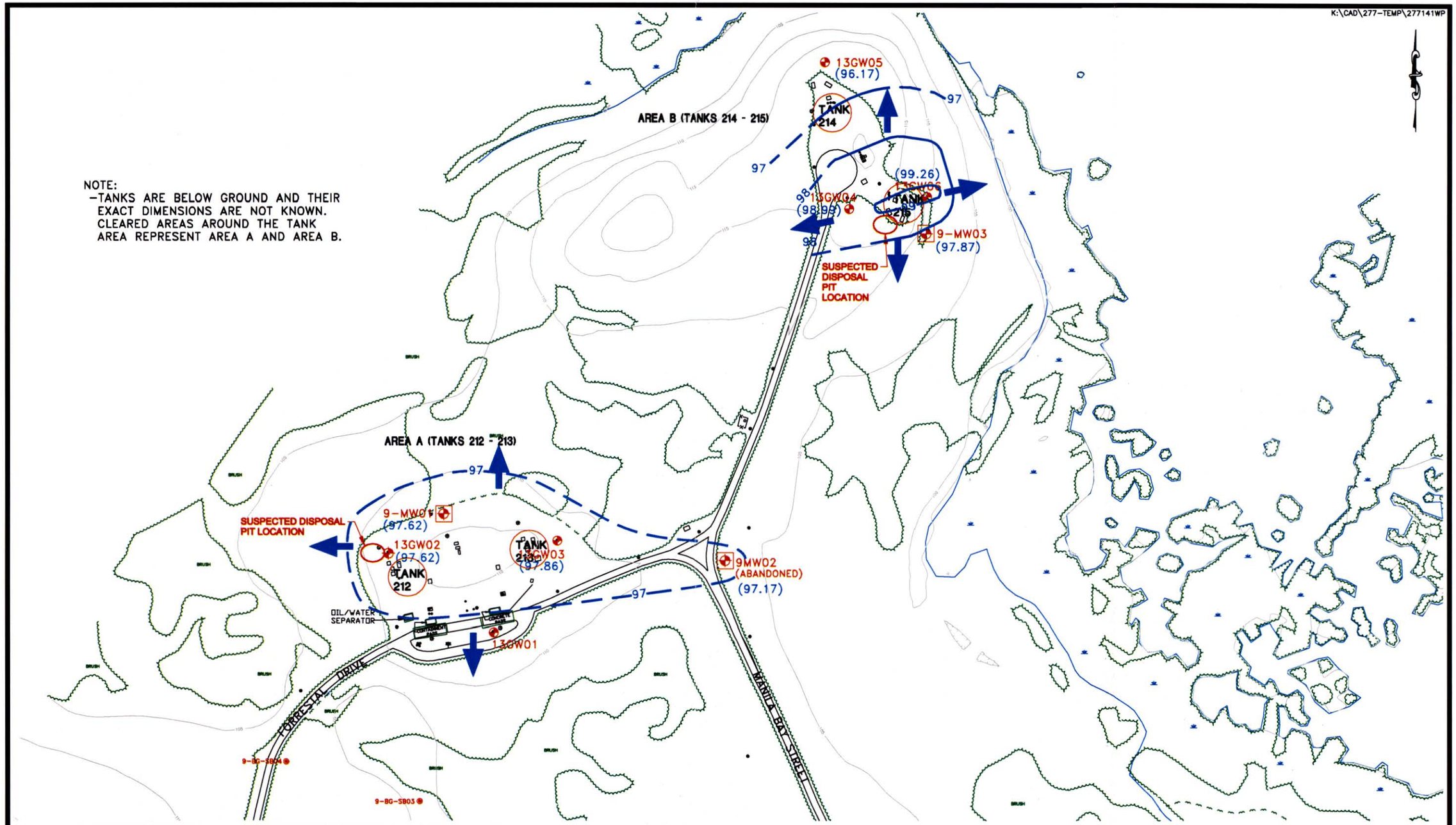
THE SOIL BORING INFORMATION IS CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS. SUBSURFACE CONDITIONS INTERPOLATED BETWEEN BORINGS ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND GEOLOGIC JUDGEMENT.

FIGURE 4-3
HYDROGEOLOGIC CROSS-SECTION B-B'
SWMU 9 - AREAS A AND B
TANKS 212 - 215

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

K:\CAD\277-TEMP\277141WP

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA A AND AREA B.



LEGEND

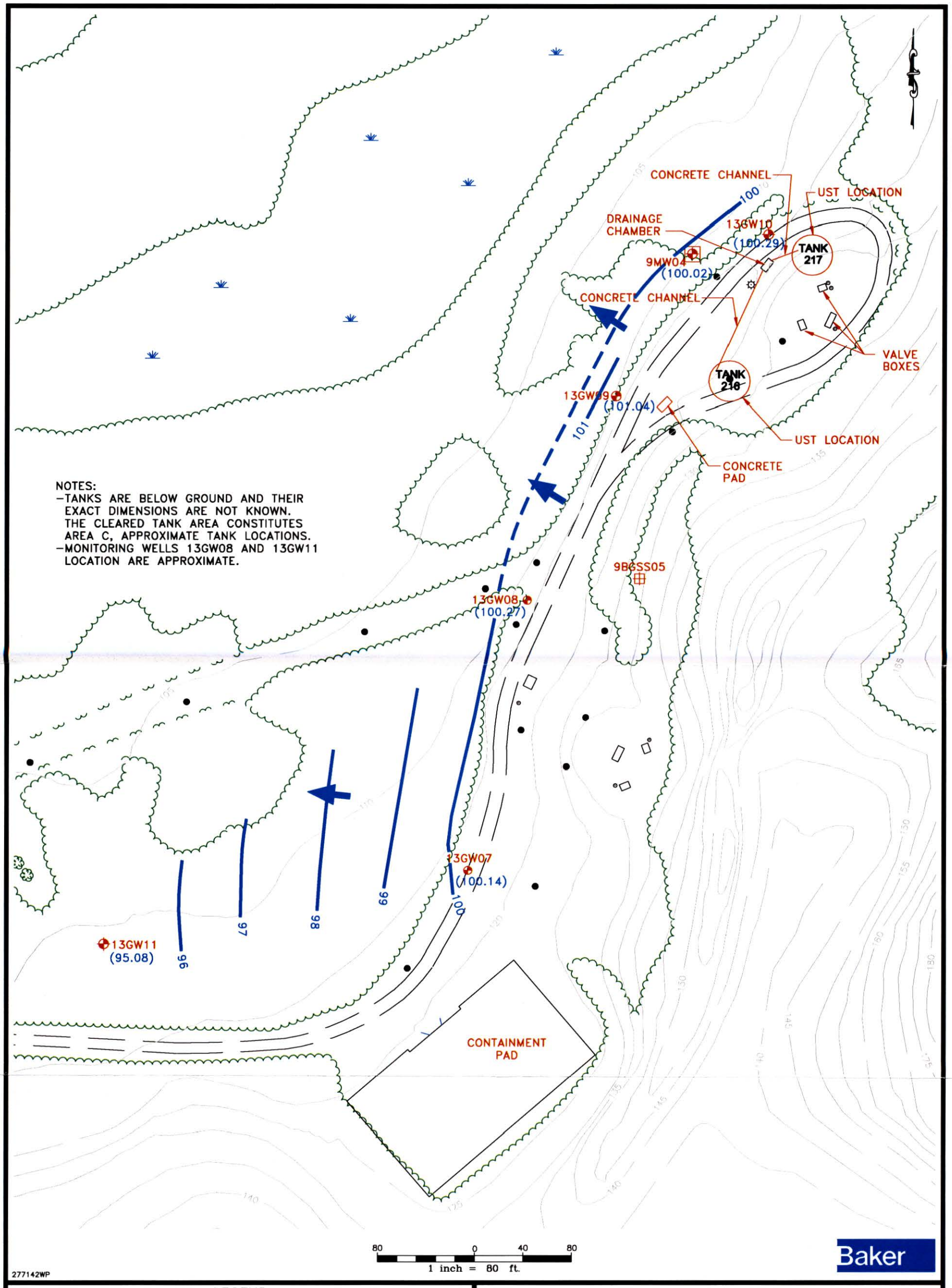
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- (97.62) - GROUNDWATER ELEVATION (FT., MSL)
- 97 - GROUNDWATER ELEVATION CONTOUR
- 97 - INFERRED GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION
- 115 - SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

180 0 90 180
1 inch = 180 ft.

Baker

FIGURE 4-4
GROUNDWATER CONTOUR MAP - MAY 10, 1996
SWMU 9 - AREAS A AND B
TANKS 212 - 215
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

00779LB6Y



NOTES:
- TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. THE CLEARED TANK AREA CONSTITUTES AREA C, APPROXIMATE TANK LOCATIONS.
- MONITORING WELLS 13GW08 AND 13GW11 LOCATION ARE APPROXIMATE.

LEGEND

- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- (95.08) – GROUNDWATER ELEVATION (FT., MSL)
- 95 – GROUNDWATER ELEVATION CONTOUR
- 95 – INFERRED GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION
- 140 – SURFACE ELEVATION CONTOUR
- TELEPHONE POLE

FIGURE 4-5
GROUNDWATER CONTOUR MAP – MAY 10, 1996
SWMU 9 – AREA C
TANKS 216 – 217

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

5.0 NATURE AND EXTENT OF CONTAMINATION

This section presents an overview of chemical analytical results obtained from samples taken during the field investigations. The objective of this section is to characterize the nature and delineate the extent of potential contamination at each site. SWMU 9 characterization data was obtained through sample collection and analysis of the surface and subsurface soil, groundwater, surface water, and sediment. The analytical results for environmental and QA/QC samples also are presented in this section.

SWMU 9 area-specific soil sample results presented in the following sections have been compared with several criteria. Organic compounds, except TPH, detected in soil samples were compared with their respective risk-based concentrations (RBCs) for both industrial and residential conditions as determined by EPA Region III (October 7, 1999a). The TPH values were compared to the PREQB screening guidance. Inorganic compounds were compared against the RBCs and the background analytical data. The background screening criteria was developed by taking twice the average of each constituent detected in the five background samples. One-half the detection limit was used for non-detects. This background value was determined in accordance with recent EPA guidance (EPA, 1999b). Because an average was used as the basis of the background screening criteria, five is a sufficient number of samples.

Organic and inorganic compounds detected in the groundwater samples were compared with the respective tap water RBCs as well as the Federal maximum contaminant levels (MCLs) (EPA, 1999c). The groundwater samples analyzed for water quality were also compared to the EPA Drinking Water Regulations and Health Advisories Secondary Maximum Contaminant Levels (SMCLs) (EPA, 1999c). The SMCLs are unenforceable Federal guidelines regarding taste, odor, color, and certain other non-aesthetic effects of drinking water.

The surface water samples were compared against the National Ambient Water Quality Criteria (NAWQC) Criteria Continuous Concentration (CCC) and Criteria Maximum Concentration (CMC) (EPA, 1999d). The sediment samples were compared to Florida Department of Environmental Protection (FDEP) Probable Effects Level (PEL) and Threshold Effects Level (TEL) (MacDonald

1994). See Section 7.2.1 for description of PEL and TEL marine and estuarine sediment quality guideline.

Section 5.1 presents the background data that was used for the data comparison with Areas A, B, and C. The detailed data comparison results for Areas A, B, and C is presented within Section 5.2. The QA/QC sample results and data validation for each of the areas is presented within Sections 5.3 and 5.4, respectively.

Appendix D presents the chain-of-custody forms while Appendices H and I present the complete listing of the analytical results and quality assurance/quality control results, respectively.

5.1 Background Conditions

Background samples collected during this investigation included surface and subsurface soil, groundwater, surface water, and sediment. There were five sampling locations associated with the surface and subsurface soils and groundwater samples. Four of the locations are associated with Areas A and B and represent the nearest points available that are sufficiently away from the SWMU to be unaffected by site activities. One background location was established in Area C, again sufficiently away from site activities to be unaffected yet close enough to be representative of background site conditions. In addition, there was one surface water and sediment sample collected for screening comparison with like samples collected from Areas A, B, and C and used for calculating ecological risks. Tables 5-1 through 5-8 present the positive detection results of the analytical testing of background samples.

The subsections that follow discuss background conditions in various media. In these subsections, background inorganic constituent concentrations are discussed and compared to media-appropriate screening criteria (e.g., the Tap Water RBC for groundwater, and FDEP PEL and TEL for sediments). The purpose of these comparisons is to identify the potential for inorganic detections above screening criteria to be related to natural occurrence rather than site activities.

5.1.1 Background Surface Soil

Table 5-1 shows the inorganic compounds detected in the comparison background surface soil samples collected from five locations. A total of six surface soil samples, including one duplicate, were collected from the five locations (9-BG-SS01 through 9-BG-SS05 and 9-BG-SS01D). There were 14 different inorganic compounds detected in the surface soil samples. Of these detected inorganics, only arsenic exceeded the RBC for residential soil occurring in five samples, including one duplicate, in the concentrations ranging from 0.8J mg/kg to 2.5J mg/kg, Figures 5-1 and 5-2. None of the concentrations exceeded the industrial RBC values. It should be noted that the surface soil sample obtained from Area C was below the screening criteria.

5.1.2 Background Subsurface Soil

A total of six subsurface soil samples were collected from the five locations (labeled 9-BG-SB01 through 9-BG-SB05, along with the sampling depth interval). Two sample depths were collected from sample 9-BG-SB05. Table 5-2 shows the inorganic compounds detected in the comparison background subsurface soil samples. There were 16 inorganic compounds detected in the subsurface soil samples. Of these detected inorganics, only arsenic exceeded the RBC for residential soil. The exceedences occurred in four samples from Areas A and B and ranged from 0.53J mg/kg to 1.5J mg/kg, (Figures 5-3 and 5-4). None of the concentrations exceeded the industrial RBC values.

5.1.3 Background Groundwater

There were five groundwater samples including one duplicate sample collected from four temporary piezometer locations (9-BG-GW01 through 9-BG-GW04) and analyzed for VOCs. Two of these samples were also analyzed for SVOCs. Positive detections for the groundwater organics are listed in Table 5-3. Acetone was the only organic detected in one of the background groundwater samples. The result for acetone was below the EPA Region III Tap Water RBC value. There is no Federal MCL established for acetone.

Tables 5-4 presents the total inorganic compounds detected in the four background groundwater samples including one duplicate. Sixteen different total inorganic compounds were detected. The total antimony concentration for 9-BG-GW01 exceeded the Federal MCL with a value of 14.2 μg/L. The total arsenic concentrations in three samples including one duplicate (9-BG-GW01, 9-BG-GW03, and 9-BG-GW03D) exceeded the EPA Region III Tap Water RBC with concentrations ranging from of 5.8J μg/L to 22.4J μg/L. Total cadmium results exceeded the Federal MCL in three samples with ranges of 14.8J μg/L to 53.1 μg/L. The total cadmium concentrations also exceeded the Tap Water RBC in two of these samples with values of 32.4 to 53.1 μg/L. The beryllium, cadmium, chromium, copper, lead, and nickel total fraction exceeded the Federal MCL in sample 9-BG-GW03, with results of 7.8 μg/L, 53.1 μg/L, 112 μg/L, 2,700 μg/L, 32.5J μg/L, and 158 μg/L, respectively. The total cadmium, chromium, and copper concentrations of sample 9-BG-GW03 also exceeded the Tap Water RBC. The total vanadium concentration of 3,000 μg/L in sample 9-GW-MW03 exceeded the Tap Water RBC. All inorganic exceedences are shown on Figures 5-5 and 5-6.

Table 5-5 presents the dissolved inorganic compounds detected in the four background groundwater samples including one duplicate. Dissolved inorganic compounds detected include the same constituents detected in the total fraction. The dissolved arsenic concentrations in three samples including one duplicate (9-BG-GW01, 9-BG-GW03, and 9-BG-GW03D) exceeded the EPA Region III Tap Water RBC with concentrations ranging from of 8.7J μg/L to 17.7J μg/L. Dissolved cadmium results exceeded the Federal MCL in three samples with ranges of 15.4J μg/L to 36 μg/L. The dissolved cadmium concentrations also exceeded the Tap Water RBC in two of these samples with values of 33.6 and 36 μg/L. The dissolved vanadium concentration of 265 μg/L in samples 9-BG-GW03 and the duplicate the duplicate 9-BG-GW03D exceeded the Tap Water RBC. All inorganic exceedences are shown on Figures 5-5 and 5-6.

5.1.4 Background Surface Water

There were seven total inorganics detected in the surface water including arsenic, barium, chromium, cobalt, tin, vanadium, and zinc, (Table 5-6). There are NAWQC CMC and CCC established criteria for the arsenic, chromium, and zinc. The detections in the surface water sample were below the referenced criteria. There are no established screening criteria for the additional compounds detected. Barium was detected at 55.9 μg/L, cobalt was 3.2J μg/L, tin was 2.7J μg/L, and vanadium was reported at 48.4J μg/L.

5.1.5 Background Sediment

There was one sediment sample collected (9SD05) and analyzed for VOCs, SVOCs, and Total Appendix IX Inorganics. Positive detection for the sediment organics is listed in Table 5-7. Acetone was the only organic detected in the background sediment sample. The result for acetone was 140 μg/kg. There is no established FDEP sediment PEL or TEL for acetone. Acetone is a common laboratory contaminant and is not believed to be related to background conditions.

There were 11 inorganic compounds detected in the sediment sample, (Table 5-8). None of the established FDEP PELs were exceeded. The only compound that exceeded the FDEP sediment TEL was copper with a value of 58J μg/kg, (Figure 5-7). The were five compounds detected that did not have an established PEL or TEL and included barium, beryllium, cobalt, tin, and vanadium with concentrations at 8.1 μg/kg, 0.047 μg/kg, 4.7 μg/kg, 4.2J μg/kg, and 110 μg/kg, respectively.

5.1.6 Background Summary

There were 14 inorganic compounds detected in the surface soil samples and only arsenic exceeded the residential soil RBC at four of the five sampling locations (all from Areas A and B). None of the inorganic concentrations exceeded the industrial RBC values.

There were 16 inorganic compounds detected in the subsurface soil samples and only arsenic exceeded the residential soil RBC at four of the five sampling locations (all from Areas A and B). None of the inorganic compound concentrations exceeded the industrial RBC values.

Acetone was the only organic detected in the background groundwater samples. The result for acetone was below EPA Region III Tap Water RBC value. Acetone is not a fuel related compound and is more closely associated with laboratory artifacts.

Sixteen different total inorganic compounds were detected in the four background groundwater samples. The total antimony concentration exceeded the Federal MCL in only one of the four background samples analyzed for inorganics, however, two of the results were determined to be unreliable. The total arsenic concentrations exceeded the EPA Region III Tap Water RBC in three

samples. Total cadmium results exceeded the Federal MCL in three samples and the Tap Water RBC in two samples and also appears to be a common naturally occurring constituent. The beryllium, cadmium, chromium, copper, lead, and nickel total fraction exceeded the Federal MCL in sample 9-BG-GW03. In the duplicate sample to 9-BG-GW03, 9-BG-GW03D, only the total cadmium concentration exceeded the Federal MCL. The total cadmium, chromium, copper, and vanadium concentrations of sample 9-BG-GW03 also exceeded the Tap Water RBC. The background data suggest the potential for naturally occurring constituents such as beryllium and lead to sporadically exceed RBCs. Furthermore, arsenic and cadmium appear frequently above RBCs. These constituents appear to be common naturally occurring constituents in the SWMU 9 area.

Dissolved inorganic compounds detected include antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium, silver, tin, vanadium, and zinc. The dissolved arsenic concentrations exceeded the EPA Region III Tap Water RBC in three of the four samples including one duplicate. Dissolved cadmium results exceeded the Federal MCL in three of the four samples. The dissolved cadmium concentrations exceeded the Tap Water RBC in two samples. The dissolved vanadium concentration also exceeded the Tap Water RBC in two samples. All inorganic exceedences are shown on Figures 5-5 and 5-6.

There were seven total inorganics detected in the surface water. There are NAWQC CMC and CCC established criteria for the arsenic, chromium, and zinc. The detections in the surface water sample for arsenic, chromium, and zinc were below the NAWQC CMC and CCC established criteria. There are no established reporting criteria for the additional compounds detected (barium, cobalt, tin, and vanadium).

Acetone was the only organic constituent detected in the background sediment sample. There are no established FDEP sediment PEL or TEL criteria for acetone.

None of the detected inorganics in the sediment sample exceeded the established FDEP PELs. The only inorganic compound that exceeded the FDEP sediment TEL was copper with a value of 58J μg/kg. The five compounds detected that did not have an established PEL or TEL included barium, beryllium, cobalt, tin, and vanadium.

It should be noted that arsenic appears in all background media sampled, and generally above the Residential RBC. Arsenic was also detected in the base-wide background media (Baker, 1998). Concentrations in the base-wide background also exceeded the Residential RBC. An important factor in the natural circulation of arsenic is the volatility of the element and some of its compounds (Hem, 1992). Hem also indicates that arsenic is associated with volcanic activity. The genesis of Puerto Rico is volcanic activity, and the ubiquitous presence of arsenic at NSRR may be related to that.

5.2 SWMU 9 - Tanks 212-217

Sampling activities during the various phases of investigations within Areas A, B, and C involved the collection of surface and subsurface soil, sediment, surface water, and groundwater samples. These samples were submitted to a designated laboratory for various analysis of a host of parameters. The analysis of the soil and sediment samples varied among the following parameters:

- BTEX
- TPH diesel and gasoline range organics
- Appendix IX VOCs
- Appendix IX SVOCs
- Sulfide
- Metalloids (arsenic and cyanide)
- RCRA Metals
- Appendix IX Inorganics

The analysis of the surface water and groundwater samples varied among the following parameters:

- Appendix IX VOCs
- Appendix IX SVOCs
- PCBs
- BTEX
- TPH diesel and gasoline range organics
- Water Quality Parameters
- Total and dissolved metalloids (arsenic and cyanide)

- Total and dissolved RCRA Metals
- Total and dissolved Appendix IX Inorganics

The reporting of the analytical results will be based on the combination of each phase of investigation by area. Within Area A (Tanks 212 and 213), a total of four surface soil samples, 34 subsurface soil samples, 31 groundwater samples, and one surface water and sediment sample were collected during the investigations. At Area B (Tanks 214 and 215), a total of three surface soil samples, 13 subsurface soil samples, 17 groundwater samples, and four surface water and sediment samples were collected during the investigations. At Area C (Tanks 216 and 217), a total of three surface soil samples, ten subsurface soil samples, 10 groundwater samples, and two surface water and sediment samples were collected during the investigations.

5.2.1 SWMU 9 Area A – Tanks 212-213

The following Subsections detail the analytical results of the Area A sampling activities during the various phases of investigations. The analytical results are divided into each sampling media and include surface soil, subsurface soil, groundwater, surface water, and sediment.

5.2.1.1 Area A Surface Soil

A total of four surface soil samples were collected from Area A during the investigations (9SS01, 9SS02, 9MW01-00, and 9MW02-00). Detected organic compounds in surface soil samples are shown in Table 5-9. One VOC, acetone (9SS02), and two SVOCs, benzyl alcohol (9MW01-00) and diethylphthalate (9MW02-00) were the only organic compounds detected in the surface soils. These three detected concentrations of organic compounds in the surface soil samples were below their respective industrial and residential RBCs. Diethylphthalate is not related to the site as it was detected in the associated QA/QC blanks discussed in Section 5.3. Additionally, there were no TPH concentrations reported above the method detection limits in the four surface soil samples. A complete set of the surface soil organic analytical data is presented as Appendix H.1.

The inorganic compound arsenic was detected in all four surface soil samples at levels that exceeded the residential RBC with concentrations ranging from 0.93 mg/kg to 3.7 mg/kg (Table 5-10). The

concentrations of barium, selenium, and silver detected from sample 9MW02-00 exceeded the background screening criteria. The background screening criteria was also exceeded for selenium in sample 9MW01-00. None of the inorganic compounds detected in the surface soil samples exceeded their respective industrial RBC values. Surface soil inorganic exceedences of the screening criteria are presented on Figure 5-8. The complete set of the inorganic data for the surface soils can be found as Appendix H.2.

5.2.1.2 Area A Subsurface Soil

A total of 34 subsurface soil samples (including two duplicates) were submitted for laboratory analysis from Area A. Detected organic compounds from the subsurface soil samples are listed in Table 5-11. Ten of the subsurface soil samples were analyzed for VOCs, SVOCs, and TPH diesel and gasoline range organics. There were six VOCs detected among six of the samples including acetone, benzene, 2-butanone, ethylbenzene, toluene, and xylene. Table 5-11 shows that no VOCs were detected above laboratory reporting limits in four of the samples. None of the six samples with VOC detections exceeded the industrial or residential screening criteria.

Four SVOCs were detected subsurface soil samples including di-n-butylphthalate, butylbenzylphthalate, o-cresol, and m,p-cresol. These detections were from two of the ten samples analyzed (9TP07-04 and 9TP09-04) for SVOCs. The SVOCs detected in these samples were at levels below the industrial and residential RBC screening criteria.

One or more of the BTEX components were detected in six of the 24 subsurface soil samples analyzed for BTEX (Table 5-11). Benzene was detected in three of these samples at concentrations ranging from 2.4 μg/kg to 21 μg/kg. Toluene was detected in three samples at concentrations ranging from 3.1 μg/kg to 52 μg/kg. Ethylbenzene was detected in five samples at concentrations ranging from 0.68J μg/kg to 11 μg/kg. Xylene was detected in six samples at concentrations ranging from 4.5 μg/kg to 140 μg/kg. The reported BTEX organic concentrations from the subsurface soil samples were below the industrial and residential soil RBCs.

All 34 subsurface soil samples were analyzed for TPH concentrations; the laboratory reportable limits were exceeded in 19 of these samples. Seven of the 19 samples were found to contain TPH diesel

range organics at levels of ranging from 1,300 μg/kg (9-02R-HP07) to 14,000 μg/kg (9TP08-04). There were 16 samples with detected gasoline range organic concentration values that ranged from 33J μg/kg (9MW02N-05) to 130,000J μg/kg (9-02R-HP01). None of the diesel range organics exceeded the PREQB TPH screening criteria of 100,000 μg/kg; however, the gasoline range sample from 9-02R-HP01 did exceed the TPH screening criteria with a value of 130,000J μg/kg. The subsurface soil TPH exceedence of the screening criteria is presented on Figure 5-9. The complete set of the organic data for the subsurface soils can be found as Appendix H.3.

A total of 20 subsurface soil samples were analyzed for inorganic RCRA metals. Eight inorganic metals were detected in the subsurface soils (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver). The detection data is presented in Table 5-12. Arsenic was detected in 11 of the 20 subsurface soil samples. Arsenic was the only inorganic compound found in the subsurface soils that exceeded both industrial and residential RBC values (Table 5-12). The residential value was exceeded in six samples, 9MW02N-05, 9MW02S-05, 9TP08-04, 9TP09A-01, 9TP10-04, and 9TP18-05, with detections ranging from 0.44J mg/kg to 5J mg/kg. Of these samples, only 9TP08-04, also exceeded both the industrial RBC and background screening level with a concentration of 5J mg/kg. Sample 9MW02N-05 also exceeded the arsenic background screening level. Barium was detected in all of the samples and two samples, 9TP07A-01 (156J mg/kg) and 9TP09A-02 (240J mg/kg), exceeded the background criteria. Cadmium was detected in six of the samples and each of these values exceeded the background criteria. Chromium was detected in each sample and ranged from 2.4 mg/kg to 50.8J mg/kg. The chromium result for samples 9TP07-04 (50.8J mg/kg) and 9MW02N-05 (28.9 mg/kg) exceeded background criteria. Lead was detected in 18 of the samples and results ranged from 0.35 mg/kg to 19.3J mg/kg. The concentration of lead in samples 9TP07-04, 9TP08-04, and 9TP10-04 exceeded the background screening level with concentrations of 6J, 5.9J, and 19.3J mg/kg, respectively. Mercury was detected in one sample, 9MW02S-05 (0.1 mg/kg), which exceeded the background criteria. Selenium was detected in eight of the samples at concentrations ranging from 0.39J mg/kg to 1.8 mg/kg, none exceeded the screening criteria. Each of the ten silver sample detections exceeded the background criteria and ranged from 0.07J mg/kg to 0.67 mg/kg, however, none of these exceeded the industrial or residential screening criteria. Subsurface soil inorganic exceedences of the screening criteria are presented on Figure 5-9. The complete set of the inorganic data for the subsurface soils can be found as Appendix H.4.

5.2.1.3 Area A Groundwater

A total of 33 groundwater samples were collected during the various investigations within Area A, refer to Tables 5-13 and 5-14. The 31 groundwater samples were comprised of sampling eight groundwater monitoring wells, five newly installed and three existing, and 17 temporary piezometer locations. Five Area A monitoring wells were sampled for VOCs, SVOCs, PCBs, and TPH diesel and gasoline range organics (13GW01, 13GW02, 13GW03, 9MW01 and 9MW02) in addition 9MW01 and 9MW02 were also analyzed for total and dissolved RCRA Metals. Positive detections for groundwater organics are listed in Table 5-13. There were five VOCs detected in the samples including benzene, ethylbenzene, methylene chloride, toluene, and xylene. Monitoring well 9MW02 had detected concentrations of all five VOCs, in which, methylene chloride (7 μg/L) and benzene (1,600J μg/L) were both in excess of the Federal MCLs and EPA Region III Tap Water RBCs. Benzene concentrations also exceeded the MCLs and Tap Water RBCs in sample 13GW02 with a concentration of 130 μg/L. There were two other VOCs detected in 13GW02, ethylbenzene and xylene, which were both below the screening criteria.

There were seven SVOCs detected within the five groundwater samples. The SVOC bis(2-ethylhexyl)phthalate exceeded the Tap Water RBC in samples 13GW01 (5J μg/L) and 13GW02 (5J μg/L). It is believed that the detection of bis(2-ethylhexyl)phthalate is not site related as it was also detected in the associated QA/QC blanks discussed in Section 5.3. Acetophenone concentration exceeded the Tap Water RBC in sample 9MW01 with a concentration of 1J μg/L The naphthalene concentration in sample 13GW02 exceeded the Tap Water RBC with a value of 26 ug/L. The five monitoring wells sampled did not contain any PCBs above the method detection limits.

Four monitoring well and one temporary piezometer groundwater samples were sent for off site laboratory BTEX analysis. BTEX concentrations were detected in four of the five groundwater samples (Table 5-13). The benzene concentrations ranged from 1.7 μg/L to 4,900 μg/L. Three of these benzene values exceeded the Federal MCL value and all two detections exceeded the Tap Water RBC value. Ethylbenzene was detected at a range of 0.52J μg/L to 220 μg/L in four of the five samples below the screening criteria. Toluene was detected in two of the five samples. The toluene results were between 240 μg/L and 4,100 μg/L, with the 4,100 μg/L exceeding the Tap Water RBC

and the Federal MCL value. Xylene was detected in four of the five samples with results between 2.4 μg/L and 840 μg/L with no screening criteria exceedences.

All eight of the Area A monitoring wells were sampled and analyzed for TPH (gasoline and diesel range organics) with the off site laboratory, Table 5-13. The TPH gasoline range organics were detected in four of the samples (13GW02, 13GW03, 9MW02, and 9GW02R) with values of 9,000 μg/L, 100J μg/L, 770 μg/L, and 15,000 μg/L, respectively. Samples 13GW02 and 9GW02R also had a TPH diesel range organic concentrations of 2,300J μg/L and 1,700 μg/L, respectively.

Organic exceedences of the groundwater screening criteria are presented on Figure 5-10. Figure 5-11 depicts the distribution of BTEX contaminants in groundwater.

A total of 23 groundwater samples were collected and analyzed onsite for BTEX during the Phase III Investigation. This sampling was used to delineate the extent of potential contamination from two monitoring well locations within Area A. The onsite samples were collected from monitoring wells 13-GW02 and 9-MW02R and 17 Geoprobe® temporary piezometer locations. There were five temporary piezometer locations established in the vicinity of 13-GW02 (9-A02-HP01 through 9-A02-HP05). A total of nine groundwater samples, including three duplicates, were collected to define the extent of contamination associated with monitoring well 13GW02. Six of these samples including two duplicates were positive for BTEX constituents. Benzene concentrations were detected in six of the samples and ranged from 32 μg/L to 7,400 μg/L. Toluene was detected in six of the samples and ranged from 36 μg/L to 3,400 μg/L. Ethylbenzene was detected in four of these groundwater samples and ranged from 6 μg/L to 1,400 μg/L. Xylene was detected in five of the samples with concentrations ranging from 150 μg/L to 670 μg/L.

There were 12 temporary piezometer locations established in the vicinity of 9-MW02R (9-02R-GW01 through 9-02R-GW12). A total of 14 groundwater samples, including one duplicate, were collected and analyzed onsite to define the extent of contamination in the vicinity of 9-MW02R. Benzene concentrations were detected in four of the samples analyzed onsite and ranged from 61 μg/L to 12,000 μg/L. Toluene was detected in three of the samples and ranged from 6 μg/L to 7,200 μg/L. Ethylbenzene and xylene were detected in one groundwater sample analyzed onsite at 280 μg/L and

2,200 μg/L. Refer to Table 5-14 to view the onsite testing results. The complete on-site laboratory analytical package is provided as Appendix H.45.

Of the 23 temporary piezometer groundwater samples collected, ten were collected and analyzed onsite for TPH (gasoline and diesel range organics). All of the onsite results for these samples were non-detect. Refer to Table 5-14 to view these results.

Table 5-15 presents the total inorganic compounds detected in the Area A wells sampled (9MW01, 9MW02, 9MW02N, 9MW02R, and 9MW02S). Total inorganic compounds detected include arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. The total arsenic concentration in sample 9GW02S was 29.2J μg/L. This value exceeded the EPA Region III Tap Water RBC and the background screening criteria. The total arsenic concentration for 9MW02N also exceeded the Tap Water RBC with a value of 14.1 μg/L. Barium was detected in all five samples, however, no exceedences resulted with these detections. The total fraction of the cadmium exceeded the Federal MCL in three of the five samples with ranges of 8.9J to 29 μg/L. The 29 μg/L concentration of cadmium also exceeded the Tap Water RBC. The chromium total fraction exceeded the background screening criteria, Federal MCL, and Tap Water RBC in sample 9GW02S, with a result of 193 μg/L. There were no lead, mercury, selenium, or silver detected at concentrations that exceeded the Federal MCL or EPA Region III Tape Water RBC values. The total mercury concentration of 0.33J μg/L in sample 9MW02 exceeded the background screening criteria.

Table 5-16 presents the dissolved inorganic compounds detected in the Area A wells sampled (9MW01, 9MW02, 9MW02N, 9MW02R, and 9MW02S). Dissolved inorganic compounds detected include arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. The dissolved arsenic concentration in sample 9GW02S was 12.8J μg/L. This value exceeded the EPA Region III Tap Water RBC for arsenic concentrations. Barium was detected in all five samples, however, no exceedences resulted with these detections. The dissolved fraction of the cadmium exceeded the Federal MCL in four of the five samples with ranges of 5.5 μg/L to 30.4 μg/L. The concentration of 30.4 μg/L for cadmium in sample 9MW02 also exceeded the Tap Water RBC. There were no lead, mercury, selenium, or silver detected at concentrations that exceeded the Federal MCL or EPA Region III Tap Water RBC values. The dissolved mercury concentration of 0.31J μg/L in sample 9MW02 exceeded the background screening criteria. The dissolved lead concentration in sample 9GW02R exceeded the background screening level with a concentration of 1.9J μg/L.

The inorganic exceedences of the screening criteria are presented on Figure 5-12. The complete set of the groundwater data is presented as Appendices H.5, H.6, H.7, and H.8 for organic, total inorganic, and dissolved inorganic fractions, respectively.

Two monitoring wells were sampled and analyzed for 14 water quality parameters, 13GW02 and 9-MW02R (Table 5-17). The sample from 9-MW02R exceeded the EPA Region III Tap Water RBC for iron with a value of 37.4 mg/L. Both of the samples, 13GW02 and 9-MW02R, also exceeded the EPA Region III Tap Water RBC for manganese with concentrations of 1.33 mg/L and 26.3 mg/L, respectively. Both of these samples also exceeded the EPA SMCLs for aluminum, chloride, color, iron, and total dissolved solids (TDS). The EPA SMCL threshold odor number (TON) was exceeded in sample 13GW02 with a value of 16 TON. The values of these EPA SMCL exceedences are presented in Table 5-17.

5.2.1.4 Area A Surface Water

One surface water sample, 9-SW02, was collected from the Area A location. There were no volatile or semivolatile organics detected in this sample. The inorganic compounds detected include arsenic, barium, cadmium, cobalt, selenium, tin, vanadium, and zinc (Table 5-18). There are NAWQC CMC and CCC established criteria for the arsenic, cadmium, selenium, and zinc. The arsenic concentration exceeded the NAWQC CCC criteria with a concentration of 38.3J µg/L. The cadmium and selenium concentrations exceeded the background criteria with concentrations of 0.7J µg/L and 22.3J µg/L. The inorganic exceedences of the screening criteria are presented on Figure 5-13. The complete set of the organic and inorganic surface water data is presented as Appendix H.9 and H.10.

5.2.1.5 Area A Sediment

There was one sediment sample collected (9-SD02) and analyzed for VOCs, SVOCs, sulfide, metalloids, and Appendix IX Inorganics. Positive detections for the sediment organics are listed in Table 5-19. Acetone was the only organic detected at a concentration of 130J µg/kg. There is no established FDEP sediment PEL or TEL for acetone. The complete set of the organic sediment data is presented as Appendix H.11.

The inorganic compounds detected in the sediment sample include arsenic, barium, beryllium, chromium, cobalt, copper, lead, mercury, nickel, tin, vanadium, and zinc (Table 5-20). Three of the 12 inorganic concentrations exceeded the background screening criteria including beryllium, lead, and zinc. The only compound that exceeded the FDEP sediment TEL was copper with a value of 63J µg/kg. It should be noted that this value is below the background criteria for copper. The were five compounds detected that did not have an established PEL or TEL and included barium, beryllium, cobalt, tin, and vanadium with concentrations at 14 µg/kg, 0.29J µg/kg, 6.9 µg/kg, 4.3J µg/kg, and 180 µg/kg, respectively. The inorganic exceedences of the screening criteria are presented on Figure 5-14. The complete set of the inorganic sediment data is presented as Appendix H.12.

5.2.1.6 Area A Summary

Evidence of the impact of past site operations on surface soil is limited. Acetone, benzyl alcohol, and one phthalate compound were detected at low concentrations below EPA Region III RBC screening criteria in sample locations scattered in the vicinity Tanks 212 and 213. None of these compounds are associated with diesel fuel and unleaded gasoline. Several inorganic compounds were also detected above screening criteria in sample locations scattered in the vicinity Tanks 212 and 213. None of these compounds, including selenium silver, barium, and arsenic are associated with diesel fuel and unleaded gasoline. It should be noted that arsenic appears to be naturally occurring above RBCs and that arsenic levels detected in the four site samples are below or within the range of detections in the background samples.

There is evidence of the impact of past site operations on subsurface soils. BTEX and TPH constituents were detected in several subsurface soil samples. However, only one detection exceeded any screening criteria (gasoline range TPH exceeded the PREQB screening level of 100,000 µg/kg at 9-02R-HP02). The locations of BTEX and TPH detections are consistent with spills and leaks related to tank operations. BTEX constituents as well as gasoline and diesel range TPH were detected in test pits 9TP07, 9TP07A, and 9TP08, located immediately down slope of Tank 212 and the suspected sludge disposal pit location. Ethylbenzene, total xylene, and gasoline range TPH were detected in 9TP09A, located down slope from Tank 213. Primarily gasoline range TPH and BTEX constituents were detected in borings 9MW02, 9MW02R, 9-02R-HP01, 9-02R-HP02, and 9-02R-HP06. These borings are located in the vicinity of the fuel pipeline valve pit. It should be

noted that the fuel lines from Tanks 212 and 213 and Tanks 214 and 215 merge near 9MW02R at the valve pit before traveling south along Manilla Bay Street. Diesel range TPH was detected in borings located farther away from the junction, including 9-02R-HP07, 9-02R-HP08, and 9-02R-HP09. Several other organic compounds were detected, including acetone and phthalate compounds. These detections were below screening criteria and are not associated with diesel fuel and unleaded gasoline.

Several inorganic compounds were detected above background screening criteria in subsurface soil samples scattered throughout Area A. However, none of the inorganic compounds are associated with diesel fuel and unleaded gasoline. Only Arsenic was detected in excess of RBCs. The presence of arsenic appears to be naturally occurring. It should be noted that lead was detected above background criteria in association with BTEX and gasoline range TPH contamination. While not conclusive, it suggests that leaded gasoline may have been stored in Area A tanks.

There is evidence of the impact of past site operations on groundwater. BTEX compounds were detected in several of the temporary and permanent monitoring wells located in the vicinity of Tank 212. It should be noted that an insufficient number of fixed-based confirmation samples were available to generate a meaningful distribution figure. Instead, Phase III mobile laboratory data were used. Figure 5-11 depicts the distribution of total BTEX constituents in groundwater. A BTEX plume is evident downgradient of Tank 212, between the tank and the mangrove swamp. The location of the plume is consistent with past leaks or spills during the operation of Tank 214. Additionally, the plume is coincident with detections of BTEX and TPH constituents in subsurface soil. A second BTEX plume is evident in the vicinity of well 9-MW02R. The plume appears to extend radially from the valve pit. Again, the location of the plume is consistent with past leaks or spills related to the valve pit. The location of the maximum BTEX concentration is located near the possible source (the valve pit). This suggests that the spills or leaks may have occurred relatively recently. Benzene was detected above the Federal MCL and EPA Region III RBC for Tap Water in both plume locations. A further evaluation of the risks associated with these exceedences is provided in Sections 6.0 and 7.0 of this document.

Arsenic, cadmium, chromium, lead, and mercury were detected in groundwater samples above the federal MCL and/or tap water RBC. However, a majority of the detections were below the background screening criteria. Additionally, none of these inorganic compounds are associated the

diesel fuel or unleaded gasoline. Detections of the compounds appear to be scattered and not in a pattern related to tank or valve pit leaks or spills. Because detections were below background and not associated with site operations, the occurrence of these compounds may be natural.

The comparison of water quality parameters in Section 5.2.1.3 to federal standards shows several exceedences. These exceedences include several metals, as well as sulfate, color, and TDS. This suggests that untreated groundwater is not suitable for human use because of odor, color, and staining problems.

There is limited evidence of the impact of past site operations on surface water and sediment. Many inorganic compounds were detected in surface water and sediment, and several exceeded the background screening criteria. However, most of the inorganic compounds are not associated with fuel storage operations. Lead is typically associated with fuel storage operations, and was detected in sediment above background screening criteria.

5.2.2 Area B - Tanks 214 - 215

5.2.2.1 Area B Surface Soil

Three surface soil samples were collected from Area B during Phase I. Surface soil samples were not collected during Phase II or Phase III.

Positive detections of organic compounds in surface soil sample analytical data are presented in Table 5-21. Acetone was detected in samples 9SS03 and 9MW03-00 at 22J µg/kg and 14J µg/kg, respectively. Di-n-butylphthalate was detected in sample 9SS03 at 40J µg/kg. These concentrations did not exceed any of the screening criteria. Additionally, none of the samples reported TPH gasoline range or diesel range levels above the method detection limits.

Positive detections of inorganic compounds in surface soil sample analytical data are presented in Table 5-22, and exceedences of the screening criteria are presented on Figure 5-15. Several inorganic compounds were detected, including arsenic, barium, cadmium, chromium, lead, and selenium. Barium, chromium, and cadmium concentrations did not exceed background or RBC criteria. Arsenic was detected in all samples and also exceeded the residential RBC, ranging from 1.3 mg/kg to 2

mg/kg. However, the arsenic value was below the background screening criteria and industrial RBC. Lead was detected in all three samples. Lead concentrations in samples 9SS03 and 9SS04 exceeded the background screening criteria with concentrations of 30 mg/kg and 258 mg/kg, respectively. Lead concentrations did not exceed the residential or industrial RBCs. Selenium was detected in two of the three samples, in 9SS03 at 1.1J mg/kg and in 9MW03-00 at 0.62J mg/kg. Both detections exceeded the background screening criteria, but were below RBCs.

5.2.2.2 Area B Subsurface Soil

A total of 13 subsurface soil samples were collected from Area B in Phases I and II. No subsurface soil samples were collected in Phase III.

Positive detections of organic compounds in subsurface soil sample analytical data are presented in Table 5-23. Two SVOCs, di-n-butylphthalate and butylbenzylphthalate were detected in 9TP06-04 at 800 μg/kg and 68J μg/kg, respectively. Neither concentration exceeded the industrial nor residential RBCs. Two samples exhibited gasoline and/or diesel range TPH. Sample 9TP05-04 exhibited a TPH diesel range concentration of 15,000 μg/kg and 9TP02-06 exhibited a TPH gasoline range concentration of 6,400 μg/kg. No RBCs have been established for TPH. The PREQB has however, established a screening of 100 mg/kg (100,000 μg/kg), which is a number used for combined DRO/GRO. TPH concentrations detected in subsurface soil samples did not exceed the PREQB screening level.

Positive detections of RCRA metals in subsurface soil sample analytical data are presented in Table 5-24, and exceedences of the screening criteria are presented on Figure 5-16. Several inorganic compounds were detected, including arsenic, barium, cadmium, chromium, lead, selenium, and silver. Neither chromium nor selenium exceeded any of the screening criteria. Arsenic was found at concentrations ranging from 0.27J mg/kg to 2J mg/kg. The background screening criteria and the residential RBC were exceeded at 9TP03-03 (2J mg/kg) and 9TP02-06 (1.5 mg/kg). The residential RBC was exceeded at 9TP06-04 (0.45J mg/kg), 9TP01A-01 (1.2J mg/kg), and 9TP02A-01 (0.69J mg/kg). Barium was found at concentrations ranging from 18.8 mg/kg to 182J mg/kg. In samples 9TP01A-01 and 9TP02A-01, the background screening criteria for barium was exceeded (182J mg/kg and 143J mg/kg, respectively) Cadmium was detected in four samples (9TP01A-01, 9TP01A-02,

9TP02A-01, and 9TP02A-02) ranging from 0.83 mg/kg to 2.3 mg/kg. Each of these concentrations exceeded the background screening criteria, but not the RBCs. Lead was detected in 9 of 11 samples, ranging from 0.28J mg/kg to 34.2J mg/kg. However, lead exceeded the background screening criteria in only one sample (9TP03-03 at 34.2J mg/kg). Silver was detected in four samples (9MW03-09, 9TP01A-01, 9TP01A-02, and 9TP02A-01) ranging from 0.12J mg/kg to 1.1 mg/kg. Each of these values exceeded the background screening criteria, but not the RBCs.

5.2.2.3 Area B Groundwater

Monitoring wells 13GW04, 13GW05, 13GW06, and 9MW03 were sampled in Phase I. Ten temporary monitoring wells were installed and sampled in Phase III. Analysis for temporary monitoring well samples was conducted on site using a mobile laboratory, as well as samples from 13GW05 and 13GW06. One sample, namely 9-B05-HP02 was split and sent to a fixed-base laboratory for confirmation purposes.

The mobile laboratory analytical data is presented in Table 5-25. Analysis focused on BTEX constituents. In terms of total BTEX constituents, detections ranged from 38.3 μg/L (9-B05-HP05 to 30,200 μg/L (9-B05-HP02), and were detected in six temporary monitoring wells. The presence of benzene, ethylbenzene, and total xylenes was confirmed by the fixed-base laboratory in the split sample 9-B05-HP02 (Table 5-26). Individual constituent detections in sample 9-B05-HP02 however, were approximately an order of magnitude less compared with the mobile laboratory results. Benzene was detected by the fixed-base laboratory at 1,200 μg/L, which exceeded the Federal MCL and Tap Water RBC. Ethylbenzene and total xylene were detected at 230 μg/L and 200 μg/L, respectively. Neither concentration exceeded the Federal MCL or Tap Water RBC. The mobile laboratory appears to be a reliable qualitative tool, in that the fixed-base laboratory confirmed the detections. The mobile laboratory appears not to be a qualitative tool, however. An order of magnitude difference is apparent between the fixed-base and mobile laboratories. For that reason, the mobile laboratory data is not compared to screening criteria.

Positive detections of organic compounds in groundwater sample analytical data are presented in Table 5-26, and exceedences of the screening criteria are presented on Figure 5-17. Several VOCs were detected during Phase I and Phase III. Benzene was detected in well 13GW05 at 140 μg/L and 9-B05-HP02 at 1,200 μg/L , which exceeded the Federal MCL and Tap Water RBC. Several VOCs were detected in 13GW06, including chloroform (1,100 μg/L), methylene chloride (11 μg/L), bromoform (360 μg/L), bromodichloromethane (460 μg/L), and dibromochloromethane (300 μg/L). These detections exceeded the Federal MCL and Tap Water RBC. Chloroform was detected in 9MW03 at a concentration of 5J μg/L, and exceeded the Tap Water RBC. Bis(2-ethylhexyl)phthalate was detected in well 13GW04 at 7J μg/L, exceeding the Federal MCL and Tap Water RBC. TPH gasoline range organics were detected in well 13GW04 at 4,200 μg/L and in well 13GW05 at 160J μg/L.

Bis(2-ethylhexyl)phthalate, bromodichloromethane and dibromochloromethane were detected in field blanks associated with samples from wells 13GW04, 13GW05, and 13GW06 (Section 5.3.1). Bis(2-ethylhexyl)phthalate is a common laboratory contaminant (EPA 1989a). According to the EPA Risk Assessment Guidance (EPA 1989a) sample results should be considered positive only if the sample concentration is at least ten times the maximum blank concentration. Bis(2-ethylhexyl)phthalate was detected in well 13GW04 at a concentration less than the maximum blank concentration. Bromodichloromethane and dibromochloromethane are not common laboratory contaminants, and sample results should be considered positive only if the sample concentration is at least five times the maximum blank concentration (EPA 1989a). Sample concentrations of bromodichloromethane and dibromochloromethane are more than five time the maximum blank concentration. Only Bis(2-ethylhexyl)phthalate can be considered a laboratory artifact and not site related.

Table 5-27 presents total inorganic compounds detected and Table 5-28 presents the dissolved inorganic compounds detected in sample 9MW03. Total barium, cadmium, and mercury, as well as dissolved barium and cadmium were detected. Total cadmium exceeded the Federal MCL and Tap Water RBC (at 26.4 μg/L). Total barium and mercury did not exceed any screening criteria. Dissolved cadmium exceeded the Federal MCL and Tap Water RBC (at 25.1 μg/L). Dissolved barium did not exceed screening criteria. These exceedences are shown on Figure 5-17.

Water quality parameters were sampled and analyzed to determine the potability of the groundwater in the aquifer investigated. A summary of water quality parameter detections is presented in Table 5-29. Water quality parameter exceedences of the screening criteria are shown on Figure 5-18. All 14 water quality parameters were detected. Several water quality parameters exceeded screening criteria. Aluminum, manganese, chloride, color, and total dissolved solids (TDS) exceeded the Federal Secondary MCL in both samples. Iron exceeded the Federal Secondary MCL in sample 13GW05 (2.09 mg/L). Manganese was detected in sample 13GW06 at 13.8 mg/L, which exceeded the Tap Water RBC and the Federal Secondary MCL. Manganese was detected in sample 13GW05 at 0.512 mg/L, which exceeded the Federal Secondary MCL. Sulfate was also detected in sample 13GW06 at 1,300 mg/L, which exceeded the Federal primary and secondary MCLs.

5.2.2.4 Area B Surface Water

Three surface water samples and one duplicate sample were collected in the Mangrove area adjacent to (and north and east of) Area B. Surface water samples were collected during Phase III only.

Positive detections of organic compounds in surface water sample analytical data are presented in Table 5-30. No organic compounds were detected in the three surface water samples. It should be noted that methylene chloride was detected in the duplicate sample of 9SW01 at 2.7J μg/L. This detection did not exceed the Federal MCL or Tap Water RBC. The detection of methylene chloride at a low concentration, and not in the environmental sample suggests that it is an analytical artifact and not representative of site conditions.

Positive detections of total inorganic compounds in surface water sample analytical data are presented in Table 5-31, and exceedences of the screening criteria are presented on Figure 5-19. All 14 inorganic analytes were detected in surface water samples. Nearly all analytes exceeded screening criteria in at least one sample. The exceptions are barium, chromium, and cobalt. Beryllium, copper, cyanide, nickel, vanadium, and zinc exceeded the background screening criteria in sample 9SW01. Copper also exceeded the NAWQC CMC and NAWQC CCC criteria as well. Nickel also exceeded the NAWQC CCC criteria. The duplicate sample (9SW01D) exhibited a similar exceedence pattern, with the following exceptions: antimony and tin exceeded the background screening criteria; but cyanide did not as it was not detected. Cadmium, nickel, and vanadium exceeded the background

screening criteria in sample 9SW03. Beryllium, cadmium, copper, lead, and nickel exceeded the background screening criteria in sample 9SW04. Arsenic and copper also exceeded the NAWQC CMC criteria and copper also exceeded the NAWQC CCC criteria as well.

5.2.2.5 Area B Sediment

Three sediment samples were collected in the Mangrove area adjacent to (and north and east of) Area B. Sediment samples were collected at the same locations as surface water samples during Phase III.

Positive detections of organic compounds in sediment sample analytical data are presented in Table 5-32. Acetone was detected in all three samples including the duplicate, ranging from 87J µg/kg at 9SD01 to 200 µg/kg at 9SD04. Carbon disulfide was detected in 9SD03 and 9SD04 at 5.3J µg/kg and 8.9J µg/kg, respectively. 2-Butanone was detected in the same two samples at 28J µg/kg and 39J µg/kg, respectively. None of the positive detections exceeded either the FDEP Sediment PEL or TEL.

Positive detections of inorganic compounds in sediment sample analytical data are presented in Table 5-33, and exceedences of the screening criteria are presented on Figure 5-20. All 14 inorganic analytes were detected in the sediment samples. Arsenic, barium, beryllium, chromium, cobalt, copper, lead, mercury, nickel, tin, vanadium, and zinc were detected in all four samples. Beryllium and zinc exceeded the background screening criteria and copper exceeded the FDEP sediment TEL in sample 9SD01. Beryllium, mercury, and zinc exceeded the background screening criteria and copper exceeded the FDEP sediment TEL in sample 9SD01D. Beryllium, cadmium, lead, mercury, sulfide, and zinc exceeded the background screening criteria in sample 9SD03. Lead and copper also exceeded the FDEP Sediment TEL. All analytes except arsenic, chromium, tin, and vanadium exceeded the background screening criteria in sample 9SD04. Copper exceeded the FDEP sediment PEL and TEL as well.

5.2.2.6 Area B Summary

Evidence of the impact of past site operations on surface soil is limited. Acetone and one phthalate compound were detected in low concentrations below screening criteria. Neither compound is associated with aviation gasoline (AVGAS) or diesel fuel, marine (DFM). Samples exhibiting detections of inorganic compounds above screening criteria are located topographicly down-slope of Tanks 214 and 215 (Figure 5-18). Lead is associated with gasoline and was in a sample down-slope of Tank 214 at 258 mg/kg. Selenium and arsenic are not associated with fuel storage operations. Arsenic was detected in Area B and in background, and its presence in Area B appears to be a natural occurrence.

There is some evidence of the impact of past site operations on subsurface soil. TPH was detected in two subsurface soil samples. TPH (diesel range) was detected in 9TP05-04 at 15,000 μg/kg and TPH (gasoline range) was detected in 9TP02-06 at 6,400 μg/kg. Test pit 9TP05 is located up-slope of Tank 214, approximately 40 feet from the valve pit. Test pit 9TP02 is located immediately down-slope of Tank 215. SVOC detections are limited, do not exceed RBCs, and are not associated with fuel storage operations. Barium, cadmium, lead, and silver were detected in subsurface soil samples above background screening criteria. Barium, cadmium, and silver are not associated with AVGAS or DFM. Lead is associated with gasoline, however lead exceeded background screening criteria in only one sample located up-slope of Tank 215 (9TP03-03). Arsenic exceeded the Residential RBC in more than four subsurface soil samples. Even though arsenic appears to naturally exceed screening criteria, its distribution in subsurface soils (5-10' bgs) is shown on Figure 5-21 to demonstrate a pattern unrelated to site activities. The distribution pattern of arsenic in subsurface soil shows the highest concentrations north of Tank 215 (sample 9TP03-03) with lesser concentrations east and south of Tank 215.

There is evidence of the impact of past site operations on groundwater. BTEX compounds were detected in several of the temporary monitoring wells located downgradient of Tanks 214 and 215. It should be noted that an insufficient number of fixed-based confirmation samples were available to generate a meaningful distribution figure. Instead, the mobile laboratory data were used. BTEX compounds were detected as high as 30,200 μg/L in 9-B05-HP02. Figure 5-22 depicts the distribution of total BTEX constituents in groundwater. A BTEX plume is evident downgradient of Tank 214,

between the tank and the mangrove swamp. The location of the plume is consistent with past leaks or spills during the operation of Tank 214. The location of the maximum BTEX concentration is approximately 100 feet downgradient of the tank. This suggests that the spills or leaks have not recently occurred. A much smaller plume with lower concentrations is located southwest of Tank 215. Again, its location is consistent with past leaks or spills during the operation of Tank 215. TPH gasoline range compounds were also detected in two permanent monitoring wells, (13GW04 and 13GW05). These locations are consistent with the locations of the BTEX plumes. Other organic compounds were detected in groundwater, but are not associated with fuel storage operations. Cadmium was detected in groundwater in excess of the Tap Water MCL, but not background screening criteria. Cadmium is not associated with fuel storage operations.

The comparison of water quality parameters in Section 5.2.2.3 to federal standards shows several exceedences. These exceedences include several metals, as well as sulfate, color, and TDS. This suggests that untreated groundwater is not suitable for human use because of odor, color, and staining problems.

There is limited evidence of the impact of past site operations on surface water and sediment. Several VOCs were detected in sediments, but all were below screening criteria. Many inorganic compounds were detected in surface water and sediment, and many exceeded the background screening criteria. However, most of the inorganic compounds are not associated with fuel storage operations. Lead is typically associated with fuel storage operations, and was detected in surface water and sediment above screening criteria. Arsenic can be associated with pesticide use. Arsenic was detected in surface water and sediment, but only one surface water sample exhibited detections above screening criteria.

5.2.3 Area C - Tanks 216 - 217

The sections that follow discuss the nature and extent of contaminant in various media, including surface soil, subsurface soil, groundwater, surface water, and sediment.

5.2.3.1 Area C Surface Soil

Three surface soil samples were collected from Area C during Phase I. No surface soils were collected in subsequent phases.

Positive detections of organic compounds in surface soil sample analytical data are presented in Table 5-34. None of the samples contained detectable levels of VOCs. However, in sample 9MW04-00, four SVOCs were detected, including benzo(b)fluoranthene (59J µg/kg), chrysene (45J µg/kg), di-n-butylphthalate (100J µg/kg), and pyrene (56J µg/kg). None of the positive detections exceeded either the residential or industrial RBCs. TPH gasoline range compounds were also detected, in sample 9SS06 at a concentration of 27J µg/kg. The PREQB has however, established a screening level of 100 mg/kg (100,000 µg/kg), which is a number used for combined DRO/GRO. TPH concentrations detected in surface soil samples did not exceed the PREQB screening level.

Positive detections of inorganic compounds in surface soil sample analytical data are presented in Table 5-35, and exceedences of the screening criteria are presented on Figure 5-23. Barium, chromium, and lead were detected in all three of the surface soil samples. Barium concentrations ranged from 52.6 mg/kg to 110 mg/kg, chromium concentrations ranged from 17.6J mg/kg to 30.4J mg/kg, and lead concentrations ranged from 9.3 mg/kg to 52.5 mg/kg. Lead was the only inorganic compound to exceed the background screening (sample 9SS06). Barium, chromium, and lead concentrations detected in the surface soil samples did not exceed the industrial or residential soil RBCs.

5.2.3.2 Area C Subsurface Soil

Ten subsurface soil samples including two duplicate samples were collected from Area C during Phase I. No subsurface soils were collected in subsequent phases.

Positive detections of organic compounds in subsurface soil sample analytical data are presented in Table 5-36. Acetone, xylene, and TPH gasoline range organics were the only organics detected. Acetone was detected in three samples ranging from 24J µg/kg to 95 µg/kg. Xylene was detected in one sample at a concentration of 2 J µg/kg. None of the positive detections exceeded either the

residential or industrial RBCs. TPH gasoline range organics were detected in sample 9TP13-04 at a concentration of 19J µg/kg. TPH concentrations detected in surface soil samples did not exceed the PREQB screening level.

Positive detections of inorganic compounds in subsurface soil sample analytical data are presented in Table 5-37, and exceedences of the screening criteria are presented on Figure 5-24. Barium, chromium, lead, and silver were detected. Barium was detected in all samples ranging from 31.6 mg/kg to 96.9 mg/kg. Barium did not exceed any screening criteria. Chromium was detected in all samples, but the validator rejected the data for nearly all samples. Chromium was detected in samples 9MW04-03 at 28.3 mg/kg and 9MW04-05 at 20.4 mg/kg. Chromium exceeded background screening criteria in sample 9MW04-03. Lead concentrations were detected in all eight samples and exceeded the background screening criteria in five of eight (excluding duplicates). The highest lead concentration was detected in sample 9TP16-05 at 31.5J mg/kg. Silver concentrations exceed background screening criteria in six of eight subsurface soil samples; the highest concentration was detected in sample 9TP16-05 at 0.86 mg/kg. Chromium, lead and silver subsurface soil sample concentrations did not exceed the industrial or residential soil RBCs.

5.2.3.3 Area C Groundwater

Groundwater samples were collected from six monitoring wells in Area C during Phase I. Additionally, groundwater samples were collected from two monitoring wells during Phase III.

Positive detections of organic compounds in groundwater sample analytical data are presented in Table 5-38, and exceedences of the screening criteria are presented on Figure 5-25. Positive detections include toluene (13GW11 at 4.2J µg/L [Phase III]), 1,2-dichloropropane (13GW11 at 2J µg/L [Phase I]), and bis(2-ethylhexyl)phthalate (13GW10 at 38 µg/L [Phase I]). Bis(2-ethylhexyl)phthalate exceeded screening criteria; both the Tap Water RBC and the Federal MCL. 1,2-Dichloropropane exceeded the Tap Water RBC. It should be noted that the Phase II RFI Report stated that 1,2-dichloropropane and bis(2-ethylhexyl)phthalate were common laboratory artifacts and were not believed to be site related. Neither compound was detected in subsequent groundwater sampling events. The lack of consistent detections supports that assertion. No other organic compound, including TPH gasoline or diesel range organics was detected in either phase.

One sample for inorganic analysis has been collected at Area C. Phase I and III inorganic data (total and dissolved) is presented on Tables 5-39 and 5-40, respectively. Inorganic exceedences of the screening criteria are shown on Figure 5-25. Total barium and cadmium were detected in sample 9MW04 with concentrations of 235 µg/L and 12.1 µg/L, respectively. Barium and cadmium were below background screening criteria, however cadmium exceeded the Federal MCL. In the dissolved data, barium and cadmium were detected at concentrations of 209 µg/L and 11.4 µg/L, respectively during Phase I. Cadmium was detected at a concentration of 24.7 µg/L during Phase III. Barium and cadmium were below background screening criteria, however cadmium exceeded the Federal MCL.

Water quality parameters were sampled and analyzed to determine the potability of the groundwater in the aquifer investigated. A summary of water quality parameter detections is presented on Table 5-41. Water quality parameter exceedences of the screening criteria are shown on Figure 5-26. All 14 water quality parameters were detected. Several water quality parameters exceeded screening criteria. Aluminum, chloride, manganese, and TDS exceeded the Federal Secondary MCL for all three samples. Manganese also exceeded the Tap Water RBC in all three. Iron exceeded the Tap Water RBC and secondary MCL in samples 13GW10 and 13GW11. Color exceeded the Federal Secondary MCL in samples 13GW10 and 13GW11. Sulfate exceeded the Federal MCL in sample 9MW04.

5.2.3.4 Area C Surface Water

Two surface water samples were collected in the Mangrove area adjacent to, and northwest of Area C. Surface water samples were collected during Phase III only.

Positive detections of organic compounds in surface water sample analytical data are presented in Table 5-42. Only one organic compound was detected, namely methylene chloride (9SW07 at 2.9J µg/L). This detection did not exceed the NAWQC CMC or NAWQC CCC.

Positive detections of inorganic compounds in surface water sample analytical data are presented in Table 5-43, and exceedences of the screening criteria are presented on Figure 5-27. All 13 inorganic analytes were detected in sample 9SW06. All compounds except arsenic exceeded the background screening criteria. Arsenic exceeded only the NAWQC CCC. Chromium, lead, nickel, and vanadium

exceeded the background and NAWQC CCC criteria. Copper and zinc exceeded all three criteria. Twelve of 13 inorganic analytes were detected in sample 9SW07 (only cadmium was not detected). All detections except arsenic exceeded the background screening level. Chromium, lead, nickel, and vanadium exceeded the background and NAWQC CCC criteria. Copper and zinc exceeded all three criteria.

5.2.3.5 Area C Sediment

Two sediment samples were collected in the Mangrove area adjacent to, and northwest of Area C. Sediment samples were collected at the same locations as surface water during Phase III.

Positive detections of organic compounds in sediment sample analytical data are presented in Table 5-44. Acetone was detected in both samples; 290 µg/kg at 9SD06 and 74J µg/kg at 9SD07. Carbon disulfide was detected in 9SD07 at 16 µg/kg. 2-Butanone was detected in 9SD06 at 68J µg/kg. None of the positive detections exceeded the FDEP PEL/TEL.

Positive detections of inorganic compounds in sediment sample analytical data are presented in Table 5-45, and exceedences of the screening criteria are presented on Figure 5-28. All 14 inorganic analytes were detected in sample 9SD06. Arsenic, barium, beryllium, cobalt, lead, selenium, sulfide, and zinc exceeded only the background screening criteria. Copper exceeded the only FDEP Sediment TEL. Eleven of 14 inorganic analytes were detected in sample 9SD07 (selenium, sulfide, and zinc were not detected). Only two compounds exceeded criteria. Barium exceeded only the background screening criteria. Copper exceeded only the FDEP Sediment TEL.

5.2.3.6 Area C Summary

Evidence of the impact of past site operations on surface soil is limited. Four SVOCs were detected in only one surface soil sample (9MW04-00), located down slope of Tanks 216 and 217. However, detected concentrations were below RBCs. Benzo(b)fluoranthene, chrysene, and pyrene are typically associated with tars, greases, heavy oils, and poorly refined fuels. Their presence may be related to site operations, but are limited in extent and concentration. Lead concentrations exceeded background

screening criteria in only one sample (9SS06). Low levels of gasoline-range TPH were also detected in the same sample.

There is also limited evidence of the impact of past site operations on subsurface soil. Lead concentrations exceeded background screening criteria in six of eight samples, but did not exceed either the residential or industrial RBCs. Lead can be associated with leaded gasoline and its presence can be attributable to former site operations. Silver concentrations exceeded background screening criteria, in five of eight samples, but did not exceed either the residential or industrial RBCs. Silver is not associated with fuel storage operations and may be related to ambient soil conditions. Organic compound detections in subsurface soils are limited and do not exceed RBCs.

There is no evidence of the impact of past site operations on groundwater. Detection of organic compounds is sporadic, both temporally and spatially. Additionally, the organic compounds were detected at low levels. In terms of inorganic compounds, only barium and cadmium were detected. Cadmium exceeded only the Federal MCL, and is not typically associated with fuel storage operations.

The comparison of water quality parameters in Section 5.2.3.3 to federal standards shows several exceedences. These exceedences include several metals, as well as sulfate, color, and TDS. This suggests that untreated groundwater is not suitable for human use because of odor, color, and staining problems.

There is limited evidence of the impact of past site operations on surface water and sediment. Several VOCs were detected, but all were below screening criteria. Most inorganic analytes were detected in surface water and sediment, and many exceeded screening criteria. However, most of the inorganic compounds are not associated with fuel storage operations. Lead can be associated with fuel storage operations (leaded gasoline). Lead was detected in both surface water and sediment above screening criteria.

5.3 Quality Assurance/Quality Control Sample Results

A portion of the QA/QC sampling efforts consisted of equipment rinsate samples, field blanks, and trip blanks. The analytical results from the QA/QC sampling is presented as Appendix I.

5.3.1 Phase I - QA/QC Sample Results

During the initial assessment the equipment rinsate samples were analyzed for full Appendix IX parameters and TPH diesel and gasoline range organics. The field blank samples were analyzed for VOCs, SVOCs, TPH diesel and gasoline range organics, and RCRA Metals. The trip blank samples were analyzed for VOCs.

5.3.1.1 Equipment Rinsate Samples

Two equipment rinsate samples (9RB01 and 9RB02) were collected during the initial phase field activities. Samples 9RB01 and 9RB02 were collected while pouring lab grade deionized water over a stainless steel spoon and a split spoon, respectively. No VOCs were detected from the two equipment rinsate samples. Three SVOCs [diethyphthalate (1J µg/L), 1,4-dichlorobenzene (2J µg/L), and bis(2-ethylhexyl)phthalate (1J µg/L)] were detected at minor concentrations in sample 9RB02 (Table 5-46). An inorganic concentration of barium was detected in sample 9RB02 at 0.93 µg/L.

5.3.1.2 Field Blank Samples

Three field blank samples (FB01, FB02, and FB03) were collected during the investigation. The water analyzed included the store bought distilled water, NSRR water supply (fire hydrant), and lab-grade deionized water. Chloroform concentrations were detected in samples FB01 and FB02 at 4J µg/L and 150 µg/L, respectively (Table 5-46). Bromodichloromethane and dibromochloromethane were also detected in sample FB02 at concentrations of 14 µg/L, 3J µg/L, respectively. Sample FB03 had two positive SVOC results of 1,4-dichlorobenzene (2J µg/L), and bis(2-ethylhexyl)phthalate (16 µg/L). These organic compounds are common laboratory contaminants and had no impact on the sample results.

Sample FB01 had three positive detections for inorganics (cadmium at 4.4 µg/L, copper at 5.6 µg/L, and zinc at 5.1 µg/L). Sample FB02 had five positive detections for inorganics (antimony at 13 µg/L, barium at 5 µg/L, copper at 3.1 µg/L, lead at 1J µg/L, mercury at 0.14 µg/L, and zinc at 7.3 µg/L).

Sample FB03 had three positive detections for inorganics (barium at 1.5 μg/L, chromium at 5.1 μg/L, copper at 2.6 μg/L). These results do not have an impact on the samples for this investigation.

5.3.1.3 Trip Blank Samples

A total of 12 trip blanks were analyzed as part of the initial assessment. No VOCs were detected in the trip blank samples.

5.3.2 Phase II - QA/QC Sample Results

During the second phase SWMU 9 investigation the equipment rinsate and field blank samples were analyzed for BTEX, TPH diesel and gasoline range organics, and RCRA Metals.

5.3.2.1 Equipment Rinsate Samples

Two equipment rinsate samples were collected and analyzed during the second phase of the SWMU 9 investigation activity, 9ER01 and 9ER02. Sample 9ER01 and 9ER02 was collected while pouring lab grade deionized water through a disposable bailer and over a stainless steel spoon, respectively. The only organic positive detection was toluene in sample 9ER01 at a concentration of 0.8J μg/L and 0.5J μg/L in sample 9ER02 (Table 5-47). This concentration did not have any impact on the analytical results for the second phase groundwater sampling. An inorganic concentration of chromium was detected in sample 9ER01 at 1.6J μg/L and 9ER02 at 1.4J μg/L. The concentration of chromium detected had little to no impact on groundwater sample results.

5.3.2.2 Field Blank Samples

A field blank sample (FB01) was collected from the base water supply. The were no detectable organics detected in this sample. Two total inorganics were detected in this sample, barium and chromium, at concentrations of 3.4J μg/L and 2J μg/L, respectively (Table 5-47). These detections had little to no impact on sampling results.

5.3.3 Phase III - QA/QC Sample Results

During the third phase SWMU 9 investigation the equipment rinsate and field blank samples were analyzed for VOCs, SVOCs, PCBs, TPH diesel and gasoline range organics, Appendix IX Inorganics, cyanide, and sulfide.

5.3.3.1 Equipment Rinsate Samples

Four equipment rinsate samples were collected and analyzed during the third phase of the SWMU 9 investigation activity, 99-ER01, 99-ER02, 99-ER03, and 99-ER04. Each equipment rinsate sample was collected while pouring lab grade deionized water over or through selected sampling equipment. Sample 99-ER01 was collected from a large-core acetate sampler liner, 99-ER02 was collected from a stainless steel spoon, 99-ER03 was collected from a marco-core acetate sampler liner, and 99-ER04 was collected from a disposable bailer.

No VOCs, SVOCs, or hydrocarbons were detected in any of the rinsate samples. Several inorganic compounds were detected (Table 5-48). Copper was detected in 99-ER01 at 0.92J µg/L, and in 99-ER04 at 1J µg/L. Copper may be attributable to the lab grade deionized water, as copper was detected in a lab grade deionized water sample Section 5.3.3.2). Lead was detected in 99-ER02 at 1.2J µg/L. The lead concentration had little to no impact on soil sample results because they are two or more orders of magnitude less than detections in environmental samples.

5.3.3.2 Field Blank Samples

Two field blank samples (99-FB01 and 99-FB02) were collected during the third phase of the investigation. The water analyzed included lab-grade deionized water (99-FB01) and NSRR water supply (99-FB02). The NSRR water supply was taken from a spigot at the Tow Way Fuel Farm Pump House. No VOCs, SVOCs, or hydrocarbons were detected in 99-FB01. Copper and zinc were detected in 99-FB01 at 0.81J µg/L and 2.4J µg/L, respectively (Table 5-48). These concentrations had little to no impact on soil sample results because they are two or more orders of magnitude less than detections in environmental samples. Chloroform and Bromodichloromethane were detected in 99-FB02 at 84 µg/L and 14 µg/L, respectively (Table 5-48). These organic compounds are common laboratory contaminants and had no impact on the sample results. Several inorganic compounds were detected in 99-FB02 (Table 5-48), including arsenic (1.4J µg/L), barium (8.9J µg/L), copper (10.6 µg/L), vanadium (0.74J µg/L), and zinc (63.3 µg/L). The presence of copper in two equipment rinsate samples may be attributable to the presence of copper used in the lab-grade deionized water sample. The other inorganic compound concentrations had little to no impact on soil sample results because they are two or more orders of magnitude less than detections in environmental samples.

5.3.3.3 Trip Blank Samples

A total of 6 trip blanks were analyzed as part of the Phase III investigation. Two VOCs were detected in the trip blank samples. Chloromethane was detected in 9TB06 at 7.2J µg/L. Methylene chloride was detected in 9TB05 at 2.7J µg/L. The compound concentrations had no impact on soil sample results. Methylene chloride was not detected in any of the environmental samples associated with 9TB05. Additionally, chloromethane was not detected in any of the environmental samples associated with 9TB06.

5.4 Data Validation

A detailed and independent data validation was performed by Heartland Environmental Services, Inc. (Phases I and II) and Environmental Data Quality, Inc. (Phase III) to verify the qualitative and quantitative reliability of the data presented and adherence to stated analytical protocols. This review included a detailed review and interpretation of all the data generated by the laboratory for data quality

Level D deliverables. The primary tools that were utilized by the experienced data validation personnel included analytical method operating procedures, Statement of Work (SOW) for CLP guidance documents, EPA Region II guidelines for data validation, established criteria, and professional judgement.

The data validation reports stated that the overall laboratory performance was acceptable. The overall quality of the data package is acceptable. The reported results are accepted as reported by the laboratory with the noted qualifications. The data reviewer estimated that less than 10 percent of the data required qualifications. Data validation reports were prepared by the data validator which provided the back-up information accompanying the qualifying statements presented in the QA review.

SECTION 5.0
TABLES

TABLE 5-1

SUMMARY OF INORGANIC DETECTIONS IN SURFACE SOIL
SWMU 09 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID	EPA Region III Industrial RBC (mg/kg)	**EPA Region III Residential RBC (mg/kg)**	9-BG-SS01	9-BG-SS01D	9-BG-SS02	9-BG-SS03	9-BG-SS04	9-BG-SS05
Sample Date			06/26/99	06/26/99	06/26/99	06/26/99	06/26/99	06/27/99
Depth Range (ft bgs)			0.00-0.50	0.00-0.50	0.00-0.50	0.00-0.50	0.00-0.50	0.00-0.50
Inorganics (mg/kg)								
Arsenic	3.82	0.43	**2.2** J	**0.8** J	**2.5** J	**2.3** J	**2.1** J	0.21 J
Barium	143,080	5,475	91	75	53	110	62	66
Beryllium	4,100	160	0.36 J	0.34 J	0.17 J	0.18 J	0.15 J	0.32 J
Cadmium	2,044	78.21	0.062 U	0.062 U	0.92 J	0.059 U	0.18 J	0.061 U
Chromium	6,100 (1)	230 (1)	9.6	9.5	17	10	27	34
Cobalt	122,640	4,693	64	48	29	25	16	33
Copper	81,760	3,129	78 J	78 J	67 J	100 J	67 J	66 J
Lead	400 (2)	400 (2)	3.9 J	3 J	8.3 J	3.5 J	16 J	21 J
Mercury	NE	NE	0.058 J	0.037 J	0.12 J	0.032 J	0.03 J	0.071 J
Nickel	40,880	1,564	5.5	5.3	4.6 J	6.6	15	17
Tin	1,226,400	46,929	2.3 J	2.3 J	1.4 J	2.1 J	2 J	2.3 J
Vanadium	14,308	548	270	270	230	180	120	180
Zinc	613,200	23,464	36 J	36 J	49 J	67 J	50 J	61 J
Sulfide	NE	NE	31 U	31 U	30 U	29 U	39	44

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:

ft - feet

bgs - below ground surface.

NE - Not established.

mg/kg - milligrams per kilogram.

(1) The RBC for Chromium VI was used for screening because there is not total a chromium RBC available.

(2) 1996 EPA Soil Screening Guidance.

TABLE 5-1 (continued)

SUMMARY OF INORGANIC DETECTIONS IN SURFACE SOIL
SWMU 09 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	EPA Region III Industrial RBC (mg/kg)	EPA Region III Residential RBC (mg/kg)	Number Exceeding EPA Region III Industrial RBC	Range Exceeding EPA Region III Industrial RBC	Number Exceeding EPA Region III Residential RBC	Range Exceeding EPA Region III Residential RBC	Location Maximum Detect
Inorganics (mg/kg)							
Arsenic	3.82	0.43	0/6		5/6	0.8J-2.5J	9-BG-SS02
Barium	143,080	5,475	0/6		0/6		9-BG-SS03
Beryllium	4,100	160	0/6		0/6		9-BG-SS01
Cadmium	2,044	78.21	0/6		0/6		9-BG-SS02
Chromium	6,100 (1)	230 (1)	0/6		0/6		9-BG-SS05
Cobalt	122,640	4,693	0/6		0/6		9-BG-SS01
Copper	81,760	3,129	0/6		0/6		9-BG-SS03
Lead	400 (2)	400 (2)	0/6		0/6		9-BG-SS05
Mercury	NE	NE	NE		NE		9-BG-SS02
Nickel	40,880	1,564	0/6		0/6		9-BG-SS05
Tin	1,226,400	46,929	0/6		0/6		9-BG-SS01, 9-BG-SS01D, 9-BG-SS05
Vanadium	14,308	548	0/6		0/6		9-BG-SS01, 9-BG-SS01D
Zinc	613,200	23,464	0/6		0/6		9-BG-SS03
Sulfide	NE	NE	NE		NE		9-BG-SS05

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

(1) The RBC for Chromium VI was used for screening because there is not total a chromium RBC available.

(2) 1996 EPA Soil Screening Guidance.

Notes:

ft - feet

bgs - below ground surface.

NE - Not established.

mg/kg - milligrams per kilogram.

TABLE 5-2

SUMMARY OF INORGANIC DETECTIONS IN SUBSURFACE SOIL
SWMU 09 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	EPA Region III Industrial RBC (mg/kg)	**EPA Region III Residential RBC (mg/kg)**	9-BG-SB01-10-12 06/26/99 10.00-12.00	9-BG-SB02-8-10 06/26/99 8.00-10.00	9-BG-SB03-8-10 06/26/99 8.00-10.00	9-BG-SB04-10-12 06/26/99 10.00-12.00	9-BG-SB05-21-23 06/27/99 21.00-23.00	9-BG-SS05-15-17 06/27/99 15.00-17.00
Inorganics (mg/kg)								
Arsenic	3.82	0.43	**0.54** J	**0.53** J	**0.85** J	**1.5** J	0.15 UJ	0.28 J
Barium	143,080	5,475	54	9.3	150	53	45	82
Beryllium	4,100	160	0.077 J	0.21 J	0.93	0.1 J	0.35 J	0.38 J
Cadmium	2,044	78.21	0.061 U	0.066 U	0.12 U	0.079 U	0.33 J	0.099 J
Chromium	6,100 (1)	230 (1)	3.9	10	6	8.7	28	24
Cobalt	122,640	4,693	78	2.5	8.9	6.5	25	23
Copper	81,760	3,129	160 J	130 J	260 J	89 J	210 J	200 J
Lead	400 (2)	400 (2)	0.27 J	3 J	4.5 J	2.7 J	1.9 J	2 J
Mercury	NE	NE	0.0055 UJ	0.006 UJ	0.0051 UJ	0.024 J	0.0057 UJ	0.0052 UJ
Nickel	40,880	1,564	5.9	1.1 J	2.1 J	2.4 J	18	17
Selenium	10,220	391	0.94 UJ	0.22 UJ	3.8 J	1.8 J	0.98 J	0.98 UJ
Sulfide	NE	NE	30 U	33 U	31 U	40 U	29 U	37
Thallium	143	5.48	0.2 UJ	0.24 UJ	0.2 UJ	0.29 J	0.21 UJ	0.21 J
Tin	1,226,400	46,929	2.2 J	2.6 J	2.4 J	2.2 J	3.6 J	2.5 J
Vanadium	14,308	548	200	360	410	110	190	160
Zinc	613,200	23,464	52 J	27 U	98 J	40 J	83 J	76 J

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

ft - feet

bgs - below ground surface.

ND - Not detected.

NE - Not established.

mg/kg - milligrams per kilogram.

(1) The RBC for Chromium VI was used for screening because there is not total a chromium RBC available.

(2) 1996 EPA Soil Screening Guidance.

TABLE 5-2 (continued)

SUMMARY OF INORGANIC DETECTIONS IN SUBSURFACE SOIL
SWMU 09 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	EPA Region III Industrial RBC (mg/kg)	EPA Region III Residential RBC (mg/kg)	Number Exceeding EPA Region III Industrial RBC	Range Exceeding EPA Region III Industrial RBC	Number Exceeding EPA Region III Residential RBC	Range Exceeding EPA Region III Residential RBC	Location Maximum Detect
Inorganics (mg/kg)							
Arsenic	3.82	0.43	0/6		4/6	0.53J-1.5J	9-BG-SB04-10-12
Barium	143,080	5,475	0/6		0/6		9-BG-SB03-8-10
Beryllium	4,100	160	0/6		0/6		9-BG-SB03-8-10
Cadmium	2,044	78.21	0/6		0/6		9-BG-SB05-21-23
Chromium	6,100 (1)	230 (1)	0/6		0/6		9-BG-SB05-21-23
Cobalt	122,640	4,693	0/6		0/6		9-BG-SB01-10-12
Copper	81,760	3,129	0/6		0/6		9-BG-SB03-8-10
Lead	400 (2)	400 (2)	0/6		0/6		9-BG-SB03-8-10
Mercury	NE	NE	NE		NE		9-BG-SB04-10-12
Nickel	40,880	1,564	0/6		0/6		9-BG-SB05-21-23
Selenium	10,220	391	0/6		0/6		9-BG-SB03-8-10
Sulfide	NE	NE	NE		NE		9-BG-SS05-15-17
Thallium	143	5.48	0/6		0/6		9-BG-SB04-10-12
Tin	1,226,400	46,929	0/6		0/6		9-BG-SB05-21-23
Vanadium	14,308	548	0/6		0/6		9-BG-SB03-8-10
Zinc	613,200	23,464	0/6		0/6		9-BG-SB03-8-10

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

ft - feet

bgs - below ground surface.

ND - Not detected.

NE - Not established.

mg/kg - milligrams per kilogram.

(1) The RBC for Chromium VI was used for screening because there is not total a chromium RBC available.

(2) 1996 EPA Soil Screening Guidance.

TABLE 5-3

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER
SWMU 09 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/L)	EPA Region III Tap Water RBC (ug/L)	9-BG-GW01 6/29/99	9-BG-GW01D 6/29/99	9-BG-GW02 6/29/99	9-BG-GW03 06/28/99	9-BG-GW04 6/29/99
Volatiles (ug/L)							
Acetone	NE	610	50 U	50 U	50 U	50 U	26 J
Semivolatiles (ug/L)							
Not Detected							

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:

NE - Not established.

ug/L - micrograms per liter.

TABLE 5-3 (continued)

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER
SWMU 09 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/L)	EPA Region III Tap Water RBC (ug/L)	Number Exceeding Federal MCL	Range Exceeding Federal MCL	Number Exceeding EPA Region III Tap Water RBC	Range Exceeding EPA Region III Tap Water RBC	Location Maximum Detect
Volatiles (ug/L)							
Acetone	NE	610	NE		0/5		9-BG-GW04
Semivolatiles (ug/L)							
Not Detected							

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:

NE - Not established.

ug/L - micrograms per liter.

TABLE 5-4

SUMMARY OF INORGANIC (TOTAL) DETECTIONS IN GROUNDWATER
SWMU 09 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/L)	EPA Region III Tap Water RBC (ug/L)	9-BG-GW01 06/29/99	9-BG-GW01D 06/29/99	9-BG-GW02 06/29/99	9-BG-GW03 06/29/99	9-BG-GW03D 06/29/99	9-BG-GW04 06/29/99
Inorganics (ug/L)								
Antimony, Total	6	14.6	14.2 J	NA	13.5 R	5.7 U	13.5 R	NA
Arsenic, Total	50	0.04	**5.8** J	NA	2.6 UJ	**22.4** J	**13.3** J	NA
Barium, Total	2,000	2,555	156 J	NA	315 J	1,870 J	191 J	NA
Beryllium, Total	4	73	0.83 J	NA	1.3 J	7.8	0.99 J	NA
Cadmium, Total	5	18.3	2.5 U	NA	14.8 J	**53.1**	**32.4**	NA
Chromium, Total	100	110 (1)	4 U	NA	6.9 J	**112**	4 U	NA
Cobalt, Total	NE	2,190	11.1 J	NA	507	778	428	NA
Copper, Total	1,300 (2)	1,460	52.5 J	NA	200	**2,700**	223	NA
Lead, Total	15 (3)	NE	0.9 U	NA	0.9 U	32.5 J	0.9 U	NA
Mercury, Total	2	NE	0.1 U	NA	0.12 J	0.21	0.1 U	NA
Nickel, Total	100	730	12.6 J	NA	79.7 J	158	44 J	NA
Selenium, Total	50	183	17 U	NA	42.7 J	17 UJ	8.5 U	NA
Silver, Total	NE	183	3 U	NA	3 U	30.1	3 U	NA
Tin, Total	NE	21,900	10.9 J	NA	8.5 U	15.5 J	8.5 U	NA
Vanadium, Total	NE	256	73.3	NA	218	**3,000**	70.8	NA
Zinc, Total	NE	10,950	24.9 U	NA	695	2,410	299	NA

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:

NA - Not analyzed.
NE - Not established.
ug/L - micrograms per liter.
(1) The RBC for Chromium VI was used for screening because there is not total a chromium RBC available.
(2) EPA Action Level for Copper (www.epa.gov/ogwdw/wot.appa.html) November 1999.
(3) EPA Action Level for Lead (www.epa.gov/ogwdw/wot.appa.html) November 1999.

TABLE 5-4 (continued)

SUMMARY OF INORGANIC (TOTAL) DETECTIONS IN GROUNDWATER
SWMU 09 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/L)	EPA Region III Tap Water RBC (ug/L)	Number Exceeding Federal MCL	Range Exceeding Federal MCL	Number Exceeding EPA Region III Tap Water RBC	Range Exceeding EPA Region III Tap Water RBC	Location Maximum Detect
Inorganics (ug/L)							
Antimony, Total	6	14.6	1/4	14.2J	0/4		9-BG-GW01
Arsenic, Total	50	0.04	0/4		3/4	5.8J-22.4J	9-BG-GW03
Barium, Total	2,000	2,555	0/4		0/4		9-BG-GW03
Beryllium, Total	4	73	1/4	7.8	0/4		9-BG-GW03
Cadmium, Total	5	18.3	3/4	14.8J-53.1	2/4	32.4-53.1	9-BG-GW03
Chromium, Total	100	110 (1)	1/4	112	1/4	112	9-BG-GW03
Cobalt, Total	NE	2,190	NE		0/4		9-BG-GW03
Copper, Total	1,300 (2)	1,460	1/4	2,700	1/4	2,700	9-BG-GW03
Lead, Total	15 (3)	NE	1/4	32.5J	NE		9-BG-GW03
Mercury, Total	2	NE	0/4		NE		9-BG-GW03
Nickel, Total	100	730	1/4	158	0/4		9-BG-GW03
Selenium, Total	50	183	0/4		0/4		9-BG-GW02
Silver, Total	NE	183	NE		0/4		9-BG-GW03
Tin, Total	NE	21,900	NE		0/4		9-BG-GW03
Vanadium, Total	NE	256	NE		1/4	3,000	9-BG-GW03
Zinc, Total	NE	10,950	NE		0/4		9-BG-GW03

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:

NA - Not analyzed.
NE - Not established.
ug/L - micrograms per liter.
(1) The RBC for Chromium VI was used for screening because there is not total a chromium RBC available.
(2) EPA Action Level for Copper (www.epa.gov/ogwdw/wot.appa.html) November 1999.
(3) EPA Action Level for Lead (www.epa.gov/ogwdw/wot.appa.html) November 1999.

TABLE 5-5

SUMMARY OF INORGANIC (DISSOLVED) DETECTIONS IN GROUNDWATER
SWMU 09 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/L)	EPA Region III Tap Water RBC (ug/L)	9-BG-GW01 06/29/99	9-BG-GW02 06/29/99	9-BG-GW03 06/29/99	9-BG-GW03D 06/29/99
Inorganics (ug/L)						
Antimony, Soluble	6	14.6	2.7 U	13.5 U	3.8 J	3.8 J
Arsenic, Soluble	50	0.04	**9.3** J	2.6 UJ	**17.7** J	**8.7** J
Barium, Soluble	2,000	2,555	114	271	236	236
Beryllium, Soluble	4	73	0.1 U	0.5 U	1.1 J	1.1 J
Cadmium, Soluble	5	18.3	1.7 J	15.4 J	**36**	**33.6**
Chromium, Soluble	100	110 (1)	0.8 U	4 U	8 J	8 J
Cobalt, Soluble	NE	2,190	6.6 J	501	591	533
Copper, Soluble	1,300 (2)	1,460	6.2 J	84.8 J	496 J	496 J
Lead, Soluble	15 (3)	NE	0.9 UJ	0.9 J	0.9 UJ	0.9 UJ
Mercury, Soluble	2	NE	0.13 J	0.11 J	0.2 J	0.2 J
Nickel, Soluble	100	730	2.6 J	80.1 J	57.7	57.7
Selenium, Soluble	50	183	17 U	27.3 J	18.2 J	13 J
Silver, Soluble	NE	183	1.8 J	3 U	1.9 J	1.7 J
Tin, Soluble	NE	21,900	1.7 U	8.5 U	2 J	2 J
Vanadium, Soluble	NE	256	29.3 J	3 U	**265**	**265**
Zinc, Soluble	NE	10,950	2.4 U	582	492	492

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

NE - Not established.

ug/L - micrograms per liter.

(1) The RBC for Chromium VI was used for screening because there is not total a chromium RBC available.

(2) EPA Action Level for Copper (www.epa.gov/ogwdw/wot.appa.html) November 1999.

(3) EPA Action Level for Lead (www.epa.gov/ogwdw/wot.appa.html) November 1999.

TABLE 5-5 (continued)

SUMMARY OF INORGANIC (DISSOLVED) DETECTIONS IN GROUNDWATER
SWMU 09 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/L)	EPA Region III Tap Water RBC (ug/L)	Number Exceeding Federal MCL	Range Exceeding Federal MCL	Number Exceeding EPA Region III Tap Water RBC	Range Exceeding EPA Region III Tap Water RBC	Location Maximum Detect
Inorganics (ug/L)							
Antimony, Soluble	6	14.6	0/4		0/4		9-BG-GW03, 9BG-GW03
Arsenic, Soluble	50	0.04	0/4		3/4	8.7J-17.7J	9-BG-GW03
Barium, Soluble	2,000	2,555	0/4		0/4		9-BG-GW02
Beryllium, Soluble	4	73	0/4		0/4		9-BG-GW03, 9BG-GW03
Cadmium, Soluble	5	18.3	3/4	15.4J-36	2/4	33.6-36	9-BG-GW03
Chromium, Soluble	100	110 (1)	0/4		0/4		9-BG-GW03, 9BG-GW03
Cobalt, Soluble	NE	2,190	NE		0/4		9-BG-GW03
Copper, Soluble	1,300 (2)	1,460	0/4		0/4		9-BG-GW03, 9BG-GW03
Lead, Soluble	15 (3)	NE	0/4		NE		9-BG-GW02
Mercury, Soluble	2	NE	0/4		NE		9-BG-GW03, 9BG-GW03
Nickel, Soluble	100	730	0/4		0/4		9-BG-GW02
Selenium, Soluble	50	183	0/4		0/4		9-BG-GW02
Silver, Soluble	NE	183	NE		0/4		9-BG-GW03
Tin, Soluble	NE	21,900	NE		0/4		9-BG-GW03, 9BG-GW03
Vanadium, Soluble	NE	256	NE		2/4	265	9-BG-GW03, 9BG-GW03
Zinc, Soluble	NE	10,950	NE		0/4		9-BG-GW02

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

NE - Not established.

ug/L - micrograms per liter.

(1) The RBC for Chromium VI was used for screening because there is not total a chromium RBC available.

(2) EPA Action Level for Copper (www.epa.gov/ogwdw/wot.appa.html) November 1999.

(3) EPA Action Level for Lead (www.epa.gov/ogwdw/wot.appa.html) November 1999.

TABLE 5-6

SUMMARY OF INORGANIC (TOTAL) DETECTIONS IN SURFACE WATER
SWMU 09 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	NAWQC CMC (ug/L)	NAWQC CCC (ug/L)	9SW05 06/29/99
Inorganics (ug/L)			
Arsenic, Total	69 (1)	36 (1)	35.1 J
Barium, Total	NE	NE	55.9
Chromium, Total	1,108 (2)	50.3 (2)	9.1 J
Cobalt, Total	NE	NE	3.2 J
Tin, Total	NE	NE	2.7 J
Vanadium, Total	NE	NE	48.4 J
Zinc, Total	95	85.6	11.9 J

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

Notes:

(1) - The criterion shown was derived from data for trivalent arsenic, and applied to total arsenic (USEPA 1999d).

(2) - The criterion shown is for hexavalent chromium.

CCC - Criteria Continuous Concentration

CMC - Criteria Maximum Concentration

NAWQC - National Ambient Water Quality Criteria

NE - Not established.

ug/L - micrograms per liter.

TABLE 5-6 (continued)

SUMMARY OF INORGANIC (TOTAL) DETECTIONS IN SURFACE WATER
SWMU 09 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	NAWQC CMC (ug/L)	NAWQC CCC (ug/L)	Number Exceeding NAWQC CMC	Range Exceeding NAWQC CMC	Number Exceeding NAWQC CCC	Range Exceeding NAWQC CCC	Location Maximum Detect
Inorganics (ug/L)							
Arsenic, Total	69 (1)	36 (1)	0/1		0/1		9SW05
Barium, Total	NE	NE	NE		NE		9SW05
Chromium, Total	1,108 (2)	50.3 (2)	0/1		0/1		9SW05
Cobalt, Total	NE	NE	NE		NE		9SW05
Tin, Total	NE	NE	NE		NE		9SW05
Vanadium, Total	NE	NE	NE		NE		9SW05
Zinc, Total	95	85.6	0/1		0/1		9SW05

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

Notes:

(1) - The criterion shown was derived from data for trivalent arsenic, and applied to total arsenic (USEPA 1999d).

(2) - The criterion shown is for hexavalent chromium.

CCC - Criteria Continuous Concentration
CMC - Criteria Maximum Concentration
NAWQC - National Ambient Water Quality Criteria
NE - Not established.
ug/L - micrograms per liter.

TABLE 5-7

SUMMARY OF ORGANIC DETECTIONS IN SEDIMENT
SWMU 09 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	FDEP Sediment PEL (ug/kg)	**FDEP** **Sediment** **TEL** (ug/kg)	9SD05 06/29/99 0.00-0.50
Volatiles (ug/kg)			
Acetone	NE	NE	140
Semivolatiles (ug/kg)			
Not Detected			

Notes:

ft - feet
bgs - below ground surface.
FDEP - Florida Department of Environmental Protection.
NE - Not established.
PEL - Probable Effects Level.
TEL - Threshold Effects Level.
ug/kg - micrograms per kilogram.

TABLE 5-7 (continued)

SUMMARY OF ORGANIC DETECTIONS IN SEDIMENT
SWMU 09 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	FDEP Sediment PEL (ug/kg)	FDEP Sediment TEL (ug/kg)	Number Exceeding FDEP Sediment PEL	Range Exceeding FDEP Sediment PEL	Number Exceeding FDEP Sediment TEL	Range Exceeding FDEP Sediment TEL	Location Maximum Detect
Volatiles (ug/kg)							
Acetone	NE	NE	NE		NE		9SD05
Semivolatiles (ug/kg)							
Not Detected							

Notes:

ft - feet
bgs - below ground surface.
FDEP - Florida Department of Environmental Protection.
NE - Not established.
PEL - Probable Effects Level.
TEL - Threshold Effects Level.
ug/kg - micrograms per kilogram.

TABLE 5-8

SUMMARY OF INORGANIC DETECTIONS IN SEDIMENT
SWMU 09 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	FDEP Sediment PEL (mg/kg)	FDEP Sediment TEL (mg/kg)	9SD05 06/29/99 0.00-0.50
Inorganics (mg/kg)			
Arsenic	41.6	7.24	1.3 J
Barium	NE	NE	8.1
Beryllium	NE	NE	0.047 J
Chromium	160	52.3	16
Cobalt	NE	NE	4.7
Copper	108	18.7	**58** J
Lead	112	30.2	4.6 J
Mercury	0.70	0.13	0.041 J
Nickel	42.8	15.9	4.8 J
Tin	NE	NE	4.2 J
Vanadium	NE	NE	110

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

Notes:

ft - feet
bgs - below ground surface.
FDEP - Florida Department of Environmental Protection.
NE - Not established.
PEL - Probable Effects Level.
TEL - Threshold Effects Level.
mg/kg - milligrams per kilogram.

TABLE 5-8 (continued)

SUMMARY OF INORGANIC DETECTIONS IN SEDIMENT
SWMU 09 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	FDEP Sediment PEL (mg/kg)	FDEP Sediment TEL (mg/kg)	Number Exceeding FDEP Sediment PEL	Range Exceeding FDEP Sediment PEL	Number Exceeding FDEP Sediment TEL	Range Exceeding FDEP Sediment TEL	Location Maximum Detect
Inorganics (mg/kg)							
Arsenic	41.6	7.24	0/1		0/1		9SD05
Barium	NE	NE	NE		NE		9SD05
Beryllium	NE	NE	NE		NE		9SD05
Chromium	160	52.3	0/1		0/1		9SD05
Cobalt	NE	NE	NE		NE		9SD05
Copper	108	18.7	0/1		1/1	58J	9SD05
Lead	112	30.2	0/1		0/1		9SD05
Mercury	0.70	0.13	0/1		0/1		9SD05
Nickel	42.8	15.9	0/1		0/1		9SD05
Tin	NE	NE	NE		NE		9SD05
Vanadium	NE	NE	NE		NE		9SD05

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

Notes:

ft - feet
bgs - below ground surface.
FDEP - Florida Department of Environmental Protection.
NE - Not established.
PEL - Probable Effects Level.
TEL - Threshold Effects Level.
mg/kg - milligrams per kilogram.

TABLE 5-9

SUMMARY OF ORGANIC DETECTIONS IN SURFACE SOIL - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID	EPA Region III Industrial RBC (ug/kg)	EPA Region III Residential RBC (ug/kg)	9SS01	9SS02	9MW01-00	9MW02-00
Sample Date			03/20/96	03/20/96	03/20/96	03/20/96
Depth Range (ft bgs)			0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00
Volatiles (ug/kg)						
Acetone	204,400,000	7,821,429	11 UJ	12 J	12 UJ	11 UJ
Semivolatiles (ug/kg)						
Benzyl alcohol	613,200,000	23,464,286	370 UJ	380 U	440 J	370 UJ
Diethylphthalate	1,635,200,000	62,571,429	370 U	380 U	410 U	40 J
TPH (ug/kg)						
Not Detected						

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

ft - feet
bgs - below ground surface.
ug/kg - micrograms per kilogram.

TABLE 5-9 (continued)

SUMMARY OF ORGANIC DETECTIONS IN SURFACE SOIL - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	EPA Region III Industrial RBC (ug/kg)	EPA Region III Residential RBC (ug/kg)	Number Exceeding EPA Region III Industrial RBC	Range Exceeding EPA Region III Industrial RBC	Number Exceeding EPA Region III Residential RBC	Range Exceeding EPA Region III Residential RBC	Location Maximum Detect
Volatiles (ug/kg)							
Acetone	204,400,000	7,821,429	0/4		0/4		9SS02
Semivolatiles (ug/kg)							
Benzyl alcohol	613,200,000	23,464,286	0/4		0/4		9MW01-00
Diethylphthalate	1,635,200,000	62,571,429	0/4		0/4		9MW02-00
TPH (ug/kg)							
Not Detected							

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

ft - feet
bgs - below ground surface.
ug/kg - micrograms per kilogram.

TABLE 5-10

SUMMARY OF INORGANIC DETECTIONS IN SURFACE SOIL - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	2 X Average Detected Background (mg/kg)	EPA Region III Industrial RBC (mg/kg)	EPA Region III Residential RBC (mg/kg)	9SS01 03/20/96 0.00-1.00	9SS02 03/20/96 0.00-1.00	9MW01-00 03/20/96 0.00-1.00	9MW02-00 03/20/96 0.00-1.00
RCRA Metals (mg/kg)							
Arsenic	3.72	3.815	0.426	1.6	1.1	0.93	3.7
Barium	152.8	143,080	5,475	93.1	81.6	66.2	232
Chromium	39.0	6,100 (1)	230 (1)	17.6 J	7.7 J	7.6 J	29.7 J
Lead	21.1	400 (2)	400 (2)	15.6	6	4.2	10.7
Selenium	ND	10,220	391	0.18 UJ	0.18 UJ	0.87 J	1.6 J
Silver	ND	10,220	391	0.28 U	0.33 U	0.37 U	0.35

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

ft - feet

bgs - below ground surface.

ND - Not detected.

NE - Not established.

mg/kg - milligrams per kilogram.

(1) The RBC for Chromium VI was used for screening because there is not a total chromium RBC available.

(2) 1996 EPA Soil Screening Guidance.

TABLE 5-10 (continued)

SUMMARY OF INORGANIC DETECTIONS IN SURFACE SOIL - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	2 X Average Detected Background (mg/kg)	EPA Region III Industrial RBC (mg/kg)	EPA Region III Residential RBC (mg/kg)	Number Exceeding 2 X Average Detected Background	Range Exceeding 2 X Average Detected Background	Number Exceeding EPA Region III Industrial RBC	Range Exceeding EPA Region III Industrial RBC	Number Exceeding EPA Region III Residential RBC	Range Exceeding EPA Region III Residential RBC	Location Maximum Detect
RCRA Metals (mg/kg)										
Arsenic	3.72	3.815	0.426	0/4		0/4		4/4	0.93-3.7	9MW02-00
Barium	152.8	143,080	5,475	1/4	232	0/4		0/4		9MW02-00
Chromium	39.0	6,100 (1)	230 (1)	0/4		0/4		0/4		9MW02-00
Lead	21.1	400 (2)	400 (2)	0/4		0/4		0/4		9SS01
Selenium	ND	10,220	391	2/4	0.87J-1.6J	0/4		0/4		9MW02-00
Silver	ND	10,220	391	1/4	0.35	0/4		0/4		9MW02-00

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

ft - feet
bgs - below ground surface.
ND - Not detected.
NE - Not established.
mg/kg - milligrams per kilogram.
(1) The RBC for Chromium VI was used for screening because there is not a total chromium RBC available.
(2) 1996 EPA Soil Screening Guidance.

TABLE 5-11

SUMMARY OF ORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	EPA Region III Industrial RBC (ug/kg)	**EPA Region III Residential RBC** (ug/kg)	9MW01-08 04/10/96 16.00-18.00	9MW01-15 04/10/96 30.00-32.00	9MW02-04 04/12/96 8.00-10.00	9MW02-06 04/12/96 12.00-14.00	9MW02-10 04/12/96 20.00-22.00	9TP07-04 04/08/96 9.00	9TP08-04 04/08/96 9.00
Volatiles (ug/kg)									
Acetone	204,400,000	7,821,429	14 UJ	13 U	670 J	70 UJ	14 U	1,200	620 J
Benzene	197,352	22,025	7 U	7 U	39 U	960 J	180	63 U	28 UJ
2-Butanone	1,226,400,000	46,928,571	14 UJ	13 U	160 J	70 UJ	14 U	130 UJ	56 UJ
Ethylbenzene	204,400,000	7,821,429	7 U	7 U	39 U	1,300 J	7 U	51 J	240 J
Toluene	408,800,000	15,642,857	7 U	7 U	39 U	5,300 J	5 J	63 U	28 UJ
Xylene (total)	4,088,000,000	156,428,571	7 U	7 U	39 U	4,700 J	5 J	91	220 J
Semivolatiles (ug/kg)									
Di-n-butylphthalate	204,400,000	7,821,429	460 U	440 U	500 U	460 U	470 U	420 U	370 U
Butylbenzylphthalate	408,800,000	15,642,857	460 U	440 U	500 U	460 U	470 U	420 U	370 U
o-Cresol	102,200,000	3,910,714	460 U	440 U	500 U	460 U	470 U	61 J	370 U
m,p-Cresol	100,000,000	3,900,000	460 U	440 U	500 U	460 U	470 U	54 J	370 U
BTEX (ug/kg)									
Benzene	197,352	22,025	NA	NA	NA	NA	NA	NA	NA
Toluene	410,000,000	16,000,000	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	200,000,000	7,800,000	NA	NA	NA	NA	NA	NA	NA
Xylene (total)	4,100,000,000	160,000,000	NA	NA	NA	NA	NA	NA	NA
TPH (ug/kg)									
Diesel Range Organics	100,000 (1)	100,000 (1)	5,800 U	5,500 U	6,300 UJ	5,800 UJ	5,900 UJ	6,200	14,000
Gasoline Range organics	100,000 (1)	100,000 (1)	42 U	40 U	400 J	57,000 J	180	8,900 J	15,000

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

ft - feet
bgs - below ground surface.
NA - Not analyzed.
NE - Not established.
ug/kg - micrograms per kilogram.
(1) - Puerto Rico Environmental Quality Board Criteria

TABLE 5-11 (continued)

SUMMARY OF ORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	EPA Region III Industrial RBC (ug/kg)	**EPA Region III Residential RBC** (ug/kg)	9TP09-04 04/08/96 9.00	9TP10-04 04/08/96 8.00	9TP18-05 04/14/96 10.00	9MW02N-05 09/21/97 8.00-10.00	9MW02R-05 09/21/97 8.00-10.00	9MW02R-06 09/21/97 10.00-12.00	9MW02S-05 09/21/97 8.00-10.00
Volatiles (ug/kg)									
Acetone	204,400,000	7,821,429	12 U	12 U	87 J	NA	NA	NA	NA
Benzene	197,352	22,025	6 U	6 U	6 U	NA	NA	NA	NA
2-Butanone	1,226,400,000	46,928,571	12 UJ	12 UJ	13 U	NA	NA	NA	NA
Ethylbenzene	204,400,000	7,821,429	6 U	6 U	6 U	NA	NA	NA	NA
Toluene	408,800,000	15,642,857	6 U	6 U	6 U	NA	NA	NA	NA
Xylene (total)	4,088,000,000	156,428,571	6 U	6 U	6 U	NA	NA	NA	NA
Semivolatiles (ug/kg)									
Di-n-butylphthalate	204,400,000	7,821,429	870	410 U	410 U	NA	NA	NA	NA
Butylbenzylphthalate	408,800,000	15,642,857	100 J	410 U	410 U	NA	NA	NA	NA
o-Cresol	102,200,000	3,910,714	400 U	410 U	410 U	NA	NA	NA	NA
m,p-Cresol	100,000,000	3,900,000	400 U	410 U	410 U	NA	NA	NA	NA
BTEX (ug/kg)									
Benzene	197,352	22,025	NA	NA	NA	1.3 U	18	21	1.4 U
Toluene	410,000,000	16,000,000	NA	NA	NA	1.3 U	6.6 U	52	1.4 U
Ethylbenzene	200,000,000	7,800,000	NA	NA	NA	1.3 U	11	0.68 J	1.4 U
Xylene (total)	4,100,000,000	160,000,000	NA	NA	NA	1.3 U	140	29	1.4 U
TPH (ug/kg)									
Diesel Range Organics	100,000 (1)	100,000 (1)	5,000 U	5,100 U	5,300 U	8,000 U	8,000 U	8,200 U	8,400 U
Gasoline Range organics	100,000 (1)	100,000 (1)	36 U	37 U	41	33 J	52,000	31,000	69 U

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

ft - feet
bgs - below ground surface.
NA - Not analyzed.
NE - Not established.
ug/kg - micrograms per kilogram.
(1) - Puerto Rico Environmental Quality Board Criteria

TABLE 5-11 (continued)

SUMMARY OF ORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	EPA Region III Industrial RBC (ug/kg)	EPA Region III Residential RBC (ug/kg)	9TP07A-01 10/01/97 8.00-10.00	9TP07A-02 10/01/97 8.00-10.00	9TP07B-01 10/01/97 8.00-10.00	9TP07B-02 10/01/97 8.00-10.00	9TP09A-01 10/01/97 8.00-10.00	9TP09A-02 10/01/97 8.00-10.00	9-02R-HP01 06/22/99 11.00-12.00
Volatiles (ug/kg)									
Acetone	204,400,000	7,821,429	NA	NA	NA	NA	NA	NA	NA
Benzene	197,352	22,025	NA	NA	NA	NA	NA	NA	NA
2-Butanone	1,226,400,000	46,928,571	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	204,400,000	7,821,429	NA	NA	NA	NA	NA	NA	NA
Toluene	408,800,000	15,642,857	NA	NA	NA	NA	NA	NA	NA
Xylene (total)	4,088,000,000	156,428,571	NA	NA	NA	NA	NA	NA	NA
Semivolatiles (ug/kg)									
Di-n-butylphthalate	204,400,000	7,821,429	NA	NA	NA	NA	NA	NA	NA
Butylbenzylphthalate	408,800,000	15,642,857	NA	NA	NA	NA	NA	NA	NA
o-Cresol	102,200,000	3,910,714	NA	NA	NA	NA	NA	NA	NA
m,p-Cresol	100,000,000	3,900,000	NA	NA	NA	NA	NA	NA	NA
BTEX (ug/kg)									
Benzene	197,352	22,025	2.4	1.2 U	1.4 U	1.2 U	1.2 U	1.3 U	6.9 U
Toluene	410,000,000	16,000,000	11	3.1	1.4 U	1.2 U	1.2 U	1.3 U	6.9 U
Ethylbenzene	200,000,000	7,800,000	2.9	0.72 J	1.4 U	1.2 U	1.2 U	1.4	6.9 U
Xylene (total)	4,100,000,000	160,000,000	4.5	11	1.4 U	1.2 U	1.2 U	23	14 U
TPH (ug/kg)									
Diesel Range Organics	100,000 (1)	100,000 (1)	8,200 U	7,500 U	8,600 U	7,200 U	7,100 U	8,100 U	2,700 J
Gasoline Range organics	100,000 (1)	100,000 (1)	530	740	70 U	58 U	58 U	950	**130,000** J

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

ft - feet
bgs - below ground surface.
NA - Not analyzed.
NE - Not established.
ug/kg - micrograms per kilogram.
(1) - Puerto Rico Environmental Quality Board Criteria

TABLE 5-11 (continued)

SUMMARY OF ORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	EPA Region III Industrial RBC (ug/kg)	EPA Region III Residential RBC (ug/kg)	9-02R-HP02 06/23/99 11.00-12.00	9-02R-HP02D 06/23/99 11.00-12.00	9-02R-HP03 6/22/99 10.00-12.00	9-02R-HP04 06/23/99 10.00-12.00	9-02R-HP05 06/23/99 10.00-12.00	9-02R-HP06 06/23/99 10.00-12.00	9-02R-HP07 06/23/99 10.00-12.00
Volatiles (ug/kg)									
Acetone	204,400,000	7,821,429	NA	NA	NA	NA	NA	NA	NA
Benzene	197,352	22,025	NA	NA	NA	NA	NA	NA	NA
2-Butanone	1,226,400,000	46,928,571	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	204,400,000	7,821,429	NA	NA	NA	NA	NA	NA	NA
Toluene	408,800,000	15,642,857	NA	NA	NA	NA	NA	NA	NA
Xylene (total)	4,088,000,000	156,428,571	NA	NA	NA	NA	NA	NA	NA
Semivolatiles (ug/kg)									
Di-n-butylphthalate	204,400,000	7,821,429	NA	NA	NA	NA	NA	NA	NA
Butylbenzylphthalate	408,800,000	15,642,857	NA	NA	NA	NA	NA	NA	NA
o-Cresol	102,200,000	3,910,714	NA	NA	NA	NA	NA	NA	NA
m,p-Cresol	100,000,000	3,900,000	NA	NA	NA	NA	NA	NA	NA
BTEX (ug/kg)									
Benzene	197,352	22,025	7 U	7 U	6.9 U	6.8 U	6.8 U	6.7 U	7.4 U
Toluene	410,000,000	16,000,000	7 U	7 U	6.9 U	6.8 U	6.8 U	6.7 U	7.4 U
Ethylbenzene	200,000,000	7,800,000	7 U	7 U	6.9 U	6.8 U	6.8 U	6.7 U	7.4 U
Xylene (total)	4,100,000,000	160,000,000	7.3 J	14 U	14 U	14 U	14 U	13 U	15 U
TPH (ug/kg)									
Diesel Range Organics	100,000 (1)	100,000 (1)	1,400 J	4,600 U	4,600 U	4,500 U	4,400 U	4,300 U	1,300 J
Gasoline Range organics	100,000 (1)	100,000 (1)	16,000	77,000	350 U	340 U	340 U	270 J	370 U

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

ft - feet
bgs - below ground surface.
NA - Not analyzed.
NE - Not established.
ug/kg - micrograms per kilogram.
(1) - Puerto Rico Environmental Quality Board Criteria

TABLE 5-11 (continued)

SUMMARY OF ORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	EPA Region III Industrial RBC (ug/kg)	EPA Region III Residential RBC (ug/kg)	9-02R-HP08 06/23/99 10.00-12.00	9-02R-HP09 06/23/99 14.00-16.00	9-02R-HP10-01 06/26/99 0.00-4.00	9-02R-HP11-01 06/26/99 12.00-16.00	9-02R-HP11-01D 06/26/99 12.00-16.00	9-02R-HP12-01 06/26/99 5.00-6.00
Volatiles (ug/kg)								
Acetone	204,400,000	7,821,429	NA	NA	NA	NA	NA	NA
Benzene	197,352	22,025	NA	NA	NA	NA	NA	NA
2-Butanone	1,226,400,000	46,928,571	NA	NA	NA	NA	NA	NA
Ethylbenzene	204,400,000	7,821,429	NA	NA	NA	NA	NA	NA
Toluene	408,800,000	15,642,857	NA	NA	NA	NA	NA	NA
Xylene (total)	4,088,000,000	156,428,571	NA	NA	NA	NA	NA	NA
Semivolatiles (ug/kg)								
Di-n-butylphthalate	204,400,000	7,821,429	NA	NA	NA	NA	NA	NA
Butylbenzylphthalate	408,800,000	15,642,857	NA	NA	NA	NA	NA	NA
o-Cresol	102,200,000	3,910,714	NA	NA	NA	NA	NA	NA
m,p-Cresol	100,000,000	3,900,000	NA	NA	NA	NA	NA	NA
BTEX (ug/kg)								
Benzene	197,352	22,025	8.3 U	6.8 U	7.2 U	6.1 U	7.2 U	7.1 U
Toluene	410,000,000	16,000,000	8.3 U	6.8 U	7.2 U	6.1 U	7.2 U	7.1 U
Ethylbenzene	200,000,000	7,800,000	8.3 U	6.8 U	7.2 U	6.1 U	7.2 U	7.1 U
Xylene (total)	4,100,000,000	160,000,000	16 U	14 U	14 U	12 U	14 U	14 U
TPH (ug/kg)								
Diesel Range Organics	100,000 (1)	100,000 (1)	6,500	1,400 J	4,600 U	3,900 U	4,300 U	4,800 U
Gasoline Range organics	100,000 (1)	100,000 (1)	400 U	340 U	350 U	300 U	330 U	370 U

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

ft - feet
bgs - below ground surface.
NA - Not analyzed.
NE - Not established.
ug/kg - micrograms per kilogram.
(1) - Puerto Rico Environmental Quality Board Criteria

TABLE 5-11 (continued)

SUMMARY OF ORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	EPA Region III Industrial RBC (ug/kg)	EPA Region III Residential RBC (ug/kg)	Number Exceeding EPA Region III Industrial RBC	Range Exceeding EPA Region III Industrial RBC	Number Exceeding EPA Region III Residential RBC	Range Exceeding EPA Region III Residential RBC	Location Maximum Detect
Volatiles (ug/kg)							
Acetone	204,400,000	7,821,429	0/10		0/10		9TP07-04
Benzene	197,352	22,025	0/10		0/10		9MW02-06
2-Butanone	1,226,400,000	46,928,571	0/10		0/10		9MW02-04
Ethylbenzene	204,400,000	7,821,429	0/10		0/10		9MW02-06
Toluene	408,800,000	15,642,857	0/10		0/10		9MW02-06
Xylene (total)	4,088,000,000	156,428,571	0/10		0/10		9MW02-06
Semivolatiles (ug/kg)							
Di-n-butylphthalate	204,400,000	7,821,429	0/10		0/10		9TP09-04
Butylbenzylphthalate	408,800,000	15,642,857	0/10		0/10		9TP09-04
o-Cresol	102,200,000	3,910,714	0/10		0/10		9TP07-04
m,p-Cresol	100,000,000	3,900,000	0/10		0/10		9TP07-04
BTEX (ug/kg)							
Benzene	197,352	22,025	0/24		0/24		9MW02R-06
Toluene	410,000,000	16,000,000	0/24		0/24		9MW02R-06
Ethylbenzene	200,000,000	7,800,000	0/24		0/24		9MW02R-05
Xylene (total)	4,100,000,000	160,000,000	0/24		0/24		9MW02R-05
TPH (ug/kg)							
Diesel Range Organics	100,000 (1)	100,000 (1)	0/34		0/34		9TP08-04
Gasoline Range organics	100,000 (1)	100,000 (1)	1/34	130,000 J	1/34	130,000 J	9-02R-HP01

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

ft - feet
bgs - below ground surface.
NA - Not analyzed.
NE - Not established.
ug/kg - micrograms per kilogram.
(1) - Puerto Rico Environmental Quality Board Criteria

TABLE 5-12

SUMMARY OF INORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	2 X Average Detected Background (mg/kg)	**EPA Region III Industrial RBC** (mg/kg)	EPA Region III Residential RBC (mg/kg)	9MW01-08 04/10/96 16.00-18.00	9MW01-15 04/10/96 30.00-32.00	9MW02-04 04/12/96 8.00-10.00	9MW02-06 04/12/96 12.00-14.00	9MW02-10 04/12/96 20.00-22.00	9TP07-04 04/08/96 9.00	9TP08-04 04/08/96 9.00
RCRA Metals (mg/kg)										
Arsenic	1.26	3.82	0.426	0.23 J	0.12 UJ	0.14 UJ	0.71 UJ	0.19 J	0.15 J	5 J
Barium	131	143,080	5,475	36.7	9	11.6	40	77.2	119	45.7
Cadmium	0.20	2,044	78.21	0.39 U	0.29 U	0.37 UJ	0.31 UJ	0.31 UJ	0.28 U	0.27 U
Chromium	26.9	6,100 (1)	230 (1)	5.3 J	3.2 J	2.8 R	2.8 R	6.9 R	50.8 J	5 J
Lead	4.79	400 (2)	400 (2)	1 J	0.69 J	1.7 J	1.7 J	0.88 J	6 J	5.9 J
Mercury	0.013	NE	NE	0.05 U	0.06 U	0.06 UJ	0.05 UJ	0.07 UJ	0.05 U	0.06 U
Selenium	2.55	10,220	391	0.19 UJ	0.14 UJ	0.32 UJ	0.33 UJ	0.33 UJ	0.16 UJ	0.13 U
Silver	ND	10,220	391	0.54 U	0.67	0.51 U	0.42 U	0.42 U	0.38 U	0.37 U

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.
R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:

ft - feet
bgs - below ground surface.
NE - Not established.
ND - Not detected.
mg/kg - milligrams per kilogram.
(1) The RBC for Chromium VI was used for screening because there is not a total chromium RBC available.
(2) 1996 EPA Soil Screening Guidance.

TABLE 5-12 (continued)

SUMMARY OF INORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	2 X Average Detected Background (mg/kg)	**EPA Region III Industrial RBC** (mg/kg)	EPA Region III Residential RBC (mg/kg)	9TP09-04 04/08/96 9.00	9TP10-04 04/08/96 8.00	9TP18-05 04/14/96 10.00	9MW02N-05 09/21/97 8.00-10.00	9MW02R-05 09/21/97 8.00-10.00	9MW02R-06 09/21/97 10.00-12.00	9MW02S-05 09/21/97 8.00-10.00
RCRA Metals (mg/kg)										
Arsenic	1.26	3.82	0.426	0.1 UJ	0.47 J	0.5 J	2.4 J	0.78 U	0.72 U	1.2 J
Barium	131	143,080	5,475	46.9	103	62.7	9.7 J	13.5 J	16.7 J	14.7 J
Cadmium	0.20	2,044	78.21	0.29 U	0.29 U	0.3 UJ	0.23 U	0.04 U	0.18 U	0.05 U
Chromium	26.9	6,100 (1)	230 (1)	2.7 J	7.2 J	5.2 R	28.9	4	7	8.2
Lead	4.79	400 (2)	400 (2)	0.83 J	19.3 J	4.1 J	1.8	3.1	1.1	1.6
Mercury	0.013	NE	NE	0.04 U	0.05 U	0.06 UJ	0.02 U	0.03 U	0.03 U	0.1
Selenium	2.55	10,220	391	0.16 UJ	0.15 UJ	0.29 UJ	0.26 U	0.39 J	0.2 U	1.8
Silver	ND	10,220	391	0.48	0.4 U	0.41 U	0.07 J	0.08 J	0.06 U	0.08 U

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.
R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:

ft - feet
bgs - below ground surface.
NE - Not established.
ND - Not detected.
mg/kg - milligrams per kilogram.
(1) The RBC for Chromium VI was used for screening because there is not a total chromium RBC available.
(2) 1996 EPA Soil Screening Guidance.

TABLE 5-12 (continued)

SUMMARY OF INORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	2 X Average Detected Background (mg/kg)	**EPA Region III Industrial RBC** (mg/kg)	EPA Region III Residential RBC (mg/kg)	9TP07A-01 10/01/97 8.00-10.00	9TP07A-02 10/01/97 8.00-10.00	9TP07B-01 10/01/97 8.00-10.00	9TP07B-02 10/01/97 8.00-10.00	9TP09A-01 10/01/97 8.00-10.00	9TP09A-02 10/01/97 8.00-10.00
RCRA Metals (mg/kg)									
Arsenic	1.26	3.82	0.426	0.28 UJ	0.29 J	0.31 UJ	0.24 UJ	0.44 J	0.28 J
Barium	131	143,080	5,475	156 J	51.4 J	32.2 J	42.8 J	131 J	240 J
Cadmium	0.20	2,044	78.21	1.3	1.6	1.3	0.99	1.5	1.6
Chromium	26.9	6,100 (1)	230 (1)	11.3 J	2.4 J	6.3 J	4.1 J	8.3 J	11.3 J
Lead	4.79	400 (2)	400 (2)	0.79	3.7	0.18 U	0.15 U	0.35	1.2
Mercury	0.013	NE	NE	0.03 U	0.02 U	0.03 U	0.02 U	0.02 U	0.03 U
Selenium	2.55	10,220	391	1.6 J	0.67 J	0.84 J	1 J	0.49 J	1 J
Silver	ND	10,220	391	0.4 J	0.3 J	0.28 J	0.3 J	0.25 J	0.22 J

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:

ft - feet

bgs - below ground surface.

NE - Not established.

ND - Not detected.

mg/kg - milligrams per kilogram.

(1) The RBC for Chromium VI was used for screening because there is not a total chromium RBC available.

(2) 1996 EPA Soil Screening Guidance.

TABLE 5-12 (continued)

SUMMARY OF INORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	2 X Average Detected Background (mg/kg)	EPA Region III Industrial RBC (mg/kg)	EPA Region III Residential RBC (mg/kg)	Number Exceeding 2 X Average Detected Background	Range Exceeding 2 X Average Detected Background	Number Exceeding EPA Region III Industrial RBC	Range Exceeding EPA Region III Industrial RBC	Number Exceeding EPA Region III Residential RBC	Range Exceeding EPA Region III Residential RBC	Location Maximum Detect
RCRA Metals (mg/kg)										
Arsenic	1.26	3.82	0.426	2/20	2.4J-5J	1/20	5J	6/20	0.44J-5J	9TP08-04
Barium	131	143,080	5,475	2/20	156J-240J	0/20		0/20		9TP09A-02
Cadmium	0.20	2,044	78.21	6/20	0.99-1.6	0/20		0/20		9TP07A-02/ 9TP09A-02
Chromium	26.9	6,100 (1)	230 (1)	2/20	28.9-50.8J	0/20		0/20		9TP07-04
Lead	4.79	400 (2)	400 (2)	3/20	5.9J-19.3J	0/20		0/20		9TP10-04
Mercury	0.013	NE	NE	1/20	0.1	NE		NE		9MW02S-05
Selenium	2.55	10,220	391	0/20		0/20		0/20		9MW02S-05
Silver	ND	10,220	391	10/20	0.07J-0.67	0/20		0/20		9MW01-15

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.
R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:

ft - feet
bgs - below ground surface.
NE - Not established.
ND - Not detected.
mg/kg - milligrams per kilogram.
(1) The RBC for Chromium VI was used for screening because there is not a total chromium RBC available.
(2) 1996 EPA Soil Screening Guidance.

TABLE 5-13

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/L)	EPA Region III Tap Water RBC (ug/L)	13GW01 03/24/96	13GW02 03/24/96	13GW03 03/24/96	9MW01 4/15/96	9MW02 04/16/96	9GW02R 09/30/97	9GW02S 09/30/97	9GW02N 09/30/97	9-02R-GW03 06/27/99	9-A02-HP02 06/27/99
Volatiles (ug/L)												
Benzene	5	0.36	500 U	130	5 U	5 U	1,600 J	NA	NA	NA	NA	NA
Ethylbenzene	700	1,340	500 U	160	5 U	5 U	27	NA	NA	NA	NA	NA
Methylene chloride	5	4.10	500 U	5 U	5 U	5 U	7	NA	NA	NA	NA	NA
Toluene	1,000	747	500 U	5 U	5 U	5 U	180 J	NA	NA	NA	NA	NA
Xylene (total)	10,000	12,167	500 U	28	5 U	5 U	82	NA	NA	NA	NA	NA
Semivolatiles (ug/L)												
2-Methylnaphthalene	NE	122	11 U	23 J	10 UJ	10 U	10 U	NA	NA	NA	NA	NA
Acetophenone	NE	0.042	11 U	11 U	10 U	1 J	10 U	NA	NA	NA	NA	NA
Benzoic acid	NE	146,000	53 U	56 U	50 U	19 J	50 U	NA	NA	NA	NA	NA
Benzyl alcohol	NE	10,950	11 UJ	11 U	10 U	10 U	3 J	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	6	4.78	5 J	5 J	4 J	10 U	3 J	NA	NA	NA	NA	NA
Dimethylphthalate	NE	365,000	11 U	11 U	10 U	2 J	10 U	NA	NA	NA	NA	NA
Naphthalene	NE	6.5	11 U	26	10 U	10 U	10 U	NA	NA	NA	NA	NA
PCBS (ug/L)												
Not Detected												
BTEX (ug/L)												
Benzene	5	0.36	NA	NA	NA	NA	NA	4,900	1.7	1 U	230	8.7
Ethylbenzene	700	1,340	NA	NA	NA	NA	NA	220	0.52 J	1 U	6.9	110
Toluene	1,000	747	NA	NA	NA	NA	NA	4,100	3 U	1 U	240	5 U
Xylene (total)	10,000	12,167	NA	NA	NA	NA	NA	840	2.4	1 U	8.7 J	25
TPH (ug/L)												
Diesel Range Organics	NE	NE	140 UJ	2,300 J	120 UJ	120 U	130 U	1,700	130 U	140 U	NA	NA
Gasoline Range Organics	NE	NE	750 U	9,000	100 J	30 U	770	15,000	50 U	50 U	NA	NA

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ- Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

NA - Not analyzed.
NE - Not Established.
ug/L - micrograms per liter.

TABLE 5-13 (continued)

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	EPA Region III Federal MCL (ug/L)	EPA Region III Tap Water RBC (ug/L)	Number Exceeding Federal MCL	Range Exceeding Federal MCL	Number Exceeding EPA Region III Tap Water RBC	Range Exceeding EPA Region III Tap Water RBC	Location Maximum Detect
Volatiles (ug/L)							
Benzene	5	0.36	2/5	130-1,600J	2/5	130-1,600J	9MW02
Ethylbenzene	700	1,340	0/5		0/5		13GW02
Methylene chloride	5	4.10	1/5	7	1/5	7	9MW02
Toluene	1,000	747	0/5		0/5		9MW02
Xylene (total)	10,000	12,167	0/5		0/5		9MW02
Semivolatiles (ug/L)							
2-Methylnaphthalene	NE	122	NE		0/5		13GW02
Acetophenone	NE	0.042	NE		1/5	1J	9MW01
Benzoic acid	NE	146,000	NE		0/5		9MW01
Benzyl alcohol	NE	10,950	NE		0/5		9MW02
Bis(2-ethylhexyl)phthalate	6	4.78	0/5		2/5	5J	13GW01,13GW02
Dimethylphthalate	NE	365,000	NE		0/5		9MW01
Naphthalene	NE	6.5	NE		1/5	26	13GW02
PCBS (ug/L)							
Not Detected							
BTEX (ug/L)							
Benzene	5	0.36	3/5	8.7-4,900	4/5	1.7-4,900	9GW02R
Ethylbenzene	700	1,340	0/5		0/5		9GW02R
Toluene	1,000	747	1/5	4,100	1/5	4,100	9GW02R
Xylene (total)	10,000	12,167	0/5		0/5		9GW02R
TPH (ug/L)							
Diesel Range Organics	NE	NE	NE		NE		13GW02
Gasoline Range Organics	NE	NE	NE		NE		9GW02R

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ- Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

NA - Not analyzed.

NE - Not Established.

ug/L - micrograms per liter.

TABLE 5-14

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER - AREA A
ONSITE LABORATORY
SWMU 9 (TANKS 212-213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID	13-GW02	9-A02-HP01	9-A02-HP01D	9-A02-HP02	9-A02-HP03	9-A02-HP03D	9-A02-HP04	9-A02-HP05
Sample Date	6/28/99	6/26/99	6/26/99	6/27/99	6/26/99	6/26/99	6/26/99	6/26/99
Volatiles (ug/L)								
Benzene	1,900	2,800	2,200	7,400	ND	ND	ND	37
Toluene	570	2,500	2,900	3,400	ND	ND	ND	52
Ethylbenzene	ND	27	1,400	ND	ND	ND	ND	8.0
Total Xylenes	ND	250	430	670	ND	ND	ND	160
TPH (mg/L)								
Diesel Range Organics	NA	NA	NA	NA	ND	ND	ND	ND
Gasoline Range Organics	NA	NA	NA	NA	ND	ND	ND	ND

Notes:

NA - Not Analyzed.
ND - Not Detected.
ug/L - micrograms per liter.
mg/L - milligrams per liter.

TABLE 5-14 (continued)

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER - AREA A
ONSITE LABORATORY
SWMU 9 (TANKS 212-213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID	9-A02-HP05D	9-MW02R	9-A02R-GW01	9-A02R-GW02	9-02R-GW03	9-02R-GW04	9-02R-GW05	9-02R-GW06
Sample Date	6/26/99	6/28/99	6/23/99	6/23/99	6/23/99	6/23/99	6/23/99	6/23/99
Volatiles (ug/L)								
Benzene	32	8,300	61	12,000	2,100	ND	ND	ND
Toluene	36	ND	ND	7,200	2,300	ND	ND	ND
Ethylbenzene	6.0	ND	ND	280	ND	ND	ND	ND
Total Xylenes	150	ND	ND	2,200	ND	ND	ND	ND
TPH (mg/L)								
Diesel Range Organics	ND	NA	NA	NA	NA	NA	NA	ND
Gasoline Range Organics	ND	NA	NA	NA	NA	NA	NA	ND

Notes:

NA - Not Analyzed.
ND - Not Detected.
ug/L - micrograms per liter.
mg/L - milligrams per liter.

TABLE 5-14 (continued)

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER - AREA A
ONSITE LABORATORY
SWMU 9 (TANKS 212-213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID	9-02R-GW07	9-A02R-HP08	9-A02R-GW09	9-02R-HP10	9-02R-HP10D	9-02R-HP11	9-02R-HP12
Sample Date	6/23/99	6/23/99	6/23/99	6/23/99	6/23/99	6/23/99	6/23/99
Volatiles (ug/L)							
Benzene	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	6	ND	ND	ND	ND
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND
Total Xylenes	ND	ND	ND	ND	ND	ND	ND
TPH (mg/L)							
Diesel Range Organics	NA	NA	NA	ND	ND	ND	ND
Gasoline Range Organics	NA	NA	NA	ND	ND	ND	ND

Notes:

NA - Not Analyzed.
ND - Not Detected.
ug/L - micrograms per liter.
mg/L - milligrams per liter.

TABLE 5-15

SUMMARY OF INORGANIC (TOTAL) DETECTIONS IN GROUNDWATER - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	2 X Average Detected Background (ug/L)	Federal MCL (ug/L)	EPA Region III Tap Water RBC (ug/L)	9MW01 4/15/96	9MW02 4/16/96	9GW02N 09/30/97	9GW02R 09/30/97	9GW02S 09/30/97
RCRA Metals (ug/L)								
Arsenic, Total	19.7	50	0.045	6 U	6 U	14.1	2.5 U	29.2 J
Barium, Total	1,561	2,000	2,555	264	353	325	207	571 J
Cadmium, Total	46.1	5	18.3	**12.9**	**29**	3.5 J	4.3 J	**8.9** J
Chromium, Total	80.6	100	110 (1)	2.6 U	11.2 J	39.4	7.3 J	**193**
Lead, Total	22.3	15 (2)	NE	1.7 R	5.5 R	1.9 J	4.5	10.4 J
Mercury, Total	0.25	2.0	NE	0.1 UJ	0.33 J	0.1 U	0.1 U	0.1 U
Selenium, Total	39.8	50	183	28 R	28 R	11 U	8.8	11 U
Silver, Total	22.1	NE	183	4 U	4 U	1.5 J	2.6 J	3 U

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.
R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:

NE - Not established.
ug/L - micrograms per liter.
(1) The RBC for Chromium VI was used for screening because there is not total a chromium RBC available.
(2) EPA Action Level for Lead (www.epa.gov/ogwdw/wot.appa.html) November 1999.

TABLE 5-15 (continued)

SUMMARY OF INORGANIC (TOTAL) DETECTIONS IN GROUNDWATER - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	2 X Average Detected Background (ug/L)	**Federal MCL** (ug/L)	EPA Region III Tap Water RBC (ug/L)	Number Exceeding 2 X Average Detected Background	Range Exceeding 2 X Average Detected Background	**Number Exceeding Federal MCL**	**Range Exceeding Federal MCL**	Number Exceeding EPA Region III Tap Water RBC	Range Exceeding EPA Region III Tap Water RBC	Location Maximum Detect
RCRA Metals (ug/L)										
Arsenic, Total	19.7	50	0.045	1/5	29.2J	0/5		2/5	14.1-29.2J	9GW02S
Barium, Total	1,561	2,000	2,555	0/5		0/5		0/5		9GW02S
Cadmium, Total	46.1	5	18.3	0/5		3/5	8.9J-29	1/5	29	9MW02
Chromium, Total	80.6	100	110 [(1)]	1/5	193	1/5	193	1/5	193	9GW02S
Lead, Total	22.3	15 [(2)]	NE	0/5		0/5		NE		9GW02S
Mercury, Total	0.25	2.0	NE	1/5	0.33J	0/5		NE		9MW02
Selenium, Total	39.8	50	183	0/5		0/5		0/5		9GW02R
Silver, Total	22.1	NE	183	0/5		NE		0/5		9GW02R

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.
R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:

NE - Not established.
ug/L - micrograms per liter.
[(1)] The RBC for Chromium VI was used for screening because there is not total a chromium RBC available.
[(2)] EPA Action Level for Lead (www.epa.gov/ogwdw/wot.appa.html) November 1999.

TABLE 5-16

SUMMARY OF INORGANIC (DISSOLVED) DETECTIONS IN GROUNDWATER - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	2 X Average Detected Background (ug/L)	Federal MCL (ug/L)	EPA Region III Tap Water RBC (ug/L)	9MW01 4/15/96	9MW02 4/16/96	9GW02N 09/30/97	9GW02R 09/30/97	9GW02S 09/30/97
RCRA Metals (ug/L)								
Arsenic, Soluble	18.9	50	0.045	6 U	6 U	2.5 U	2.5 U	12.8 J
Barium, Soluble	414	2,000	2,555	241	277	158 J	170 J	304 J
Cadmium, Soluble	35.4	5.0	18.3	**6.3**	**30.4**	2.9 J	**5.5**	**14** J
Chromium, Soluble	6.93	100	110 (1)	2.6 U	2.6 U	0.7 U	3.2 J	3.5 U
Lead, Soluble	1.20	15 (2)	NE	1.2 UJ	2.9 R	7.5 U	1.9 J	7.5 U
Mercury, Soluble	0.29	2.0	NE	0.1 UJ	0.31 J	0.1 U	0.1 U	0.1 U
Selenium, Soluble	36.0	50.0	183	28 R	28 R	2.9 J	8.5	11 U
Silver, Soluble	3.47	NE	183	4 U	4 U	0.8 J	2.5 J	3 U

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:

NE - Not established.

ug/L - micrograms per liter.

(1) The RBC for Chromium VI was used for screening because there is not total a chromium RBC available.

(2) EPA Action Level for Lead (www.epa.gov/ogwdw/wot.appa.html) November 1999.

TABLE 5-16 (continued)

SUMMARY OF INORGANIC (DISSOLVED) DETECTIONS IN GROUNDWATER - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	2 X Average Detected Background (ug/L)	Federal MCL (ug/L)	EPA Region III Tap Water RBC (ug/L)	Number Exceeding 2 X Average Detected Background	Range Exceeding 2 X Average Detected Background	Number Exceeding Federal MCL	Range Exceeding Federal MCL	Number Exceeding EPA Region III Tap Water RBC	Range Exceeding EPA Region III Tap Water RBC	Location Maximum Detect
RCRA Metals (ug/L)										
Arsenic, Soluble	18.9	50	0.045	0/5		0/5		1/5	12.8J	9GW02S
Barium, Soluble	414	2,000	2,555	0/5		0/5		0/5		9GW02S
Cadmium, Soluble	35.4	5.0	18.3	0/5		4/5	5.5-30.4	1/5	30.4	9MW02
Chromium, Soluble	6.93	100	110 (1)	0/5		0/5		0/5		9GW02R
Lead, Soluble	1.20	15 (2)	NE	1/5	1.9J	0/5		NE		9GW02R
Mercury, Soluble	0.29	2.0	NE	1/5	0.31J	0/5		NE		9MW02
Selenium, Soluble	36.0	50.0	183	0/5		0/5		0/5		9GW02R
Silver, Soluble	3.47	NE	183	0/5		NE		0/5		9GW02R

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.
R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:

NE - Not established.
ug/L - micrograms per liter.
(1) The RBC for Chromium VI was used for screening because there is not total a chromium RBC available.
(2) EPA Action Level for Lead (www.epa.gov/ogwdw/wot.appa.html) November 1999.

TABLE 5-17

SUMMARY OF WATER QUALITY DETECTIONS IN GROUNDWATER - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (mg/L)	Secondary MCL (mg/L)	EPA Region III Tap Water RBC (mg/L)	13GW02 06/28/99	9-MW02R 06/29/99
Water Quality					
Alkalinity (as CaCO3) (mg/L)	NE	NE	NE	295	2,070
Aluminum (mg/L)	NE	0.05	36.5	**0.59** J	**9.22** J
Chloride (mg/L)	NE	250	NE	**500**	**3,000**
Color (PCU)	NE	15	NE	**100**	**100**
Copper (mg/L)	1.3 (1)	1	1.46	0.014 B	0.0311
Fluoride (mg/L)	4	2	NE	1.5	0.2 U
Iron (mg/L)	NE	0.3	10.95	**8.18**	**37.4**
Manganese (mg/L)	NE	0.05	0.73	**1.33**	**26.3**
Odor (TON)	NE	3	NE	**16**	2
Salinity (ppt)	NE	NE	NE	2.0 U	4.1
Silver (mg/L)	NE	0.1	0.18	0.0006 U	0.00064 B
Sulfate (mg/L)	500	250	NE	5 U	120
Total Dissolved Solids (mg/L)	NE	500	NE	**2,000**	**6,600**
Zinc (mg/L)	NE	5	10.95	0.0082 B	0.126

Data Qualifiers:

B - Not detected substantially above the level reported in laboratory or field blanks.

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:

NA - Not analyzed.

NE - Not Established.

PCU - primary color units.

ppt - parts per trillion.

TON - threshold odor number.

mg/L - milligrams per liter.

(1) EPA Action Level for Copper (www.epa.gov/ogwdw/wot.appa.html) November 1999.

TABLE 5-17 (continued)

SUMMARY OF WATER QUALITY DETECTIONS IN GROUNDWATER - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (mg/L)	Secondary MCL (mg/L)	EPA Region III Tap Water RBC (mg/L)	Number Exceeding Federal MCL	Range Exceeding Federal MCL	Number Exceeding Secondary MCL	Range Exceeding Secondary MCL	Number Exceeding EPA Region III Tap Water RBC	Range Exceeding EPA Region III Tap Water RBC	Location Maximum Detect
Water Quality										
Alkalinity (as CaCO3) (mg/L)	NE	NE	NE	NE		NE		NE		9-MW02R
Aluminum (mg/L)	NE	0.05	36.5	NE		2/2	0.59 J - 9.22 J	0/2		9-MW02R
Chloride (mg/L)	NE	250	NE	NE		2/2	500 - 3,000	NE		9-MW02R
Color (PCU)	NE	15	NE	NE		2/2	100 - 100	NE		13GW02, 9-MW02R
Copper (mg/L)	1.3 (1)	1	1.46	0/2		0/2		0/2		9-MW02R
Fluoride (mg/L)	4	2	NE	0/2		0/2		NE		13GW02
Iron (mg/L)	NE	0.3	10.95	NE		2/2	8.18 - 37.4	1/2	37.4	9-MW02R
Manganese (mg/L)	NE	0.05	0.73	NE		2/2	1.33 - 26.3	2/2	1.33-26.3	9-MW02R
Odor (TON)	NE	3	NE	NE		1/2	16	NE		13GW02
Salinity (ppt)	NE	NE	NE	NE		NE		NE		9-MW02R
Silver (mg/L)	NE	0.1	0.18	NE		0/2		0/2		9-MW02R
Sulfate (mg/L)	500	250	NE	0/2		0/2		NE		9-MW02R
Total Dissolved Solids (mg/L)	NE	500	NE	NE		2/2	2,000 - 6,600	NE		9-MW02R
Zinc (mg/L)	NE	5	10.95	NE		0/2		0/2		9-MW02R

Data Qualifiers:

B - Not detected substantially above the level reported in laboratory or field blanks.

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:

NA - Not analyzed.

NE - Not Established.

PCU - primary color units.

ppt - parts per trillion.

TON - threshold odor number.

mg/L - milligrams per liter.

(1) EPA Action Level for Copper (www.epa.gov/ogwdw/wot.appa.html)

November 199o

TABLE 5-18

SUMMARY OF INORGANIC (TOTAL) DETECTIONS IN SURFACE WATER - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	2 X Average Detected Background (ug/L)	NAWQC CMC (ug/L)	NAWQC CCC (ug/L)	9SW02 06/29/99
Inorganics (ug/L)				
Arsenic, Total	70.2	69	36	38.3 J
Barium, Total	112	NE	NE	50.5
Cadmium, Total	ND	42.3	9.4	0.7 J
Cobalt, Total	6.4	NE	NE	0.96 J
Selenium, Total	ND	291	71.1	22.3 J
Tin, Total	5.4	NE	NE	2.7 J
Vanadium, Total	96.8	NE	NE	88.5
Zinc, Total	23.8	95.1	85.6	6.3 J

Data Qualifier:

J - Analyte present. Reported value may not be accurate or precise.

Notes:

ND - Not detected.
NE - Not established.
CCC - Criteria Continuous Concentration.
CMC - Criteria Maximum Concentration.
NAWQC - National Ambient Water Quality Criteria.
ug/L - micrograms per liter.

TABLE 5-18 (continued)

SUMMARY OF INORGANIC (TOTAL) DETECTIONS IN SURFACE WATER - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	2 X Average Detected Background (ug/L)	NAWQC CMC (ug/L)	NAWQC CCC (ug/L)	Number Exceeding 2 X Average Detected Background	Range Exceeding 2 X Average Detected Background	Number Exceeding NAWQC CMC	Range Exceeding NAWQC CMC	Number Exceeding NAWQC CCC	Range Exceeding NAWQC CCC	Location Maximum detect
Inorganics (ug/L)										
Arsenic, Total	70.2	69	36	0/1		0/1		1/1	38.3	9SW02
Barium, Total	112	NE	NE	0/1		NE		NE		9SW02
Cadmium, Total	ND	42.3	9.4	1/1	0.7J	0/1		0/1		9SW02
Cobalt, Total	6.4	NE	NE	0/1		NE		NE		9SW02
Selenium, Total	ND	291	71.1	1/1	22.3J	0/1		0/1		9SW02
Tin, Total	5.4	NE	NE	0/1		NE		NE		9SW02
Vanadium, Total	96.8	NE	NE	0/1		NE		NE		9SW02
Zinc, Total	23.8	95.1	85.6	0/1		NE		0/1		9SW02

Data Qualifier:

J - Analyte present. Reported value may not be accurate or precise.

Notes:

ND - Not detected.
NE - Not established.
CCC - Criteria Continuous Concentration.
CMC - Criteria Maximum Concentration.
NAWQC - National Ambient Water Quality Criteria.
ug/L - micrograms per liter.

TABLE 5-19

SUMMARY OF ORGANIC DETECTIONS IN SEDIMENT - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID	FDEP Sediment PEL (ug/kg)	FDEP Sediment TEL (ug/kg)	9SD02
Sample Date			06/29/99
Depth Range (ft bgs)			0.00-0.50
Volatiles (ug/kg)			
Acetone	NE	NE	130 J
Semivolatiles (ug/kg)			
Not Detected			

Data Qualifier:

J - Analyte present. Reported value may not be accurate or precise.

Notes:

ft - feet
bgs - below ground surface.
FDEP - Florida Department of Environmental Protection.
PEL - Probable Effects Level.
TEL - Threshold Effects Level.
ug/kg - micrograms per kilogram.

TABLE 5-19 (continued)

SUMMARY OF ORGANIC DETECTIONS IN SEDIMENT - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	FDEP Sediment PEL (ug/kg)	FDEP Sediment TEL (ug/kg)	Number Exceeding FDEP Sediment PEL	Range Exceeding FDEP Sediment PEL	Number Exceeding FDEP Sediment TEL	Range Exceeding FDEP Sediment TEL	Location Maximum Detect
Volatiles (ug/kg)							
Acetone	NE	NE	NE		NE		9SD02
Semivolatiles (ug/kg)							
Not Detected							

Data Qualifier:

J - Analyte present. Reported value may not be accurate or precise.

Notes:

ft - feet
bgs - below ground surface.
FDEP - Florida Department of Environmental Protection.
PEL - Probable Effects Level.
TEL - Threshold Effects Level.
ug/kg - micrograms per kilogram.

TABLE 5-20

SUMMARY OF INORGANIC DETECTIONS IN SEDIMENT - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	2 X Average Detected Background (mg/kg)	FDEP Sediment PEL (mg/kg)	FDEP Sediment TEL (mg/kg)	9SD02 06/29/99 0.00-0.50
Inorganics (mg/kg)				
Arsenic	2.6	41.6	7.24	1.8 J
Barium	16.2	NE	NE	14
Beryllium	0.094	NE	NE	0.29 J
Chromium	32	160	52.3	21
Cobalt	9.4	NE	NE	6.9
Copper	116	108	18.7	63 J
Lead	9.2	112	30.2	12 J
Mercury	0.082	0.696	0.13	0.078 J
Nickel	9.6	42.8	15.9	6.6 J
Tin	8.4	NE	NE	4.3 J
Vanadium	220	NE	NE	180
Zinc	ND	271	124	64 J

Data Qualifier:

J - Analyte present. Reported value may not be accurate or precise.

Notes:

ft - feet
bgs - below ground surface.
FDEP - Florida Department of Environmental Protection.
PEL - Probable Effects Level.
TEL - Threshold Effects Level.
NE - Not established.
mg/kg - milligrams per kilogram.

TABLE 5-20 (continued)

SUMMARY OF INORGANIC DETECTIONS IN SEDIMENT - AREA A
SWMU 09 (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	2 X Average Detected Background (mg/kg)	**FDEP Sediment PEL** (mg/kg)	FDEP Sediment TEL (mg/kg)	Number Exceeding 2 X Average Detected Background	Range Exceeding 2 X Average Detected Background	**Number Exceeding FDEP Sediment PEL**	**Range Exceeding FDEP Sediment PEL**	Number Exceeding FDEP Sediment TEL	Range Exceeding FDEP Sediment TEL	Location Maximum Detect
Inorganics (mg/kg)										
Arsenic	2.6	41.6	7.24	0/1		0/1		0/1		9SD02
Barium	16.2	NE	NE	0/1		NE		NE		9SD02
Beryllium	0.094	NE	NE	1/1	0.29J	NE		NE		9SD02
Chromium	32	160	52.3	0/1		0/1		0/1		9SD02
Cobalt	9.4	NE	NE	0/1		NE		NE		9SD02
Copper	116	108	18.7	0/1		0/1		1/1	63J	9SD02
Lead	9.2	112	30.2	1/1	12J	0/1		0/1		9SD02
Mercury	0.082	0.696	0.13	0/1		0/1		0/1		9SD02
Nickel	9.6	42.8	15.9	0/1		0/1		0/1		9SD02
Tin	8.4	NE	NE	0/1		NE		NE		9SD02
Vanadium	220	NE	NE	0/1		NE		NE		9SD02
Zinc	ND	271	124	1/1	64J	0/1		0/1		9SD02

Data Qualifier:
J - Analyte present. Reported value may not be accurate or precise.

Notes:
ft - feet
bgs - below ground surface.
FDEP - Florida Department of Environmental Protection.
PEL - Probable Effects Level.
TEL - Threshold Effects Level.
NE - Not established.
mg/kg - milligrams per kilogram.

TABLE 5-21

SUMMARY OF ORGANIC DETECTIONS IN SURFACE SOIL - AREA B
SWMU 09 (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	EPA Region III Industrial RBC (ug/kg)	**EPA Region III Residential RBC (ug/kg)**	9SS03 03/20/96 0.00-1.00	9SS04 03/20/96 0.00-1.00	9MW03-00 03/20/96 0.00-1.00	Number Exceeding EPA Region III Industrial RBC	Range Exceeding EPA Region III Industrial RBC	**Number Exceeding EPA Region III Residential RBC**	**Range Exceeding EPA Region III Residential RBC**	Location Maximum Detect
Volatiles (ug/kg)										
Acetone	204,400,000	7,821,429	22 J	11 UJ	14 J	0/3		0/3		9SS03
Semivolatiles (ug/kg)										
Di-n-butylphthalate	204,400,000	7,821,429	40 J	360 U	350 U	0/3		0/3		9SS03
TPH (ug/kg)										
Not Detected										

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected, quantitation limit may be inaccurate or imprecise.

Notes:
ft bgs - feet below ground surface
ug/kg - micrograms per kilogram.

TABLE 5-22

SUMMARY OF INORGANIC DETECTIONS IN SURFACE SOIL - AREA B
SWMU 09 (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	2 X Average Detected Background (mg/kg)	EPA Region III Industrial RBC (mg/kg)	EPA Region III Residential RBC (mg/kg)	9SS03 03/20/96 0.00-1.00	9SS04 03/20/96 0.00-1.00	9MW03-00 03/20/96 0.00-1.00
RCRA Metals (mg/kg)						
Arsenic	3.72	3.8	0.43	2	1.7 J	1.3
Barium	153	143,080	5,475	115	84.7	56.5
Cadmium	0.48	2,044	78.2	0.2 U	0.22 U	0.42
Chromium	39.0	6,100 (1)	230 (1)	9.3 J	9.5 J	13.2 J
Lead	21.1	400 (2)	400 (2)	30	258	15.1
Selenium	ND	10,220	391	1.1 J	0.88 UJ	0.62 J

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected, quantitation limit may be inaccurate or imprecise.

Notes:
ND - Not detected.
NE - Not established.
mg/kg - milligrams per kilogram.
ft - feet below ground surface
(1) The RBC for Chromium VI was used for screening because there is not a total chromium RBC available.
(2) 1996 EPA Soil Screening Guidance.

TABLE 5-22 (continued)

SUMMARY OF INORGANIC DETECTIONS IN SURFACE SOIL - AREA B
SWMU 09 (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	2 X Average Detected Background (mg/kg)	EPA Region III Industrial RBC (mg/kg)	EPA Region III Residential RBC (mg/kg)	Number Exceeding 2 X Average Detected Background	Range Exceeding 2 X Average Detected Background	Number Exceeding EPA Region III Industrial RBC	Range Exceeding EPA Region III Industrial RBC	Number Exceeding EPA Region III Residential RBC	Range Exceeding EPA Region III Residential RBC	Location Maximum Detect
RCRA Metals (mg/kg)										
Arsenic	3.72	3.8	0.43	0/3		0/3		3/3	1.3-2	9SS03
Barium	153	143,080	5,475	0/3		0/3		0/3		9SS03
Cadmium	0.48	2,044	78.2	0/3		0/3		0/3		9MW03-00
Chromium	39.0	6,100 (1)	230 (1)	0/3		0/3		0/3		9MW03-00
Lead	21.1	400 (2)	400 (2)	2/3	30-258	0/3		0/3		9SS04
Selenium	ND	10,220	391	2/3	0.62J-1.1J	0/3		0/3		9SS03

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected, quantitation limit may be inaccurate or imprecise.

Notes:
ND - Not detected.
NE - Not established.
mg/kg - milligrams per kilogram.
ft - feet below ground surface
(1) The RBC for Chromium VI was used for screening because there is not a total chromium RBC available.
(2) 1996 EPA Soil Screening Guidance.

TABLE 5-23

SUMMARY OF ORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA B
SWMU 09 (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	EPA Region III Industrial RBC (ug/kg)	EPA Region III Residential RBC (ug/kg)	9MW03-04 04/15/96 8.00-10.00	9MW03-09 04/15/96 18.00-20.00	9TP02-06 04/01/96 11.50-12.00	9TP03-03 04/06/96 7.00	9TP04-04 04/06/96 9.00	9TP05-04 04/06/96 12.00	9TP06-04 04/06/96 9.00
Volatiles (ug/kg)									
Not Detected									
Semivolatiles (ug/kg)									
Butylbenzylphthalate	408,800,000	15,642,857	460 U	440 U	540 U	400 U	400 U	410 U	68 J
Di-n-butylphthalate	204,400,000	7,821,428	460 U	440 U	540 U	400 U	400 U	410 U	800
TPH (ug/kg)									
Gasoline Range Organics	100,000 (1)	100,000 (1)	42 U	40 U	6,400	37 U	37 U	38 U	44 U
Diesel Range Organics	100,000 (1)	100,000 (1)	5,700 U	5,500 U	6,800 U	5,100 U	5,000 U	15,000	6,100 U
BTEX (ug/kg)									
Not Detected									

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:

NA - Not analyzed.

NE - Not established.

ug/kg - micrograms per kilogram.

ft bgs - feet below ground surface

(1) - Puerto Rico Environmental Quality Board Criteria

TABLE 5-23 (continued)

SUMMARY OF ORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA B
SWMU 09 (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	EPA Region III Industrial RBC (ug/kg)	**EPA Region III Residential RBC** (ug/kg)	9TP01A-01 10/01/97 8.00-10.00	9TP01A-02 10/01/97 8.00-10.00	9TP02A-01 10/01/97 8.00-10.00	9TP02A-02 10/01/97 8.00-10.00	9-B06HP04-01 06/25/99 12.00-14.00	9-B06HP04-02 06/25/99 16.00-17.00
Volatiles (ug/kg)								
Not Detected								
Semivolatiles (ug/kg)								
Butylbenzylphthalate	408,800,000	15,642,857	NA	NA	NA	NA	NA	NA
Di-n-butylphthalate	204,400,000	7,821,428	NA	NA	NA	NA	NA	NA
TPH (ug/kg)								
Gasoline Range Organics	100,000 (1)	100,000 (1)	63 U	66 U	87 U	76 U	NA	NA
Diesel Range Organics	100,000 (1)	100,000 (1)	7,600 U	8,100 U	10,000 U	9,200 U	NA	NA
BTEX (ug/kg)								
Not Detected								

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:

NA - Not analyzed.

NE - Not established.

ug/kg - micrograms per kilogram.

ft bgs - feet below ground surface

(1) - Puerto Rico Environmental Quality Board Criteria

TABLE 5-23 (continued)

SUMMARY OF ORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA B
SWMU 09 (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	EPA Region III Industrial RBC (ug/kg)	EPA Region III Residential RBC (ug/kg)	Number Exceeding EPA Region III Industrial RBC	Range Exceeding EPA Region III Industrial RBC	Number Exceeding EPA Region III Residential RBC	Range Exceeding EPA Region III Residential RBC	Location Maximum Detect
Volatiles (ug/kg)							
Not Detected							
Semivolatiles (ug/kg)							
Butylbenzylphthalate	408,800,000	15,642,857	0/7		0/7		9TP06-04
Di-n-butylphthalate	204,400,000	7,821,428	0/7		0/7		9TP06-04
TPH (ug/kg)							
Gasoline Range Organics	100,000 (1)	100,000 (1)	0/11		0/11		9TP02-06
Diesel Range Organics	100,000 (1)	100,000 (1)	0/11		0/11		9TP05-04
BTEX (ug/kg)							
Not Detected							

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:

NA - Not analyzed.

NE - Not established.

ug/kg - micrograms per kilogram.

ft bgs - feet below ground surface

(1) - Puerto Rico Environmental Quality Board Criteria

TABLE 5-24

SUMMARY OF INORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA B
SWMU 09 (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	2 X Average Detected Background (mg/kg)	**EPA Region III Industrial RBC (mg/kg)**	EPA Region III Residential RBC (mg/kg)	9MW03-04 04/15/96 8.00-10.00	9MW03-09 04/15/96 18.00-20.00	9TP02-06 04/01/96 11.50-12.00	9TP03-03 04/06/96 7.00	9TP04-04 04/06/96 9.00
RCRA Metals (mg/kg)								
Arsenic	1.26	3.8	0.43	0.6 U	0.13 UJ	1.5	2 J	0.27 J
Barium	131	143,080	5,475	40.4	24	52.4 J	18.8	43
Cadmium	0.197	2,044	78.2	0.33 U	0.3 U	0.37 U	0.27 U	0.29 U
Chromium	26.9	6,100 (1)	230 (1)	7.1	8.3	11 J	5.1 J	3.4 J
Lead	4.79	400 (2)	400 (2)	0.77	0.54	4	34.2 J	0.28 J
Selenium	2.55	10,220	391	0.14 UJ	0.16 UJ	0.79 J	0.29 UJ	0.16 UJ
Silver	ND	10,220	391	0.46 U	1.1	0.52 U	0.37 U	0.41 U

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected, quantitation limit may be inaccurate or imprecise.

Notes:

ft bgs - feet below ground surface

ND - Not detected.

NE - Not established.

mg/kg - milligrams per kilogram.

(1) The RBC for Chromium VI was used for screening because there is not a total chromium RBC available.

(2) 1996 EPA Soil Screening Guidance.

TABLE 5-24 (continued)

SUMMARY OF INORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA B
SWMU 09 (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	2 X Average Detected Background (mg/kg)	**EPA Region III Industrial RBC** (mg/kg)	EPA Region III Residential RBC (mg/kg)	9TP05-04 04/06/96 12.00	9TP06-04 04/06/96 9.00	9TP01A-01 10/01/97 8.00-10.00	9TP01A-02 10/01/97 8.00-10.00	9TP02A-01 10/01/97 8.00-10.00	9TP02A-02 10/01/97 8.00-10.00
RCRA Metals (mg/kg)									
Arsenic	1.26	3.8	0.43	0.1 UJ	0.45 J	1.2 J	1 J	0.69 J	0.34 UJ
Barium	131	143,080	5,475	28.2	85.6	130 J	182 J	143 J	69.8 UJ
Cadmium	0.197	2,044	78.2	0.29 U	0.33 U	1.7	2.3	0.83	1.3
Chromium	26.9	6,100 (1)	230 (1)	3 J	5.6 J	9.9 J	14.4 J	7 J	5.7 J
Lead	4.79	400 (2)	400 (2)	1.5 J	0.61 J	2	0.17 U	0.54	0.21 U
Selenium	2.55	10,220	391	0.16 UJ	0.29 J	2 J	0.49 J	1.2 J	1.1 J
Silver	ND	10,220	391	0.4 U	0.46 U	0.21 J	0.25 J	0.11 U	0.12 J

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected, quantitation limit may be inaccurate or imprecise.

Notes:

ft bgs - feet below ground surface
ND - Not detected.
NE - Not established.
mg/kg - milligrams per kilogram.
(1) The RBC for Chromium VI was used for screening because there is not a total chromium RBC available.
(2) 1996 EPA Soil Screening Guidance.

TABLE 5-24 (continued)

SUMMARY OF INORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA B
SWMU 09 (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	2 X Average Detected Background (mg/kg)	EPA Region III Industrial RBC (mg/kg)	EPA Region III Residential RBC (mg/kg)	Number Exceeding 2 X Average Detected Background	Range Exceeding 2 X Average Detected Background	Number Exceeding EPA Region III Industrial RBC	Range Exceeding EPA Region III Industrial RBC	Number Exceeding EPA Region III Residential RBC	Range Exceeding EPA Region III Residential RBC	Location Maximum Detect
RCRA Metals (mg/kg)										
Arsenic	1.26	3.8	0.43	2/11	1.5 - 2 J	0/11		6/11	0.45J-2J	9TP03-03
Barium	131	143,080	5,475	2/11	143 J - 182 J	0/11		0/11		9TP01A-02
Cadmium	0.197	2,044	78.2	4/11	0.83-2.3	0/11		0/11		9TP01A-02
Chromium	26.9	6,100 (1)	230 (1)	0/11		0/11		0/11		9TP01A-02
Lead	4.79	400 (2)	400 (2)	1/11	34.2J	0/11		0/11		9TP03-03
Selenium	2.55	10,220	391	0/11		0/11		0/11		9TP01A-01
Silver	ND	10,220	391	4/11	0.12J-1.1	0/11		0/11		9MW03-09

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected, quantitation limit may be inaccurate or imprecise.

Notes:

ft bgs - feet below ground surface
ND - Not detected.
NE - Not established.
mg/kg - milligrams per kilogram.
(1) The RBC for Chromium VI was used for screening because there is not a total chromium RBC available.
(2) 1996 EPA Soil Screening Guidance.

TABLE 5-25

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER - AREA B
ONSITE LABORATORY
SWMU 9 (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID	13-GW05	9-B05-HP01	9-B05-HP02	9-B05-HP03	9-B05-HP04	9-B05-HP05	13GW06	13GW06D	9-B06-HP01	9-B06-HP02	9-B06-HP03	9-B06-HP04	9-B06-HP05
Sample Date	6/28/99	06/27/99	06/27/99	06/27/99	06/24/99	06/26/99	06/28/99	06/28/99	06/24/99	06/24/99	06/24/99	06/24/99	06/27/99
Volatiles (ug/L)													
Benzene	750	ND	11,000	610	18	29	ND	ND	ND	ND	ND	82	ND
Toluene	34	120	14,000	500	110	9.3	ND	ND	ND	ND	ND	280	ND
Ethylbenzene	ND	ND	1,200	120	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Xylenes	ND	610	4,000	310	30	ND	ND	ND	ND	ND	ND	61	ND

Note:

ND - Not Detected
ug/L - micrograms per liter

TABLE 5-26

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER - AREA B
SWMU 09 (TANKS 214 - 215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/L)	EPA Region III Tap Water RBC (ug/L)	13GW04 03/24/96	13GW05 03/24/96	13GW06 03/24/96	9MW03 04/20/96	9-B05-HP02 06/27/99	Number Exceeding Federal MCL	Range Exceeding Federal MCL	Number Exceeding EPA Region III Tap Water RBC	Range Exceeding EPA Region III Tap Water RBC	Location Maximum Detect
Volatiles (ug/L)												
Chloroform	100	0.152	5 U	5 U	1,100	5 J	NA	1/4	1,100	2/4	5 J - 1,100	13GW06
Benzene	5	0.364	5 U	140	5 U	5 U	NA	1/4	140	1/4	140	13GW05
Methylene chloride	5	4.102	5 U	5 U	11	5 U	NA	1/4	11	1/4	11	13GW06
Bromoform	100	8.50	5 U	5 U	360	5 U	NA	1/4	360	1/4	360	13GW06
Bromodichloromethane	100	0.170	5 U	5 U	460	5 U	NA	1/4	460	1/4	460	13GW06
Ethylbenzene	700	1,340	5 U	8	5 U	5 U	NA	0/4		0/4		13GW05
Dibromochloromethane	100	0.126	5 U	5 U	300	5 U	NA	1/4	300	1/4	300	13GW06
Semivolatiles (ug/L)												
Benzoic acid	NE	146,000	54 U	53 U	49 U	19 J	NA	NE		0/4		9MW03
Diethylphthalate	NE	29,200	11 U	1 J	10 U	11 U	NA	NE		0/4		13GW05
Bis(2-ethylhexyl)phthalate	6	4.784	7 J	2 J	10 U	11 U	NA	1/4	7 J	1/4	7 J	13GW04
PCBS (ug/L)												
Not Detected												
TPH (ug/L)												
Gasoline Range Organics	NE	NE	4,200	160 J	30 U	30 U	NA	NE		NE		13GW04
BTEX (ug/L)												
Benzene	5	0.364	NA	NA	NA	NA	1,200	1/1	1,200	1/1	1,200	9-B05-HP02
Ethylbenzene	700	1,340	NA	NA	NA	NA	230	0/1		0/1		9-B05-HP02
Xylene (total)	10,000	12,167	NA	NA	NA	NA	200	0/1		0/1		9-B05-HP02

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:

NE - Not Established.

ug/L - micrograms per liter.

TABLE 5-27

SUMMARY OF INORGANIC (TOTAL) DETECTIONS IN GROUNDWATER - AREA B
SWMU 09 (TANKS 214 - 215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	2 X Average Detected Background (ug/L)	Federal MCL (ug/L)	EPA Region III Tap Water RBC (ug/L)	9MW03 04/20/96	Number Exceeding 2 X Average Detected Background	Range Exceeding 2 X Average Detected Background	Number Exceeding Federal MCL	Range Exceeding Federal MCL	Number Exceeding EPA Region III Tap Water RBC	Range Exceeding EPA Region III Tap Water RBC	Location Maximum Detect
RCRA Metals (ug/L)											
Barium, Total	1,561	2,000	2,555	182	0/1		0/1		0/1		9MW03
Cadmium, Total	46.1	5	18.3	**26.4**	0/1		1/1	26.4	1/1	26.4	9MW03
Mercury, Total	0.25	2	NE	0.16 J	0/1		0/1		NE		9MW03

Data Qualifier:
J - Analyte present. Reported value may not be accurate or precise.

Notes:
ug/L - micrograms per liter.
NE - Not Established

TABLE 5-28

SUMMARY OF INORGANIC (DISSOLVED) DETECTIONS IN GROUNDWATER - AREA B
SWMU 09 (TANKS 214 - 215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	2 X Average Detected Background (ug/L)	Federal MCL (ug/L)	EPA Region III Tap Water RBC (ug/L)	9MW03 04/20/96	Number Exceeding 2 X Average Detected Background	Range Exceeding 2 X Average Detected Background	Number Exceeding Federal MCL	Range Exceeding Federal MCL	Number Exceeding EPA Region III Tap Water RBC	Range Exceeding EPA Region III Tap Water RBC	Location Maximum Detect
RCRA Metals (ug/L)											
Barium, Soluble	414	2,000	2,555	170	0/1		0/1		0/1		9MW03
Cadmium, Soluble	35.4	5	18.3	**25.1**	0/1		1/1	25.1	1/1	25.1	9MW03

Notes:
ug/L - micrograms per liter.

TABLE 5-29

SUMMARY OF WATER QUALITY DETECTIONS IN GROUNDWATER - AREA B
SWMU 09 (TANKS 214 - 215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (mg/L)	Secondary MCL (mg/L)	EPA Region III Tap Water RBC (mg/L)	13GW05 06/28/99	13GW06 06/28/99
Water Quality					
Silver (mg/L)	NE	0.1	0.183	0.0006 U	0.0237
Copper (mg/L)	1.3 (1)	1.0	1.46	0.0081 B	0.008 B
Zinc (mg/L)	NE	5.0	10.95	0.0019 B	0.334
Aluminum (mg/L)	NE	0.05	36.5	**0.344** J	**4.51** J
Iron (mg/L)	NE	0.3	10.95	**2.09**	0.0899 B
Manganese (mg/L)	NE	0.05	0.73	**0.512**	**13.8**
Alkalinity (as CaCO3) (mg/L)	NE	NE	NE	184	11,100
Salinity (ppt)	NE	NE	NE	2.90	39
Sulfate (mg/L)	500	250	NE	170	**1,300**
Chloride (mg/L)	NE	250	NE	**620**	**22,000**
Fluoride (mg/L)	4	2.0	NE	0.50	0.75
Color (PCU)	NE	15	NE	**35**	**20**
Odor (TON)	NE	3.0	NE	2.00	2.00
Total dissolved solids (mg/L)	NE	500	NE	**3,700**	**45,000**

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

B - Not detected substantially above the level reported in lab or field blanks.

Notes:

NE - Not Established.

mg/L - milligrams per liter.

ppt - parts per trillion

PCU - primary color units

TON - threshold odor number

(1) EPA Action Level for Copper (www.epa.gov/ogwdw/wot.appa.html) November 1999.

TABLE 5-29 (continued)

SUMMARY OF WATER QUALITY DETECTIONS IN GROUNDWATER - AREA B
SWMU 09 (TANKS 214 - 215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (mg/L)	Secondary MCL (mg/L)	EPA Region III Tap Water RBC (mg/L)	Number Exceeding Federal MCL	Range Exceeding Federal MCL	Number Exceeding Secondary MCL	Range Exceeding Secondary MCL	Number Exceeding EPA Region III Tap Water RBC	Range Exceeding EPA Region III Tap Water RBC	Location Maximum Detect
Water Quality										
Silver (mg/L)	NE	0.1	0.183	NE		0/2		0/2		13GW06
Copper (mg/L)	1.3 (1)	1.0	1.46	0/2		0/2		0/2		13GW05
Zinc (mg/L)	NE	5.0	10.95	NE		0/2		0/2		13GW06
Aluminum (mg/L)	NE	0.05	36.5	NE		2/2	0.344J-4.51J	0/2		13GW06
Iron (mg/L)	NE	0.3	10.95	NE		1/2	2.09	0/2		13GW05
Manganese (mg/L)	NE	0.05	0.73	NE		2/2	0.512 - 13.8	1/2	13.8	13GW06
Alkalinity (as CaCO3) (mg/L)	NE	NE	NE	NE		NE		NE		13GW06
Salinity (ppt)	NE	NE	NE	NE		NE		NE		13GW06
Sulfate (mg/L)	500	250	NE	1/2	1,300	1/2	1,300	NE		13GW06
Chloride (mg/L)	NE	250	NE	NE		2/2	620-22,000	NE		13GW06
Fluoride (mg/L)	4	2.0	NE	0/2		0/2		NE		13GW06
Color (PCU)	NE	15	NE	NE		2/2	20 - 35	NE		13GW05
Odor (TON)	NE	3.0	NE	NE		0/2		NE		13GW05, 13GW06
Total dissolved solids (mg/L)	NE	500	NE	NE		2/2	3,700-45,000	NE		13GW06

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

B - Not detected substantially above the level reported in lab or field blanks.

Notes:

NE - Not Established.

mg/L - milligrams per liter.

ppt - parts per trillion

PCU - primary color units

TON - threshold odor number

(1) EPA Action Level for Copper (www.epa.gov/ogwdw/wot.appa.html)

TABLE 5-30

SUMMARY OF ORGANIC DETECTIONS IN SURFACE WATER - AREA B
SWMU 09 (TANKS 214 - 215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	NAWQC CMC (ug/L)	**NAWQC CCC** (ug/L)	9SW01 06/29/99	9SW01D 06/29/99	9SW03 06/29/99	9SW04 06/29/99	Number Exceeding NAWQC CMC	Range Exceeding NAWQC CMC	**Number Exceeding NAWQC CCC**	**Range Exceeding NAWQC CCC**	Location Maximum Detect
Volatiles (ug/L)											
Methylene chloride	NE	NE	5 U	2.7 J	5 U	5 U	NE		NE		9SW01D

Semivolatiles (ug/L)
Not Detected

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:
ug/L - micrograms per liter.

TABLE 5-31

SUMMARY OF INORGANIC (TOTAL) DETECTIONS IN SURFACE WATER - AREA B
SWMU 09 (TANKS 214 - 215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	2 X Average Detected Background (ug/L)	NAWQC CMC (ug/L)	NAWQC CCC (ug/L)	9SW01 06/29/99	9SW01D 06/29/99	9SW03 06/29/99	9SW04 06/29/99	Number Exceeding 2 X Average Detected Background	Range Exceeding 2 X Average Detected Background	Number Exceeding NAWQC CMC	Range Exceeding NAWQC CMC	Number Exceeding NAWQC CCC	Range Exceeding NAWQC CCC	Location Maximum Detect
Total Inorganics (ug/L)														
Antimony	ND	NE	NE	13.5 U	16.5	2.7 U	2.7 U	1/4	16.5	NE		NE		9SW01D
Arsenic	70.2	69[1]	36[1]	17.8 J	10 J	33.5 J	39.7 J	0/4		0/4		1/4	39.7	9SW04
Barium	111.8	NE	NE	54.2	51.7	54.9	61.1	0/4		NE		NE		9SW04
Beryllium	ND	NE	NE	0.73	0.57	0.1 U	0.12 J	3/4	0.12 J - 0.73	NE		NE		9SW01
Cadmium	ND	42.3	9.4	2.5 U	2.5 U	0.94 J	1.5 J	2/4	0.94 J - 1.5 J	0/4		0/4		9SW04
Chromium	18.2	1,108[2]	50.3[2]	8.5	5 U	8 J	7.7 U	0/4		0/4		0/4		9SW01
Cobalt	6.4	NE	NE	4.1	3.5	3.6 J	4.4 J	0/4		NE		NE		9SW04
Copper	ND	5.8	3.7	50.4	35.7	41.4 U	55.6 J	3/4	35.7-55.6 J	3/4	35.7 - 55.6	3/4	35.7 - 55.6J	9SW04
Cyanide	ND	NE	NE	6.1	10 U	10 U	10 U	1/4	6.1	NE		NE		9SW01
Lead	ND	221	8.5	4.5 UJ	4.5 UJ	4.5 UJ	5.4 J	1/4	5.4 J	0/4		0/4		9SW04
Nickel	ND	74.7	8.3	10.1	9.7	4.5 J	4.4 J	4/4	4.4 J - 10.1	0/4		2/4	9.7 - 10.1	9SW01
Tin	5.4	NE	NE	8.5 U	9.2	5 J	3.8 J	1/4	9.2	NE		NE		9SW01D
Vanadium	96.8	NE	NE	70.9	49.6	134	72.3	1/4	134	NE		NE		9SW03
Zinc	23.8	95.1	85.6	27.4	18.7	14.5 J	19.9 J	1/4	27.4	0/4		0/4		9SW01

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

NE - Not Established.

ND - Not detected.

ug/L - micrograms per liter.

[1] - The criterion shown was derived from data for trivalent arsenic, and applied to total arsenic (USEPA 1999d).

[2] - The criterion shown is for hexavalent chromium.

TABLE 5-32

SUMMARY OF ORGANIC DETECTIONS IN SEDIMENT - AREA B
SWMU 09 (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	FDEP Sediment PEL (ug/kg)	**FDEP Sediment TEL** (ug/kg)	9SD01 06/29/99 0.00-0.50	9SD01D 06/29/99 0.00-0.50	9SD03 06/29/99 0.00-0.50	9SD04 06/29/99 0.00-0.50	Number Exceeding FDEP Sediment PEL	Range Exceeding FDEP Sediment PEL	**Number Exceeding FDEP Sediment TEL**	**Range Exceeding FDEP Sediment TEL**	Location Maximum Detect
Volatiles (ug/kg)											
Acetone	NE	NE	87 J	130	140	200	NE		NE		9SD04
Carbon disulfide	NE	NE	12 U	12 U	5.3 J	8.9 J	NE		NE		9SD04
2-Butanone	NE	NE	58 U	62 U	28 J	39 J	NE		NE		9SD04

Semivolatiles (ug/kg)
Not Detected

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:
ug/kg - micrograms per kilogram.
ft bgs - feet below ground surface

TABLE 5-33

SUMMARY OF INORGANIC DETECTIONS IN SEDIMENT - AREA B
SWMU 09 (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	2 X Average Detected Background (mg/kg)	FDEP Sediment PEL (mg/kg)	FDEP Sediment TEL (mg/kg)	9SD01 06/29/99 0.00-0.50	9SD01D 06/29/99 0.00-0.50	9SD03 06/29/99 0.00-0.50	9SD04 06/29/99 0.00-0.50	Number Exceeding 2 X Average Detected Background	Range Exceeding 2 X Average Detected Background	Number Exceeding FDEP Sediment PEL	Range Exceeding FDEP Sediment PEL	Number Exceeding FDEP Sediment TEL	Range Exceeding FDEP Sediment TEL	Location Maximum Detect
Inorganics (mg/kg)														
Arsenic	2.6	41.6	7.24	1 J	0.8 J	1.2 J	1.3 J	0/4		0/4		0/4		9SD04
Barium	16.2	NE	NE	13	14	15	20	1/4	20	NE		NE		9SD04
Beryllium	0.094	NE	NE	0.13 J	0.15 J	0.12 J	0.16 J	4/4	0.12 J - 0.16 J	NE		NE		9SD04
Cadmium	ND	4.21	0.676	0.11 U	0.13 U	0.14 J	0.12 J	2/4	0.12 J - 0.14 J	0/4		0/4		9SD03
Chromium	32	160	52.3	22	23	28	26	0/4		0/4		0/4		9SD03
Cobalt	9.4	NE	NE	7.9	5.4	8.3	12	1/4	12	NE		NE		9SD04
Copper	116	108	18.7	98 J	70 J	83 J	120 J	1/4	120 J	1/4	120 J	4/4	70 J - 120 J	9SD04
Lead	9.2	112	30.2	5 J	5.4 J	47 J	24 J	2/4	24 J - 47 J	0/4		1/4	47 J	9SD03
Mercury	0.082	0.696	0.13	0.07 J	0.085 J	0.084 J	0.1 J	3/4	0.084 J - 0.1 J	0/4		0/4		9SD04
Nickel	9.6	42.8	15.9	7.7 J	6.7	7.2 J	9.8	1/4	9.8	0/4		0/4		9SD04
Sulfide	ND	NE	NE	54 U	62 U	210	250	2/4	210-250	NE		NE		9SD04
Tin	8.4	NE	NE	4.5 J	4.7	3.6 J	4.3 J	0/4		NE		NE		9SD01D
Vanadium	220	NE	NE	160	150	130	180	0/4		NE		NE		9SD04
Zinc	ND	217	124	49 J	49 J	49 J	63 J	4/4	49 J - 63 J	0/4		0/4		9SD04

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:

ft bgs - feet below ground surface

ND - Not detected.

NE - Not established.

mg/kg - milligrams per kilogram.

TABLE 5-34

SUMMARY OF ORGANIC DETECTIONS IN SURFACE SOIL - AREA C
SWMU 09 (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	EPA Region III Industrial RBC (ug/kg)	**EPA Region III Residential RBC (ug/kg)**	9MW04-00 03/20/96 0.00-1.00	9SS05 03/20/96 0.00-1.00	9SS06 03/20/96 0.00-1.00	Number Exceeding EPA Region III Industrial RBC	Range Exceeding EPA Region III Industrial RBC	**Number Exceeding EPA Region III Residential RBC**	**Range Exceeding EPA Region III Residential RBC**	Location Maximum Detect
Volatiles (ug/kg)										
Not Detected										
Semivolatiles (ug/kg)										
Benzo(b)fluoranthene	7,840	875	59 J	350 U	340 U	0/3		0/3		9MW04-00
Chrysene	784,000	87,497	45 J	350 U	340 U	0/3		0/3		9MW04-00
Di-n-butylphthalate	204,400,000	7,821,429	100 J	350 U	340 U	0/3		0/3		9MW04-00
Pyrene	61,320,000	2,346,429	56 J	350 U	340 U	0/3		0/3		9MW04-00
TPH (ug/kg)										
Gasoline Range Organics	100,000 (1)	100,000 (1)	34 U	32 U	27 J	0/3		0/3		9SS06

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U- Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:
ug/kg - micrograms per kilogram.
ft bgs - feet below ground surface
NE - Not Established
(1) Puerto Rico Environmental Quality Board Criteria.

TABLE 5-35

SUMMARY OF INORGANIC DETECTIONS IN SURFACE SOIL - AREA C
SWMU 09 (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	2 X Average Detected Background (mg/kg)	**EPA Region III Industrial RBC (mg/kg)**	EPA Region III Residential RBC (mg/kg)	9MW04-00 03/20/96 0.00-1.00	9SS05 03/20/96 0.00-1.00	9SS06 03/20/96 0.00-1.00
RCRA Metals (mg/kg)						
Barium	153	143,080	5,475	59.6	110	52.6
Chromium	39.04	6,100 (1)	230 (1)	25.1 J	17.6 J	30.4 J
Lead	21.08	400 (2)	400 (2)	9.3	14.5	52.5

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.

Notes:
mg/kg - milligrams per kilogram.
NE - Not Established
ft bgs - feet below ground surface
(1) The RBC for Chromium VI was used for screening because there is not a total chromium RBC available.
(2) 1996 EPA Soil Screening Guidance.

TABLE 5-35 (continued)

SUMMARY OF INORGANIC DETECTIONS IN SURFACE SOIL - AREA C
SWMU 09 (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	2 X Average Detected Background (mg/kg)	EPA Region III Industrial RBC (mg/kg)	EPA Region III Residential RBC (mg/kg)	Number Exceeding 2 X Average Detected Background	Range Exceeding 2 X Average Detected Background	Number Exceeding EPA Region III Industrial RBC	Range Exceeding EPA Region III Industrial RBC	Number Exceeding EPA Region III Residential RBC	Range Exceeding EPA Region III Residential RBC	Location Maximum Detect
RCRA Metals (mg/kg)										
Barium	153	143,080	5,475	0/3		0/3		0/3		9SS05
Chromium	39.04	6,100 (1)	230 (1)	0/3		0/3		0/3		9SS06
Lead	21.08	400 (2)	400 (2)	1/3	52.5	0/3		0/3		9SS06

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.

Notes:
mg/kg - milligrams per kilogram.
NE - Not Established
ft bgs - feet below ground surface
(1) The RBC for Chromium VI was used for screening because there is not a total chromium RBC available.
(2) 1996 EPA Soil Screening Guidance.

TABLE 5-36

SUMMARY OF ORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA C
SWMU 09 (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	EPA Region III Industrial RBC (ug/kg)	**EPA Region III Residential RBC** (ug/kg)	9MW04-03 04/19/96 6.00-8.00	9MW04-05 04/19/96 10.00-12.00	9TP11-05 04/13/96 11.00	9TP13-04D 04/13/96 9.00	9TP13-04 04/13/96 9.00	9TP14-05D 04/13/96 10.00	9TP14-05 04/13/96 10.00	9TP15-05 04/13/96 10.00	9TP16-05 04/13/96 10.00	9TP17-05 04/14/96 10.00
Volatiles (ug/kg)												
Acetone	204,400,000	7,821,429	11 U	12 U	12 U	95	74 J	11 U	11 UJ	12 UJ	24 J	31 J
Xylene (total)	4,088,000,000	156,428,571	6 U	6 U	6 U	6 U	2 J	6 U	6 U	6 U	6 U	7 U
Semivolatiles (ug/kg)												
Not Detected												
TPH (ug/kg)												
Gasoline Range Organics	100,000 (1)	100,000 (1)	33 U	33 U	35 U	34 U	19 J	33 U	33 U	35 U	37 U	41 U

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be dtected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

NE - Not established.

ft bgs - feet below ground surface

ug/kg - micrograms per kilogram.

(1) Puerto Rico Environmental Quality Board Criteria.

TABLE 5-36 (continued)

SUMMARY OF ORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA C
SWMU 09 (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	EPA Region III Industrial RBC (ug/kg)	EPA Region III Residential RBC (ug/kg)	Number Exceeding EPA Region III Industrial RBC	Range Exceeding EPA Region III Industrial RBC	Number Exceeding EPA Region III Residential RBC	Range Exceeding EPA Region III Residential RBC	Location Maximum Detect
Volatiles (ug/kg)							
Acetone	204,400,000	7,821,429	0/10		0/10		9TP13-04D
Xylene (total)	4,088,000,000	156,428,571	0/10		0/10		9TP13-04
Semivolatiles (ug/kg)							
Not Detected							
TPH (ug/kg)							
Gasoline Range Organics	100,000 (1)	100,000 (1)	0/10		0/10		9TP13-04

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be dtected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

NE - Not established.

ft bgs - feet below ground surface

ug/kg - micrograms per kilogram.

(1) Puerto Rico Environmental Quality Board Criteria.

TABLE 5-37

SUMMARY OF INORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA C
SWMU 09 (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	2 X Average Detected Background (mg/kg)	EPA Region III Industrial RBC (mg/kg)	EPA Region III Residential RBC (mg/kg)	9MW04-03 04/19/96 6.00-8.00	9MW04-05 04/19/96 10.00-12.00	9TP11-05 04/13/96 11.00	9TP13-04 04/13/96 9.00	9TP13-04D 04/13/96 9.00	9TP14-05 04/13/96 10.00	9TP14-05D 04/13/96 10.00	9TP15-05 04/13/96 10.00	9TP16-05 04/13/96 10.00	9TP17-05 04/14/96 10.00
RCRA Metals (mg/kg)													
Barium	131	143,080	5,475	96.9	35.6	77.7	31.6	34.8	82.1	81.7	83.8	59.2	57.2
Chromium	26.90	6,100 (1)	230 (1)	28.3	20.4	24.2 R	24.4 R	26.2 R	22.4 R	22.4 R	22.4 R	29.1 R	24.9 R
Lead	4.79	400 (2)	400 (2)	1.4	1.2	5.2 J	6.4 J	14.5 J	26.2 J	22.1 J	24 J	31.5 J	2.2 J
Silver	ND	10,220	391	0.72	0.71	0.57	0.71	0.79	0.35 U	0.36 U	0.39 U	0.86	0.67

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:

NE - Not established.

mg/kg - milligrams per kilogram.

ft bgs - feet below ground surface

(1) The RBC for Chromium VI was used for screening because there is not a total chromium RBC available.

(2) 1996 EPA Soil Screening Guidance.

TABLE 5-37 (continued)

SUMMARY OF INORGANIC DETECTIONS IN SUBSURFACE SOIL - AREA C
SWMU 09 (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	2 X Average Detected Background (mg/kg)	EPA Region III Industrial RBC (mg/kg)	EPA Region III Residential RBC (mg/kg)	Number Exceeding 2 X Average Detected Background	Range Exceeding 2 X Average Detected Background	Number Exceeding EPA Region III Industrial RBC	Range Exceeding EPA Region III Industrial RBC	Number Exceeding EPA Region III Residential RBC	Range Exceeding EPA Region III Residential RBC	Location Maximum Detect
RCRA Metals (mg/kg)										
Barium	131	143,080	5,475	0/10		0/10		0/10		9MW04-03
Chromium	26.90	6,100 (1)	230 (1)	1/10	28.3	0/10		0/10		9MW04-03
Lead	4.79	400 (2)	400 (2)	7/10	5.2J-31.5J	0/10		0/10		9TP16
Silver	ND	10,220	391	7/10	0.57-0.86	0/10		0/10		9TP16-05

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:

NE - Not established.

mg/kg - milligrams per kilogram.

ft bgs - feet below ground surface

(1) The RBC for Chromium VI was used for screening because there is not a total chromium RBC available.

(2) 1996 EPA Soil Screening Guidance.

TABLE 5-38

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER - AREA C
SWMU 09 (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/L)	EPA Region III Tap Water RBC (ug/L)	13GW07 03/24/96	13GW08 03/24/96	13GW09 03/24/96	13GW10 03/24/96	13GW11 03/25/96	13GW10 06/29/99	13GW10D 06/29/99	13GW11 06/29/99	9MW04 04/24/96
Volatiles (ug/L)											
1,2-Dichloropropane	5	0.16	5 U	5 U	5 U	5 U	2 J	NA	NA	5 U	5 U
Toluene	1,000	747	5 U	5 U	5 U	5 U	5 U	NA	NA	4.2 J	5 U
Semivolatiles (ug/L)											
Bis(2-ethylhexyl)phthalate	6	4.78	11 U	10 U	10 U	38	10 U	10 U	10 U	NA	10 U

PCBS (ug/L)
Not Detected
TPH (ug/L)
Not Detected

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:
NA - Not analyzed.
ug/L - micrograms per liter.

TABLE 5-38 (continued)

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER - AREA C
SWMU 09 (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/L)	EPA Region III Tap Water RBC (ug/L)	Number Exceeding Federal MCL	Range Exceeding Federal MCL	Number Exceeding EPA Region III Tap Water RBC	Range Exceeding EPA Region III Tap Water RBC	Location Maximum Detect
Volatiles (ug/L)							
1,2-Dichloropropane	5	0.16	0/7		1/7	2 J	13GW11
Toluene	1,000	747	0/7		0/7		13GW11
Semivolatiles (ug/L)							
Bis(2-ethylhexyl)phthalate	6	4.78	1/8	38	1/8	38	13GW10

PCBS (ug/L)
Not Detected
TPH (ug/L)
Not Detected

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:
NA - Not analyzed.
ug/L - micrograms per liter.

TABLE 5-39

SUMMARY OF INORGANIC (TOTAL) DETECTIONS IN GROUNDWATER - AREA C
SWMU 09 (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	2 X Average Detected Background (ug/L)	**Federal MCL** (ug/L)	EPA Region III Tap Water RBC (ug/L)	9MW04 04/24/96	Number Exceeding 2 X Average Detected Background	Range Exceeding 2 X Average Detected Background	**Number Exceeding Federal MCL**	**Range Exceeding Federal MCL**	Number Exceeding EPA Region III Tap Water RBC	Range Exceeding EPA Region III Tap Water RBC	Location Maximum Detect
RCRA Metals (ug/L)											
Barium, Total	1,561	2,000	2,555	235	0/1		0/1		0/1		9MW04
Cadmium, Total	46.1	5	18.3	**12.1**	0/1		1/1	12.1	0/1		9MW04

Notes:
ug/L - micrograms per liter.

TABLE 5-40

SUMMARY OF INORGANIC (DISSOLVED) DETECTIONS IN GROUNDWATER - AREA C
SWMU 09 (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	2 X Average Detected Background (ug/L)	Federal MCL (ug/L)	EPA Region III Tap Water RBC (ug/L)	9MW04 04/24/96	9MW04 06/29/99	Number Exceeding 2 X Average Detected Background	Range Exceeding 2 X Average Detected Background	Number Exceeding Federal MCL	Range Exceeding Federal MCL	Number Exceeding EPA Region III Tap Water RBC	Range Exceeding EPA Region III Tap Water RBC	Location Maximum Detect
RCRA Metals (ug/L)												
Barium, Soluble	414	2,000	2,555	209	NA	0/1		0/1		0/1		9MW04
Cadmium, Soluble	35.4	5	18.3	**11.4**	**24.7**	0/2		2/2	11.4 - 24.7	0/2		9MW04

Notes:
ug/L - micrograms per liter.
NA - Not Analyzed

TABLE 5-41

SUMMARY OF WATER QUALITY DETECTIONS IN GROUNDWATER - AREA C
SWMU 09 (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (mg/L)	Secondary MCL (mg/L)	EPA Region III Tap Water RBC (mg/L)	13GW10 06/29/99	13GW11 06/29/99	9MW04 06/29/99
Water Quality						
Alkalinity (as CaCO3) (mg/L)	NE	NE	NE	275	2,070	10,700
Silver (mg/L)	NE	0.1	0.183	0.0006 U	0.0105	0.0378
Copper (mg/L)	1.3 (1)	1.0	1.46	0.0793	0.0563	0.0008 U
Zinc (mg/L)	NE	5.0	10.95	0.0692	0.0724	0.0068 B
Salinity (ppt)	NE	NE	NE	2.2	2.0 U	32
Sulfate (mg/L)	500	250	NE	5 U	200	**930**
Chloride (mg/L)	NE	250	NE	**600**	**8,400**	**22,000**
Fluoride (mg/L)	4	2.0	NE	0.82	0.2 U	0.28
Color (PCU)	NE	15	NE	**120**	**140**	5 U
Aluminum (mg/L)	NE	0.05	36.5	**21.9** J	**15.5** J	**0.15** B
Iron (mg/L)	NE	0.3	10.95	**25.1**	**19.7**	0.255
Manganese (mg/L)	NE	0.05	0.73	**0.998**	**1.1**	**8.84**
Total dissolved solids (mg/L)	NE	500	NE	**2,600**	**11,000**	**42,000**
Odor (TON)	NE	3.0	NE	1.0	1.0	1.0

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

B - Not detected substantially above the level reported in laboratory or field blanks.

Notes:

NE - Not Established.

mg/L - milligrams per liter.

PCU - primary color units

TON - threshold odor number

ppt - parts per trillion

(1) EPA Action Level for Copper (www.epa.gov/ogwdw/wot.appa.html) November 1999.

TABLE 5-41 (continued)

SUMMARY OF WATER QUALITY DETECTIONS IN GROUNDWATER - AREA C
SWMU 09 (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (mg/L)	Secondary MCL (mg/L)	EPA Region III Tap Water RBC (mg/L)	Number Exceeding Federal MCL	Range Exceeding Federal MCL	Number Exceeding Secondary MCL	Range Exceeding Secondary MCL	Number Exceeding EPA Region III Tap Water RBC	Range Exceeding EPA Region III Tap Water RBC	Location Maximum Detect
Water Quality										
Alkalinity (as CaCO3) (mg/L)	NE	NE	NE	NE		NE		NE		9MW04
Silver (mg/L)	NE	0.1	0.183	NE		0/3		0/3		9MW04
Copper (mg/L)	1.3 (1)	1.0	1.46	0/3		0/3		0/3		13GW10
Zinc (mg/L)	NE	5.0	10.95	NE		0/3		0/3		13GW11
Salinity (ppt)	NE	NE	NE	NE		NE		NE		9MW04
Sulfate (mg/L)	500	250	NE	1/3	930	1/3	930	NE		9MW04
Chloride (mg/L)	NE	250	NE	NE		3/3	600 - 22,000	NE		9MW04
Fluoride (mg/L)	4	2.0	NE	0/3		0/3		NE		13GW10
Color (PCU)	NE	15	NE	NE		2/3	120 - 140	NE		13GW11
Aluminum (mg/L)	NE	0.05	36.5	NE		3/3	0.15B-21.9J	0/3		13GW10
Iron (mg/L)	NE	0.3	10.95	NE		2/3	19.7 - 25.1	2/3	19.7-25.1	13GW10
Manganese (mg/L)	NE	0.05	0.73	NE		3/3	0.998 - 8.84	3/3	0.998-8.84	9MW04
Total dissolved solids (mg/L)	NE	500	NE	NE		3/3	2,600 - 42,000	NE		9MW04
Odor (TON)	NE	3.0	NE	NE		0/3		NE		13GW10, 13GW11, 9MW04

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.
B - Not detected substantially above the level reported in laboratory or field blanks.

Notes:
NE - Not Established.
mg/L - milligrams per liter.
PCU - primary color units
TON - threshold odor number
ppt - parts per trillion
(1) EPA Action Level for Copper
(www.epa.gc wdw/wot.appa.html) November 1999.

TABLE 5-42

SUMMARY OF ORGANIC DETECTIONS IN SURFACE WATER - AREA C
SWMU 09 (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	NAWQC CMC (ug/L)	**NAWQC CCC (ug/L)**	9SW06 06/29/99	9SW07 06/29/99	Number Exceeding NAWQC CMC	Range Exceeding NAWQC CMC	**Number Exceeding NAWQC CCC**	**Range Exceeding NAWQC CCC**	Location Maximum Detect
Volatiles (ug/L)									
Methylene chloride	NE	NE	5 U	2.9 J	NE		NE		9SW07

Semivolatiles (ug/L)

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:
NE - Not Established.
ug/L - micrograms per liter.

TABLE 5-43

SUMMARY OF INORGANIC (TOTAL) DETECTIONS IN SURFACE WATER - AREA C
SWMU 09 (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	2 X Average Detected Background (ug/L)	NAWQC CMC (ug/L)	NAWQC CCC (ug/L)	9SW06 06/29/99	9SW07 06/29/99	Number Exceeding 2 X Average Detected Background	Range Exceeding 2 X Average Detected Background	Number Exceeding NAWQC CMC	Range Exceeding NAWQC CMC	Number Exceeding NAWQC CCC	Range Exceeding NAWQC CCC	Location Maximum Detect
Total Inorganics (ug/L)												
Arsenic	70.2	69[1]	36[1]	60.8 J	8.7 J	0/2		0/2		1/2	60.8 J	9SW06
Barium	112	NE	NE	341	274	2/2	274-341	NE		NE		9SW06
Beryllium	ND	NE	NE	2.3	2.4	2/2	2.3-2.4	NE		NE		9SW07
Cadmium	ND	42.3	9.4	3.3	2.5 U	1/2	3.3	0/2		0/2		9SW06
Chromium	18.2	1,108[2]	50.3[2]	155	103	2/2	103-155	0/2		2/2	103-155	9SW06
Cobalt	6.4	NE	NE	145	81.6	2/2	81.6-145	NE		NE		9SW06
Copper	ND	5.8	3.7	389	368	2/2	368-389	2/2	368-389	2/2	368-389	9SW06
Lead	ND	220.8	8.5	130 J	80.9 J	2/2	80.9J-130J	0/2		2/2	80.9 J-130 J	9SW06
Mercury	ND	2.1[3]	1.1[3]	0.59	0.5	2/2	0.5-0.59	0/2		0/2		9SW06
Nickel	ND	74.7	8.3	63.4	53.5	2/2	53.5-63.4	0/2		2/2	53.5-63.4	9SW06
Tin	5.4	NE	NE	13	11.5	2/2	11.5-13	NE		NE		9SW06
Vanadium	96.8	NE	NE	1,070	660	2/2	660-1,070	NE		NE		9SW06
Zinc	23.8	95.1	85.6	425	246	2/2	246-425	2/2	246-425	2/2	246-425	9SW06

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:

NE - Not established.

ND - Not Detected

ug/L - micrograms per liter.

(1) - The criterion shown was derived from data for trivalent arsenic, and applied to total arsenic (USEPA 1999d).

(2) - The criterion shown is for hexavalent chromium.

(3) - The criterion was derived from data from inorganic mercury(II), and applied to total mercury (USEPA 1999d).

TABLE 5-44

SUMMARY OF ORGANIC DETECTIONS IN SEDIMENT - AREA C
SWMU 09 (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	FDEP Sediment PEL (ug/kg)	**FDEP Sediment TEL** (ug/kg)	9SD06 06/29/99 0.00-0.50	9SD07 06/29/99 0.00-0.50	Number Exceeding FDEP Sediment PEL	Range Exceeding FDEP Sediment PEL	**Number Exceeding FDEP Sediment TEL**	**Range Exceeding FDEP Sediment TEL**	Location Maximum Detect
Volatiles (ug/kg)									
Acetone	NE	NE	290	74 J	NE		NE		9SD06
Carbon disulfide	NE	NE	20 U	16	NE		NE		9SD07
2-Butanone	NE	NE	68 J	63 U	NE		NE		9SD06

Semivolatiles (ug/kg)
Not Detected

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:
ft bgs - feet below ground surface
ug/kg - micrograms per kilogram.

TABLE 5-45

SUMMARY OF INORGANIC DETECTIONS IN SEDIMENT - AREA C
SWMU 09 (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date Depth Range (ft bgs)	2 X Average Detected Background (mg/kg)	**FDEP Sediment PEL** (mg/kg)	FDEP Sediment TEL (mg/kg)	9SD06 06/29/99 0.00-0.50	9SD07 06/29/99 0.00-0.50	Number Exceeding 2 X Average Detected Background	Range Exceeding 2 X Average Detected Background	**Number Exceeding FDEP Sediment PEL**	**Range Exceeding FDEP Sediment PEL**	Number Exceeding FDEP Sediment TEL	Range Exceeding FDEP Sediment TEL	Location Maximum Detect
Inorganics (mg/kg)												
Arsenic	2.6	41.6	7.24	4.6 J	2.3 J	1/2	4.6 J	0/2		0/2		9SD06
Barium	16.2	NE	NE	80	29	2/2	29-80	NE		NE		9SD06
Beryllium	0.094	NE	NE	0.097 J	0.076 J	1/2	0.097 J	NE		NE		9SD06
Chromium	32	160	52.3	30	9.1	0/2		0/2		0/2		9SD06
Cobalt	9.4	NE	NE	22	7.6	1/2	22	NE		NE		9SD06
Copper	116	108	18.7	49 J	28 J	0/2		0/2		2/2	28 J - 49 J	9SD06
Lead	9.2	112	30.2	22 J	8.1 J	1/2	22 J	0/2		0/2		9SD06
Mercury	0.082	0.696	0.13	0.049 J	0.015 J	0/2		0/2		0/2		9SD06
Nickel	9.6	42.8	15.9	7 J	4.4 J	0/2		0/2		0/2		9SD06
Selenium	ND	NE	NE	0.68 J	0.39 UJ	1/2	0.68 J	NE		NE		9SD06
Sulfide	ND	NE	NE	290	57 U	1/2	290	NE		NE		9SD06
Tin	8.4	NE	NE	6 J	3.5 J	0/2		NE		NE		9SD06
Vanadium	220	NE	NE	180	66	0/2		NE		NE		9SD06
Zinc	ND	271	124	52 J	20 U	1/2	52 J	0/2		0/2		9SD06

Data Qualifiers:

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected. Quantitaion limit may be innacurate or imprecise.

J - Analyte present. Reported value may not be accurate or precise.

Notes:

NE - Not established.

ND - Not Detected.

mg/kg - milligrams per kilogram

ft bgs - feet below ground surface

TABLE 5-46

SUMMARY OF QA/QC POSITIVE DETECTIONS - PHASE I
SWMU 09 (TANKS 212-217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID	9RB01	9RB02	FB01	FB02	FB03	TB10	TB11	TB12	TB13
Sample Date	04/08/96	04/17/96	4/16/96	4/16/96	4/17/96	4/3/96	4/3/96	4/6/96	4/8/96
Volatiles (ug/L)									
Chloroform	5 U	5 U	4 J	150	5 U	5 U	5 U	5 U	5 U
Bromodichloromethane	5 U	5 U	5 U	14	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	5 U	5 U	5 U	3 J	5 U	5 U	5 U	5 U	5 U
Semivolatiles (ug/L)									
Diethylphthalate	10 U	1 J	10 U	10 U	10 U	NA	NA	NA	NA
1,4-Dichlorobenzene	10 U	2 J	10 U	10 U	2 J	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	10 U	1 J	10 U	10 U	16	NA	NA	NA	NA
Pesticides/PCBs (ug/L)									
Not Detected									
TPH (ug/L)									
Not Detected									
Inorganics (ug/L)									
Antimony, Total	NA	NA	23.5 U	13	24.6 U	NA	NA	NA	NA
Barium, Total	0.8 U	0.93	1.4 U	5	1.5	NA	NA	NA	NA
Cadmium, Total	2.9 U	2.9 U	4.4	4.2 U	2.9 U	NA	NA	NA	NA
Chromium, Total	2.6 U	2.6 U	4.6 U	4.6 U	5.1	NA	NA	NA	NA
Copper, Total	NA	NA	5.6	3.1	2.6	NA	NA	NA	NA
Lead, Total	1.2 U	1.2 U	0.8 U	1 J	1.2 U	NA	NA	NA	NA
Mercury, Total	0.1 U	0.1 U	0.1 U	0.14 J	0.1 U	NA	NA	NA	NA
Zinc, Total	NA	NA	5.1	7.3	2.8 U	NA	NA	NA	NA

Data Qualifiers:

U - Not Detected. The associated number indicates the approximate sample concentration necessary to be detected.

J - Analyte present. Reported value may not be accurate or precise.

Notes:

NA - Not Analyzed.

ug/L - micrograms per liter.

TABLE 5-46 (continued)

SUMMARY OF QA/QC POSITIVE DETECTIONS - PHASE I
SWMU 09 (TANKS 212-217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	TB14 4/12/96	TB15 4/16/96	TB16 4/17/96	TB17 4/19/96	TB18 4/20/96	TB19 4/22/96	TB20 4/25/96	TB21 4/27/96	Location Maximum Detect
Volatiles (ug/L)									
Chloroform	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	FB02
Bromodichloromethane	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	FB02
Dibromochloromethane	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	FB02
Semivolatiles (ug/L)									
Diethylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	9RB02
1,4-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	9RB02, FB03
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	NA	NA	FB03
Pesticides/PCBs (ug/L)									
Not Detected									
TPH (ug/L)									
Not Detected									
Inorganics (ug/L)									
Antimony, Total	NA	NA	NA	NA	NA	NA	NA	NA	FB02
Barium, Total	NA	NA	NA	NA	NA	NA	NA	NA	FB02
Cadmium, Total	NA	NA	NA	NA	NA	NA	NA	NA	FB01
Chromium, Total	NA	NA	NA	NA	NA	NA	NA	NA	FB03
Copper, Total	NA	NA	NA	NA	NA	NA	NA	NA	FB01
Lead, Total	NA	NA	NA	NA	NA	NA	NA	NA	FB02
Mercury, Total	NA	NA	NA	NA	NA	NA	NA	NA	FB02
Zinc, Total	NA	NA	NA	NA	NA	NA	NA	NA	FB02

Data Qualifiers:

U - Not Detected. The associated number indicates the approximate sample concentration necessary to be detected.

J - Analyte present. Reported value may not be accurate or precise.

Notes:

NA - Not Analyzed.

TABLE 5-47

SUMMARY OF QA/QC POSITIVE DETECTIONS - PHASE II
SWMU 09 (TANKS 212-217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID	9ER01	9ER02	FB01	Location Maximum
Sample Date	10/02/97	10/02/97	9/19/97	Detect
Volatiles (ug/L)				
Toluene	0.8 J	0.5 J	5 U	9ER01
TPH (ug/L)				
Not Detected				
RCRA Metals (ug/L)				
Barium, Total	0.4 U	0.4 U	3.4 J	FB01
Chromium, Total	1.6 J	1.4 J	2 J	FB01

Data Qualifiers:

U - Not Detected. The associated number indicates the approximate sample concentration necessary to be detected.

J - Analyte present. Reported value may not be accurate or precise.

Note:

ug/L - micrograms per liter.

TABLE 5-48

SUMMARY OF QA/QC POSITIVE DETECTIONS - PHASE III
SWMU 09 (TANKS 212-217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID	99-ER01	99-ER02	99-ER03	99-ER04	99FB01	99FB02	9TB01
Sample Date	06/30/99	06/30/99	06/30/99	06/30/99	06/30/99	06/30/99	06/24/99
Volatiles (ug/L)							
Bromodichloromethane	5 U	5 U	5 U	5 U	5 U	14	5 U
Chloroform	5 U	5 U	5 U	5 U	5 U	84	5 U
Chloromethane	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Methylene Chloride	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Semivolatiles (ug/L)							
Not Detected							
TPH (ug/L)							
Inorganics (ug/L)							
Copper, Total	0.92 J	0.8 U	0.8 U	1 J	0.81 J	10.6 J	NA
Arsenic, Total	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.4 J	NA
Barium, Total	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	8.9 J	NA
Lead, Total	0.9 U	1.2 J	0.9 U	0.9 U	0.9 U	0.9 U	NA
Vanadium, Total	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.74 J	NA
Zinc, Total	0.8 U	0.8 U	0.8 U	0.8 U	2.4 J	63.3	NA

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Note:

ug/L - micrograms per liter.

NA - Not Analyzed.

TABLE 5-48 (continued)

SUMMARY OF QA/QC POSITIVE DETECTIONS - PHASE III
SWMU 09 (TANKS 212-217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID	9TB03	9TB04	9TB05	9TB06	9TB07	Location Maximum Detect
Sample Date	06/28/99	06/29/99	06/29/99	06/29/99	06/30/99	
Volatiles (ug/L)						
Bromodichloromethane	5 U	5 U	5 U	5 U	5 U	99FB02
Chloroform	5 U	5 U	5 U	5 U	5 U	99FB02
Chloromethane	10 U	10 U	10 U	7.2 J	10 U	9TB06
Methylene Chloride	5 U	5 U	2.7 J	5 U	5 U	9TB05
Semivolatiles (ug/L)						
Not Detected						
TPH (ug/L)						
Inorganics (ug/L)						
Copper, Total	NA	NA	NA	NA	NA	99FB02
Arsenic, Total	NA	NA	NA	NA	NA	99FB02
Barium, Total	NA	NA	NA	NA	NA	99FB02
Lead, Total	NA	NA	NA	NA	NA	99-ER02
Vanadium, Total	NA	NA	NA	NA	NA	99FB02
Zinc, Total	NA	NA	NA	NA	NA	99FB02

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not detected. The associated number indicates approximate sample concentration necessary to be detected.

Note:

ug/L - micrograms per liter.

NA - Not Analyzed.

SECTION 5.0
FIGURES

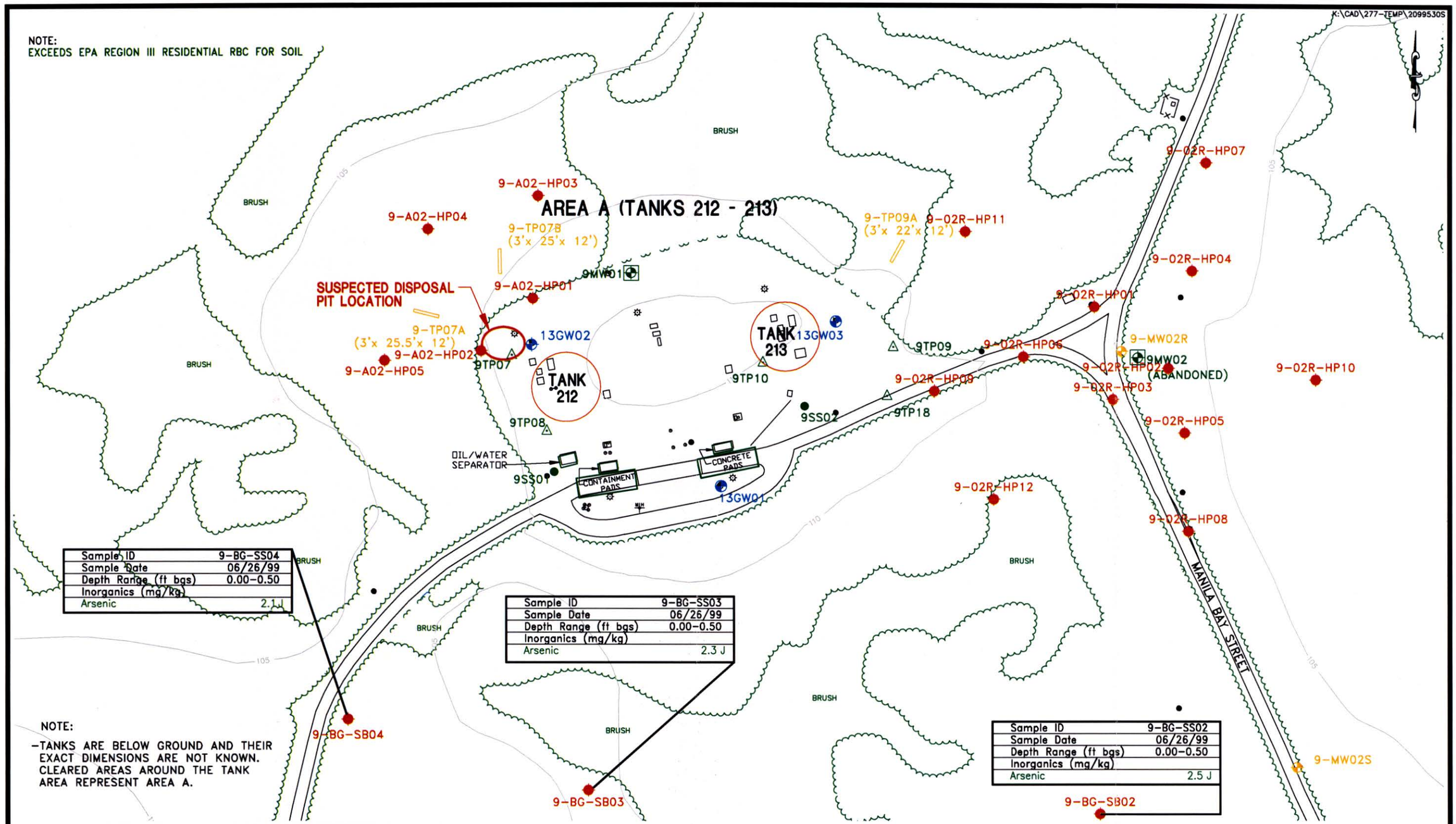


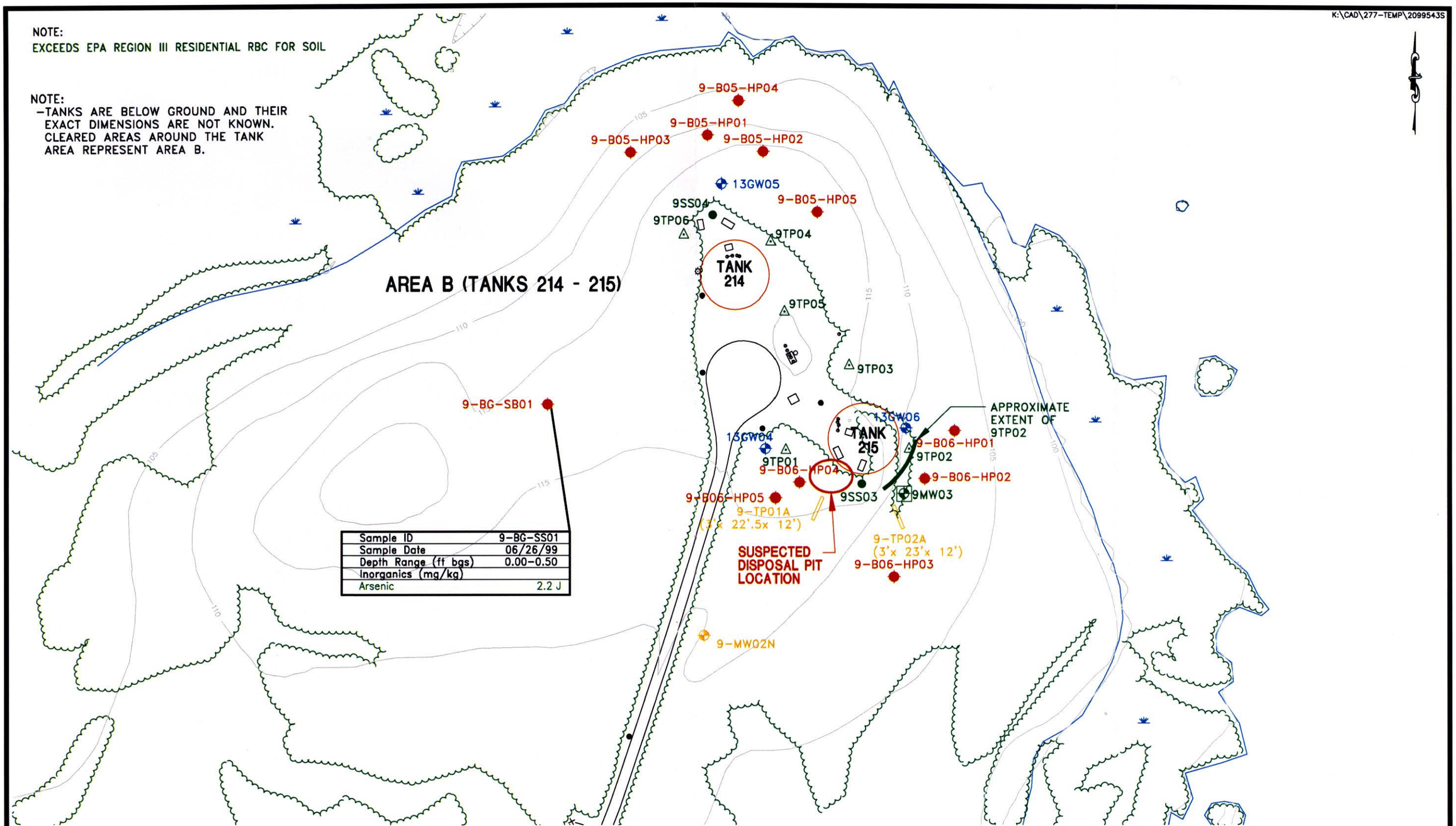
FIGURE 5-1
SURFACE SOIL DETECTIONS
ABOVE SCREENING CRITERIA
SWMU 9 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

00779LB7Y

K:\CAD\277-TEMP\2099543S

NOTE:
EXCEEDS EPA REGION III RESIDENTIAL RBC FOR SOIL

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA B.



Sample ID	9-BG-SS01
Sample Date	06/26/99
Depth Range (ft bgs)	0.00-0.50
Inorganics (mg/kg)	
Arsenic	2.2 J

LEGEND

- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE II)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- MONITORING WELL LOCATION (PHASE II)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

100 0 50 100
1 inch = 100 ft.

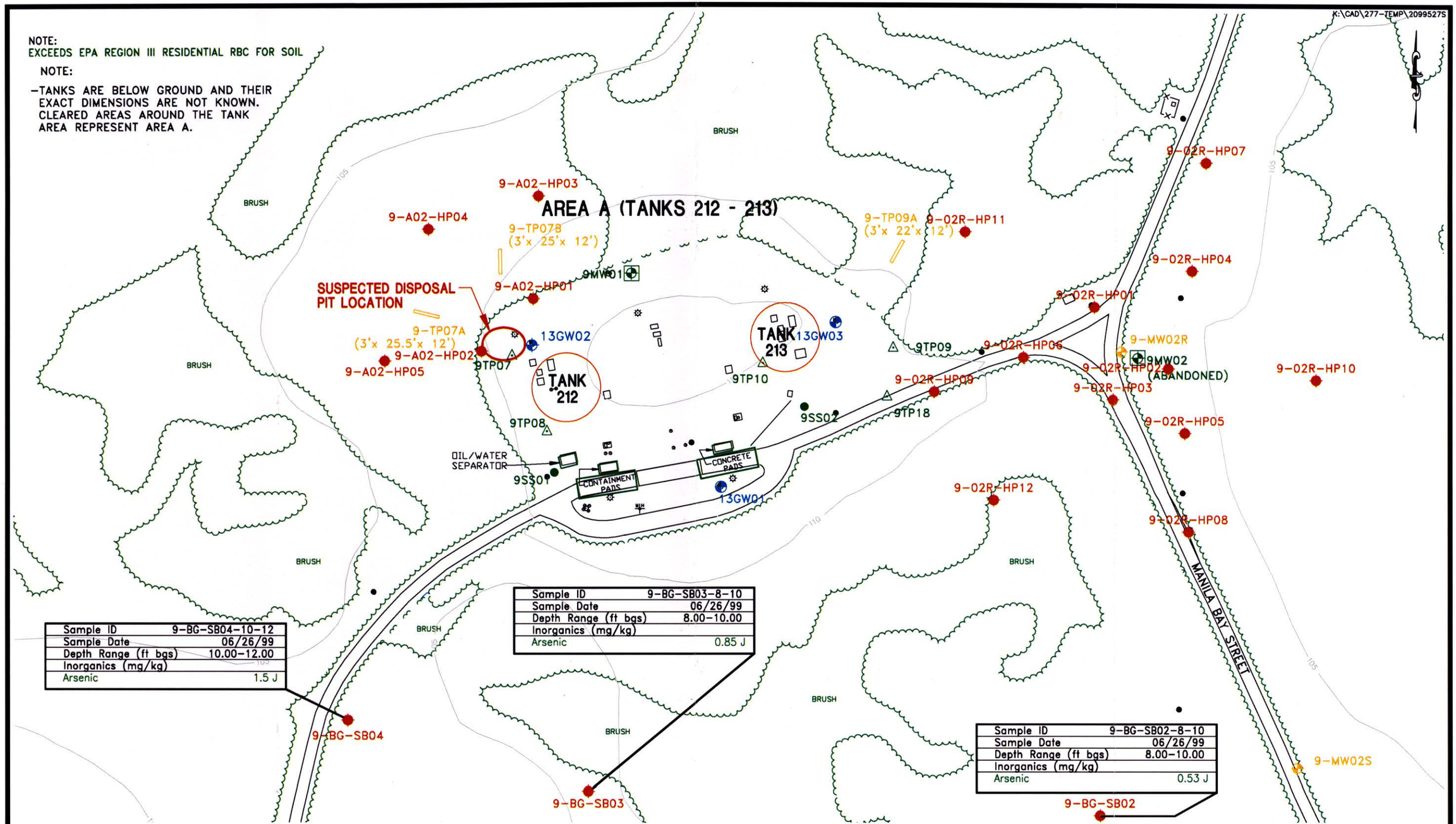
Baker

FIGURE 5-2
SURFACE SOIL DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

NOTE:
EXCEEDS EPA REGION III RESIDENTIAL RBC FOR SOIL

NOTE:

-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA A.



Sample ID	9-BG-SB04-10-12
Sample Date	06/26/99
Depth Range (ft bgs)	10.00-12.00
Inorganics (mg/kg)	
Arsenic	1.5 J

Sample ID	9-BG-SB03-8-10
Sample Date	06/26/99
Depth Range (ft bgs)	8.00-10.00
Inorganics (mg/kg)	
Arsenic	0.85 J

Sample ID	9-BG-SB02-8-10
Sample Date	06/26/99
Depth Range (ft bgs)	8.00-10.00
Inorganics (mg/kg)	
Arsenic	0.53 J

LEGEND

- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE II)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- MONITORING WELL LOCATION (PHASE II)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

100 0 50 100
1 inch = 100 ft.

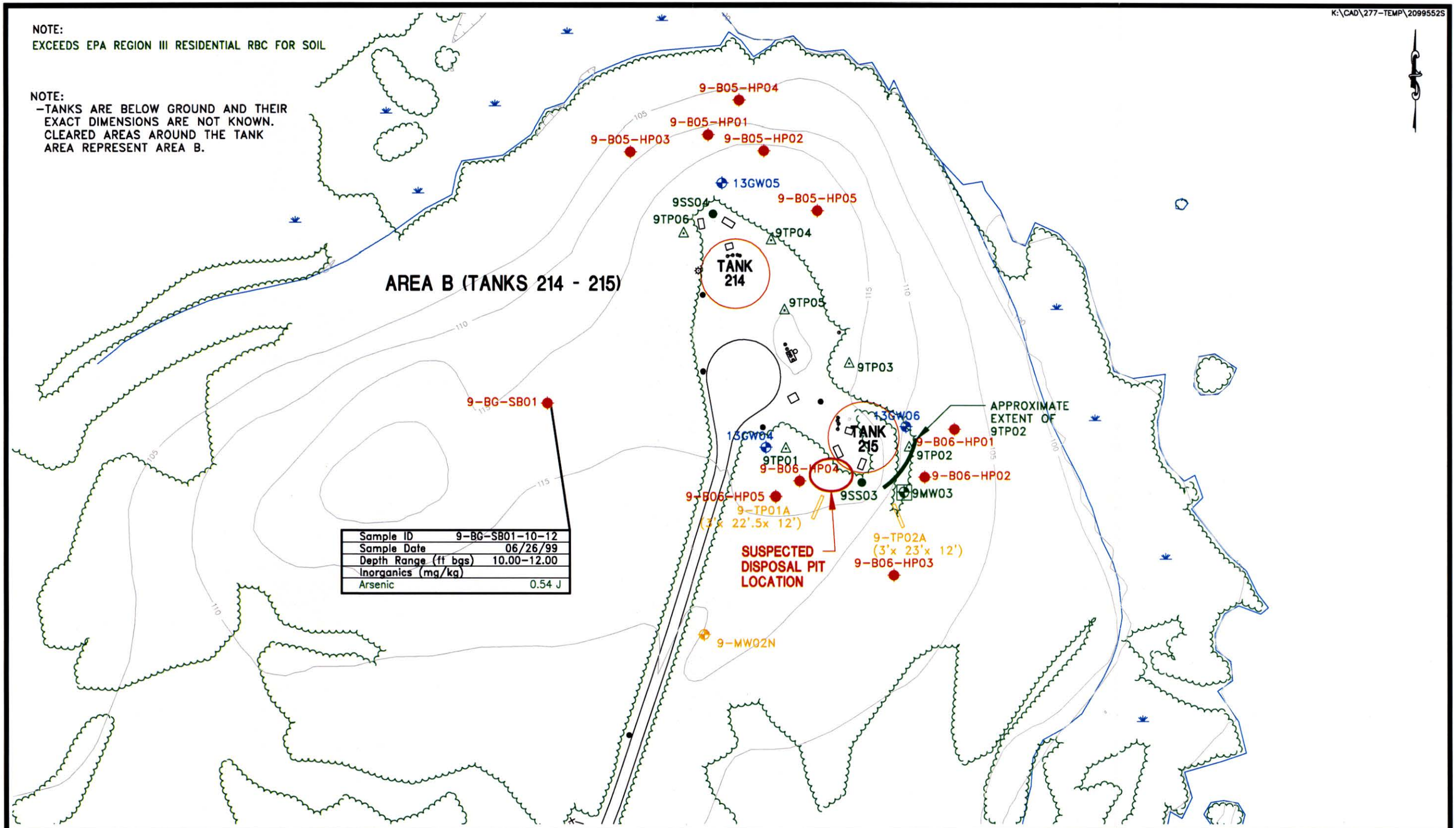
Baker

FIGURE 5-3
SUBSURFACE SOIL DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

K:\CAD\277-TEMP\2099552S

NOTE:
EXCEEDS EPA REGION III RESIDENTIAL RBC FOR SOIL

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA B.



Sample ID	9-BG-SB01-10-12
Sample Date	06/26/99
Depth Range (ft bgs)	10.00-12.00
Inorganics (mg/kg)	
Arsenic	0.54 J

LEGEND

- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE II)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- MONITORING WELL LOCATION (PHASE II)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

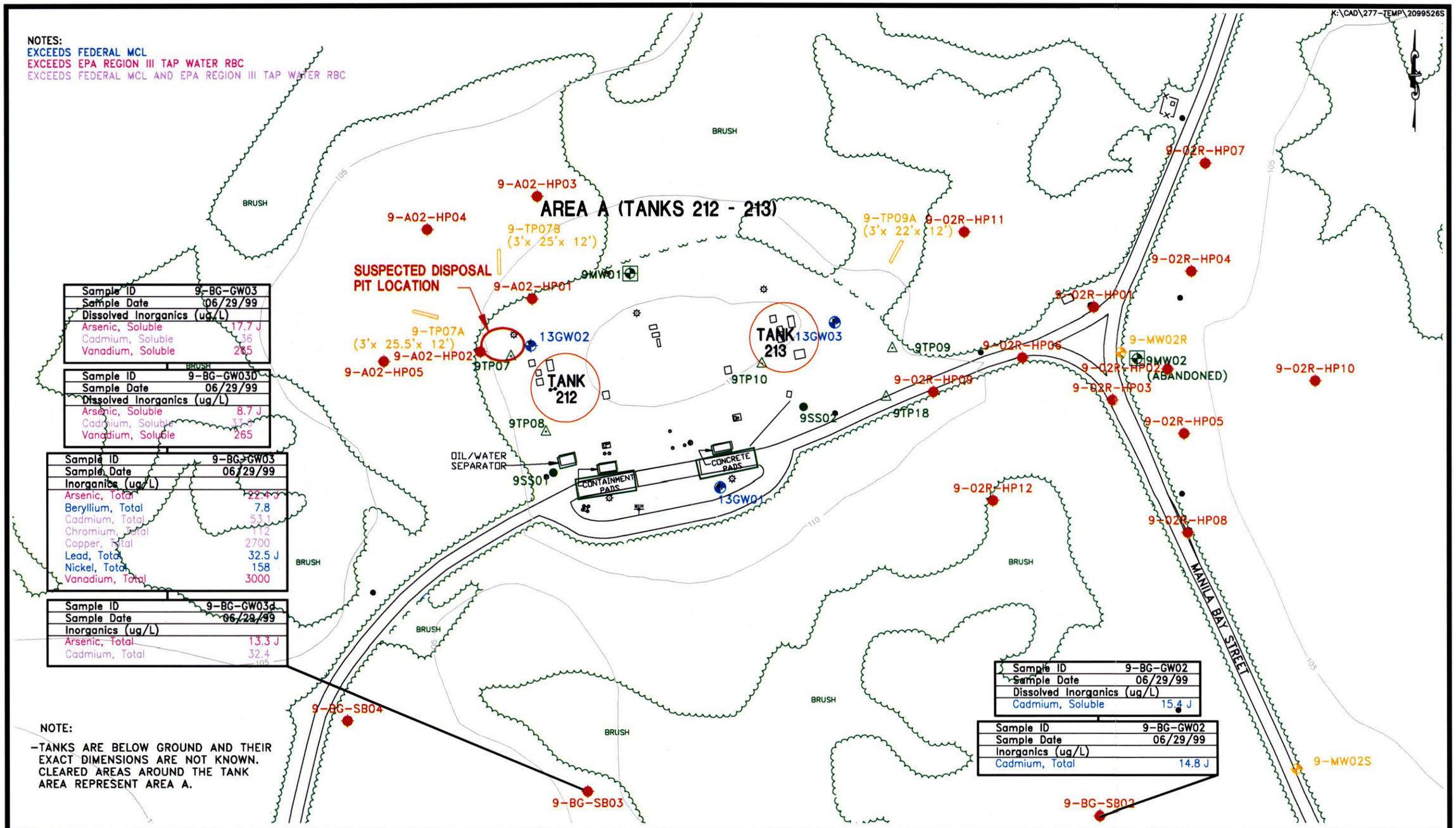
100 0 50 100
1 inch = 100 ft.

Baker

FIGURE 5-4
SUBSURFACE SOIL DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

K:\CAD\277-TEMP\2099526S

NOTES:
EXCEEDS FEDERAL MCL
EXCEEDS EPA REGION III TAP WATER RBC
EXCEEDS FEDERAL MCL AND EPA REGION III TAP WATER RBC



Sample ID	9-BG-GW03
Sample Date	06/29/99
Dissolved Inorganics (ug/L)	
Arsenic, Soluble	17.7 J
Cadmium, Soluble	36
Vanadium, Soluble	265

Sample ID	9-BG-GW03D
Sample Date	06/29/99
Dissolved Inorganics (ug/L)	
Arsenic, Soluble	8.7 J
Cadmium, Soluble	33.3
Vanadium, Soluble	265

Sample ID	9-BG-GW03
Sample Date	06/29/99
Inorganics (ug/L)	
Arsenic, Total	22.4 J
Beryllium, Total	7.8
Cadmium, Total	53.1
Chromium, Total	112
Copper, Total	2700
Lead, Total	32.5 J
Nickel, Total	158
Vanadium, Total	3000

Sample ID	9-BG-GW03d
Sample Date	06/29/99
Inorganics (ug/L)	
Arsenic, Total	13.3 J
Cadmium, Total	32.4

Sample ID	9-BG-GW02
Sample Date	06/29/99
Dissolved Inorganics (ug/L)	
Cadmium, Soluble	15.4 J

Sample ID	9-BG-GW02
Sample Date	06/29/99
Inorganics (ug/L)	
Cadmium, Total	14.8 J

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA A.

LEGEND
- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE II)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- MONITORING WELL LOCATION (PHASE II)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

100 0 50 100
1 inch = 100 ft.

Baker

FIGURE 5-5
GROUNDWATER DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 - BACKGROUND
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

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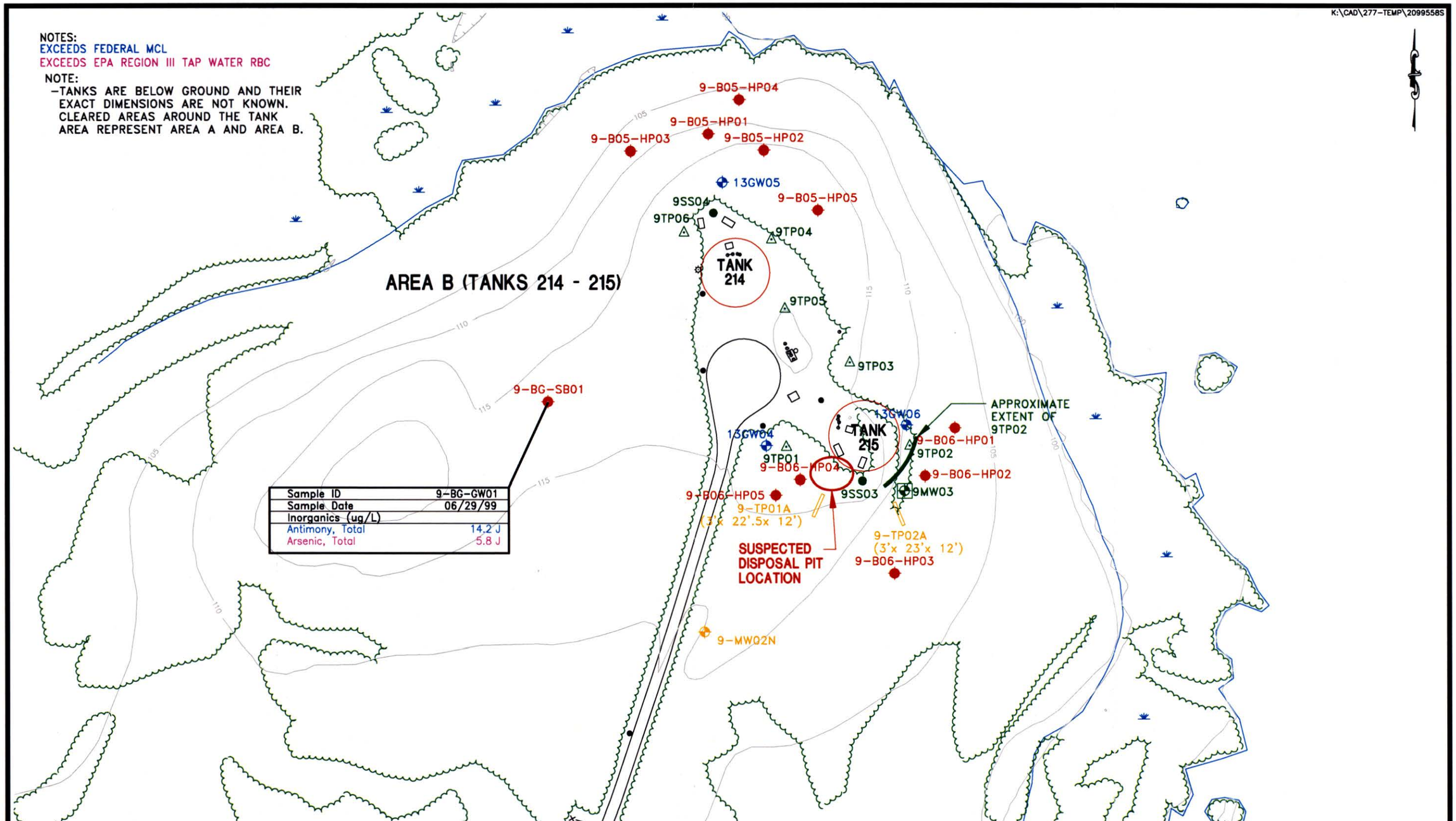
NOTES:
EXCEEDS FEDERAL MCL
EXCEEDS EPA REGION III TAP WATER RBC

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA A AND AREA B.



Sample ID	9-BG-GW01
Sample Date	06/29/99
Inorganics (ug/L)	
Antimony, Total	14.2 J
Arsenic, Total	5.8 J

LEGEND

- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE II)
- SOIL BORING LOCATION (PHASE III)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- MONITORING WELL LOCATION (PHASE II)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

100 0 50 100
1 inch = 100 ft.

Baker

FIGURE 5-6
GROUNDWATER DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 - BACKGROUND
TANKS 214 - 215
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

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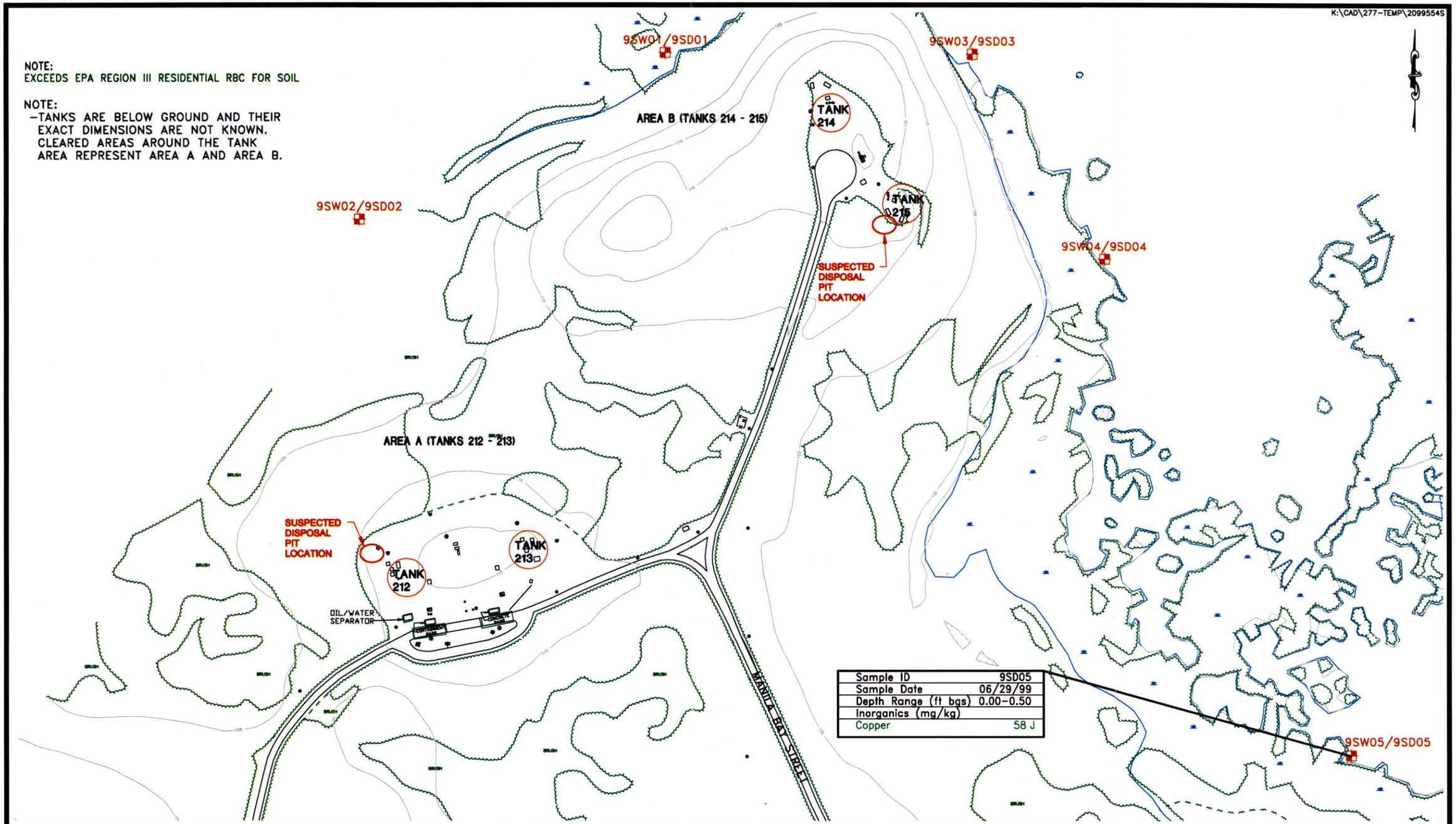
NOTE:
EXCEEDS EPA REGION III RESIDENTIAL RBC FOR SOIL

NOTE:
–TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA A AND AREA B.



Sample ID	9SD05
Sample Date	06/29/99
Depth Range (ft bgs)	0.00–0.50
Inorganics (mg/kg)	
Copper	58 J

LEGEND

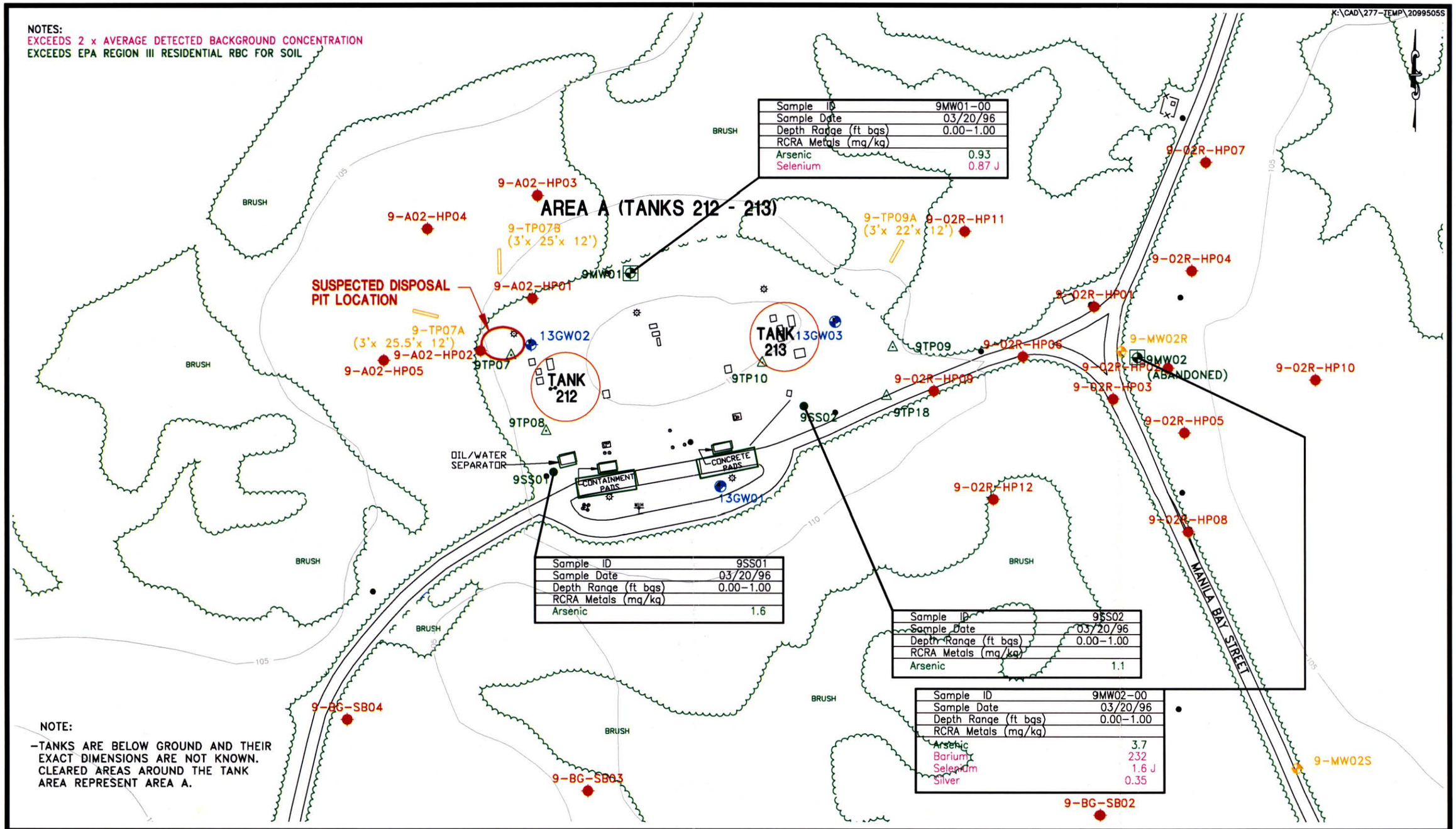
- SURFACE WATER AND SEDIMENT SAMPLING LOCATION (PHASE III)
- 115 – SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

180 0 90 180
1 inch = 180 ft.

Baker

FIGURE 5–7
SEDIMENT DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 – AREAS A AND B
BACKGROUND
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

NOTES:
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND CONCENTRATION
EXCEEDS EPA REGION III RESIDENTIAL RBC FOR SOIL



Sample ID	9MW01-00
Sample Date	03/20/96
Depth Range (ft bgs)	0.00-1.00
RCRA Metals (mg/kg)	
Arsenic	0.93
Selenium	0.87 J

Sample ID	9SS01
Sample Date	03/20/96
Depth Range (ft bgs)	0.00-1.00
RCRA Metals (mg/kg)	
Arsenic	1.6

Sample ID	9SS02
Sample Date	03/20/96
Depth Range (ft bgs)	0.00-1.00
RCRA Metals (mg/kg)	
Arsenic	1.1

Sample ID	9MW02-00
Sample Date	03/20/96
Depth Range (ft bgs)	0.00-1.00
RCRA Metals (mg/kg)	
Arsenic	3.7
Barium	232
Selenium	1.6 J
Silver	0.35

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA A.

LEGEND
- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE II)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- MONITORING WELL LOCATION (PHASE II)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

100 0 50 100
1 inch = 100 ft.

Baker

FIGURE 5-8
SURFACE SOIL DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 - AREA A
TANKS 212-213
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

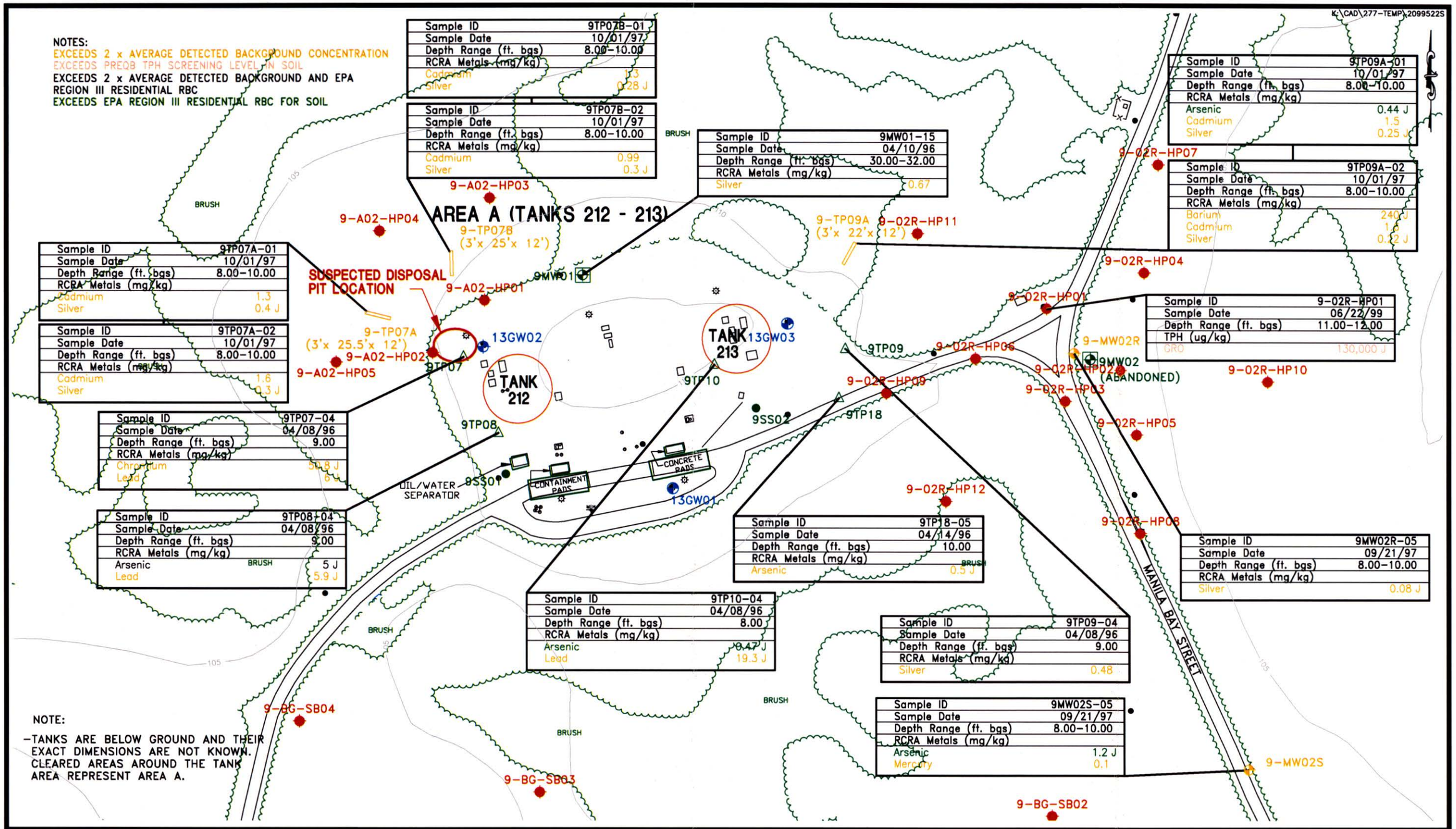


FIGURE 5-9
SUBSURFACE SOIL DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 - AREA A
TANKS 212 - 213
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

NOTES:
EXCEEDS EPA REGION III TAP WATER RBC
EXCEEDS FEDERAL MCL AND EPA REGION III TAP WATER RBC

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AREA A (TANKS 212 - 213)

SUSPECTED DISPOSAL PIT LOCATION

TANK 212

TANK 213

Sample ID	9MW01
Sample Date	04/15/96
Semivolatiles (ug/L)	
Acetophenone	1 J

Sample ID	13GW02
Sample Date	03/24/96
Volatiles (ug/L)	
Benzene	130
Semivolatiles (ug/L)	
Bis(2-ethylhexyl)phthalate	5 J
Naphthalene	26

Sample ID	9GW02R
Sample Date	09/30/97
BTEX (ug/L)	
Benzene	4,900
Toluene	4,100

Sample ID	9MW02
Sample Date	04/16/96
Volatiles (ug/L)	
Benzene	1,600 J
Methylene chloride	7

Sample ID	9-02R-GW03
Sample Date	06/27/99
BTEX (ug/L)	
Benzene	230

Sample ID	13GW01
Sample Date	03/24/96
Semivolatiles (ug/L)	
Bis(2-ethylhexyl)phthalate	5 J

Sample ID	9-A02-HP02
Sample Date	06/27/99
BTEX (ug/L)	
Benzene	8.7

Sample ID	9GW02S
Sample Date	09/30/97
BTEX (ug/L)	
Benzene	1.7

NOTE:

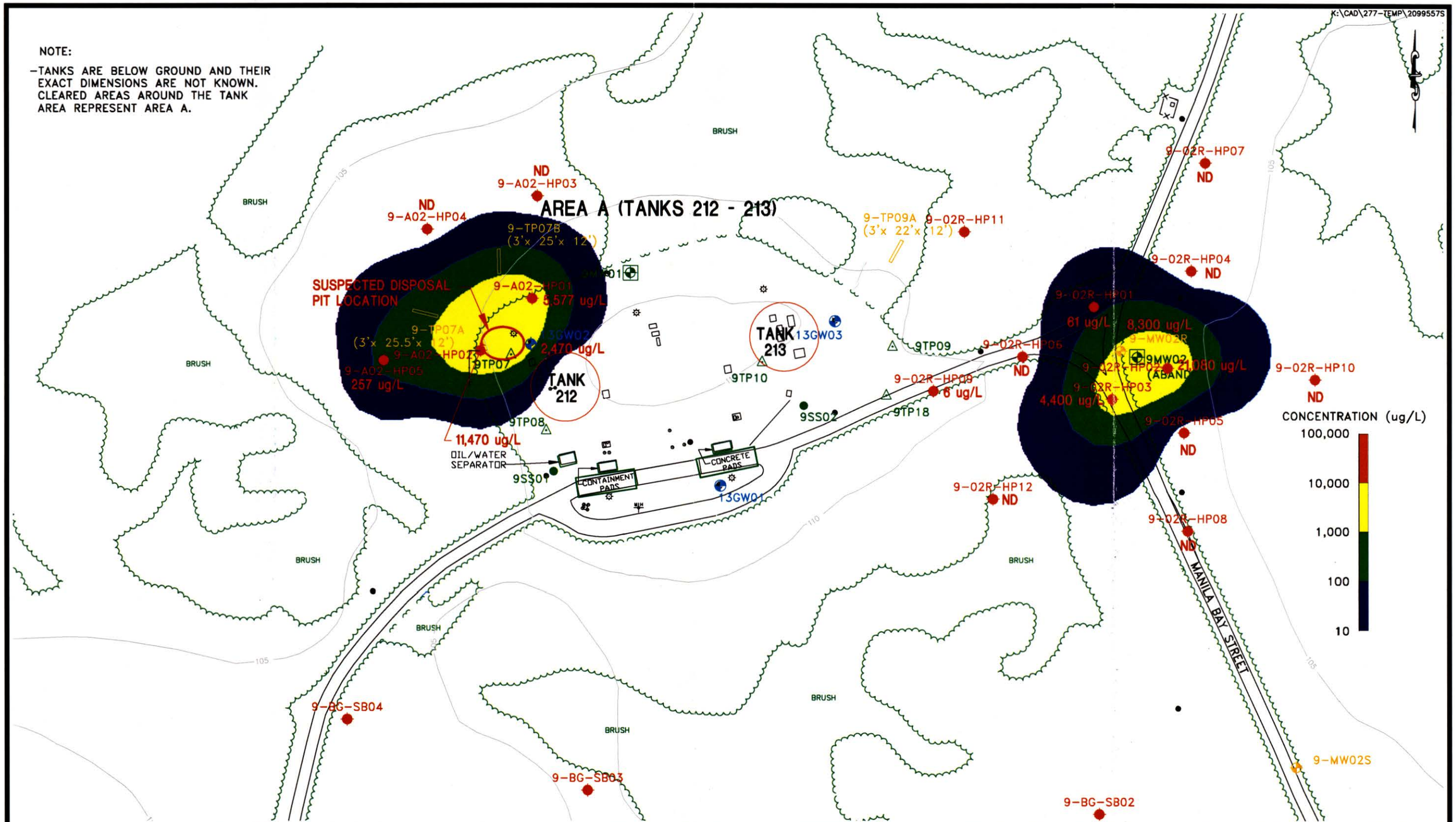
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA A.

LEGEND
- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE II)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- MONITORING WELL LOCATION (PHASE II)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

100 0 50 100
1 inch = 100 ft.

Baker

FIGURE 5-10
GROUNDWATER ORGANIC DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 - AREA A
TANKS 212 - 213
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



LEGEND

- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE II)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- MONITORING WELL LOCATION (PHASE II)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

100 0 50 100
1 inch = 100 ft.

Baker

FIGURE 5-11
DISTRIBUTION OF TOTAL BTEX IN GROUNDWATER
SWMU 9 - AREA A
TANKS 212 - 213
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

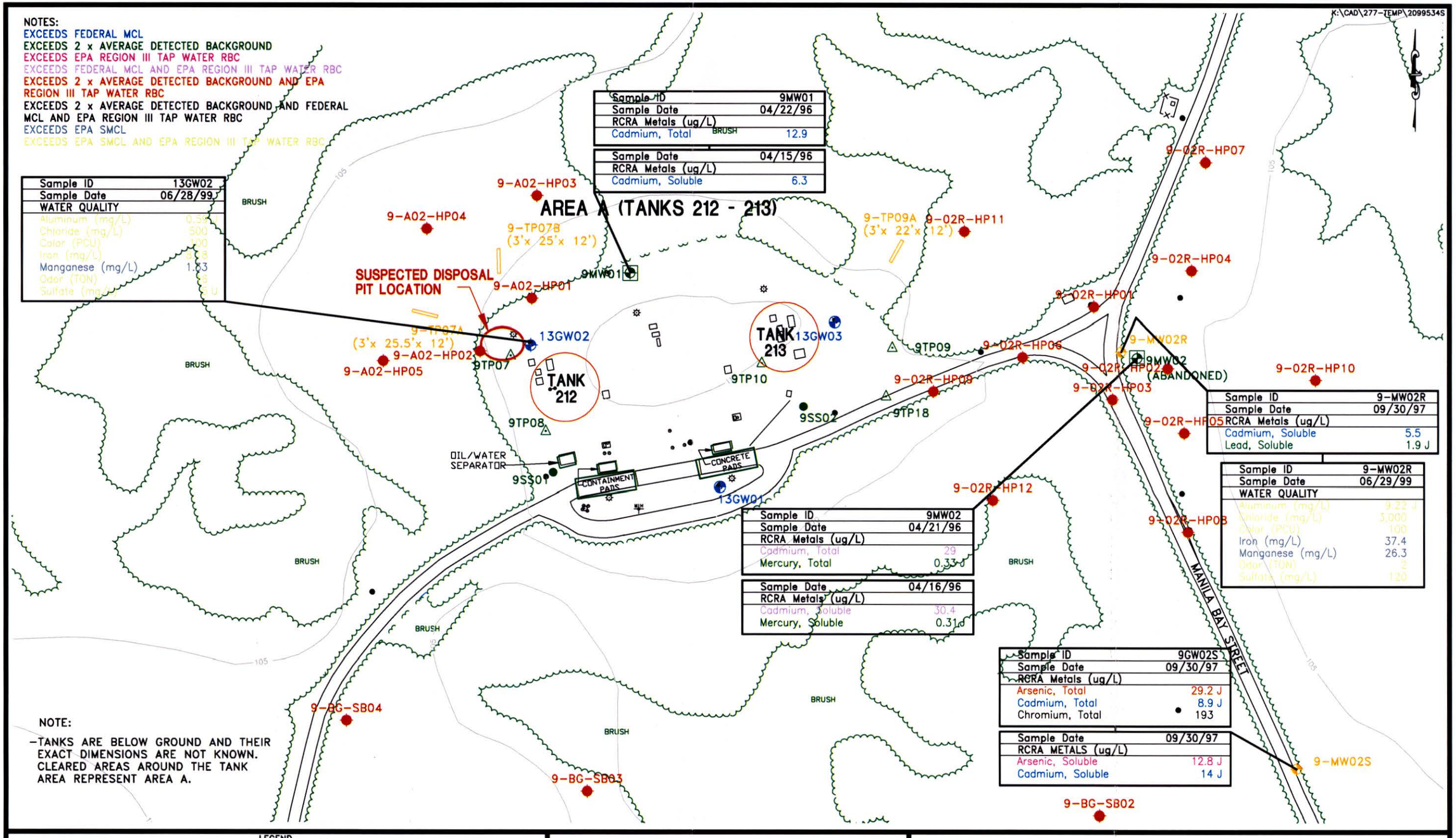


FIGURE 5-12
GROUNDWATER INORGANIC DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 - AREA A
TANKS 212 - 213
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

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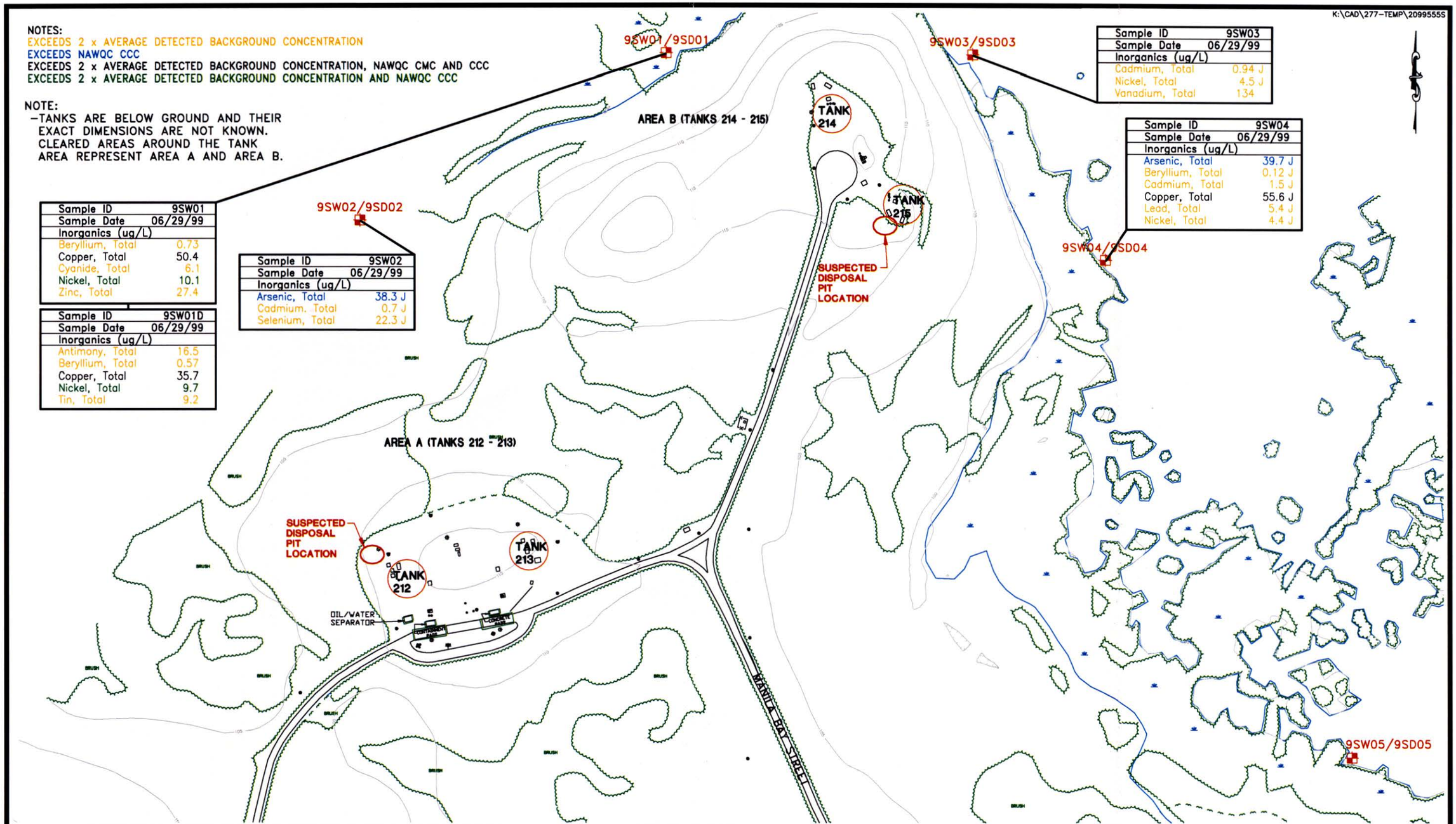
NOTES:
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND CONCENTRATION
EXCEEDS NAWQC CCC
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND CONCENTRATION, NAWQC CMC AND CCC
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND CONCENTRATION AND NAWQC CCC

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA A AND AREA B.



Sample ID	9SW01
Sample Date	06/29/99
Inorganics (ug/L)	
Beryllium, Total	0.73
Copper, Total	50.4
Cyanide, Total	6.1
Nickel, Total	10.1
Zinc, Total	27.4

Sample ID	9SW01D
Sample Date	06/29/99
Inorganics (ug/L)	
Antimony, Total	16.5
Beryllium, Total	0.57
Copper, Total	35.7
Nickel, Total	9.7
Tin, Total	9.2

Sample ID	9SW02
Sample Date	06/29/99
Inorganics (ug/L)	
Arsenic, Total	38.3 J
Cadmium, Total	0.7 J
Selenium, Total	22.3 J

Sample ID	9SW03
Sample Date	06/29/99
Inorganics (ug/L)	
Cadmium, Total	0.94 J
Nickel, Total	4.5 J
Vanadium, Total	134

Sample ID	9SW04
Sample Date	06/29/99
Inorganics (ug/L)	
Arsenic, Total	39.7 J
Beryllium, Total	0.12 J
Cadmium, Total	1.5 J
Copper, Total	55.6 J
Lead, Total	5.4 J
Nickel, Total	4.4 J

LEGEND

- SURFACE WATER AND SEDIMENT SAMPLING LOCATION (PHASE III)
- 115 – SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

180 0 90 180
1 inch = 180 ft.

Baker

FIGURE 5-13
SURFACE WATER DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 – AREAS A AND B
TANKS 212 – 215
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

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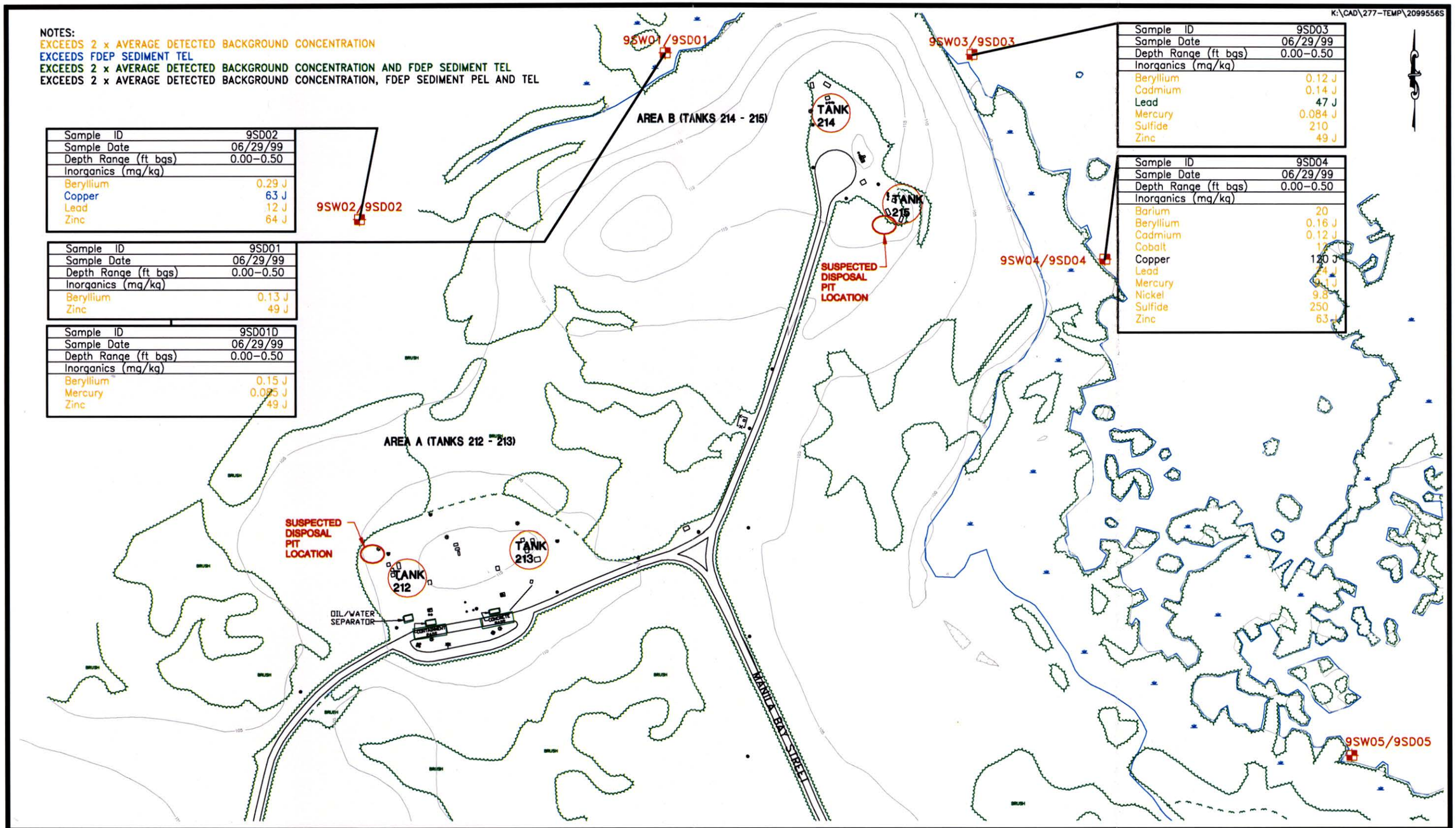
NOTES:
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND CONCENTRATION
EXCEEDS FDEP SEDIMENT TEL
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND CONCENTRATION AND FDEP SEDIMENT TEL
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND CONCENTRATION, FDEP SEDIMENT PEL AND TEL



Sample ID	9SD02
Sample Date	06/29/99
Depth Range (ft bgs)	0.00–0.50
Inorganics (mg/kg)	
Beryllium	0.29 J
Copper	63 J
Lead	12 J
Zinc	64 J

Sample ID	9SD01
Sample Date	06/29/99
Depth Range (ft bgs)	0.00–0.50
Inorganics (mg/kg)	
Beryllium	0.13 J
Zinc	49 J

Sample ID	9SD01D
Sample Date	06/29/99
Depth Range (ft bgs)	0.00–0.50
Inorganics (mg/kg)	
Beryllium	0.15 J
Mercury	0.085 J
Zinc	49 J

Sample ID	9SD03
Sample Date	06/29/99
Depth Range (ft bgs)	0.00–0.50
Inorganics (mg/kg)	
Beryllium	0.12 J
Cadmium	0.14 J
Lead	47 J
Mercury	0.084 J
Sulfide	210
Zinc	49 J

Sample ID	9SD04
Sample Date	06/29/99
Depth Range (ft bgs)	0.00–0.50
Inorganics (mg/kg)	
Barium	20
Beryllium	0.16 J
Cadmium	0.12 J
Cobalt	12
Copper	120 J
Lead	24 J
Mercury	0.1 J
Nickel	9.8
Sulfide	250
Zinc	63 J

LEGEND

- SURFACE WATER AND SEDIMENT SAMPLING LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

180 0 90 180
1 inch = 180 ft.

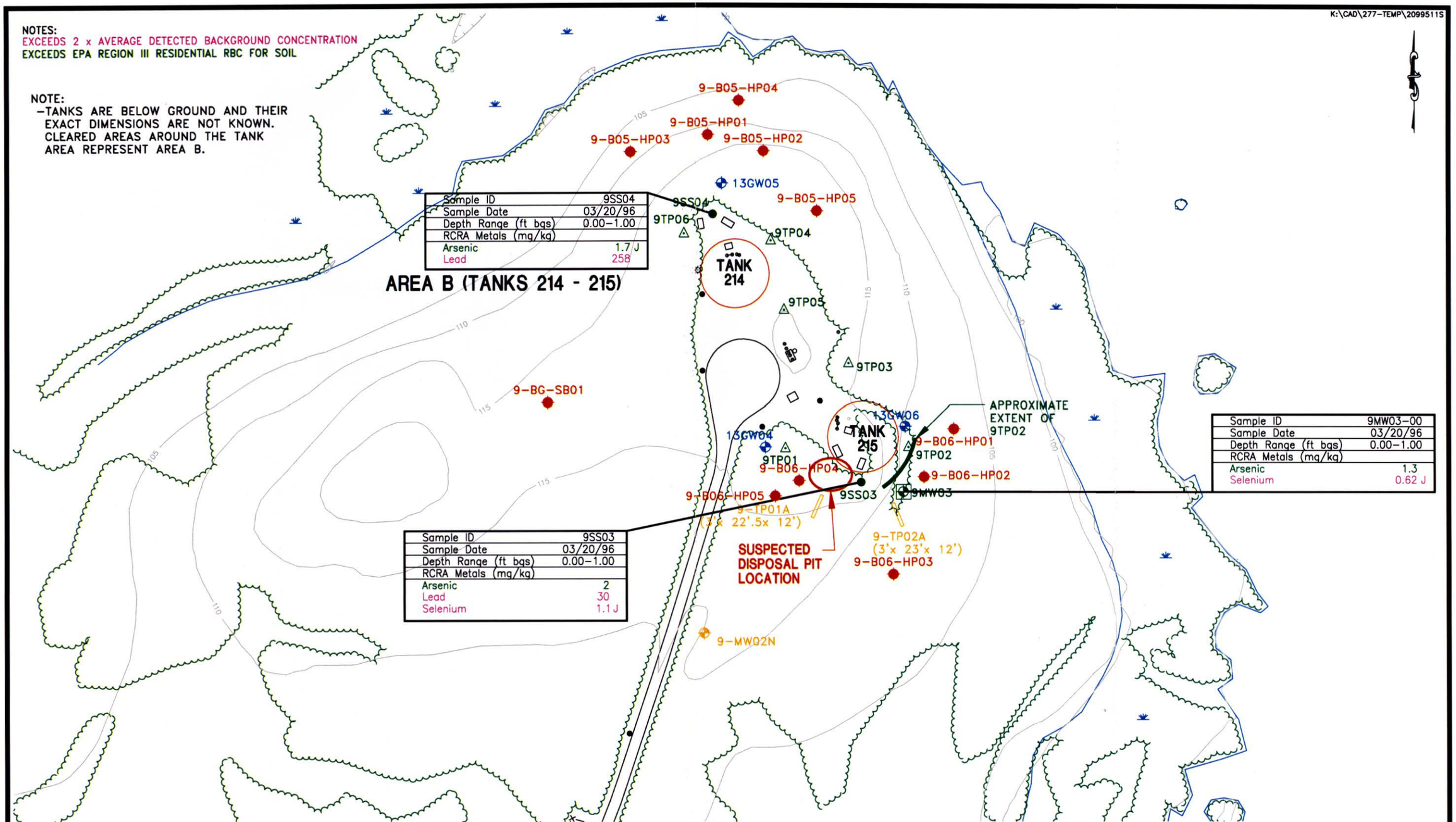
Baker

FIGURE 5-14
SEDIMENT DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 – AREAS A AND B
TANKS 212 – 215
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

K:\CAD\277-TEMP\2099511S

NOTES:
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND CONCENTRATION
EXCEEDS EPA REGION III RESIDENTIAL RBC FOR SOIL

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA B.



Sample ID	9SS04
Sample Date	03/20/96
Depth Range (ft bgs)	0.00-1.00
RCRA Metals (mg/kg)	
Arsenic	1.7 J
Lead	258

Sample ID	9MW03-00
Sample Date	03/20/96
Depth Range (ft bgs)	0.00-1.00
RCRA Metals (mg/kg)	
Arsenic	1.3
Selenium	0.62 J

Sample ID	9SS03
Sample Date	03/20/96
Depth Range (ft bgs)	0.00-1.00
RCRA Metals (mg/kg)	
Arsenic	2
Lead	30
Selenium	1.1 J

LEGEND

- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE II)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- MONITORING WELL LOCATION (PHASE II)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

100 0 50 100
1 inch = 100 ft.

Baker

FIGURE 5-15
SURFACE SOIL DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 - AREA B
TANKS 214 - 215
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

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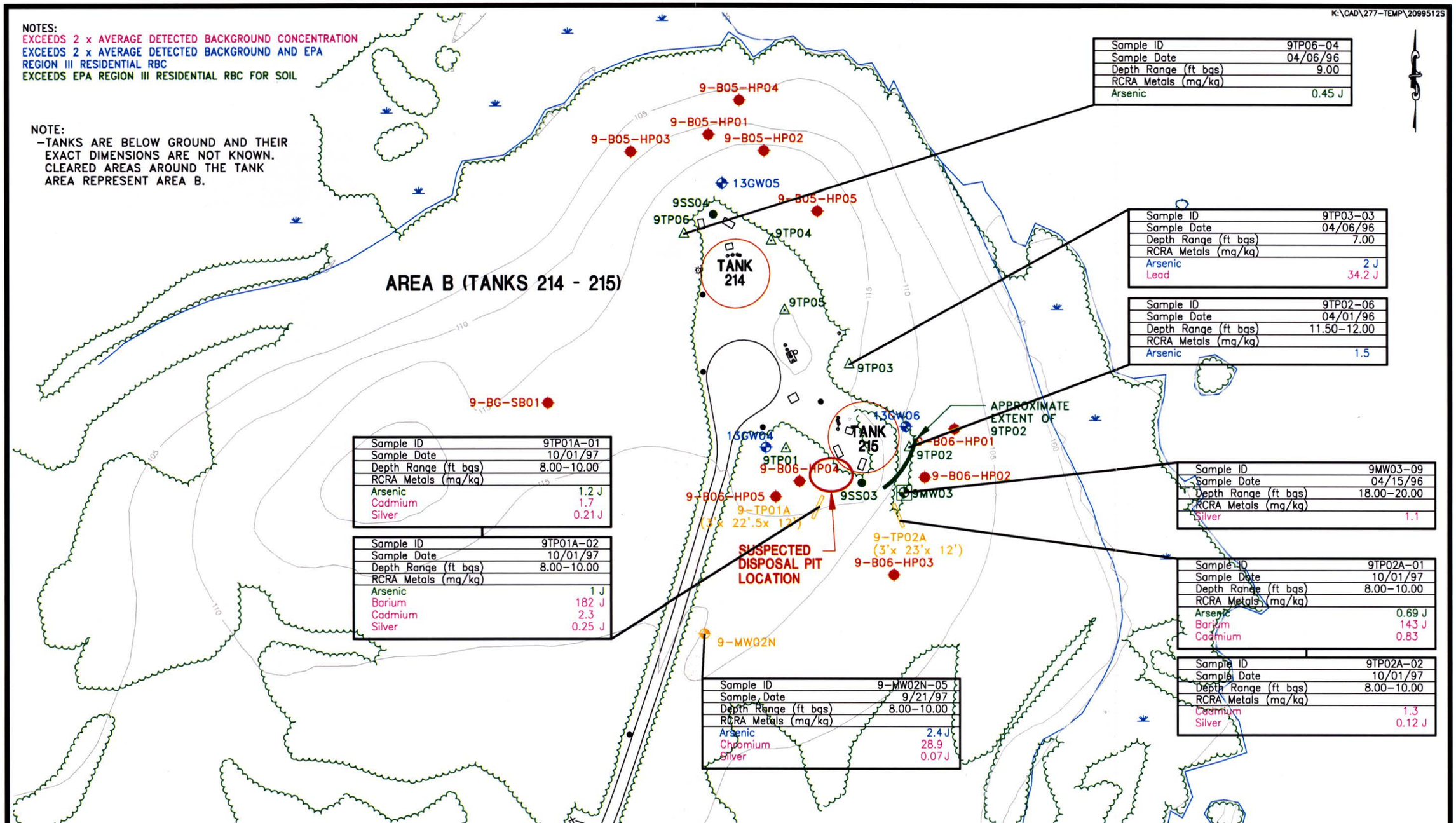
NOTES:
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND CONCENTRATION
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND AND EPA REGION III RESIDENTIAL RBC
EXCEEDS EPA REGION III RESIDENTIAL RBC FOR SOIL

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA B.



Sample ID	9TP06-04
Sample Date	04/06/96
Depth Range (ft bgs)	9.00
RCRA Metals (mg/kg)	
Arsenic	0.45 J

Sample ID	9TP03-03
Sample Date	04/06/96
Depth Range (ft bgs)	7.00
RCRA Metals (mg/kg)	
Arsenic	2 J
Lead	34.2 J

Sample ID	9TP02-06
Sample Date	04/01/96
Depth Range (ft bgs)	11.50-12.00
RCRA Metals (mg/kg)	
Arsenic	1.5

Sample ID	9TP01A-01
Sample Date	10/01/97
Depth Range (ft bgs)	8.00-10.00
RCRA Metals (mg/kg)	
Arsenic	1.2 J
Cadmium	1.7
Silver	0.21 J

Sample ID	9TP01A-02
Sample Date	10/01/97
Depth Range (ft bgs)	8.00-10.00
RCRA Metals (mg/kg)	
Arsenic	1 J
Barium	182 J
Cadmium	2.3
Silver	0.25 J

Sample ID	9MW03-09
Sample Date	04/15/96
Depth Range (ft bgs)	18.00-20.00
RCRA Metals (mg/kg)	
Silver	1.1

Sample ID	9TP02A-01
Sample Date	10/01/97
Depth Range (ft bgs)	8.00-10.00
RCRA Metals (mg/kg)	
Arsenic	0.69 J
Barium	143 J
Cadmium	0.83

Sample ID	9TP02A-02
Sample Date	10/01/97
Depth Range (ft bgs)	8.00-10.00
RCRA Metals (mg/kg)	
Cadmium	1.3
Silver	0.12 J

Sample ID	9-MW02N-05
Sample Date	9/21/97
Depth Range (ft bgs)	8.00-10.00
RCRA Metals (mg/kg)	
Arsenic	2.4 J
Chromium	28.9
Silver	0.07 J

LEGEND

- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE II)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- MONITORING WELL LOCATION (PHASE II)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

100 0 50 100
1 inch = 100 ft.

Baker

FIGURE 5-16
SUBSURFACE SOIL DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 - AREA B
TANKS 214 - 215
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

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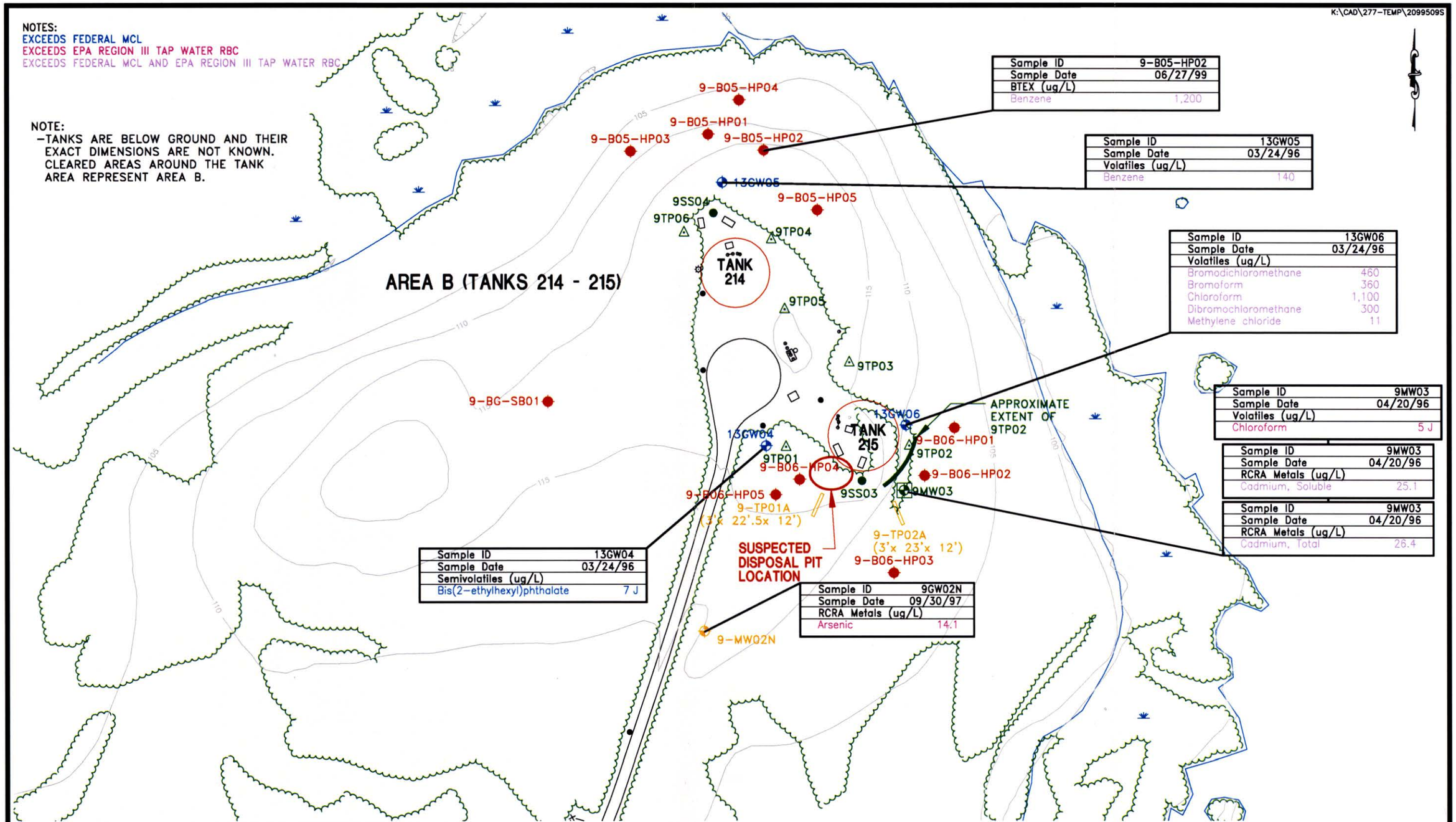
NOTES:
EXCEEDS FEDERAL MCL
EXCEEDS EPA REGION III TAP WATER RBC
EXCEEDS FEDERAL MCL AND EPA REGION III TAP WATER RBC

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA B.



Sample ID	9-B05-HP02
Sample Date	06/27/99
BTEX (ug/L)	
Benzene	1,200

Sample ID	13GW05
Sample Date	03/24/96
Volatiles (ug/L)	
Benzene	140

Sample ID	13GW06
Sample Date	03/24/96
Volatiles (ug/L)	
Bromodichloromethane	460
Bromoform	360
Chloroform	1,100
Dibromochloromethane	300
Methylene chloride	11

Sample ID	9MW03
Sample Date	04/20/96
Volatiles (ug/L)	
Chloroform	5 J

Sample ID	9MW03
Sample Date	04/20/96
RCRA Metals (ug/L)	
Cadmium, Soluble	25.1

Sample ID	9MW03
Sample Date	04/20/96
RCRA Metals (ug/L)	
Cadmium, Total	26.4

Sample ID	13GW04
Sample Date	03/24/96
Semivolatiles (ug/L)	
Bis(2-ethylhexyl)phthalate	7 J

Sample ID	9GW02N
Sample Date	09/30/97
RCRA Metals (ug/L)	
Arsenic	14.1

LEGEND

- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE II)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- MONITORING WELL LOCATION (PHASE II)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

100 0 50 100
1 inch = 100 ft.

Baker

FIGURE 5-17
GROUNDWATER DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 - AREA B
TANKS 214 - 215
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

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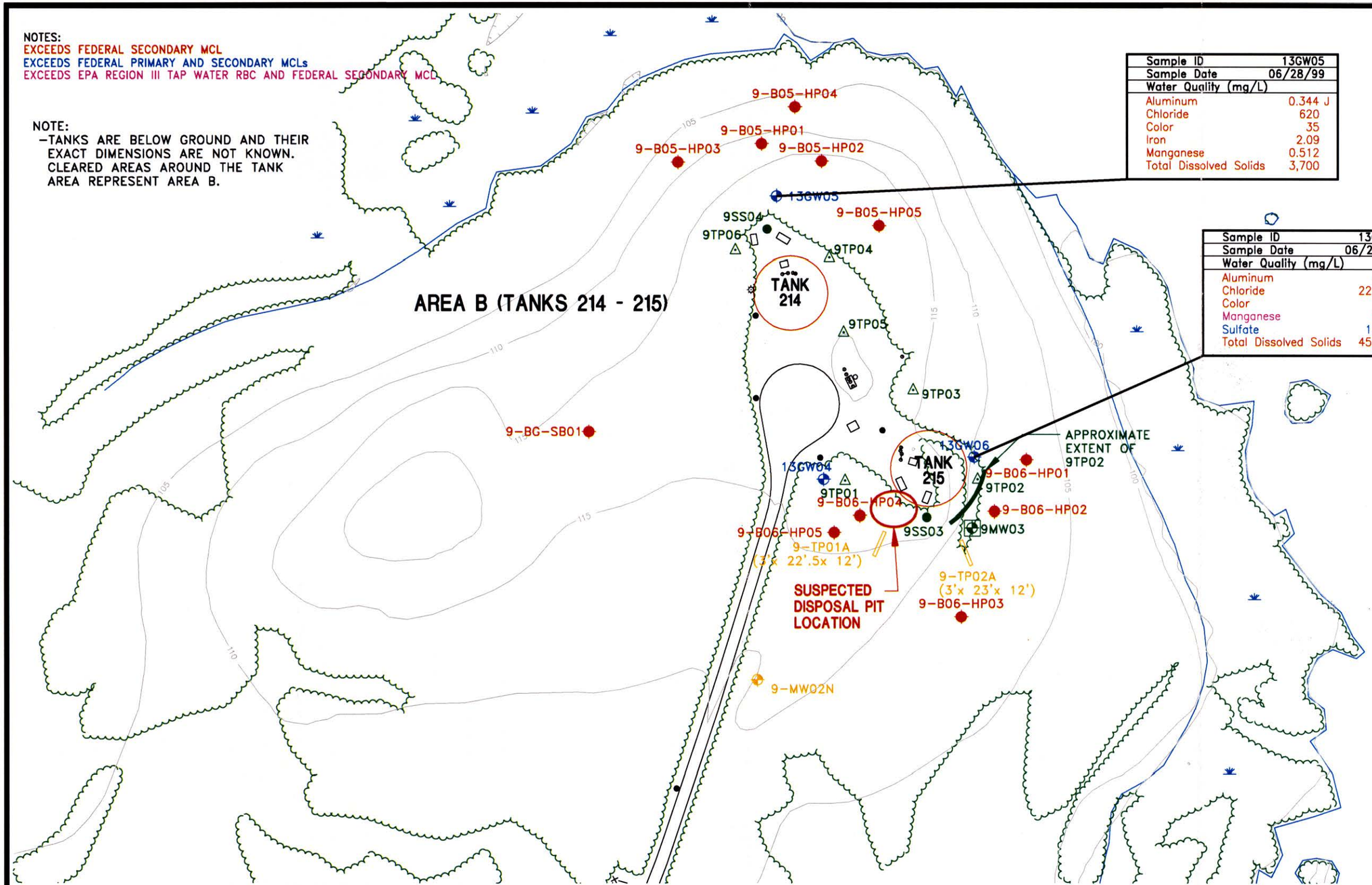
NOTES:
EXCEEDS FEDERAL SECONDARY MCL
EXCEEDS FEDERAL PRIMARY AND SECONDARY MCLs
EXCEEDS EPA REGION III TAP WATER RBC AND FEDERAL SECONDARY MCL

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA B.



Sample ID	13GW05
Sample Date	06/28/99
Water Quality (mg/L)	
Aluminum	0.344 J
Chloride	620
Color	35
Iron	2.09
Manganese	0.512
Total Dissolved Solids	3,700

Sample ID	13GW06
Sample Date	06/28/99
Water Quality (mg/L)	
Aluminum	4.51 J
Chloride	22,000
Color	20
Manganese	13.8
Sulfate	1,300
Total Dissolved Solids	45,000

LEGEND

- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE II)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- MONITORING WELL LOCATION (PHASE II)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

100 0 50 100
1 inch = 100 ft.

Baker

FIGURE 5-18
WATER QUALITY DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 - AREA B
TANKS 214 - 215
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

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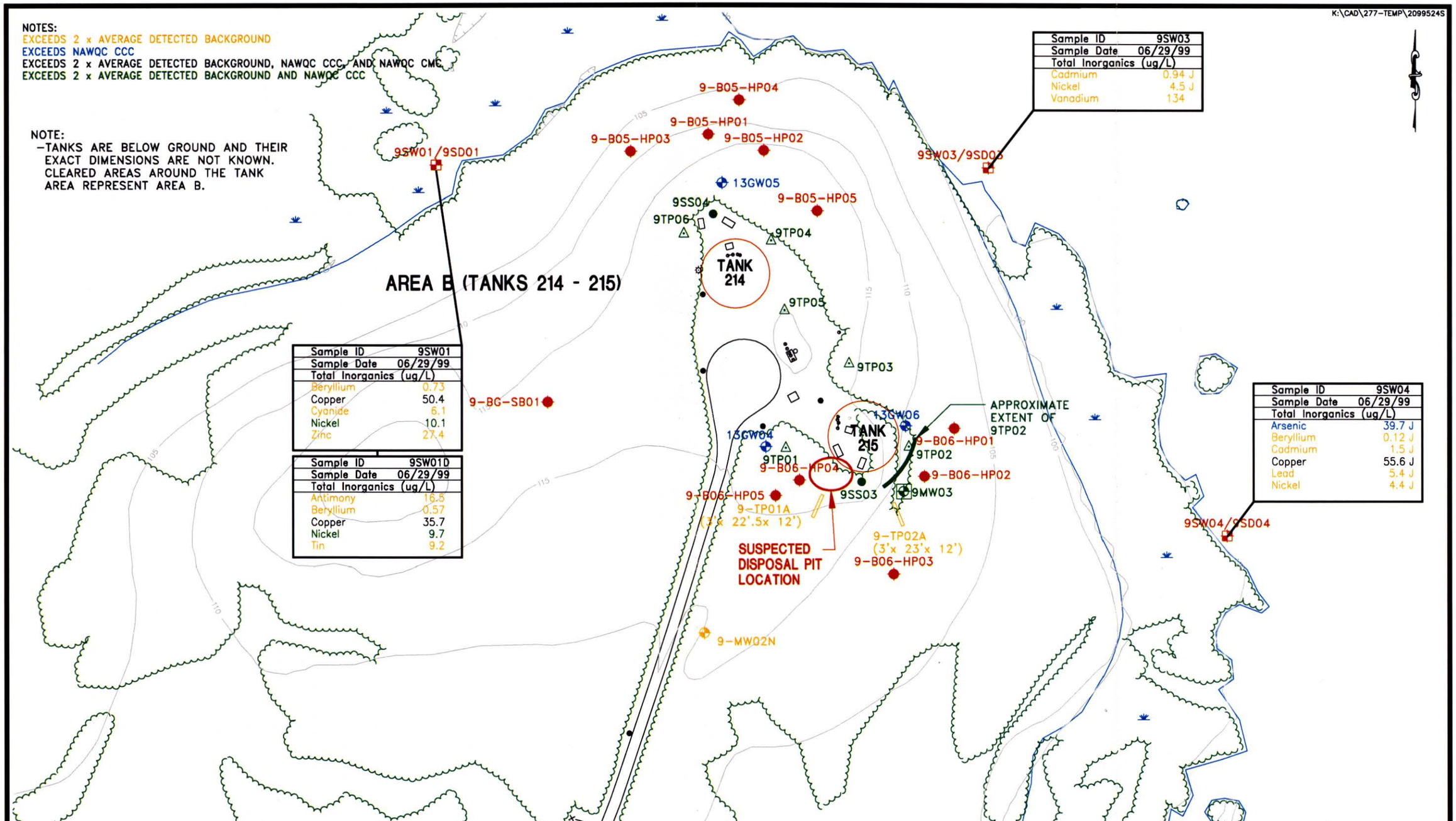
NOTES:
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND
EXCEEDS NAWQC CCC
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND, NAWQC CCC, AND NAWQC CMC
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND AND NAWQC CCC

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA B.



LEGEND

- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE II)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- MONITORING WELL LOCATION (PHASE II)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE
- SURFACE WATER AND SEDIMENT LOCATION (PHASE III)

100 0 50 100
1 inch = 100 ft.

Baker

FIGURE 5-19
SURFACE WATER DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 - AREA B
TANKS 214 - 215
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

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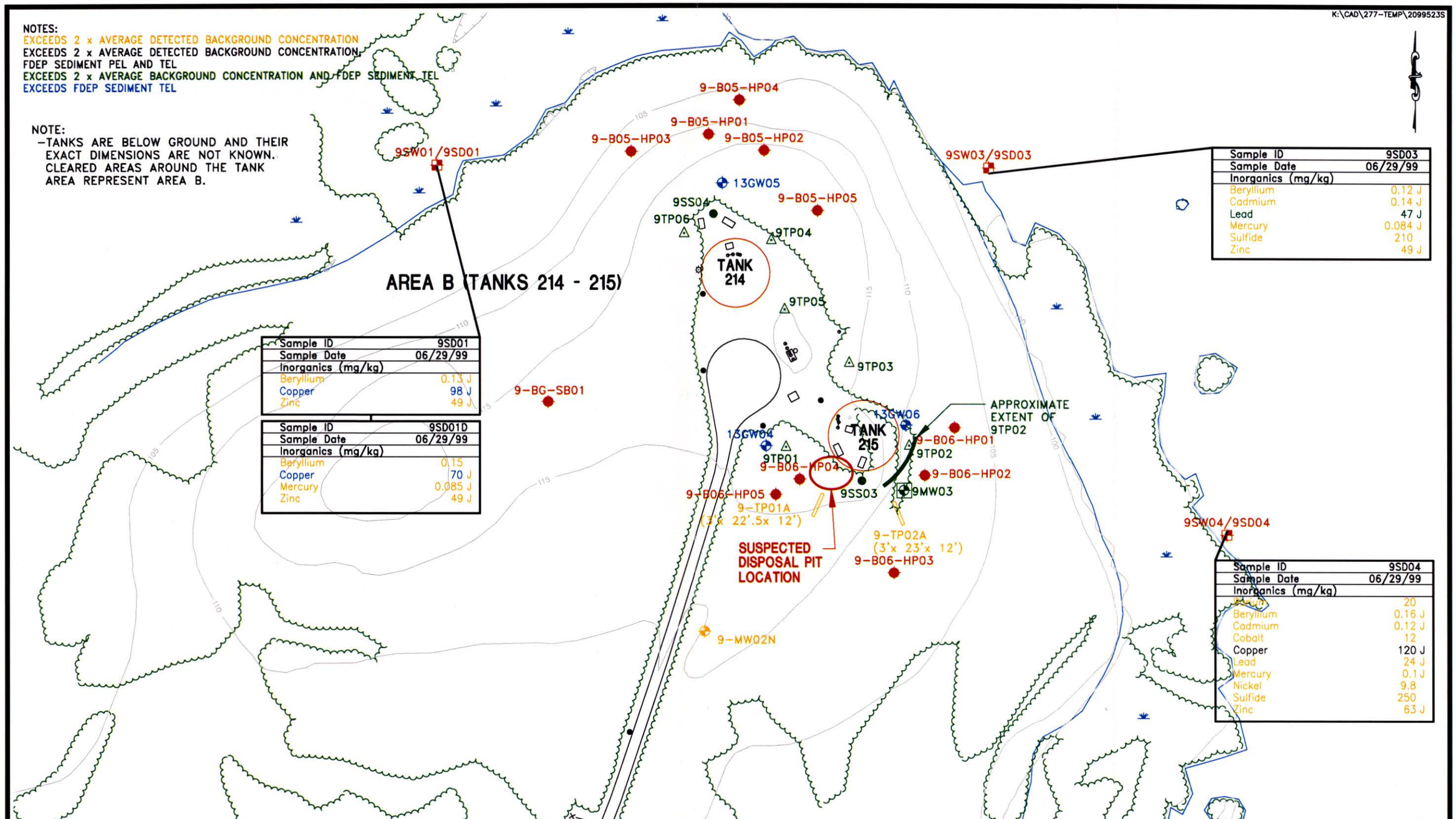
NOTES:
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND CONCENTRATION
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND CONCENTRATION, FDEP SEDIMENT PEL AND TEL
EXCEEDS 2 x AVERAGE BACKGROUND CONCENTRATION AND FDEP SEDIMENT TEL
EXCEEDS FDEP SEDIMENT TEL

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA B.



Sample ID	9SD01
Sample Date	06/29/99
Inorganics (mg/kg)	
Beryllium	0.13 J
Copper	98 J
Zinc	49 J

Sample ID	9SD01D
Sample Date	06/29/99
Inorganics (mg/kg)	
Beryllium	0.15
Copper	70 J
Mercury	0.085 J
Zinc	49 J

Sample ID	9SD03
Sample Date	06/29/99
Inorganics (mg/kg)	
Beryllium	0.12 J
Cadmium	0.14 J
Lead	47 J
Mercury	0.084 J
Sulfide	210
Zinc	49 J

Sample ID	9SD04
Sample Date	06/29/99
Inorganics (mg/kg)	
Arsenic	20
Beryllium	0.16 J
Cadmium	0.12 J
Cobalt	12
Copper	120 J
Lead	24 J
Mercury	0.1 J
Nickel	9.8
Sulfide	250
Zinc	63 J

LEGEND

- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE II)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- MONITORING WELL LOCATION (PHASE II)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE
- SURFACE WATER AND SEDIMENT LOCATION (PHASE III)

100 0 50 100
1 inch = 100 ft.

Baker

FIGURE 5-20
SEDIMENT DETECTIONS ABOVE SCREENING CITERIA
SWMU 9 - AREA B
TANKS 214 - 215
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

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NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA B.

AREA B (TANKS 214 - 215)

TANK 214

9-B05-HP04
9-B05-HP01
9-B05-HP03
9-B05-HP02
13GW05
9-B05-HP05
9SS04
9TP06
0.45 ug/L
9TP04
0.27 ug/L
9TP05
ND
9TP
2 ug/L
9-BG-SB01
13GW06
13GW04
APPROXIMATE EXTENT OF 9TP02
9-B06-HP01
9TP02
9-B06-HP04
9-B06-HP02
9-B06-HP05
9MW03 ND
9-TP01A
(3'x 22'.5x 12')
1.2 ug/L
SUSPECTED DISPOSAL PIT LOCATION
9-TP02A 0.69 ug/L
(3'x 23'x 12')
9-B06-HP03
9-MW02N

CONCENTRATION (mg/kg)

	2.00
	1.60
	1.20
	0.80
EPA REGION III RESIDENTIAL RBC	0.43

LEGEND

- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE II)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- MONITORING WELL LOCATION (PHASE II)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

100 0 50 100
1 inch = 100 ft.

Baker

FIGURE 5-21
DISTRIBUTION OF ARSENIC IN SUBSURFACE SOIL (5-10' BGS)
SWMU 9 - AREA B
TANKS 214 - 215
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

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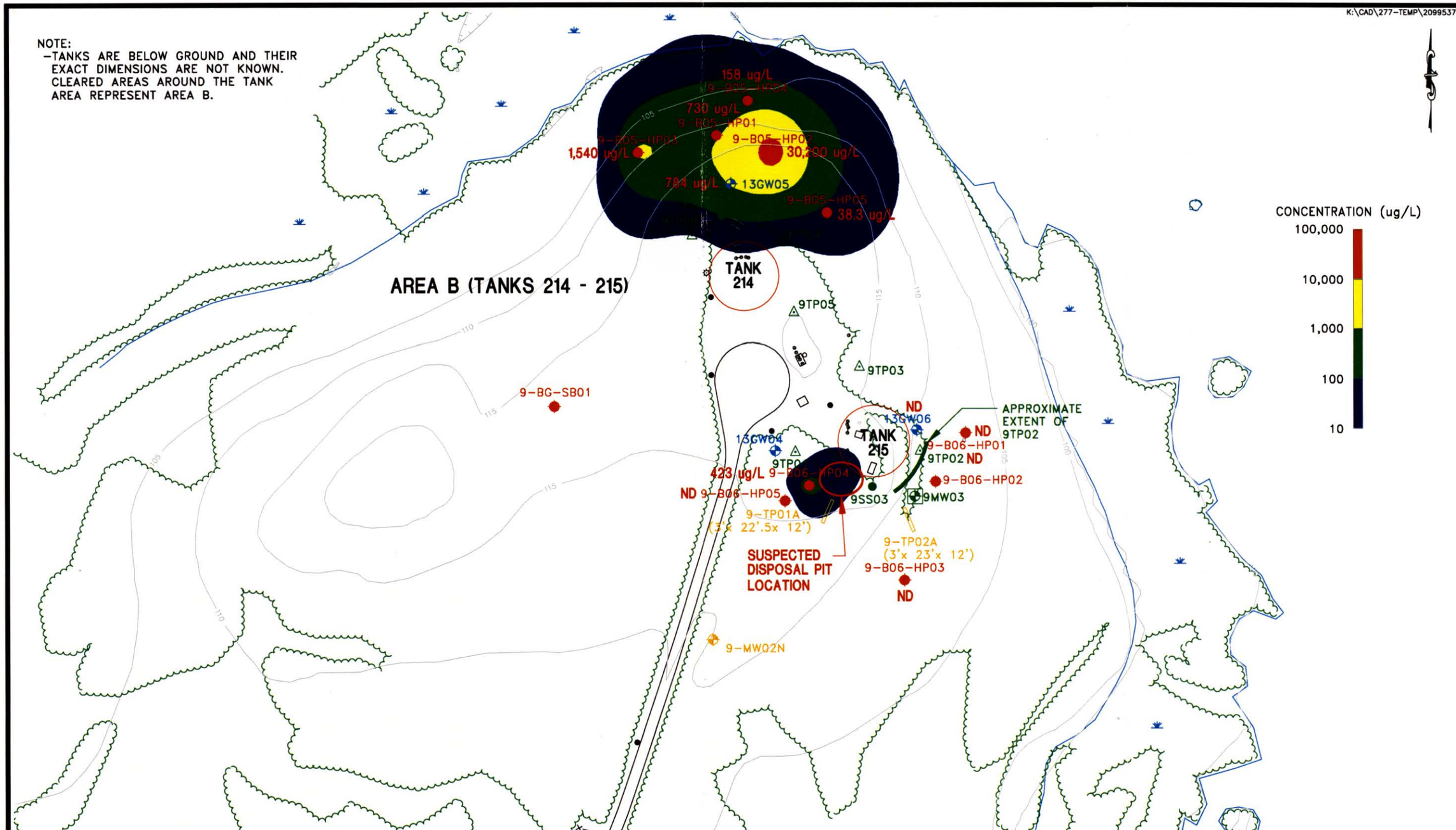
NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. CLEARED AREAS AROUND THE TANK AREA REPRESENT AREA B.



LEGEND

- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE II)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- MONITORING WELL LOCATION (PHASE II)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

100 0 50 100
1 inch = 100 ft.

Baker

FIGURE 5-22
DISTRIBUTION OF TOTAL BTEX IN GROUNDWATER
SWMU 9 - AREA B
TANKS 214 - 215
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

NOTE:
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND CONCENTRATION

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. THE CLEARED TANK AREA CONSTITUTES AREA C.

AREA C (TANKS 216-217)

9SW/SD07
9SW/SD06
13GW10
9TP13
9SS06
9MW04
9TP12
TANK 217
9SS05
9TP14
9SB01
9TP16
9TP17
TANK 216
13GW09
9TP15
9-BG-SB05
13GW08
13GW07
13GW11
9TP11
SUSPECTED DISPOSAL PIT LOCATION

Sample ID	9SS06
Sample Date	03/20/96
Depth Range (ft bgs)	0.00-1.00
RCRA Metals (mg/kg)	
Lead	52.5

80 0 40 80
1 inch = 80 ft.

Baker

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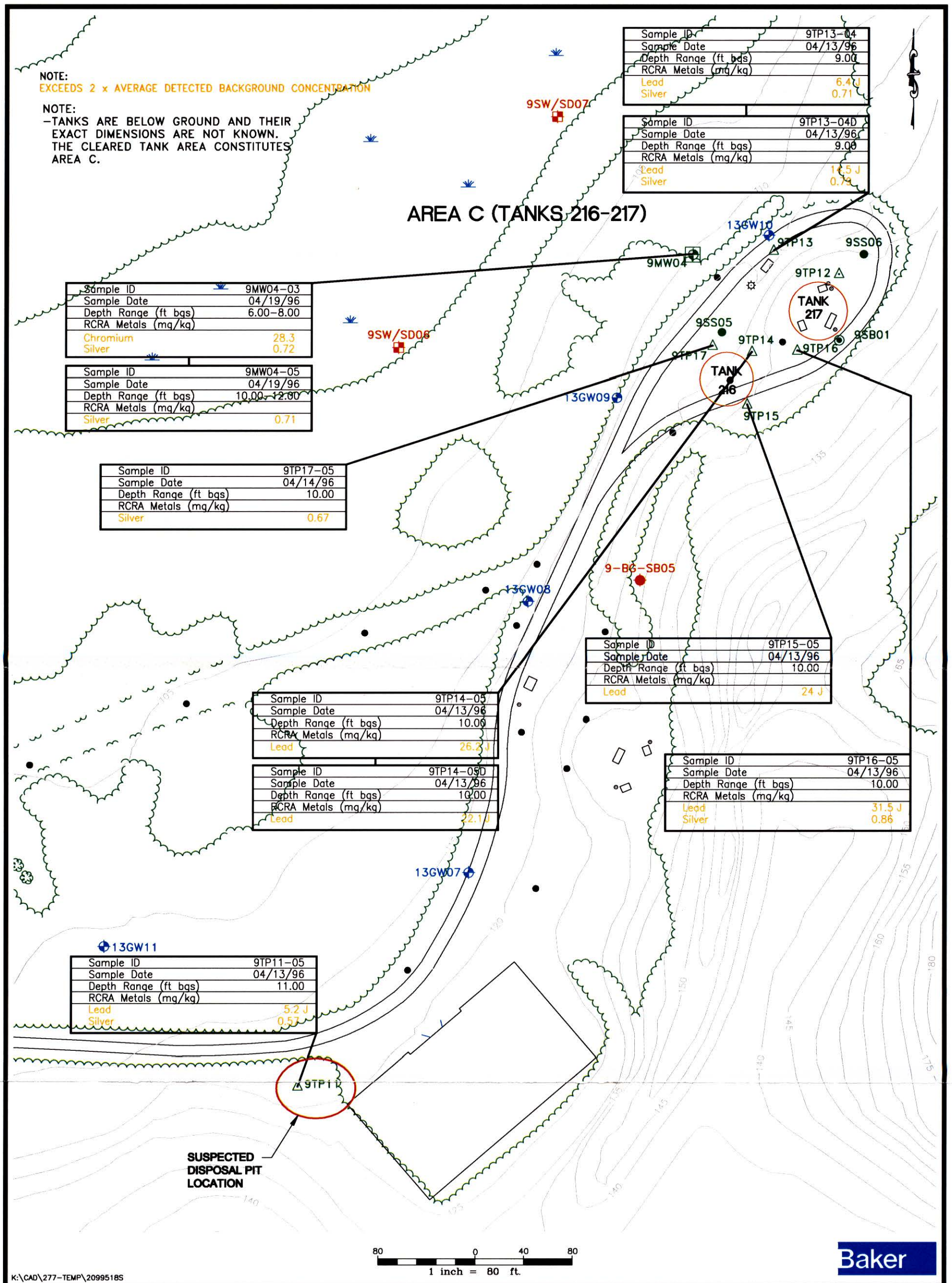
LEGEND
- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- SOIL BORING LOCATION (PHASE I)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- SURFACE WATER AND SEDIMENT SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

FIGURE 5-23
SURFACE SOIL DETECTIONS
ABOVE SCREENING CRITERIA
SWMU 9 - AREA C
TANKS 216 - 217
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



Sample ID	9TP13-04
Sample Date	04/13/96
Depth Range (ft bgs)	9.00
RCRA Metals (mg/kg)	
Lead	6.4 J
Silver	0.71

Sample ID	9TP13-04D
Sample Date	04/13/96
Depth Range (ft bgs)	9.00
RCRA Metals (mg/kg)	
Lead	14.5 J
Silver	0.79

Sample ID	9MW04-03
Sample Date	04/19/96
Depth Range (ft bgs)	6.00-8.00
RCRA Metals (mg/kg)	
Chromium	28.3
Silver	0.72

Sample ID	9MW04-05
Sample Date	04/19/96
Depth Range (ft bgs)	10.00-12.00
RCRA Metals (mg/kg)	
Silver	0.71

Sample ID	9TP17-05
Sample Date	04/14/96
Depth Range (ft bgs)	10.00
RCRA Metals (mg/kg)	
Silver	0.67

Sample ID	9TP15-05
Sample Date	04/13/96
Depth Range (ft bgs)	10.00
RCRA Metals (mg/kg)	
Lead	24 J

Sample ID	9TP14-05
Sample Date	04/13/96
Depth Range (ft bgs)	10.00
RCRA Metals (mg/kg)	
Lead	26.2 J

Sample ID	9TP14-05D
Sample Date	04/13/96
Depth Range (ft bgs)	10.00
RCRA Metals (mg/kg)	
Lead	22.1 J

Sample ID	9TP16-05
Sample Date	04/13/96
Depth Range (ft bgs)	10.00
RCRA Metals (mg/kg)	
Lead	31.5 J
Silver	0.86

Sample ID	9TP11-05
Sample Date	04/13/96
Depth Range (ft bgs)	11.00
RCRA Metals (mg/kg)	
Lead	5.2 J
Silver	0.57

LEGEND

- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- SOIL BORING LOCATION (PHASE I)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- SURFACE WATER AND SEDIMENT SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

FIGURE 5-24
SUBSURFACE SOIL DETECTIONS
ABOVE SCREENING CRITERIA
SWMU 9 - AREA C
TANKS 216 - 217

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

NOTES:
EXCEEDS FEDERAL MCL AND EPA REGION III TAP WATER RBC
EXCEEDS FEDERAL MCL

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. THE CLEARED TANK AREA CONSTITUTES AREA C.

AREA C (TANKS 216-217)

9SW/SD07
9SW/SD08
9MW04
13GW10
9TP13
9SS06
9TP12
TANK 217
9SS05
9TP14
9TP16
9SB01
9TP17
TANK 216
9TP15
13GW09
9-BC-SB05
13GW08
13GW07
13GW11
9TP11

Sample ID	9MW04
Sample Date	04/24/96
RCRA Metals (ug/L)	
Cadmium, Total	12.1

Sample ID	9MW04
Sample Date	04/24/96
RCRA Metals (ug/L)	
Cadmium, Soluble	11.4

Sample ID	9MW04
Sample Date	06/29/99
RCRA Metals (ug/L)	
Cadmium, Soluble	24.7

Sample ID	13GW10
Sample Date	03/24/96
Semivolatiles (ug/L)	
Bis(2-ethylhexyl)phthalate	38

SUSPECTED DISPOSAL PIT LOCATION

80 0 40 80
1 inch = 80 ft.

Baker

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LEGEND

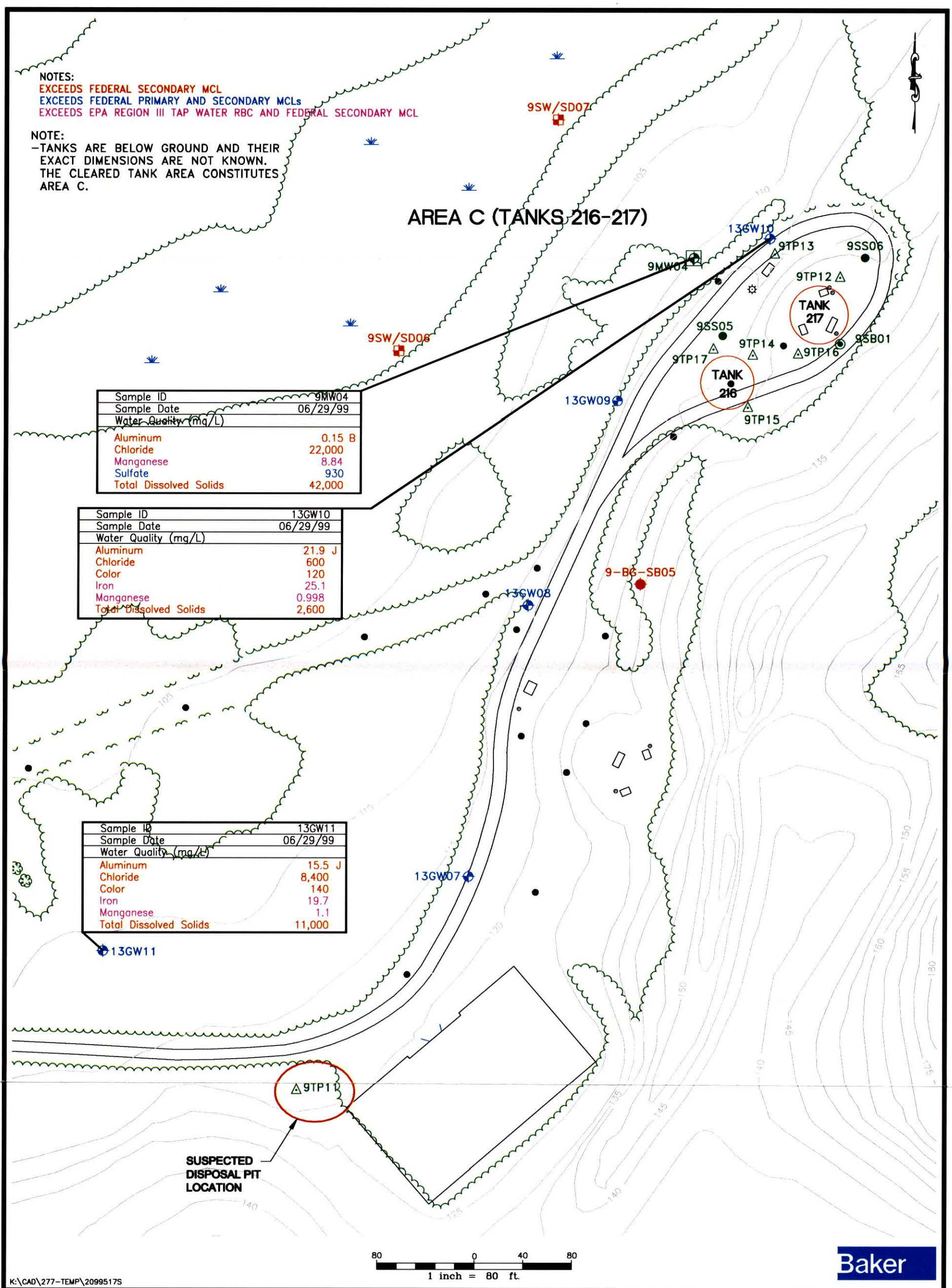
- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- SOIL BORING LOCATION (PHASE I)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- SURFACE WATER AND SEDIMENT SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

FIGURE 5-25
GROUNDWATER DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 - AREA C
TANKS 216 - 217
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

NOTES:
EXCEEDS FEDERAL SECONDARY MCL
EXCEEDS FEDERAL PRIMARY AND SECONDARY MCLs
EXCEEDS EPA REGION III TAP WATER RBC AND FEDERAL SECONDARY MCL

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. THE CLEARED TANK AREA CONSTITUTES AREA C.

AREA C (TANKS 216-217)



Sample ID	9MW04
Sample Date	06/29/99
Water Quality (mg/L)	
Aluminum	0.15 B
Chloride	22,000
Manganese	8.84
Sulfate	930
Total Dissolved Solids	42,000

Sample ID	13GW10
Sample Date	06/29/99
Water Quality (mg/L)	
Aluminum	21.9 J
Chloride	600
Color	120
Iron	25.1
Manganese	0.998
Total Dissolved Solids	2,600

Sample ID	13GW11
Sample Date	06/29/99
Water Quality (mg/L)	
Aluminum	15.5 J
Chloride	8,400
Color	140
Iron	19.7
Manganese	1.1
Total Dissolved Solids	11,000

K:\CAD\277-TEMP\2099517S

Baker

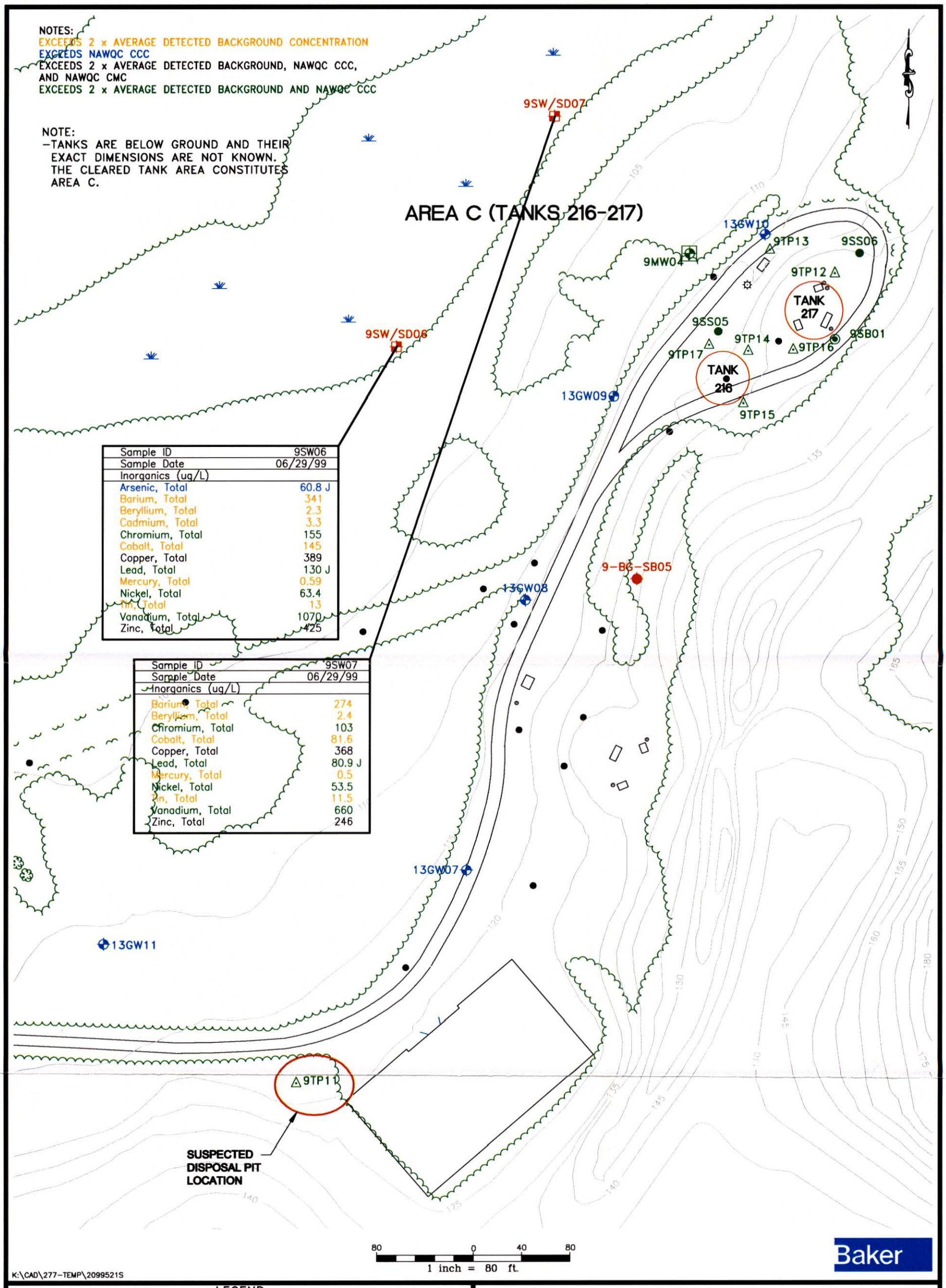
LEGEND

- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- SOIL BORING LOCATION (PHASE I)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- SURFACE WATER AND SEDIMENT SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

FIGURE 5-26
WATER QUALITY DETECTIONS
ABOVE SCREENING CRITERIA
SWMU 9 - AREA C
TANKS 216 - 217
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

NOTES:
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND CONCENTRATION
EXCEEDS NAWQC CCC
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND, NAWQC CCC, AND NAWQC CMC
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND AND NAWQC CCC

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. THE CLEARED TANK AREA CONSTITUTES AREA C.



Sample ID	9SW06
Sample Date	06/29/99
Inorganics (ug/L)	
Arsenic, Total	60.8 J
Barium, Total	341
Beryllium, Total	2.3
Cadmium, Total	3.3
Chromium, Total	155
Cobalt, Total	145
Copper, Total	389
Lead, Total	130 J
Mercury, Total	0.59
Nickel, Total	63.4
Tin, Total	13
Vanadium, Total	1070
Zinc, Total	425

Sample ID	9SW07
Sample Date	06/29/99
Inorganics (ug/L)	
Barium, Total	274
Beryllium, Total	2.4
Chromium, Total	103
Cobalt, Total	81.6
Copper, Total	368
Lead, Total	80.9 J
Mercury, Total	0.5
Nickel, Total	53.5
Tin, Total	11.5
Vanadium, Total	660
Zinc, Total	246

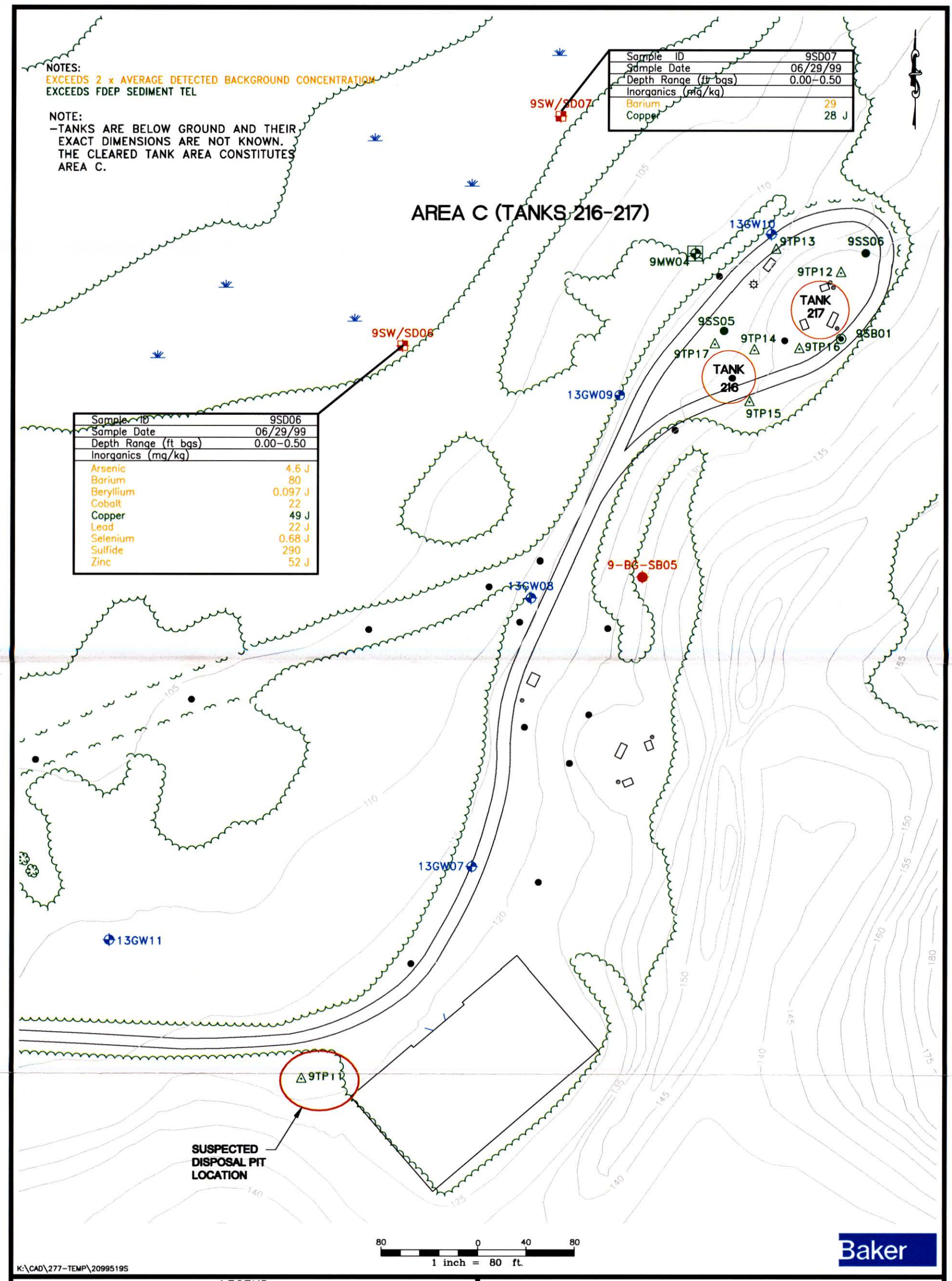
LEGEND

- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- SOIL BORING LOCATION (PHASE I)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- SURFACE WATER AND SEDIMENT SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

FIGURE 5-27
SURFACE WATER DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 - AREA C
TANKS 216 - 217
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

NOTES:
EXCEEDS 2 x AVERAGE DETECTED BACKGROUND CONCENTRATION
EXCEEDS FDEP SEDIMENT TEL

NOTE:
-TANKS ARE BELOW GROUND AND THEIR EXACT DIMENSIONS ARE NOT KNOWN. THE CLEARED TANK AREA CONSTITUTES AREA C.



Sample ID	9SD07
Sample Date	06/29/99
Depth Range (ft bgs)	0.00-0.50
Inorganics (mg/kg)	
Barium	29
Copper	28 J

Sample ID	9SD06
Sample Date	06/29/99
Depth Range (ft bgs)	0.00-0.50
Inorganics (mg/kg)	
Arsenic	4.6 J
Barium	80
Beryllium	0.097 J
Cobalt	22
Copper	49 J
Lead	22 J
Selenium	0.68 J
Sulfide	290
Zinc	52 J

LEGEND

- SURFACE SOIL SAMPLE LOCATION (PHASE I)
- TEST PIT LOCATION (PHASE I)
- SOIL BORING LOCATION (PHASE I)
- HYDROPUNCH SOIL AND/OR GROUNDWATER SAMPLE LOCATION (PHASE III)
- EXISTING MONITORING WELL LOCATION
- MONITORING WELL LOCATION (PHASE I)
- SURFACE WATER AND SEDIMENT SAMPLE LOCATION (PHASE III)
- SURFACE ELEVATION CONTOUR
- SUSPECTED LOCATION OF DISPOSAL PIT
- TELEPHONE POLE

FIGURE 5-28
SEDIMENT DETECTIONS ABOVE SCREENING CRITERIA
SWMU 9 - AREA C
TANKS 216 - 217
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

6.0 HUMAN HEALTH RISK ASSESSMENT

A baseline human health risk assessment (HHRA) was performed, as part of a RCRA facility investigation being conducted at SWMU 9 (Tanks 212 - 217) at NSRR, Puerto Rico. The purpose of the baseline HHRA is to evaluate the potential risks associated with exposure to environmental media resulting from existing conditions at the site if no additional remedial action is undertaken. The baseline HHRA considers the most likely routes of potential human exposure for both current and future risk scenarios and was conducted in accordance with the following documentation: Risk Assessment Guidance for Superfund (RAGS), Volume I. Human Health Evaluation Manual (Part A), Interim Final, December 1989 (EPA, 1989a); and the EPA Region III Risk-Based Concentration Table, dated October,1999 (EPA, 1999a).

This baseline HHRA is comprised of six sections: Section 6.1 presents the selection of COPCs; Sections 6.2 and 6.3 present the exposure assessment and toxicity assessment, respectively; the risk characterization is presented in Section 6.4; Section 6.5 presents sources of uncertainty inherent in the estimation of inferential potential human health effects; and a summary of the baseline HHRA is provided in Section 6.6.

6.1 Identification of Chemicals of Potential Concern

This section provides a summary of the analytical data for surface soil, subsurface soil, groundwater, sediment and surface water that was collected in the RFI investigation, and identifies those chemicals that may pose the most significant risk associated with SWMU 9. Each area of concern, A, B, and C, will be evaluated individually in this HHRA.

6.1.1 Data Evaluation

The environmental media investigated at SWMU 9 includes surface (0 - 1 foot bgs) and subsurface (deeper than 1 foot bgs) soil, groundwater, surface water and sediment. A detailed discussion of laboratory analytical results associated with these media is presented in Section 5.0 of this report. Sample locations for each area of concern (A, B, C) at SWMU 9 are provided on Figures 3-1, 3-2 and 3-3 respectively.

6.1.2 COPC Selection Criteria

EPA Region III suggests that; "The baseline risk assessment process can be made more efficient by focusing on dominant contaminants and routes of exposure at the earliest feasible stage. Two mechanisms recommended for identifying the dominant contaminants are (1) eliminating contaminants that are below background concentrations, and (2) use of a risk-based concentration screen (EPA, 1993, 1989a). Therefore, for this HHRA a two step process was used to identify the dominant contaminants at SWMU 9, or chemicals of potential concern (COPC).

COPCs are those chemicals having the greatest potential to affect human health and the environment. COPCs were selected by first comparing the maximum inorganic chemical concentration detected in the environmental sample to 2 times the average background concentration (EPA, 1999b). Region II Gina Ferria recommends comparing the average site concentration to the average background concentration (EPA, 1999b). However, comparing averages to averages during the initial screening process may ultimately under estimate the risk at a site in which the data distributions for each data set vary significantly. Thus, for this HHRA the maximum site concentration was compared to 2 times the average so that "hot" spot locations would be retained for further analysis. In accordance with EPA Risk Assessment Guidelines comparison with background concentrations is only applicable to inorganic chemicals. It is assumed that while some organic chemicals may be ubiquitous in nature, it is unlikely that the majority of organic chemicals found on a site are naturally occurring (EPA, 1989a). Thus, only inorganic chemicals were screened using the background comparison. Any inorganic chemical exceeding 2 times the average background concentration was retained for further analysis. All organic chemicals will be retained for further analysis.

The second step in the screening process was conducted by comparing the chemicals in environmental samples to Region III Risk Based Concentrations (RBCs) (EPA 1999a). RBCs are derived using conservative EPA promulgated default values and the most recent toxicological criteria available. RBCs for potentially carcinogenic and noncarcinogenic chemicals are individually derived based on a target incremental lifetime cancer risk (ICR) of 1×10^{-6} and a target hazard quotient (HQ) of 1.0, respectively. For potential carcinogens, the toxicity criteria applicable to the derivation of the RBCs are chronic oral and inhalation cancer slope factors; for noncarcinogens they are oral and inhalation reference doses. Noncarcinogenic RBCs were adjusted downward to correspond to a target HQ of 0.1

rather than 1 to ensure that chemicals with additive effects are not prematurely eliminated during screening (EPA 1993a).

6.1.3 Selection of COPCs

The results of the two step screening process are presented in Tables 6-1 through 6-40. A summary of COPCs is presented in Tables 6-41 and 6-42, a discussion of COPC screening results is presented in the following paragraphs.

Background Screen

The following inorganic chemicals exceeded 2 times the average background concentration. The results of this screening process are presented in Tables 6-1 through 6-12, and summarized on Table 6-41. Background screening was not conducted for sediments and surface water because only one sample was collected and an average value could not be calculated. Therefore, all inorganic chemicals detected in sediment and surface water were retained for further analysis in the health based criteria screen.

Area A

Surface Soil	barium, silver, selenium
Subsurface Soil	arsenic, barium, cadmium, chromium, silver, lead
Groundwater, Total	arsenic, chromium, mercury
Groundwater, Soluble	mercury, lead

Area B

Surface Soil	lead, selenium
Subsurface Soil	arsenic, barium, cadmium, lead, silver
Groundwater, Total	none
Groundwater, Soluble	none

Area C

Surface Soil	lead
Subsurface Soil	chromium, silver, lead
Groundwater, Total	none
Groundwater, Soluble	none

Those chemicals that did not pass this first screening against background concentrations were not retained for further analysis in this HHRA.

EPA Region III Health Based Criteria Screen

The following chemicals exceeded their respective EPA Region III RBC. For soils and sediment, the Residential Soil RBC was used for screening. The Tap Water RBC concentrations was conservatively used to screen chemicals in groundwater and surface water. These results are presented in Tables 6-13 through 6-40, and are summarized on Table 6-42.

Area A

Surface Soil	none
Subsurface Soil	arsenic, chromium
Groundwater	acetophenone, benzene, bis (2-ethylhexyl phthalate), ethylbenzene, 2 methylnapthalene, methylene chloride, naphthalene, toluene, arsenic, chromium
Sediment	arsenic, vanadium
Surface Water	arsenic, selenium, vanadium

Area B

Surface Soil	none
Subsurface Soil	arsenic
Groundwater	benzene, bromodichloromethane, bromoform, chloroform, dibromochloromethane, methylene chloride, bis (2-ethyhexyl phthalate)
Sediment	arsenic, chromium, sulfide, vanadium
Surface Water	antimony, arsenic, vanadium

Area C

Surface Soil	none
Subsurface Soil	chromium
Groundwater	1,2 dichloropropane, bis(2-ethylhexyl phthalate)
Sediment	arsenic, chromium, sulfide, vanadium
Surface Water	arsenic, barium, cadmium, chromium, copper, lead, vanadium

The chemicals listed above exceeded both the background concentration screen and the health based concentration screen using EPA Region III RBC's, and were therefore retained for further analysis in this HHRA.

6.2 Exposure Assessment

The exposure assessment addresses each potential current and future exposure pathway in soil, groundwater, surface water, sediment, and air. To determine whether human exposure could occur at SWMU 9 in the absence of remedial action, an exposure assessment was conducted to identify potential exposure pathways and receptors. The following four elements were considered to ascertain whether a complete exposure pathway was present (EPA, 1989a):

- A source and potential mechanism of chemical release
- An environmental retention or transport medium
- A point of potential human contact with the contaminated medium
- An exposure route (e.g., ingestion) at the contact point

The exposure scenarios presented in the following sections are used to estimate individual risks. The reasonable maximum exposure (RME) was evaluated for each scenario utilized in this baseline HHRA. Relevant equations for assessing intakes and exposure factors were obtained from RAGS (EPA, 1989a), Exposure Factors Handbook (EPA, 1989b, 1997a), Dermal Exposure Assessment: Principles and Applications, Interim Report (EPA, 1992a), and Standard Default Exposure Factors. Interim Final (EPA, 1991a). Unless otherwise noted, all the statistical data associated with the factors used in the dose evaluation equations for assessing exposure were obtained from the Exposure Factors Handbook (EPA, 1989b) and the accompanying guidance manuals.

6.2.1 Fate and Transport

This section discusses the potential release and migration of COPCs between or within media. The potential for a chemical to migrate spatially and persist in environmental media is important in the estimation of exposure.

The distribution relationships for a chemical between the environmental compartments of air, water, and soil can be evaluated using a series of equilibrium constants. By utilizing the physiochemical properties of a constituent, it is possible to estimate a chemical's expected environmental distribution and its ultimate environmental fate.

The environmental mobility and persistence of a chemical will be influenced primarily by its physical and chemical properties and the chemistry of the medium in which it occurs. These properties include vapor pressure, water solubility, octanol-water partition coefficient, soil adsorption coefficient, specific gravity, and Henry's Law constant. A discussion of the environmental significance of each of these properties follows.

- Vapor pressure is an indication of the rate at which a chemical will volatilize. It is of primary significance as a removal mechanism at environmental interfaces such as shallow (surface) soil-air and surface water-air. In general, vapor pressures for volatile organics, would be higher than vapor pressures for semivolatiles or pesticides. Chemicals with higher vapor pressures are expected to enter the atmosphere more readily than chemicals with lower vapor pressures. Therefore, volatilization can be a significant loss process for VOCs in shallow (surface) soil and surface water.

- Water solubility measures how much of a chemical can be solubilized and potentially leached from soil by infiltrating precipitation. In general, more soluble chemicals, such as VOCs, are more readily leached than less soluble chemicals.

- The octanol-water partition coefficient (K_{ow}) is a measure of the equilibrium partitioning of chemicals between octanol and water. The coefficient also is useful in characterizing the sorption of compounds by organic soil where experimental values are not available. The octanol water partition coefficient also is used to estimate bioconcentration factors (BCFs) in aquatic organisms.

- The organic carbon adsorption coefficient (K_{oc}) is an indication of the tendency of a chemical to adhere to soil particles containing organic carbon. Chemicals with high soil or sediment adsorption coefficients generally have low water solubilities (and vice versa), as evidenced by the semivolatiles. For example, chemicals such as polynuclear aromatic hydrocarbons (PAHs) are preferentially bound to the soil and are not subject to aqueous transport to the extent as compounds with higher water solubilities, such as VOCs.

- Specific gravity is the ratio of the weight of a given volume of pure chemical at a specified temperature to the weight of the same volume of water at a given temperature. Its primary use is to determine whether a constituent will have a tendency to float or sink (as an immiscible liquid) in water if it is present as a pure compound or at concentrations which exceed its water solubility.

Both vapor pressure and water solubility are of use in determining volatilization rates from surface water bodies and from groundwater. The ratio of these two parameters (Henry's Law constant) is used to calculate the equilibrium constituent concentrations in the vapor (air) phase versus the liquid (water) phase for the dilute solutions commonly encountered in environmental settings.

6.2.2 Potential Human Receptors and Exposure Pathways

NSRR currently operates, and will continue to operate, as a key Naval Station providing full support for Atlantic Fleet Weapons training and development activities. Current potential human receptors being evaluated in this baseline HHRA for possible exposures to COPCs detected in environmental media are limited to on-site adult workers. The on-site workers are assumed to be civilian and/or military personnel who may perform various maintenance and manual labor activities at NSRR. These

activities may result in direct contact exposures to surface soil (0 to 1 foot bgs), sediment and surface water at SWMU 9. Potential exposures to COPCs in the surface soil may occur via the pathways of accidental ingestion, dermal contact and the inhalation of fugitive dusts emanating from areas of low vegetative cover and no pavement. However, the results of the screening process indicate that there are no COPCs in surface soil, thus it will not be evaluated under this scenario. Potential exposures to sediments and surface water that may occur include incidental ingestion and dermal contact.

Groundwater as a potable source will not be evaluated in either a current or future exposure scenario. Groundwater pump tests were conducted at Roosevelt Roads in early May, 1999. Pump tests were conducted for 2.5 days in duration (60 hours) using two well locations. The aggregate yield from these wells was 98.7 gallons per day (McLaren/Hart, Inc., 1999). Potable groundwater aquifers are considered those aquifers which can sustain a residential household requiring 150 gallons of water per day (EPA, 1999). Pump tests indicate that groundwater at Roosevelt Roads could not be used for potable purposes based on yield results and the generally poor, naturally occurring water quality observed throughout at the Station.

Another potential current receptor group considered for evaluation under current exposures scenarios in this baseline HHRA is the recreational users/trespassers. However, due to access restrictions to SWMU 9, exposures to this receptor group are unlikely and will not be evaluated in this baseline HHRA. Despite access restrictions, potential human receptors (and media) include:

- Onsite workers (surface water, sediment)
- Construction workers (Subsurface soil, groundwater)
- Future Military residents (surface water, sediment, groundwater [non-potable])
- Future construction workers (subsurface soil)

Currently, there are no facilities for personnel housing located at any of the sites included in this study. The area will not be developed for personnel housing in the future because of the Station's mission and the need to keep the area in close proximity to the Ensenada Honda as "industrial" for continued support of the fleet. Although future residential development of any SWMU is highly unlikely, future military residential exposures to adult and young child (ages 1 through 6 years old) receptors were evaluated. Future military residents may be exposed to contaminants on surface soil via accidental

ingestion, dermal contact and inhalation of fugitive dusts. Because no COPCs were identified in surface soil, it is considered an incomplete pathway and will not be evaluated.

The future military residents will be evaluated for beneficial use of groundwater. Beneficial use of groundwater for future military residents is defined as washing vehicles and/or exposure to a sprinkler for recreation. In addition a military resident may potentially be exposed to contaminants in sediments and surface water via incidental ingestion and dermal contact, both pathways will be evaluated in this HHRA.

In addition to the future military residents, future construction workers that may perform excavation and related construction activities, were evaluated as potential receptors. Generally, it was assumed that the majority of COPC exposures to this receptor would be due to direct contact with excavated subsurface soil and incidental contact with groundwater. Direct contact exposures to surface soil was not evaluated because no COPCs were identified in surface soil. Therefore, future construction workers were only evaluated for subsurface soil exposures, via the pathways of incidental ingestion, dermal contact and the inhalation of fugitive dusts emanating from excavated subsurface soils at a construction site and incidental contact with groundwater via incidental ingestion and dermal contact. Exposure to vapors emanating from subsurface soil and shallow groundwater would be limited by the type and concentration of contaminants in these SWMU 9 media.

Exposure scenarios and pathways are summarized in Tables 6-46. Exposure parameters associated with each scenario are presented in Appendix J.

6.2.3 Conceptual Site Model

Development of a conceptual site model of potential exposure is critical in evaluating all potential exposures for the aforementioned human receptors. The conceptual site model describes the area of concern in terms of potential sources of contamination, release mechanisms, affected media, and all potential routes of migration of the contaminants present.

The primary sources of contamination are the possible spills and releases into the environment that occurred at SWMU 9. The primary current and future release mechanisms assumed to result in the exposure concentrations of COPCs identified in the environmental media being evaluated in this baseline HHRA include: surface runoff from SWMUs to surface soil in other areas, leaching and vertical migration of contaminants from surface to subsurface soils and groundwater; horizontal contaminant migration through groundwater; and fugitive dust generation from surface soil and future excavated subsurface soil (though current surface generation of fugitive dusts may be hindered to a great extent by existing vegetation). Volatilization of organic contaminants from groundwater through the soil column to ambient air or into foundations was not evaluated as a pathway in this HHRA because of the concentrations present in this medium at SWMU 9. Figure 6-1 presents the site conceptual model for SWMU 9.

6.2.4 Quantification of Exposure

6.2.4.1 Concentrations Used in the Estimate of Exposure

The chemical concentrations used in the estimation of chronic daily intakes (CDIs) and dermally absorbed doses (DADs) for each medium are considered to be representative of the types of potential exposure encountered by each receptor.

Exposure can occur discretely or at a number of sampling locations depending on the type of scenario considered for a given receptor. Furthermore, certain environmental media such as groundwater are migratory and chemical concentrations detected in this medium change frequently over time. Soil, by nature, is less transitory. The manner in which environmental data are represented also depends on the number of samples and sampling locations available for a given area and a given medium.

To quantify exposure, analytical data must be evaluated to determine its distributional nature. In general, two types of distributions are applied to environmental data; these are the normal and log-normal distributions. For example, most large data sets from soil sampling are log-normally distributed rather than normally distributed. The geometric mean is the best estimator of central tendency for a log-normal data set (EPA, 1992b). However, most Agency health criteria are based on the long-term average exposure which is expressed as the sum of all daily intakes divided by the

total number of days in the averaging period. The geometric mean of a set of sampling results may not adequately represent random exposure and the cumulative intake that would result from long-term contact with site contaminants.

Potential exposure to soil and groundwater is considered as having an equal probability of occurrence as an individual moves randomly across the site. Therefore, for these media, the exposure point concentration (EPC) for a constituent in the intake equation can be reasonably estimated as the arithmetic average concentration of site sampling data. EPA supplemental risk assessment guidance (EPA, 1992b) states that the average concentration is an appropriate estimator of the exposure concentration for two reasons: 1) carcinogenic and chronic noncarcinogenic toxicity criteria are based on lifetime average exposures; and 2) the average concentration is most representative of the concentration that would be contacted over time. However, uncertainty is inherent in the estimation of the true average constituent concentration at the site.

The EPC was calculated using the EPA 1992 Calculating the Concentration Term Guidance and was based on its distribution. The Shapiro Wilkes test for samples less than 50 was used to determine if the data is distributed normally or lognormally. Tables 6-43 through 6-45 presents the results of this test. The appropriate method as provided in the 1992 EPA Guidance was used to calculate the EPC based on the distribution of the data (i.e., normal or lognormal). If the 95% UCL was greater than the maximum detected concentration, the maximum concentration was used as the EPC (EPA, 1992b). Appendix K contains the results of the Shapiro Wilkes test and calculation of the 95% UCL.

For results reported as "nondetect" (i.e., results flagged with the following validation qualifiers: U, UJ, UL, and UK), a value of one half of the sample-specific detection limit was used to calculate the 95% UCL. A value of half the detection limit was assigned to nondetects when estimating the 95% UCL because the actual value could be between zero and a value just below the detection limit. Ninety-five percent UCLs were calculated only for the constituents detected in at least one sample collected from the environmental medium of interest. Estimated concentrations also were used to calculate the 95% UCL, such as "J"-qualified (estimated), "L"-qualified (estimated, biased low) and "K"-qualified (estimated, biased high) data. "N"-qualified (tentatively identified) data were also used to estimate the exposure concentration. Reported concentrations qualified with an "R" (rejected) were not used in the statistical evaluation.

6.2.4.2 Calculation of Chronic Daily Intakes

In order to numerically estimate the risks for current and future human receptors at SWMU 9, a CDI or DAD must be estimated for each COPC in every retained exposure pathway. Both the CDI and DAD are chemical intakes, expressed in terms of dose; however, the different terms refer to different pathways of exposure. The CDI term is used to describe chemical intake via the oral and inhalation pathways; the DAD term is used to describe chemical intake via dermal absorption. The CDI/DAD for each COPC is calculated by combining the concentration term with assumed or known conservative exposure factors that describe the rates, frequency and duration of exposure. Since the CDI/DAD is a dose term, body weight of the receptor is also incorporated into the calculation, and the long-term exposure is divided by the total number of days in the averaging period. Thus, the unit obtained for the CDI/DAD resulting from chemical exposure is mg/kg/day. Appendix L contains the specific CDI/DAD calculations for each exposure scenario of interest. These equations were adopted from EPA's Risk Assessment Guidance for Superfund, Volume I (EPA, 1989a; 1991b).

The subsections which follow present the equations and input parameters used in the calculation of CDIs/DADs for each potential exposure pathway being evaluated for this SWMU. Input parameters were taken from EPA's default exposure factors guidelines where available and applicable. All inputs not defined by EPA were derived from EPA documents concerning exposure or were the result of best professional judgment.

6.2.4.2.1 Surface Soil and Subsurface Soil

Accidental Ingestion of Soil

The daily intake associated with the potential accidental ingestion of COPCs detected in soil was calculated using the following equation (EPA, 1989a):

$$CDI = \frac{Cs \ x \ IR \ x \ FI \ x \ CF \ x \ EF \ x \ ED}{BW \ x \ AT}$$

Where:

CDI	=	Chronic Daily Intake, milligram per kilogram day (mg/kg-day)
Cs	=	Chemical concentration in soil, mg/kg
IR	=	Ingestion rate, mg/day
FI	=	Fraction Ingested, unitless
CF	=	Conversion factor, 10^{-6} kg/mg
EF	=	Frequency of exposure, days/year
ED	=	Exposure duration, years
BW	=	Average body weight, kg
AT	=	Averaging time, days

CDI calculations using the above equation are presented in Appendix L.

Dermal Contact with Soil

The absorbed dose associated with the potential dermal contact of COPCs in soil was calculated using the following equation (EPA, 1989a):

$$DAD = \frac{CSxAFxABSxCFxSAxEFxED}{BWxAT}$$

Where:

DAD	=	Dermally absorbed dose, mg/kg-day
CS	=	Chemical concentration in the soil, mg/kg
AF	=	Adherence factor, milligram per square centimeter day (mg/cm^2-d)
ABS	=	Absorbed fraction, unitless
CF	=	Conversion factor, 10^{+6} mg/kg
SA	=	Surface area of exposed skin, cm^2
EF	=	Exposure frequency, days/year
ED	=	Exposure duration, years
BW	=	Average body weight, kg
AT	=	Averaging time, days

CDI calculations using the above equation are presented in Appendix L.

Inhalation of Fugitive Dust

The daily intake resulting from the inhalation of soil COPCs adsorbed onto fugitive dust particulates was estimated using the following equation (EPA, 1989a):

$$CDI = \frac{Ca \times RR \times ET \times EF \times ED}{BW \times AT}$$

Where:

CDI	=	Chronic Daily Intake, mg/kg-day
Ca	=	Chemical concentration in air as fugitive dust,(mg/m^3)
RR	=	Respiration rate, m^3/day
ET	=	Exposure time, hours/day
EF	=	Frequency of exposure, days/year
ED	=	Exposure duration, years
BW	=	Average body weight, kg
AT	=	Averaging time, days

The air concentration (Ca) of a chemical in fugitive dust emissions was estimated from the following equation, as determined by Cowherd (1985), and provided by the EPA (1991b). The particulate emission factor used is recommended by EPA Soil Screening Guidance (EPA 1996) and assumes 50% vegetative cover and an annual wind-speed of 4.69 m/s.

$$Ca = Cs \times 1/PEF$$

Where:

Cs	=	Concentration of chemical in the soil, mg/kg
PEF	=	Particulate emission factor, $1.32 \times 10^{+9}$ m^3/kg

CDI calculations using the above equations are presented in Appendix L.

6.2.3.2.2 <u>*Groundwater*</u>

Ingestion of Non-Potable Groundwater

The daily intake associated with the incidental ingestion of the COPCs in groundwater under a non-potable use scenario was calculated using the following equation (EPA, 1989b):

$$CDI = \frac{Cw \times IR \times EF \times ED \times ET}{BW \times AT}$$

Where:

CDI	=	Chronic Daily Intake, mg/kg-day
Cw	=	Chemical concentration in groundwater, mg/L
IR	=	Ingestion rate, L/hr
EF	=	Frequency of exposure, days/year
ED	=	Exposure duration, years
ET	=	Exposure time, hours/day
BW	=	Average body weight, kg
AT	=	Averaging time, days

Dermal Contact with Non-Potable Groundwater

The absorbed dose associated with potential incidental dermal contact with COPCs in groundwater was calculated using the following equation (EPA, 1989b):

$$DAD = \frac{Cw \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$$

Where:

DAD	=	Dermally absorbed dose, mg/kg-day
Cw	=	Concentration in water, mg/L
SA	=	Surface area of exposed skin, cm^2
PC	=	Permeability constant, cm/hr
ET	=	Exposure time, hours/day
EF	=	Exposure frequency, days/year
ED	=	Exposure duration, years
CF	=	Conversion factor, 1 L/1000 cm^3
BW	=	Average body weight, kg
AT	=	Averaging time, days

6.2.4.3 Exposure Factors Used To Derive Chronic Daily Intakes

Exposure factors used in the estimation of potential CDIs/DADs for COPCs retained for current on-site workers, future construction workers, and future on-site military adult and child residents, respectively are located in Appendix J. EPA promulgated exposure factors are used in conjunction with EPA standard default exposure factors for the RME scenarios. Furthermore, when EPA exposure factors are not available, best professional judgment and site-specific information are used to derive a conservative and defensible value.

6.3 Toxicity Assessment

Section 6.2 presented potential exposure pathways and receptors for this baseline HHRA. This section will review the available toxicological information for COPCs retained for quantitative evaluation.

An important component of the HHRA process is the relationship between the dose of a compound (amount to which an individual or population is potentially exposed) and the potential for adverse health effects resulting from exposure to that dose. Dose-response relationships provide a means by which potential public health impacts may be evaluated. Standard reference doses (RfDs) and/or carcinogenic slope factors (CSFs) have been developed for many of the COPCs. This section provides a brief description of these parameters.

6.3.1 Reference Doses

The RfDs and Reference Concentrations (RfCs for inhalation) are developed for chronic and/or subchronic human exposure to chemicals and are based solely on the noncarcinogenic effects of chemical substances. These values presented in Tables 6-47 through 6-49 and are defined as an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of adverse effects during a lifetime. The RfD is expressed as dose (mg) per unit body weight (kg) per unit time (day). The RfC is expressed as dose (mg) per cubic meter of air (m^3) (EPA 1997b, EPA 1999e).

6.3.2 Carcinogenic Slope Factors

The potential carcinogenic health effects associated with exposures to carcinogenic COPCs were evaluated using cancer slope factors (CSF) established by EPA (1999e). The CSF is an estimate of an upper-bound probability of an individual developing cancer as a result of a lifetime of exposure to a particular level or dose of potential carcinogen. The cancer slope factor is expressed as $(mg/kg/day)^1$. CSFs for oral and inhalation pathways have been developed. The CSFs developed by EPA for the COPCs and the EPA Weight of Evidence (WOE) Classification for each COPC are presented in Tables 6-50 through 6-53 of this HHRA. The WOE classifications are explained below:

Group A	Human Carcinogen (sufficient evidence of carcinogenicity in humans)
Group B1	Probable Human Carcinogen (limited evidence of carcinogenicity in humans)
Group B2	Probable Human Carcinogen (sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans)
Group C	Possible Human Carcinogen (limited evidence of carcinogenicity in animal or lack of human data)
Group D	Not Classifiable as to Human Carcinogenicity (inadequate or no evidence)
Group E	Evidence of Noncarcinogenicity for Humans (no evidence of carcinogenicity in adequate studies)

According to EPA guidance (1989a), only those chemicals with Group A, B (B1 or B2), or rankings need to be addressed for possible carcinogenic effects.

6.3.3 Dermal Absorption Efficiency

Many of the RfDs and CSFs are derived from oral toxicological studies based on administered dose and do not account for the amount of a substance that can penetrate exchange boundaries after contact (e.g., absorbed dose). As a result, there is very little information available regarding dermal toxicity criteria. Therefore, in order to account for a difference in toxicity between an administered dose and an absorbed dose, the RfDs and CSFs (that were based on an administered dose) were adjusted, as described by the EPA (EPA, 1989a), using experimentally-derived oral absorption efficiencies. The adjustment for the oral RfD that would correspond to a dermally absorbed dose is represented by multiplying the RfD by an oral absorption efficiency. The adjustment for the oral CSF that would correspond to the dermally absorbed dose is represented by dividing the CSF by an oral absorption efficiency. The oral absorption efficiencies were obtained from sources such as the National Center for Environmental Assessment, IRIS, toxicological profiles, toxicology publications, toxicology references, and EPA Regional Offices (EPA 1999e).

Chemical-specific absorption efficiencies used in this baseline HHRA for SWMU 9 are also presented in Appendix M.

6.4 Risk Characterization

The risk characterization combines COPCs, potential exposure, and toxicity, to produce a quantitative estimate of current and future potential human health risks associated with SWMU 9.

6.4.1 Carcinogenic Compounds

Quantitative risk calculations for potentially carcinogenic compounds estimate inferentially (versus probabilistically) the potential ILCR for an individual in a specified population. This unit of risk refers to a potential cancer risk that is above the background cancer risk in unexposed individuals. For example, an ILCR of 1×10^{-6} indicates that an exposed individual has an increased probability of one in one million of developing cancer subsequent to exposure over the course of their lifetime. The potential lifetime ILCR for an individual was estimated from the following relationship:

$$ILCR = \sum_{i=1}^{n} (CDI_i \text{ or } DAD_i) \times CSF_i$$

where the CSF_i is expressed as $(mg/kg/day)^{-1}$ for compound i, and the CDI_i and dermally absorbed dose (DAD_i) is expressed as mg/kg/day for compound i. Since the units of CSF are (mg chemical/kg body weight-day)$^{-1}$ and the units of intake or dose are [mg chemical/kg body weight-day], the ILCR value is dimensionless. The aforementioned equation was derived assuming that cancer is a nonthreshold process and that the potential excess risk level is proportional to the cumulative intake over a lifetime.

For quantitative estimation of risk, it is assumed that cancer risks from various exposure routes are additive. Estimated ILCR values will be compared to 1×10^{-6} to 1×10^{-4} which represents the target risk range of ILCR values considered by the EPA to represent an acceptable (i.e., de minimis) risk (EPA, 1990).

6.4.2 Noncarcinogenic Compounds

Noncarcinogenic compounds assume that a threshold toxicological effect exists. Therefore, the potential for noncarcinogenic effects is calculated by comparing (i.e., dividing) CDI_i or DAD_i levels with RfDs for each COPC.

Noncarcinogenic effects are estimated by calculating the HQ for individual chemicals and the HI for overall chemicals and pathways by the following equation:

$$HI = \sum_{i=1}^{n} HQ_i$$

$$\text{where: } HQ_i = (CDI_i \text{ or } DAD_i)/RfD_i \text{ or } RfC_I$$

A HQ is the ratio of the daily intake or absorbed dose to the reference dose (or reference concentration for inhalation exposure). CDI_i is the chronic daily intake (mg/kg/day) of contaminant i; DAD_i is the

dermally absorbed dose (mg/kg/day) of contaminant i; and RfD_i is the reference dose (mg/kg/day) of contaminant i over a prolonged period of exposure. RfC is the reference concentration used when determining exposure due to inhalation. Since the units of RfD are mg/kg-day and the units of CDI or DAD are mg/kg/day, the HQ and HI are dimensionless.

To account for the additivity of noncarcinogenic risk following exposure to numerous chemicals, the HI, which is the sum of all the HQs, will be calculated. A ratio of 1.0 is used for examination of the HQ and HI. Ratios less than 1.0 indicate that adverse noncarcinogenic health effects are unlikely. Ratios greater than or equal to 1.0 indicate the potential for adverse noncarcinogenic health effects to occur at that exposure level and caution should be exercised. However, this does not mean that adverse effects will definitely be observed since the RfD incorporates safety and modifying factors to ensure that it is well below that dose for which adverse effects have been observed. This procedure assumes that the risks from exposure to multiple chemicals are additive, an assumption that is probably valid for compounds that have the same target organ or cause the same toxic effect.

6.4.3 Potential Human Health Effects

Potential carcinogenic and noncarcinogenic human health risks were estimated for human receptors under RME scenarios previously identified in Section 6.2.1. For each receptor, total site carcinogenic and total site noncarcinogenic risks were estimated for area A, B and C individually and are presented in Tables 6-53 through 6-61 (Note: the total site risks presented for future residents represent the lifetime sum of the adult and child risks at one residence location for a period of 30 years.). Those scenarios that resulted in unacceptable risks, i.e., those scenarios for which carcinogenic and/or noncarcinogenic risks were estimated to exceed EPA acceptable risk criteria (the target risk range of 1×10^{-6} to 1×10^{-4} and the target HI value of 1.0, respectively) are shaded in the table. The risk calculation spreadsheets showing the calculation of all CDIs, DADs, ILCRs, and HIs, by receptor, SWMU and pathway, are presented in Appendix L.

The following risks are discussed by receptor and by area of concern.

6.4.3.1 Area A

Future On-site Residents

Table 6-53 shows that the total ILCRs estimated for adult and young child residential exposures (1.3 x 10^{-5} and 8.0 x 10^{-6}, respectively) to groundwater, surface water, and sediment at SWMU 9 Area A did not exceed EPA's generally acceptable target risk range of 1 x 10^{-6} to 1 x 10^{-4}.

The total HI values estimated for adult residential exposures (0.50) to noncarcinogenic COPCs in SWMU 9 Area A groundwater, surface water and sediment did not exceed EPA's acceptable target value of 1.0. The total HI for the young residential child did exceed the acceptable HI, with an HI of 1.06. Eighty-one percent of this exceedance was contributed by exposures to chromium and benzene in groundwater (24% benzene-ingestion groundwater, 3% chromium-ingestion groundwater, 20% benzene-dermal groundwater, and 35% chromium dermal groundwater.

Hazard quotient values for benzene and chromium cannot be summed. The RfD for benzene is not specific to a primary target organ but benzene is most likely to affect the blood. Chromium affects the gastrointestinal tract. As a result, no adverse systemic health effects are expected subsequent to exposure.

Current On-Site Workers

Table 6-54 shows that the total ILCR (3.0 x 10^{-6}) estimated for on-site worker exposures to surface water and sediment at SWMU 9 Area A did not exceed EPA's generally acceptable target risk range of 1 x 10^{-6} to 1 x 10^{-4}. The total HI value (0.04) estimated for on-site worker exposures to noncarcinogenic COPCs in SWMU 9 Area A surface water and sediment is less than 1.0, indicating that the potential for the occurrence of adverse systemic effects is insignificant.

Future Construction Workers

Table 6-55 shows that the total ILCR (8.4 x 10^{-7}) estimated for construction worker exposures to subsurface soil and groundwater at SWMU 9 Area A did not exceeded EPA's generally acceptable target risk range of 1 x 10^{-6} to 1 x 10^{-4}. The total HI value (1.11) estimated for construction worker exposures to noncarcinogenic COPCs in SWMU 9 surface soil was greater than 1.0, indicating that the potential for the occurrence of adverse systemic effects exist. Incidental exposure to groundwater contributes eighty-six percent of the noncarcinogenic risk, of which thirty-eight percent is from dermal

contact with chromium in groundwater, and twenty-two percent is from dermal contact with benzene in groundwater. Exposure to subsurface soil contributed 14% of the nonconcarcinogenic risk. Seventy-five percent of the risk from subsurface soil is contributed from dermal exposures to chromium.

Hazard quotient values for benzene and chromium cannot be summed. The RfD for benzene is not specific to a primary target organ but benzene is most likely to affect the blood. Chromium affects the gastrointestinal tract. As a result, no adverse systemic health effects are expected subsequent to exposure.

6.4.3.2 Area B

Future On-Site Residents

Table 6-56 shows that the total ILCRs estimated for adult and young child residential exposures (9.0×10^{-6} and 6.4×10^{-6}, respectively) to groundwater, surface water, and sediment at SWMU 9 Area B did not exceed EPA's generally acceptable target risk range of 1×10^{-6} to 1×10^{-4}.

The total HI values estimated for adult residential exposures and young residential exposures (0.39 and 0.78, respectively) to noncarcinogenic COPCs in SWMU 9 Area B groundwater, surface water and sediment did not exceed EPA's acceptable target value of 1.0. These results indicate that the potential for the occurrence of adverse systemic effects is insignificant

Current On-Site Workers

Table 6-57 shows that the total ILCR (3.0×10^{-6}) estimated for on-site worker exposures to surface water and sediment at SWMU 9 Area B did not exceeded EPA's generally acceptable target risk range of 1×10^{-6} to 1×10^{-4}. The total HI value (0.25) estimated for on-site worker exposures to noncarcinogenic COPCs in SWMU 9 Area A surface water and sediment is less than 1.0, indicating that the potential for the occurrence of adverse systemic effects is insignificant.

Future Construction Workers

Table 6-58 shows that the total ILCR (6.5×10^{-7}) estimated for construction worker exposures to subsurface soil and groundwater at SWMU 9 Area B did not exceeded EPA's generally acceptable target risk range of 1×10^{-6} to 1×10^{-4}. The total HI value (0.15) estimated for construction worker exposures to noncarcinogenic COPCs in SWMU 9 Area B surface water and sediment is less than 1.0, indicating that the potential for the occurrence of adverse systemic effects is insignificant.

6.4.3.3 Area C

Future On-Site Residents

Table 6-59 shows that the total ILCRs estimated for adult and young child residential exposures (7.1×10^{-6} and 2.2×10^{-6}, respectively) to groundwater, surface water, and sediment at SWMU 9 Area C did not exceed EPA's generally acceptable target risk range of 1×10^{-6} to 1×10^{-4}.

The total HI values estimated for adult residential exposures (0.79) to noncarcinogenic COPCs in SWMU 9 Area C groundwater, surface water and sediment did not exceed EPA's acceptable target value of 1.0. The total HI for the young residential child did exceed the acceptable HI, with an HI of 1.29. Ninety percent of the risk this exceedance was contributed by dermal exposure to chromium and vanadium in surface water and sediment (34% vanadium surface water, 23% chromium surface water, 15% chromium in sediment, and 19% vanadium in sediment).

Current On-Site Workers

Table 6-60 shows that the total ILCR (6.1×10^{-6}) estimated for on-site worker exposures to surface water and sediment at SWMU 9 Area C did not exceeded EPA's generally acceptable target risk range of 1×10^{-6} to 1×10^{-4}. The total HI value (0.57) estimated for on-site worker exposures to noncarcinogenic COPCs in SWMU 9 Area C surface water and sediment is less than 1.0, indicating that the potential for the occurrence of adverse systemic effects is insignificant.

Future Construction Workers

Table 6-61 shows that the total ILCR (2.4×10^{-8}) estimated for construction worker exposures to subsurface soil and groundwater at SWMU 9 Area C did not exceeded EPA's generally acceptable target risk range of 1×10^{-6} to 1×10^{-4}. The total HI value (0.42) estimated for construction worker exposures to noncarcinogenic COPCs in SWMU 9 Area C surface water and sediment is less than 1.0, indicating that the potential for the occurrence of adverse systemic effects is insignificant.

6.5 Sources of Uncertainty

Uncertainties are encountered throughout the process of performing a risk assessment. This section discusses the sources of uncertainty inherent in the following elements of the baseline human health risk assessment prepared for SWMU 9, NSRR:

- Sampling and analysis
- Selection of COPCs
- Exposure assessment
- Toxicity assessment
- Risk characterization

Uncertainties associated with this baseline HHRA are discussed in the following paragraphs.

6.5.1 Sampling and Analysis

The development of a risk assessment depends on the reliability of, and uncertainties associated with, the analytical data available to the risk assessor. These, in turn, are dependent on the operating procedures and techniques applied to the collection of environmental samples in the field and their subsequent analyses in the laboratory. To minimize the uncertainties associated with sampling and analysis at SWMU 9, EPA approved sampling and analytical methods were employed. Data were generated following RCRA methods of analysis for organics and inorganics, and were validated in accordance with EPA Region II procedures. Samples were taken from locations specified in the approved Work Plan along with the necessary QA/QC samples. However, there are inherent uncertainties in incorporating several data sets from different investigations. The dates of sample collection differ by several years. The older data may not represent current conditions at the site. In

addition, data sets from previous investigations were generated from different analytical methods. The quality and usability of these data are uncertain since no data validation was performed.

The reporting of elevated detection sample quantitation limits (SQLs) for individual VOC and SVOC constituents in surface and subsurface soil samples, in conjunction with the observed elevated detections of TPH, indicate the possible masking of actual constituent concentrations by interferences due to the presence of free product and matrix effects. One reason for the elevated SQLs is the dilution of samples. Analysis of a diluted sample could potentially impact a risk assessment since SQLs are reported at elevated values proportional to the magnitude of the dilution factor, and elevated SQLs could be masking detectable concentrations of lesser values. Values of one-half the elevated SQLs are then used for sample sets greater than ten samples to calculate exposure concentrations in the risk assessment, in accordance with Federal EPA risk assessment guidance (EPA, 1989a), equal to the upper limit of the 95 percent confidence interval of the arithmetic mean concentration.

Also, elevated SQLs due to the conversion of wet weight laboratory results to dry weight results for soil samples using the reported percent moisture content of the samples. This procedure is necessary in order to obtain "true" soil concentrations of the solid phase, rather than wet weight results which are representative of both the solid and aqueous phase of the sample.

The statistical methods used to compile and analyze the data (mean concentrations, detection frequencies) are subject to the overall uncertainty in data measurement. Furthermore, chemical concentrations in environmental media fluctuate over time and with respect to sampling location. Analytical data should be sufficient to consider the temporal and spatial characteristics of contamination at the site with respect to exposure. Tables 6-43, 6-44 and 6-45 indicate that in most cases, there was not a sufficient number of sampling locations to accurately identify an upper-bound (i.e. 95% UCL) exposure concentration. Therefore, the maximum concentration was used to calculate the CDI or DAD, and ultimately to estimate the carcinogenic and non-carcinogenic risk. Using the maximum concentration as an EPC could potentially overestimate the risk associated with contaminants in environmental media.

6.5.2 Selection of COPCs

The selection of COPCs is performed in a risk assessment following the evaluation of data. Analytical data also must be comprehensive in order to address the COPCs associated with the site. Types of organic COPCs encountered at SWMU 9 include VOCs (in the groundwater) and SVOCs (in the groundwater). Inorganic constituents were detected in every medium investigated. A summary of the COPC selection criteria for chemicals detected in soil groundwater, surface water and sediment is presented below.

- Soil and groundwater inorganic maximum concentrations were screened to 2 times the average background concentration.

- Soil and sediment COPCs were selected based on comparisons of the maximum detected concentration with Region III risk-based residential soil RBCs.

- Groundwater COPCs were selected based on comparisons of the detected concentrations with Region III risk-based tap water COC screening values and Federal MCLs.

Region III RBCs are based on exposure assumptions and equations that are intended to introduce conservatism in the risk assessment process by changing the COPC screening method from a relative toxicity screen as presented in RAGS, to an absolute comparison of risk. However, the use of the Region III RBCs which incorporate a set of non-site-specific assumptions in the selection of COPCs at SWMU 9, adds conservatism to the baseline HHRA.

Currently, no Station closures are planned for NSRR and future residential development of the land is not expected. Therefore, using residential RBCs to select COPCs could be considered conservative. The use of conservative COPC selections in the baseline HHRA ensures the protection of public health in that the results of the baseline HHRA are incorporated into the determination of remedial alternatives and remedial action objectives in the CMS.

6.5.3 Exposure Assessment

In performing exposure assessments, uncertainties arise from two main sources. First, uncertainties arise in estimating the fate of a compound in the environment, including estimating release and transport in a particular environmental medium. Second, uncertainties arise in the estimation of chemical intakes resulting from contact by a receptor with a particular medium. An example of uncertainty introduced by the latter source is the estimation of potential intakes to construction workers as a result of incidental contact exposures to groundwater during excavation/construction activities. Incidental contact exposures to groundwater during construction activities include dermal contact and ingestion of groundwater by hand to mouth or splashing activity. It was assumed in this HHRA that these exposures would occur while standing in an excavation trench. Groundwater at SWMU 9 lies approximately 6-12 feet bgs. It is unlikely that a worker would be standing in a 6-12 foot trench due to health and safety regulations. In addition, it was assumed that this activity would occur for one hour each working day. Again, it is unlikely that a worker would submerse himself in groundwater in an excavation trench for one-hour.

To estimate an intake, certain assumptions must be made about exposure events, exposure durations, and the corresponding assimilation of constituents by the receptor. Exposure factors have been generated by the scientific community and have undergone review by the EPA. The EPA has published an Exposure Factors Handbook (EPA, 1997) which contains the best and latest values. Regardless of the validity of these exposure factors, they have been derived from a range of values generated by studies of limited numbers of individuals. In all instances, values used in this risk assessment, scientific judgments, and conservative assumptions agree with those of the EPA.

The EPA recommended use of the 95%UCL (normal or lognormal) as the RME concentration (in addition to RME assumptions) is designed to overestimate actual risks expected to result from "real-world" exposures. The Shapiro Wilkes (Gilbert, 1987) was performed on all data sets of the draft report in order to determine the underlying distribution (normal or lognormal) of each data set, and consequently, to determine whether the normal or lognormal 95%UCL would be more appropriate to use as an exposure concentration. The results of the W-Test, which are presented in Appendix K, indicate that some data sets consist of normally distributed data; some are lognormally distributed data; some data sets could be described by both distributions; while others could be described by

neither distribution. As can be seen in Appendix K, the lognormal 95%UCLs are generally greater in value than the normal 95%UCLs. As discussed in the previous paragraph, the 95%UCL for the arithmetic mean versus the maximum detected concentration was used for risk calculations (i.e., assuming all data sets are normally distributed) to reduce the potential for the overestimation of risks. Likewise, the normal 95%UCL was used as the exposure concentration, instead of the lognormal 95%UCL in order to reduce the potential for the overestimation of risks. Therefore, in this risk assessment, the use of the normal 95%UCL reduces the uncertainty resulting from overestimation of actual exposures assumed to occur randomly across SWMU 9.

6.5.4 Toxicological Assessment

In making quantitative estimates of the toxicity for varying dosages of compounds to human receptors, uncertainties arise from two sources. First, data on human exposure and the subsequent effects are usually insufficient, if they are at all available. Human exposure data usually lack adequate concentration estimations and suffer from inherent temporal variability. Therefore, animal studies are often used, and new uncertainties arise from the process of extrapolating animal results to humans. Second, to obtain observable effects with a manageable number of experimental subjects, high doses of a compound are often used. In this situation, a high dose means that high exposures are used in the experiment with respect to most environmental exposures. Therefore, when applying the results of the animal experiment to the human condition, the effects at the high doses must be extrapolated to approximate effects at lower doses. In extrapolating effects from high doses in animals to low doses in humans, scientific judgment and conservative assumptions are employed. In selecting animal studies for use in dose-response calculations, the following factors are considered:

- Studies are preferred where the animal closely mimics human toxicokinetics.
- Studies are preferred where dose intake most closely mimics the intake route and duration for humans.
- Studies are preferred which demonstrate the most sensitive response to the compound in question.

For compounds believed to cause threshold effects (i.e., noncarcinogens) safety factors are employed in the extrapolation of effects from animals to humans and from high doses to low doses. In deriving carcinogenic potency factors, the 95% UCL value is promulgated by the EPA to prevent underestimation of potential risk.

Uncertainties Associated with RfDs

The RfD for hexavalent chromium Cr(VI) was used to estimate risk associated with total chromium concentrations. Cr(VI) can penetrate biological membranes more rapidly than trivalent Cr(III) and, therefore, can create a much larger potential for adverse health effects (ATSDR, 1993). Assuming that 100% of the chromium present in media at the site is Cr(VI) is unlikely for two reasons. First it is suspected that the chromium detected on site is naturally occurring. Cr(VI) does not occur naturally in the environment, however Cr(III) can be found in both soil and groundwater (ATSDR, 1993). Cr(VI) is produced by the chemical industry and used for chrome plating, the manufacture of dyes, and pigments, leather tanning, and wood preserving (ATSDR, 1993). None of the operations have taken place on Navy property. Given that the RfD for Cr(VI) is 0.003 mg/kg-day, and the RfD for Cr(III) is 1.5 mg/kg-day (EPA, 1999e), assuming that the chromium detected in groundwater and a surface soil is 100% Cr(VI) may be overestimate the risk by three orders of magnitude.

In summary, the use of conservative assumptions results in quantitative indices of toxicity that are not expected to underestimate potential toxic effects, but may overestimate these effects by an order of magnitude or more.

6.6 Summary of Risk Assessment Results

This section summarizes the results of the baseline HHRA, and identifies COPCs in environmental media that may pose potential human health risks. The SWMU 9 RFI was conducted at SWMU 9 at NSRR, Puerto Rico. Descriptions and historical background for the SWMU were provided in the previous sections of this RFI report. The purpose of the baseline HHRA is to evaluate the potential human health risks posed by the presence of COPCs detected in the environmental media investigated in Area A, B and C located within SWMU 9. This baseline HHRA demonstrates that potentially unacceptable risks may be associated with an environmental medium within the boundary of Area A and C at SWMU 9.

6.6.1 Summary of Results of the Baseline Human Health Risk Assessment

COPCs were identified based on exceedences of health-based standards/criteria, as discussed in Section 6.1.2, and as summarized in Tables 6-1 through 6-42. The following summarizes COPCs that were identified from surface soil, subsurface soil groundwater sediment, and surface water samples collected throughout in Areas A, B and C of SWMU 9.

Area A

Surface Soil	none
Subsurface Soil	arsenic, chromium
Groundwater	acetophenone, benzene, bis (2-ethylhexyl phthalate), ethylbenzene, 2 methylnapthalene, methylene chloride, naphthalene, toluene, arsenic, chromium
Sediment	arsenic, vanadium
Surface Water	arsenic, selenium, vanadium

Area B

Surface Soil	none
Subsurface Soil	arsenic
Groundwater	benzene, bromodichloromethane, bromoform, chloroform, dibromochloromethane, methylene chloride, bis (2-ethyhexyl phthalate)
Sediment	arsenic, chromium, sulfide, vanadium
Surface Water	antimony, arsenic, vanadium

Area C

Surface Soil	none
Subsurface Soil	chromium
Groundwater	1,2 dichloropropane, bis(2-ethylhexyl phthalate)
Sediment	arsenic, chromium, sulfide, vanadium
Surface Water	arsenic, barium, cadmium, chromium, copper, lead, vanadium

Constituents identified as COPCs in Areas A, B and C were retained for quantitative evaluation in the baseline HHRA. The baseline HHRA estimated potential carcinogenic and noncarcinogenic risks to potential current and future human receptors that would result from exposures to COPCs in the investigated environmental media. Current receptor groups evaluated included only the on-site adult workers; future receptor groups evaluated included on-site construction workers and adult and child (ages 1-6 years old) military residents. The human exposure pathways evaluated for each receptor are summarized below.

Current on-site adult workers:

- Incidental ingestion of sediments
- Dermal contact with sediments
- Incidental ingestion of surface water
- Dermal contact with surface water
- Incidental ingestion of groundwater
- Dermal contact with groundwater

Future on-site adult construction workers:

- Incidental ingestion of subsurface soil
- Dermal contact with subsurface soil
- Inhalation of fugitive dust emanating from excavated subsurface soil
- Incidental ingestion of groundwater
- Dermal contact with groundwater

Future on-site adult and child (1-6 years old) military residents:

- Incidental ingestion of sediments
- Dermal contact with sediments
- Incidental ingestion of surface water
- Dermal contact with surface water
- Incidental ingestion of groundwater
- Dermal contact with groundwater

It should be noted that currently, there are no facilities for personnel housing within SWMU 9, nor are there any likely to be developed. It is highly improbable that SWMU 9 will be developed for residential/ military personnel housing in the future since the mission of NSRR is that of a key naval station providing full support for Atlantic Fleet Weapons training and development activities, and the area surrounding Ensenada Honda (the harbor) is needed to support the mission.

This HHRA did not identify an increase lifetime cancer risk greater than the acceptable EPA limits in Area A, B or C.

Noncarcinogenic risk may exist for future young child military residents with a total HI of 1.06 in Area A. Almost forty-percent of the risk can be attributed to exposures to chromium in groundwater. As mentioned previously in the uncertainty section, assuming that 100% of the chromium detected is Cr(VI) may overestimate the risk by 3 fold. Thus, it is recommended that future sampling events would include specification of chromium for Cr(VI) and Cr(III). Benzene is the second leading contaminant driving an increase in risk at Area A, contributing thirty-three percent of the risk from ingestion and dermal contact with groundwater. The risk associated with benzene was based on a provisional RfD established by the National Center for Exposure Assessment, and has not been adopted into the EPA IRIS database (EPA, 2000). As a result it is not appropriate to sum the chromium and benzene values because benzene affects the blood and chromium affects the gastrointestinal tract. The EPA IRIS database just recently (January 2000) updated the database with a revised cancer slope factor for benzene. Therefore, evaluation of carcinogenic risk could be considered a more defensible indicator of the risks associated with environmental exposures to benzene. The ILCR for the young child resident is 8×10^{-6}, which falls within EPA acceptable limits of 1×10^{-4} and 1×10^{-6}.

Future young child military residents in Area C may also potentially be at risk with a total HI of 1.29. In Area C contaminants in groundwater contribute less than one percent of the noncarcinogenic risk. Chromium and vanadium in surface water and sediment drive ninety-four percent of the risk (thirty-eight percent chromium, and fifty-six percent vanadium). Similar to observance made in Area A, assuming total chromium may have overestimated the noncarcinogenic risk.

Future construction workers in Area A have may potentially be at risk with a HI of 1.11. This HI is primarily the result of exposures to chromium in subsurface soil and groundwater and benzene in groundwater. Chromium in soil and groundwater contributes fifty-nine percent of the risk and benzene contributes thirty-nine percent of the risk. Also, the assumption that chromium is in the +VI oxidation state likely overestimates the risk to chromium. Because benzene likely affects the blood and chromium affects the gastrointestinal tract, HQ values should not be summed and unacceptable systemic health affects are not likely to occur. The total ILCR for Area C is 8.4×10^{-7}, falling below the acceptable EPA limits (1×10^{-6}).

No other unacceptable noncarcinogenic risk associated with exposures to contaminants detected in Area A, B, or C were estimated in this HHRA. This HHRA concludes that a minimal noncarcinogenic risk may potentially exist for future military child resident in Area A and C, and future construction worker in Area A; no increase in carcinogenic risk would be expected in any Area located at SMWU 9.

SECTION 6.0
TABLES

TABLE 6-1

COMPARISON OF MAXIMUM CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SURFACE SOIL TO 2X AVERAGE DETECTED BACKGROUND CONCENTRATIONS
SWMU 9 - AREA A (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9SS01 03/20/96	9SS02 03/20/96	9MW01-00 03/20/96	9MW02-00 03/20/96	Maximum Detected Concentration	2x Average Detected Background	Does the Maximum Concentration Exceed the Criteria?
RCRA Metals (mg/kg)							
Arsenic	1.6	1.1	0.93	3.7	3.7	3.72	no
Barium	93.1	81.6	66.2	**232**	**232**	153	**YES**
Chromium	17.6 J	7.7 J	7.6 J	29.7 J	29.7 J	39.0	no
Lead	15.6	6	4.2	10.7	15.6	21.1	no
Selenium	0.18 UJ	0.18 UJ	**0.87 J**	**1.6 J**	**1.6 J**	ND	**YES**
Silver	0.28 U	0.33 U	0.37 U	**0.35**	**0.35**	ND	**YES**

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:
Bolding indicates that the concentration exceeds 2x the average detected background concentration.
mg/kg - milligrams per kilogram

TABLE 6-2

COMPARISON OF MAX. CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SUBSURFACE SOIL TO 2X AVERAGE DETECTED BACKGROUND CONCENTRATIONS
SWMU 9 - AREA A (TANKS 212-213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID	9MW01-08	9MW01-15	9MW02-04	9MW02-06	9MW02-10	9TP07-04	9TP08-04	9TP09-04	9TP10-04	9TP18-05	9MW02R-05	9MW02R-06
Sample Date	04/10/96	04/10/96	04/12/96	04/12/96	04/12/96	04/08/96	04/08/96	04/08/96	04/08/96	04/14/96	09/21/97	09/21/97
RCRA Metals (mg/kg)												
Arsenic	0.23 J	0.12 UJ	0.14 UJ	0.71 UJ	0.19 J	0.15 J	**5 J**	0.1 UJ	0.47 J	0.5 J	0.78 U	0.72 U
Barium	36.7	9	11.6	40	77.2	119	45.7	46.9	103	62.7	13.5 J	16.7 J
Cadmium	0.39 U	0.29 U	0.37 UJ	0.31 UJ	0.31 UJ	0.28 U	0.27 U	0.29 U	0.29 U	0.3 UJ	0.04 U	0.18 U
Chromium	5.3 J	3.2 J	2.8 R	2.8 R	6.9 R	**50.8 J**	5 J	2.7 J	7.2 J	5.2 R	4	7
Lead	1 J	0.69 J	1.7 J	1.7 J	0.88 J	**6 J**	**5.9 J**	0.83 J	**19.3 J**	4.1 J	3.1	1.1
Mercury	0.05 U	0.06 U	0.06 UJ	0.05 UJ	0.07 UJ	0.05 U	0.06 U	0.04 U	0.05 U	0.06 UJ	0.03 U	0.03 U
Selenium	0.19 UJ	0.14 UJ	0.32 UJ	0.33 UJ	0.33 UJ	0.16 UJ	0.13 U	0.16 UJ	0.15 UJ	0.29 UJ	0.39 J	0.2 U
Silver	0.54 U	**0.67**	0.51 U	0.42 U	0.42 U	0.38 U	0.37 U	**0.48**	0.4 U	0.41 U	**0.08 J**	0.06 U

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.
R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:
Bolding indicates that the concentration exceeds 2x the average detected background concentration.
mg/kg - milligrams per kilogram

TABLE 6-2 (Cont.)

COMPARISON OF MAX. CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SUBSURFACE SOIL TO 2X AVERAGE DETECTED BACKGROUND CONCENTRATIONS
SWMU 9 - AREA A (TANKS 212-213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9MW02S-05 09/21/97	9MW02N-05 09/21/97	9TP07A-01 10/01/97	9TP07A-02 10/01/97	9TP07B-01 10/01/97	9TP07B-02 10/01/97	9TP09A-01 10/01/97	9TP09A-02 10/01/97	Maximum Detected Concentration	2 X Average Detected Background	Does the Maximum Concentration Exceed the Criteria?
RCRA Metals (mg/kg)											
Arsenic	1.2 J	**2.4 J**	0.28 UJ	0.29 J	0.31 UJ	0.24 UJ	0.44 J	0.28 J	**5 J**	1.3	**YES**
Barium	14.7 J	9.7 J	**156 J**	51.4 J	32.2 J	42.8 J	131 J	**240 J**	**240 J**	131	**YES**
Cadmium	0.05 U	0.23 U	**1.3**	**1.6**	**1.3**	**0.99**	**1.5**	**1.6**	**1.6**	0.2	**YES**
Chromium	8.2	**28.9**	11.3 J	2.4 J	6.3 J	4.1 J	8.3 J	11.3 J	**50.8 J**	26.9	**YES**
Lead	1.6	1.8	0.79	3.7	0.18 U	0.15 U	0.35	1.2	**19.3 J**	4.8	**YES**
Mercury	0.1	0.02 U	0.03 U	0.02 U	0.03 U	0.02 U	0.02 U	0.03 U	0.1	0.1	no
Selenium	1.8	0.26 U	1.6 J	0.67 J	0.84 J	1 J	0.49 J	1 J	1.8	2.6	no
Silver	0.08 U	**0.07 J**	**0.4 J**	**0.3 J**	**0.28 J**	**0.3 J**	**0.25 J**	**0.22 J**	**0.67**	ND	**YES**

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:

Bolding indicates that the concentration exceeds 2x the average detected background concentration.

mg/kg - milligrams per kilogram

TABLE 6-3

COMPARISON OF MAXIMUM CONCENTRATIONS FOR TOTAL INORGANIC ANALYTES DETECTED IN GROUNDWATER SAMPLES TO 2X AVERAGE DETECTED BACKGROUND CONCENTRATIONS
SWMU 9 - AREA A (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9MW01 4/15/96	9MW02 4/16/96	9GW02R 09/30/97	9GW02S 09/30/97	9GW02N 09/30/97	Maximum Detected Concentration	2 X Average Detected Background	Does the Maximum Concentration Exceed the Criteria?
RCRA Metals (µg/L)								
Arsenic, Total	6 U	6 U	2.5 U	**29.2 J**	14.1	**29.2 J**	19.7	**YES**
Barium, Total	264	353	207	571 J	325	571 J	1,561	no
Cadmium, Total	12.9	29	4.3 J	8.9 J	3.5 J	29	46.1	no
Chromium, Total	2.6 U	11.2 J	7.3 J	**193**	39.4	**193**	80.6	**YES**
Lead, Total	1.7 R	5.5 R	4.5	10.4 J	1.9 J	10.4 J	22.3	no
Mercury, Total	0.1 UJ	**0.33 J**	0.1 U	0.1 U	0.1 U	**0.33 J**	0.3	**YES**
Selenium, Total	28 R	28 R	8.8	11 U	11 U	8.8	39.8	no
Silver, Total	4 U	4 U	2.6 J	3 U	1.5 J	2.6 J	22	no

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.
R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:
Bolding indicates that the concentration exceeds 2x the average detected background concentration.
µg/L - micrograms per liter

TABLE 6-4

COMPARISON OF MAXIMUM CONCENTRATIONS FOR DISSOLVED INORGANIC ANALYTES DETECTED IN GROUNDWATER SAMPLES TO 2X AVERAGE DETECTED BACKGROUND CONCENTRATIONS
SWMU 9 - AREA A (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9MW01 4/15/96	9MW02 4/16/96	9GW02R 09/30/97	9GW02S 09/30/97	9GW02N 09/30/97	Maximum Detected	2 X Average Detected Background	Does the Maximum Concentration Exceed the Criteria?
RCRA Metals (µg/L)								
Arsenic, Soluble	6 U	6 U	2.5 U	12.8 J	2.5 U	12.8 J	18.9	no
Barium, Soluble	241	277	170 J	304 J	158 J	304 J	414	no
Cadmium, Soluble	6.3	30.4	5.5	14 J	2.9 J	30.4	35.4	no
Chromium, Soluble	2.6 U	2.6 U	3.2 J	3.5 U	0.7 U	3.2 J	6.93	no
Lead, Soluble	1.2 UJ	2.9 R	**1.9 J**	7.5 U	7.5 U	**1.9 J**	1.2	**YES**
Mercury, Soluble	0.1 UJ	**0.31 J**	0.1 U	0.1 U	0.1 U	**0.31 J**	0.29	**YES**
Selenium, Soluble	28 R	28 R	8.5	11 U	2.9 J	8.5	36	no
Silver, Soluble	4 U	4 U	2.5 J	3 U	0.8 J	2.5 J	3.47	no

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:

Bolding indicates that the concentration exceeds 2x the average detected background concentration.

µg/L - micrograms per liter

TABLE 6-5

COMPARISON OF MAXIMUM CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SURFACE SOIL TO 2X AVERAGE DETECTED BACKGROUND CONCENTRATIONS
SWMU 9 - AREA B (TANKS 214 - 215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9SS03 03/20/96	9SS04 03/20/96	9MW03-00 03/20/96	Maximum Detected	2x Average Detected Background	Does the Maximum Concentration Exceed the Criteria?
RCRA Metals (mg/kg)						
Arsenic	2	1.7 J	1.3	2	3.7	no
Barium	115	84.7	56.5	115	152.8	no
Cadmium	0.2 U	0.22 U	0.42	0.42	0.5	no
Chromium	9.3 J	9.5 J	13.2 J	13.2 J	39.0	no
Lead	**30**	**258**	15.1	**258**	21.1	**YES**
Selenium	**1.1 J**	0.88 UJ	**0.62 J**	**1.1 J**	ND	**YES**

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:
Bolding indicates that the concentration exceeds 2x the average detected background concentration.
mg/kg - milligrams per kilogram

TABLE 6-6

COMPARISON OF MAXIMUM CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SUBSURFACE SOIL TO 2X AVERAGE DETECTED BACKGROUND CONCENTRATIONS
SWMU 9 - AREA B (TANKS 214 - 215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID	9MW03-04	9MW03-09	9TP02-06	9TP03-03	9TP04-04	9TP05-04	9TP06-04	9TP01A-01	9TP01A-02	9TP02A-01	9TP02A-02	Maximum Detected	2x Average Detected Background	Does the Maximum Concentration Exceed the Criteria?
Sample Date	04/15/96	04/15/96	04/01/96	04/06/96	04/06/96	04/06/96	04/06/96	10/01/97	10/01/97	10/01/97	10/01/97			
RCRA Metals (mg/kg)														
Arsenic	0.6 U	0.13 UJ	0.0015	**2 J**	0.27 J	0.1 UJ	0.45 J	1.2 J	1 J	0.69 J	0.34 UJ	**2 J**	1.3	**YES**
Barium	40.4	24	0.0524 J	18.8	43	28.2	85.6	130 J	**182 J**	**143 J**	69.8 UJ	**182 J**	131	**YES**
Cadmium	0.33 U	0.3 U	0.0004 U	0.27 U	0.29 U	0.29 U	0.33 U	**1.7**	**2.3**	**0.83**	**1.3**	**2.3**	0.2	**YES**
Chromium	7.1	8.3	0.011 J	5.1 J	3.4 J	3 J	5.6 J	9.9 J	14.4 J	7 J	5.7 J	14.4 J	26.9	no
Lead	0.77	0.54	0.004	**34.2 J**	0.28 J	1.5 J	0.61 J	2	0.17 U	0.54	0.21 U	**34.2 J**	4.8	**YES**
Selenium	0.14 UJ	0.16 UJ	0.0008 J	0.29 UJ	0.16 UJ	0.16 UJ	0.29 J	2 J	0.49 J	1.2 J	1.1 J	2 J	2.6	no
Silver	0.46 U	**1.1**	0.0005 U	0.37 U	0.41 U	0.4 U	0.46 U	**0.21 J**	**0.25 J**	0.11 U	**0.12 J**	**1.1**	ND	**YES**

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:
Bolding indicates that the maximum concentration exceeds 2x the average detected background concentration.
mg/kg - milligrams per kilogram

TABLE 6-7

COMPARISON OF MAXIMUM CONCENTRATIONS FOR TOTAL INORGANIC ANALYTES DETECTED IN GROUNDWATER SAMPLES TO 2X AVERAGE DETECTED BACKGROUND CONCENTRATIONS
SWMU 9 - AREA B (TANKS 214 - 215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9MW03 04/20/96	2 X Average Detected Background	Does the Maximum Concentration Exceed the Criteria?
RCRA Metals (µg/L)			
Barium, Total	182	1,561	no
Cadmium, Total	26.4	46.1	no
Mercury, Total	0.16 J	0.3	no

Data Qualifier:
J - Analyte present. Reported value may not be accurate or precise.

Note:
µg/L - micrograms per liter

TABLE 6-8

COMPARISON OF MAXIMUM CONCENTRATIONS FOR DISSOLVED INORGANIC ANALYTES DETECTED IN GROUNDWATER TO 2X AVERAGE DETECTED BACKGROUND CONCENTRATIONS
SWMU 9 - AREA B (TANKS 214 - 215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9MW03 04/20/96	2 X Average Detected Background	Does the Maximum Concentration Exceed the Criteria?
RCRA Metals (µg/L)			
Barium, Soluble	170	414	no
Cadmium, Soluble	25.1	35.4	no

Note:
µg/L - micrograms per liter

TABLE 6-9

COMPARISON OF MAXIMUM CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SURFACE SOIL TO 2X AVERAGE DETECTED BACKGROUND CONCENTRATIONS
SWMU 9 - AREA C (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9SS05 03/20/96	9SS06 03/20/96	9MW04-00 03/20/96	Maximum Detected	2x Average Detected Background	Does the Maximum Concentration Exceed the Criteria?
RCRA Metals (mg/kg)						
Barium	110	52.6	59.6	110	153	no
Chromium	17.6 J	30.4 J	25.1 J	30.4 J	39.0	no
Lead	14.5	**52.5**	9.3	**52.5**	21.1	**YES**

Data Qualifier:
J - Analyte present. Reported value may not be accurate or precise.

Notes:
Bolding indicates that the concentration exceeds 2x the average detected background concentration.
mg/kg - milligrams per kilogram

TABLE 6-10

COMPARISON OF MAXIMUM CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SUBSURFACE SOIL TO 2X AVERAGE DETECTED BACKGROUND CONCENTRATIONS
SWMU 9 - AREA C (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9MW04-03 04/19/96	9MW04-05 04/19/96	9TP11-05 04/13/96	9TP13-04 04/13/96	9TP14-05 04/13/96	9TP15-05 04/13/96	9TP16-05 04/13/96	9TP17-05 04/14/96	Maximum Detected	2x Average Detected Background	Does the Maximum Concentration Exceed the Criteria?
RCRA Metals (mg/kg)											
Barium	96.9	35.6	77.7	31.6	82.1	83.8	59.2	57.2	96.9	131	no
Chromium	**28.3**	20.4	24.2 R	24.4 R	22.4 R	22.4 R	29.1 R	24.9 R	**28.3**	26.87	**YES**
Lead	1.4	1.2	**5.2 J**	**6.4 J**	**26.2 J**	**24 J**	**31.5 J**	2.2 J	**31.5 J**	4.79	**YES**
Silver	**0.72**	**0.71**	**0.57**	**0.71**	0.35 U	0.39 U	**0.86**	**0.67**	**0.86**	ND	**YES**

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.
R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:
Bolding indicates that the concentration exceeds 2x the average detected background concentration.
mg/kg - milligrams per kilogram

TABLE 6-11

COMPARISON OF MAXIMUM CONCENTRATIONS FOR TOTAL INORGANIC ANALYTES DETECTED IN GROUNDWATER TO 2X AVERAGE DETECTED BACKGROUND SWMU 9 - AREA C (TANKS 216 - 217) NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9MW04 04/24/96	2x Average Detected Background	Does the Maximum Concentration Exceed the Criteria?
RCRA Metals (µg/L)			
Barium, Total	235	1,561	no
Cadmium, Total	12.1	46.1	no

Note:
µg/L - micrograms per liter

TABLE 6-12

COMPARISON OF MAXIMUM CONCENTRATIONS FOR DISSOLVED INORGANIC ANALYTES DETECTED IN GROUNDWATER TO 2X AVERAGE DETECTED BACKGROUND CONCENTRATIONS
SWMU 9 - AREA C (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9MW04 04/24/96	9MW04 06/29/99	Maximum Detection	2x Average Detected Background	Does the Maximum Concentration Exceed the Criteria?
RCRA Metals (µg/L)					
Barium, Soluble	209	NA	209	414	no
Cadmium, Soluble	11.4	24.7	24.7	35.4	no

Notes:
NA - Not Analyzed
µg/L - micrograms per liter

TABLE 6-13

COMPARISON OF MAXIMUM CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SURFACE SOIL TO EPA REGION III RBC CONCENTRATIONS
SWMU 9 - AREA A (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9SS01 03/20/96	9SS02 03/20/96	9MW01-00 03/20/96	9MW02-00 03/20/96	Maximum Detected	EPA Region III Residential Soil RBC[1]	Does the Maximum Concentration Exceed the Criteria?
RCRA Metals (mg/kg)							
Barium	93.1	81.6	66.2	232	232	550 N	no
Selenium	0.18 UJ	0.18 UJ	0.87 J	1.6 J	1.6 J	39 N	no
Silver	0.28 U	0.33 U	0.37 U	0.35	0.35	39 N	no

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.
U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:
N - noncarcinogenic
[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.
mg/kg - milligrams per kilogram

TABLE 6-14

COMPARISON OF MAXIMUM CONCENTRATIONS FOR ORGANIC ANALYTES DETECTED IN SURFACE SOIL TO EPA REGION III RBC CONCENTRATIONS
SWMU 9 - AREA A (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9SS01 03/20/96	9SS02 03/20/96	9MW01-00 03/20/96	9MW02-00 03/20/96	Maximum Detected	EPA Region III Residential Soil RBC[1]	Does the Maximum Concentration Exceed the Criteria?
Volatiles (µg/kg)							
Acetone	11 UJ	12 J	12 UJ	11 UJ	12 J	780,000 N	no
Semivolatiles (µg/kg)							
Benzyl alcohol	370 UJ	380 U	440 J	370 UJ	440 J	2,300,000 N	no
Diethylphthalate	370 U	380 U	410 U	40 J	40 J	6,300,000 N	no

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

N - noncarcinogenic
µg/kg - micrograms per kilogram

TABLE 6-15

COMPARISON OF MAXIMUM CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SUBSURFACE SOIL TO EPA REGION III RBC CONCENTRATIONS
SWMU 9 - AREA A (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID	9MW01-08	9MW01-15	9MW02-04	9MW02-06	9MW02-10	9TP07-04	9TP08-04
Sample Date	04/10/96	04/10/96	04/12/96	04/12/96	04/12/96	04/08/96	04/08/96
RCRA Metals (mg/kg)							
Arsenic	0.23 J	0.12 UJ	0.14 UJ	0.71 UJ	0.19 J	0.15 J	**5 J**
Barium	36.7	9	11.6	40	77.2	119	45.7
Cadmium	0.39 U	0.29 U	0.37 UJ	0.31 UJ	0.31 UJ	0.28 U	0.27 U
Chromium(2)	5.3 J	3.2 J	2.8 R	2.8 R	6.9 R	**50.8 J**	5 J
Lead(3)	1 J	0.69 J	1.7 J	1.7 J	0.88 J	6 J	5.9 J
Silver	0.54 U	0.67	0.51 U	0.42 U	0.42 U	0.38 U	0.37 U

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:

Bolding indicates that the concentration exceeds EPA Region III Residential RBC.

C - carcinogenic

N - noncarcinogenic

(1) The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

(2) The RBC for Cr(VI) was used for screening because there is not a total chromium RBC available.

(3) Currently there is not an established RfD for Lead therefore; as recommended in 1996 EPA Soil Screening Guidance document, and EPA 1994a Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities a screening level of 400 mg/kg was used.

mg/kg - milligrams per kilogram

TABLE 6-15 (Continued)

COMPARISON OF MAXIMUM CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SUBSURFACE SOIL TO EPA REGION III RBC CONCENTRATIONS
SWMU 9 - AREA A (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9TP07A-02 10/01/97	9TP07B-01 10/01/97	9TP07B-02 10/01/97	9TP09A-01 10/01/97	9TP09A-02 10/01/97	Maximum Detected	EPA Region III Residential Soil RBC(1)	Does the Maximum Concentration Exceed the Criteria?
RCRA Metals (mg/kg)								
Arsenic	0.29 J	0.31 UJ	0.24 UJ	**0.44 J**	0.28 J	**5 J**	0.43 C	**YES**
Barium	51.4 J	32.2 J	42.8 J	131 J	240 J	240 J	550 N	no
Cadmium	1.6	1.3	0.99	1.5	1.6	1.6	7.8 N	no
Chromium(2)	2.4 J	6.3 J	4.1 J	8.3 J	11.3 J	**50.8 J**	23 N	**YES**
Lead(3)	3.7	0.18 U	0.15 U	0.35	1.2	19.3 J	400	no
Silver	0.3 J	0.28 J	0.3 J	0.25 J	0.22 J	0.67	39 N	no

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:

Bolding indicates that the concentration exceeds EPA Region III Residential RBC.

C - carcinogenic

N - noncarcinogenic

(1) The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

(2) The RBC for Cr(VI) was used for screening because there is not a total chromium RBC available.

(3) Currently there is not an established RfD for Lead therefore; as recommended in 1996 EPA Soil Screening Guidance document, and EPA 1994a Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities a screening level of 400 mg/kg was used.

mg/kg - milligrams per kilogram

TABLE 6-15 (Continued)

COMPARISON OF MAXIMUM CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SUBSURFACE SOIL TO EPA REGION III RBC CONCENTRATIONS
SWMU 9 - AREA A (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID	9TP09-04	9TP10-04	9TP18-05	9MW02R-05	9MW02R-06	9MW02S-05	9MW02N-05	9TP07A-01
Sample Date	04/08/96	04/08/96	04/14/96	09/21/97	09/21/97	09/21/97	09/21/97	10/01/97
RCRA Metals (mg/kg)								
Arsenic	0.1 UJ	**0.47 J**	**0.5 J**	0.78 U	0.72 U	**1.2 J**	**2.4 J**	0.28 UJ
Barium	46.9	103	62.7	13.5 J	16.7 J	14.7 J	9.7 J	156 J
Cadmium	0.29 U	0.29 U	0.3 UJ	0.04 U	0.18 U	0.05 U	0.23 U	1.3
Chromium(2)	2.7 J	7.2 J	5.2 R	4	7	8.2	**28.9**	11.3 J
Lead(3)	0.83 J	19.3 J	4.1 J	3.1	1.1	1.6	1.8	0.79
Silver	0.48	0.4 U	0.41 U	0.08 J	0.06 U	0.08 U	0.07 J	0.4 J

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:

Bolding indicates that the concentration exceeds EPA Region III Residential RBC.

C - carcinogenic

N - noncarcinogenic

(1) The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

(2) The RBC for Cr(VI) was used for screening because there is not a total chromium RBC available.

(3) Currently there is not an established RfD for Lead therefore; as recommended in 1996 EPA Soil Screening Guidance document, and EPA 1994a Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities a screening level of 400 mg/kg was used.

mg/kg - milligrams per kilogram

TABLE 6-16

COMPARISON OF MAXIMUM CONCENTRATIONS FOR ORGANIC ANALYTES
DETECTED IN SUBSURFACE SOIL TO EPA REGION III RBC CONCENTRATIONS
SWMU 9 - AREA A (TANKS 212-213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID	9MW01-08	9MW01-15	9MW02-04	9MW02-06	9MW02-10	9TP07-04
Sample Date	04/10/96	04/10/96	04/12/96	04/12/96	04/12/96	04/08/96
Volatiles (µg/kg)						
2-Butanone	14 U	13 U	160 J	70 UJ	14 U	130 UJ
Acetone	14 U	13 U	670 J	70 UJ	14 U	1,200
Benzene	7 U	7 U	39 U	960 J	180	63 U
Ethylbenzene	7 U	7 U	39 U	1,300 J	7 U	51 J
Toluene	7 U	7 U	39 U	5,300 J	5 J	63 U
Xylene (total)	7 U	7 U	39 U	4,700 J	5 J	91
Semivolatiles (µg/kg)						
Butylbenzylphthalate	460 U	440 U	500 U	460 U	470 U	420 U
Di-n-butylphthalate	460 U	440 U	500 U	460 U	470 U	420 U
m,p-Cresol (methylphenol)	460 U	440 U	500 U	460 U	470 U	54 J
o-Cresol (methylphenol)	460 U	440 U	500 U	460 U	470 U	61 J

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

C - carcinogenic

N - noncarcinogenic

(1) The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

µg/kg - micrograms per kilogram

TABLE 6-16 (Continued)

COMPARISON OF MAXIMUM CONCENTRATIONS FOR ORGANIC ANALYTES
DETECTED IN SUBSURFACE SOIL TO EPA REGION III RBC CONCENTRATIONS
SWMU 9 - AREA A (TANKS 212-213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9TP08-04 04/08/96	9TP09-04 04/08/96	9TP10-04 04/08/96	9TP18-05 04/14/96	Maximum Detected	EPA Region III Residential Soil RBC[1]	Does the Maximum Concentration Exceed the Criteria?
Volatiles (µg/kg)							
2-Butanone	56 U	12 U	12 UJ	13 U	160 J	4,700,000 N	no
Acetone	620 J	12 U	12 U	87 J	1,200	780,000 N	no
Benzene	28 U	6 U	6 U	6 U	960 J	22,000 C	no
Ethylbenzene	240 J	6 U	6 U	6 U	1,300 J	780,000 N	no
Toluene	28 U	6 U	6 U	6 U	5,300 J	1,600,000 N	no
Xylene (total)	220 J	6 U	6 U	6 U	4,700 J	16,000,000 N	no
Semivolatiles (µg/kg)							
Butylbenzylphthalate	370 U	100 J	410 U	410 U	100 J	1,600,000 N	no
Di-n-butylphthalate	370 U	870	410 U	410 U	870	780,000 N	no
m,p-Cresol (methylphenol)	370 U	400 U	410 U	410 U	54 J	390,000 N	no
o-Cresol (methylphenol)	370 U	400 U	410 U	410 U	61 J	390,000 N	no

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

C - carcinogenic

N - noncarcinogenic

[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

µg/kg - micrograms per kilogram

TABLE 6-17

COMPARISON OF MAXIMUM CONCENTRATIONS FOR TOTAL INORGANIC ANALYTES DETECTED IN GROUNDWATER SAMPLES TO EPA REGION III RBC CONCENTRATIONS
SWMU 9 - AREA A (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9MW01 4/15/96	9MW02 4/16/96	9GW02R 09/30/97	9GW02S 09/30/97	9GW02N 09/30/97	Maximum Concentration	EPA Region III Tap Water RBC[1]	Does the Maximum Concentration Exceed the Criteria?
RCRA Metals (µg/L)								
Arsenic, Total	6 U	6 U	2.5 U	**29.2 J**	**14.1**	**29.2 J**	0.045 C	**YES**
Chromium[2], Total	2.6 U	**11.2 J**	7.3 J	**193**	**39.4**	**193**	11 N	**YES**
Mercury[3], Total	0.1 UJ	0.33 J	0.1 U	0.1 U	0.1 U	0.33 J	1.1 N	no

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.
Notes:
Bolding indicates that the concentration exceeds EPA Region III Tap Water RBC.
N - non-carcinogenic
C - carcinogenic
µg/L - micrograms per liter

(1) The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

(2) The RBC for Cr(VI) was used for screening because there is not a total chromium RBC available.

(3) An RBC for Inorganic Mercury has not been established; therefore, all mercury was screened using the mercuric chloride RBC.

TABLE 6-18

COMPARISON OF MAXIMUM CONCENTRATIONS FOR DISSOLVED INORGANIC ANALYTES DETECTED IN GROUNDWATER SAMPLES TO EPA REGION III RBC CONCENTRATIONS
SWMU 9 - AREA A (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9MW01 4/15/96	9MW02 4/16/96	9GW02R 09/30/97	9GW02S 09/30/97	9GW02N 09/30/97	Maximum Detected	EPA Region III Tap Water RBC[1]	Does the Maximum Concentration Exceed the Criteria?
RCRA Metals (µg/L)								
Lead, Soluble [2]	1.2 UJ	2.9 R	1.9 J	7.5 U	7.5 U	1.9 J	15	no
Mercury, Soluble [3]	0.1 UJ	0.31 J	0.1 U	0.1 U	0.1 U	0.31 J	1.1 N	no

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:
Bolding indicates that the concentration exceeds EPA Region III Tap Water RBC.
N - noncarcinogenic
µg/L - micrograms per liter

[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

[2] EPA Action Level for Lead (www.epa.gov/OGWDW/wot.appa.html) November 1999c.

[3] An RBC for Inorganic Mercury has not been established; therefore, all mercury was screened using the mercuric chloride RBC.

TABLE 6-19

COMPARISON OF MAXIMUM CONCENTRATIONS FOR ORGANIC ANALYTES
DETECTED IN GROUNDWATER SAMPLES TO EPA REGION III RBC CONCENTRATIONS
SWMU 9 - AREA A (TANKS 212 - 213)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	13GW01 03/24/96	13GW02 03/24/96	13GW03 03/24/96	9MW01 04/14/96	9MW02 04/16/96	Maximum Detected	EPA Region III Tap Water RBC[1]	Does the Maximum Concentration Exceed the Criteria?
Volatiles (µg/L)								
Benzene	500 U	**130**	5 U	5 U	**1,600 J**	**1,600 J**	0.36	**YES**
Methylene chloride	500 U	5 U	5 U	5 U	**7**	**7**	4.1	**YES**
Ethylbenzene	500 U	**160**	5 U	5 U	27	**160**	130	**YES**
Toluene	500 U	5 U	5 U	5 U	**180 J**	**180 J**	75	**YES**
Xylene (total)	500 U	28	5 U	5 U	82	82	1,200	no
Semivolatiles (µg/L)								
Benzoic acid	53 U	56 U	50 U	19 J	50 U	19 J	15,000	no
Naphthalene	11 U	**26**	10 U	10 U	10 U	**26**	0.65	**YES**
2-Methylnaphthalene	11 U	**23 J**	10 UJ	10 U	10 U	**23 J**	12	**YES**
Acetophenone	11 U	11 U	10 U	**1 J**	10 U	**1 J**	0.0042	**YES**
Benzyl alcohol	11 UJ	11 U	10 U	10 U	3 J	3 J	1,100	no
Bis(2-ethylhexyl)phthalate	**5 J**	**5 J**	4 J	10 U	3 J	**5 J**	4.8	**YES**
Dimethylphthalate	11 U	11 U	10 U	2 J	10 U	2 J	37,000	no

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:
Bolding indicates that the concentration exceeds EPA Region III Tap Water RBC.
C - carcinogenic
N - noncarcinogenic
µg/L - micrograms per liter

[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

TABLE 6-20

COMPARISON OF MAXIMUM CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SEDIMENT SAMPLES TO EPA REGION III RBC CONCENTRATIONS SWMU 9 - AREA A (TANKS 212 - 213) NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9SD02 06/29/99	EPA Region III Residential Soil RBC[1]	Does the Maximum Concentration Exceed the Criteria?
Inorganics (mg/kg)			
Arsenic	**1.8 J**	0.43 C	**YES**
Barium	14	550 N	no
Beryllium	0.29 J	16 N	no
Chromium[2]	21	23 N	no
Cobalt	6.9	470 N	no
Copper	63 J	310 N	no
Lead[3]	12 J	400 N	no
Mercury[4]	0.078 J	2.3 N	no
Nickel	6.6 J	160 N	no
Tin	4.3 J	4,700 N	no
Vanadium	**180**	55 N	**YES**
Zinc	64 J	2,300 N	no

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.

Notes:
Bolding indicates that the concentration exceeds EPA Region III Residential Soil RBC.
C - carcinogenic
N - noncarcinogenic
mg/kg - milligrams per kilogram
[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.
[2] The RBC for Cr(VI) was used for screening because there is not a total chromium RBC available.
[3] Currently there is not an established RfD for Lead therefore as recommended in 1996 EPA Soil Screening Guidance document, and EPA 1994a Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities a screening level of 400 mg/kg was used.
[4] An RBC for Inorganic Mercury has not been established; therefore, mercury was screened using the mercuric chloride RBC.

TABLE 6-21

COMPARISON OF MAXIMUM CONCENTRATIONS FOR ORGANIC ANALYTES DETECTED IN SEDIMENT SAMPLES TO EPA REGION III RBC CONCENTRATIONS SWMU 9 - AREA A (TANKS 212 - 213) NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9SD02 6/29/99	EPA Region III Residential Soil RBC[1]	Does the Maximum Concentration Exceed the Criteria?
Volatiles (µg/kg)			
Acetone	130 J	780,000 N	no

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

Notes:

Bolding indicates that the concentration exceeds EPA Region III Residential Soil RBC.

N - noncarcinogenic

µg/kg - micrograms per kilogram

[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

TABLE 6-22

COMPARISON OF MAXIMUM CONCENTRATIONS FOR TOTAL INORGANIC ANALYTES DETECTED IN SURFACE WATER SAMPLES TO EPA REGION III RBC CONCENTRATIONS SWMU 9 - AREA A (TANKS 212 - 213) NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9SW02 06/29/99	EPA Region III Tap Water RBC[1]	Does the Maximum Concentration Exceed the Criteria?
Inorganics (µg/L)			
Arsenic, Total	**38.3 J**	0.045 C	**YES**
Barium, Total	50.5	255 N	no
Cadmium, Total	0.7 J	1.8 N	no
Cobalt, Total	0.96 J	220 N	no
Selenium, Total	**22.3 J**	18 N	**YES**
Tin, Total	2.7 J	2,200 N	no
Vanadium, Total	**88.5**	26 N	**YES**
Zinc, Total	6.3 J	1,100 N	no

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.

Notes:
Bolding indicates that the concentration exceeded the EPA Region III Tap Water RBC.
C - carcinogenic
N - noncarcinogenic
[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.
µg/L - micrograms per liter

TABLE 6-23

COMPARISON OF MAXIMUM CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SURFACE SOIL SAMPLES TO EPA REGION III RBC CONCENTRATIONS SWMU 9 - AREA B (TANKS 214 - 215) NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9SS03 03/20/96	9SS04 03/20/96	9MW03-00 03/20/96	Maximum Detected Concentration	EPA Region III Residential Soil RBC[1]	Does the Maximum Concentration Exceed the Criteria?
RCRA Metals (mg/kg)						
Lead[2]	30	258	15.1	258	400	no
Selenium	1.1 J	0.88 UJ	0.62 J	1.1 J	39.0 N	no

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:
Bolding indicates that the concentration exceeded the EPA Region III Residential Soil RBC.
N - noncarcinogenic
mg/kg - milligrams per kilogram
[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.
[2] Currently there is not an established RfD for Lead therefore as recommended in 1996 EPA Soil Screening Guidance document, and EPA 1994a Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities a screening level of 400 mg/kg was used.

TABLE 6-24

COMPARISON OF MAXIMUM CONCENTRATIONS FOR ORGANIC ANALYTES DETECTED IN SURFACE SOIL SAMPLES TO EPA REGION III RBC CONCENTRATIONS SWMU 9 - AREA B (TANKS 214 - 215) NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9SS03 03/20/96	9SS04 03/20/96	9MW03-00 03/20/96	Maximum Detected Concentration	EPA Region III Residential Soil RBC[1]	Does the Maximum Concentration Exceed the Criteria?
Volatiles (µg/kg)						
Acetone	22 J	11 UJ	14 J	22 J	780,000 N	no
Semivolatiles (µg/kg)						
Di-n-butylphthalate	40 J	360 U	350 U	40 J	780,000 N	no

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

Bolding indicates that the concentration exceeded the EPA Region III Residential Soil RBC.

N - noncarcinogenic

µg/kg - micrograms per kilogram

[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

TABLE 6-25

COMPARISON OF MAXIMUM CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SUBSURFACE SOIL SAMPLES TO EPA REGION III RBC CONCENTRATIONS
SWMU 9 - AREA B (TANKS 214 - 215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID	9MW03-04	9MW03-09	9TP02-06	9TP03-03	9TP04-04	9TP05-04	9TP06-04
Sample Date	04/15/96	04/15/96	04/01/96	04/06/96	04/06/96	04/06/96	04/06/96
RCRA Metals (mg/kg)							
Arsenic	0.6 U	0.13 UJ	0.0015	**2 J**	0.27 J	0.1 UJ	**0.45 J**
Barium	40.4	24	0.0524 J	18.8	43	28.2	85.6
Cadmium	0.33 U	0.3 U	0.37 U	0.27 U	0.29 U	0.29 U	0.33 U
Lead[2]	0.77	0.54	0.004	34.2 J	0.28 J	1.5 J	0.61 J
Silver	0.46 U	1.1	0.52 U	0.37 U	0.41 U	0.4 U	0.46 U

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:
Bolding indicates that the concentration exceeds the EPA Region III Residential Soil RBC.
C - carcinogenic
N - noncarcinogenic
mg/kg - milligrams per kilogram
[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.
[2] Currently there is not an established RfD for Lead therefore as recommended in 1996 EPA Soil Screening Guidance document, and EPA 1994a Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities a screening level of 400 mg/kg was used.

TABLE 6-25 (Continued)

COMPARISON OF MAXIMUM CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SUBSURFACE SOIL SAMPLES TO EPA REGION III RBC CONCENTRATIONS
SWMU 9 - AREA B (TANKS 214 - 215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9TP01A-01 10/01/97	9TP01A-02 10/01/97	9TP02A-01 10/01/97	9TP02A-02 10/01/97	Maximum Detected Concentration	EPA Region III Residential Soil RBC[1]	Does the Maximum Concentration Exceed the Criteria?
RCRA Metals (mg/kg)							
Arsenic	**1.2 J**	**1 J**	**0.69 J**	0.34 UJ	**2 J**	0.4 C	**YES**
Barium	130 J	182 J	143 J	69.8 UJ	182 J	550 N	no
Cadmium	1.7	2.3	0.83	1.3	2.3	7.8 N	no
Lead[2]	2	0.17 U	0.54	0.21 U	34.2 J	400.0 N	no
Silver	0.21 J	0.25 J	0.11 U	0.12 J	1.1	39.0 N	no

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.
UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:
Bolding indicates that the concentration exceeds the EPA Region III Residential Soil RBC.
C - carcinogenic
N - noncarcinogenic
mg/kg - milligrams per kilogram
[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.
[2] Currently there is not an established RfD for Lead therefore as recommended in 1996 EPA Soil Screening Guidance document, and EPA 1994a Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities a screening level of 400 mg/kg was used.

TABLE 6-26

COMPARISON OF MAXIMUM CONCENTRATIONS FOR ORGANIC ANALYTES
DETECTED IN SUBSURFACE SOIL SAMPLES TO EPA REGION III RBC CONCENTRATIONS
SWMU 9 - AREA B (TANKS 214 - 215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9MW03-04 04/15/96	9MW03-09 04/15/96	9TP02-06 04/02/96	9TP03-03 04/06/96	9TP04-04 04/06/96	9TP05-04 04/06/96	9TP06-04 04/06/96	Maximum Detected Concentration	EPA Region III Residential Soil RBC[1]	Does the Maximum Concentration Exceed the Criteria?
Semivolatiles (µg/kg)										
Di-n-butylphthalate	460 U	440 U	540 U	400 U	400 U	410 U	800	800	780,000 N	no
Butylbenzylphthalate	460 U	440 U	540 U	400 U	400 U	410 U	68 J	68 J	1,600,000 N	no

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:
Bolding indicates that the concentration exceeds the Region III Residential Soil RBC.
N - noncarcinogenic

[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.
µg/kg - micrograms per kilogram

TABLE 6-27

COMPARISON OF MAXIMUM CONCENTRATIONS FOR ORGANIC ANALYTES DETECTED IN GROUNDWATER SAMPLES TO EPA REGION III RBC CONCENTRATIONS SWMU 9 - AREA B (TANKS 214 - 215) NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	13GW04 3/24/96	13GW05 03/24/96	13GW06 03/24/96	9MW03 04/20/96	Maximum Detected Concentration	EPA Region III Tap Water RBC[1]	Does the Maximum Concentration Exceed the Criteria?
Volatiles (µg/L)							
Benzene	5 U	**140**	5 U	5 U	**140**	0.36 C	**YES**
Bromodichloromethane	5 U	5 U	**460**	5 U	**460**	0.17 C	**YES**
Bromoform	5 U	5 U	**360**	5 U	**360**	8.5 C	**YES**
Chloroform	5 U	5 U	**1,100**	**5 J**	**1,100**	0.15 C	**YES**
Dibromochloromethane	5 U	5 U	**300**	5 U	**300**	0.126 C	**YES**
Ethylbenzene	5 U	8	5 U	5 U	8	130 N	no
Methylene chloride	5 U	5 U	**11**	5 U	**11**	4.1 C	**YES**
Semivolatiles (µg/L)							
Benzoic acid	54 U	53 U	49 U	19 J	19 J	15,000 N	no
Bis(2-ethylhexyl)phthalate	**7 J**	2 J	10 U	11 U	**7 J**	4.8 C	**YES**
Diethylphthalate	11 U	1 J	10 U	11 U	1 J	2,900 N	no

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:

Bolding indicates that the concentration exceeds the EPA Region III Tap Water RBC.

µg/L - micrograms per liter

N - noncarcinogenic

C - carcinogenic

[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

TABLE 6-28

COMPARISON OF MAXIMUM CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SEDIMENT SAMPLES TO EPA REGION III RBC CONCENTRATIONS SWMU 9 - AREA B (TANKS 214 - 215) NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9SD01 06/29/99	9SD03 06/29/99	9SD04 06/29/99	Maximum Detected Concentration	EPA Region III Residential Soil RBC[1]	Does the Maximum Concentration Exceed the Criteria?
Inorganics (mg/kg)						
Arsenic	**1 J**	**1.2 J**	**1.3 J**	**1.3 J**	0.43 C	**YES**
Barium	14	15	20	20	550 N	no
Beryllium	0.15 J	0.12 J	0.16 J	0.16 J	16 N	no
Cadmium	0.13 U	0.14 J	0.12 J	0.14 J	7.8 N	no
Chromium[2]	23	**28**	**26**	**28**	23 N	**YES**
Cobalt	7.9	8.3	12	12	470 N	no
Copper	98 J	83 J	120 J	120 J	310 N	no
Lead[3]	5.4 J	47 J	24 J	47 J	400	no
Mercury[4]	0.085 J	0.084 J	0.1 J	0.1 J	2.3 N	no
Nickel	7.7 J	7.2 J	9.8	9.8	160 N	no
Sulfide	62 U	210	250	250	NA	**YES**
Tin	4.7	3.6 J	4.3 J	4.7	4,700 N	no
Vanadium	**160**	**130**	**180**	**180**	55 N	**YES**
Zinc	49 J	49 J	63 J	63 J	2,300 N	no

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:

Bolding indicates that the concentration exceeds EPA Region III Residential Soil RBC.

mg/kg - milligrams per kilogram

NA - not available

C - carcinogenic

N - noncarcinogenic

(1) The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

(2) The RBC for Cr(VI) was used for screening because there is not a total chromium RBC available.

(3) Currently there is not an established RfD for Lead therefore as recommended in 1996 EPA Soil Screening Guidance document, and EPA 1994a Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities a screening level of 400 mg/kg was used.

(4) An RBC for Inorganic Mercury has not been established; therefore, all mercury was screened using the mercuric chloride RBC.

TABLE 6-29

COMPARISON OF MAXIMUM CONCENTRATIONS FOR ORGANIC ANALYTES DETECTED IN SEDIMENT SAMPLES TO EPA REGION III RBC CONCENTRATIONS
SWMU 9 - AREA B (TANKS 214 - 215)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9SD01 6/29/99	9SD03 6/29/99	9SD04 6/29/99	Maximum Detected Concentration	EPA Region III Residential Soil RBC[1]	Does the Maximum Concentration Exceed the Criteria?
Volatiles (µg/kg)						
Acetone	130	140	200	200	780,000 N	no
Carbon disulfide	12 U	5.3 J	8.9 J	8.9 J	780,000 N	no
2-Butanone (methyl ethyl ketone)	62 U	28 J	39 J	39 J	4,900,000 N	no

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:

Bolding indicates that the concentration exceeds EPA Region III Residential Soil RBC.

µg/kg - micrograms per kilogram

N - noncarcinogenic

[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

TABLE 6-30

COMPARISON OF MAXIMUM CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SURFACE WATER SAMPLES TO EPA REGION III RBC CONCENTRATIONS SWMU 9 - AREA B (TANKS 214 - 215) NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9SW01 06/29/99	9SW03 06/29/99	9SW04 06/29/99	Maximum Detected Concentration	EPA Region III Tap Water RBC[1]	Does the Maximum Concentration Exceed the Criteria?
Inorganics (µg/L)						
Antimony	**16.5**	2.7 U	2.7 U	**16.5**	15 C	**YES**
Arsenic	**17.8 J**	**33.5 J**	**39.7 J**	**39.7 J**	0.045 N	**YES**
Barium	54.2	54.9	61.1	61.1	260 N	no
Beryllium	0.73	0.1 U	0.12 J	0.73	7.3 N	no
Cadmium	2.5 U	0.94 J	1.5 J	1.5 J	1.8 N	no
Chromium[2]	8.5	8 J	7.7 U	8.5	11 N	no
Cobalt	4.1	3.6 J	4.4 J	4.4 J	220 N	no
Copper	50.4	41.4 U	55.6 J	55.6 J	150 N	no
Lead[2]	4.5 UJ	4.5 UJ	5.4 J	5.4 J	15 N	no
Nickel	10.1	4.5 J	4.4 J	10.1	73 N	no
Tin	9.2	5 J	3.8 J	9.2	2,200 N	no
Vanadium	**70.9**	**134**	**72.3**	**134**	26 N	**YES**
Zinc	27.4	14.5 J	19.9 J	27.4	1,100 N	no
Cyanide	6.1	10 U	10 U	6.1	73 N	no

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

Bolding indicates that the concentration exceeds EPA Region III Tap Water RBC.

µg/L - micrograms per liter

C - carcinogenic

N - noncarcinogenic

[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

[2] The RBC for Cr(V1) was used because there is not a total chromium RBC available.

[3] EPA Action Level for Lead (www.epa.gov/OGWDW/wot.appa.html) November 1999c.

TABLE 6-31

COMPARISON OF MAXIMUM CONCENTRATIONS FOR ORGANIC ANALYTES DETECTED IN SURFACE WATER SAMPLES TO EPA REGION III RBC CONCENTRATIONS SWMU 9 - AREA B (TANKS 214 - 215) NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9SW01 6/29/99	9SW03 6/29/99	9SW04 6/29/99	Maximum Detected Concentration	EPA Region III Tap Water RBC[1]	Does the Maximum Concentration Exceed the Criteria?
Volatiles (µg/L)						
Methylene chloride	2.7 J	5 U	5 U	2.7 J	4.1 C	no

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:

Bolding indicates that the concentration exceeds EPA Region III Tap Water RBC.

µg/L - micrograms per liter

C - carcinogenic

[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

TABLE 6-32

COMPARISON OF MAXIMUM CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SURFACE SOIL SAMPLES TO EPA REGION III RBC CONCENTRATIONS SWMU 9 - AREA C (TANKS 216 - 217) NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9SS05 03/20/96	9SS06 03/20/96	9MW04-00 03/20/96	Maximum Detected Concentration	EPA Region III Residential Soil RBCs[1]	Does the Maximum Concentration Exceed the Criteria?
RCRA Metals (mg/kg)						
Lead[2]	14.5	52.5	9.3	52.5	400	no

Notes:

[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

[2] Currently there is not an established RfD for Lead therefore as recommended in 1996 EPA Soil Screening Guidance document, and EPA 1994a Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities a screening level of 400 mg/kg was used.

TABLE 6-33

COMPARISON OF MAXIMUM CONCENTRATIONS FOR ORGANIC ANALYTES DETECTED IN SURFACE SOIL SAMPLES TO EPA REGION III RBC CONCENTRATIONS SWMU 9 - AREA C (TANKS 216 - 217) NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9SS05 03/20/96	9SS06 03/20/96	9MW04-00 03/20/96	Maximum Detected Concentration	EPA Region III Residential Soil RBCs[1]	Does the Maximum Concentration Exceed the Criteria?
Semivolatiles (µg/kg)						
Di-n-butylphthalate	350 U	340 U	100 J	100 J	780,000 N	no
Pyrene	350 U	340 U	56 J	56 J	230,000 N	no
Benzo(b)fluoranthene	350 U	340 U	59 J	59 J	870 C	no
Chrysene	350 U	340 U	45 J	45 J	87,000 C	no

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:

C - carcinogenic

N - noncarcinogenic

µg/kg - micrograms per kilogram

[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

TABLE 6-34

COMPARISON OF MAXIMUM CONCENTRATIONS FOR INORGANIC ANALYTES
DETECTED IN SUBSURFACE SOIL SAMPLES TO EPA REGION III RBC CONCENTRATIONS
SWMU 9 - AREA C (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9MW04-03 04/19/96	9MW04-05 04/19/96	9TP11-05 04/13/96	9TP13-04 04/13/96	9TP14-05 04/13/96	9TP15-05 04/13/96	9TP16-05 04/13/96	9TP17-05 04/14/96	Maximum Detected Concentration	EPA Region III Residential Soil RBCs[1]	Does the Maximum Concentration Exceed the Criteria?
RCRA Metals (mg/kg)											
Lead[2]	1.4	1.2	5.2 J	6.4 J	26.2 J	24 J	31.5 J	2.2 J	31.5 J	400	no
Silver	0.72	0.71	0.57	0.71	0.35 U	0.39 U	0.86	0.67	0.86	39 N	no
Chromium[3]	**28.3**	20.4	24.2 R	24.4 R	22.4 R	22.4 R	29.1 R	24.9 R	**28.3**	23 N	**YES**

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

R - Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

Notes:

Bolding indicates that the concentration exceeds EPA Region III Residential Soil RBC.

N - noncarcinogenic

mg/kg - milligrams per kilogram

(1) The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

(2) Currently there is not an established RfD for Lead therefore as recommended in 1996 EPA Soil Screening Guidance document, and EPA 1994a Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities a screening level of 400 mg/kg was used .

(3) The RBC for Cr(VI) was used for screening because there is not a total chromium RBC available.

TABLE 6-35

COMPARISON OF MAXIMUM CONCENTRATIONS FOR ORGANIC ANALYTES
DETECTED IN SUBSURFACE SOIL SAMPLES TO EPA REGION III RBC CONCENTRATIONS
SWMU 9 - AREA C (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9MW04-03 04/19/96	9MW04-05 04/19/96	9TP11-05 04/13/96	9TP13-04 04/13/96	9TP14-05 04/13/96	9TP15-05 04/13/96	9TP16-05 04/13/96	9TP17-05 04/14/96	Maximum Detected Concentration	EPA Region III Residential Soil RBCs[1]	Does the Maximum Concentration Exceed the Criteria?
Volatiles (µg/kg)											
Acetone	11 U	12 U	12 U	74 J	11 UJ	12 UJ	24 J	31 J	74 J	780,000 N	no
Xylene (total)	6 U	6 U	6 U	2 J	6 U	6 U	6 U	7 U	2 J	16,000,000 N	no

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

UJ - Not detected. Quantitation limit may be inaccurate or imprecise.

Notes:

C - carcinogenic

N - noncarcinogenic

µg/kg - micrograms per kilogram

[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

TABLE 6-36

COMPARISON OF MAXIMUM CONCENTRATIONS FOR ORGANIC ANALYTES DETECTED IN GROUNDWATER SAMPLES TO EPA REGION III RBC CONCENTRATIONS SWMU 9 - AREA C (TANKS 216 - 217) NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	13GW07 03/24/96	13GW08 03/24/96	13GW09 03/24/96	13GW10 03/24/96	13GW11 03/25/96	9MW04 04/24/96	13GW10 06/29/99	13GW11 06/29/99	Maximum Detected Concentration	EPA Region III Tap Water RBCs[1]	Does the Maximum Concentration Exceed the Criteria?
Volatiles (µg/L)											
1,2-Dichloropropane	5 U	5 U	5 U	5 U	**2 J**	5 U	NA	5 U	**2 J**	0.16 C	**YES**
Toluene	5 U	5 U	5 U	5 U	5 U	5 U	NA	4.2 J	4.2 J	75 N	no
Semivolatiles (µg/L)											
Bis(2-ethylhexyl)phthalate	11 U	10 U	10 U	**38**	10 U	10 U	10 U	NA	**38**	4.8 C	**YES**

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.

U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:

Bolding indicates that the concentration exceeds EPA Region III Tap Water RBC.

C - carcinogenic

N - noncarcinogenic

µg/L - micrograms per liter

NA - Not Analyzed

[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

TABLE 6-37

COMPARISON OF MAXIMUM CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SEDIMENT SAMPLES TO EPA REGION III RBC CONCENTRATIONS
SWMU 9 - AREA C (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Samples Date	9SD06 06/29/99	9SD07 06/29/99	Maximum Detected Concentration	EPA Region III Residential Soil RBCs[1]	Does the Maximum Concentration Exceed the Criteria?
Inorganics (mg/kg)					
Arsenic	**4.6 J**	**2.3 J**	**4.6 J**	0.43 C	**YES**
Barium	80	29	80	550 N	no
Beryllium	0.097 J	0.076 J	0.097 J	16 N	no
Chromium[2]	**30**	9.1	**30**	23 N	**YES**
Cobalt	22	7.6	22	470 N	no
Copper	49 J	28 J	49 J	310 N	no
Lead[3]	22 J	8.1 J	22 J	400 N	no
Mercury[4]	0.049 J	0.015 J	0.049 J	2.3 N	no
Nickel	7 J	4.4 J	7 J	160 N	no
Selenium	0.68 J	0.39 U	0.68 J	3.9 N	no
Sulfide	**290**	57 U	**290**	NA	**YES**
Tin	6 J	3.5 J	6 J	4,700 N	no
Vanadium	**180**	**66**	**180**	55 N	**YES**
Zinc	52 J	20 U	52 J	2,300 N	no

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:
Bolding indicates that the concentration exceeds EPA Region III Residential Soil RBC.
C - carcinogenic
N - noncarcinogenic
mg/kg - milligrams per kilogram
NA - Not Available
[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.
[2] The RBC for Cr(VI) was used for screening because there is not a total chromium RBC available.
[3] Currently there is not an established RfD for Lead therefore as recommended in 1996 EPA Soil Screening Guidance document, and EPA 1994a Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities a screening level of 400 mg/kg was used .
[4] An RBC for Inorganic Mercury has not been established; therefore, all mercury was screened using the mercuric chloride RBC.

TABLE 6-38

COMPARISON OF MAXIMUM CONCENTRATIONS FOR ORGANIC ANALYTES DETECTED IN SEDIMENT SAMPLES TO EPA REGION III RBC CONCENTRATIONS SWMU 9 - AREA C (TANKS 216 - 217) NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9SD06 6/29/99	9SD07 6/29/99	Maximum Detected Concentration	EPA Region III Residential Soil RBCs[1]	Does the Maximum Concentration Exceed the Criteria?
Volatiles (µg/kg)					
Acetone	290	74 J	290	780,000 N	no
Carbon disulfide	20 U	16	16	780,000 N	no
2-Butanone	68 J	63 U	68 J	4,700,000 N	no

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:
C - carcinogenic
N - noncarcinogenic
µg/kg - micrograms per kilogram
[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.

TABLE 6-39

COMPARISON OF MAXIMUM CONCENTRATIONS FOR INORGANIC ANALYTES DETECTED IN SURFACE WATER SAMPLES TO EPA REGION III RBC CONCENTRATIONS
SWMU 9 - AREA C (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9SW06 06/29/99	9SW07 06/29/99	Maximum Detected Concentration	EPA Region III Tap Water RBC[1]	Does the Maximum Concentration Exceed the Criteria?
Total Inorganics (µg/L)					
Arsenic	**60.8 J**	**8.7 J**	**60.8 J**	0.045 C	**YES**
Barium	**341**	**274**	**341**	260 N	**YES**
Beryllium	2.3	2.4	2.4	7.3 N	no
Cadmium	**3.3**	2.5 U	**3.3**	1.8 N	**YES**
Chromium[2]	**155**	**103**	**155**	11 N	**YES**
Cobalt	145	81.6	145	220 N	no
Copper	**389**	**368**	**389**	150 N	**YES**
Lead[3]	**130 J**	**80.9 J**	**130 J**	15	**YES**
Mercury[4]	0.59	0.5	0.59	1.1 N	no
Nickel	63.4	53.5	63.4	73 N	no
Tin	13	11.5	13	2,200 N	no
Vanadium	**1,070**	**660**	**1,070**	26 N	**YES**
Zinc	425	246	425	1,100 N	no

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:
Bolding indicates that the concentration exceeds EPA Region III Tap Water RBC.
C - carcinogenic
N - noncarcinogenic
[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.
[2] The RBC for Cr(VI) was used for screening because there is not a total chromium RBC available.
[3] Currently there is not an established RfD for Lead therefore as recommended in 1996 EPA Soil Screening Guidance document, and EPA 1994a Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities a screening level of 400 mg/kg was used.
[4] The RBC for Mercuric Chloride was used because there is not a RBC for Mercury.
µg/L - micrograms per liter

TABLE 6-40

COMPARISON OF MAXIMUM CONCENTRATIONS FOR ORGANIC ANALYTES DETECTED IN SURFACE WATER SAMPLES TO EPA REGION III RBC CONCENTRATIONS
SWMU 9 - AREA C (TANKS 216 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	9SW06 6/29/99	9SW07 6/29/99	Maximum Detected Concentration	EPA Region III Tap Water RBC[1]	Does the Maximum Concentration Exceed the Criteria?
Volatiles (µg/L)					
Methylene chloride	5 U	2.9 J	2.9 J	4.1 C	no

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not Detected. The associated number indicates approximate sample concentration necessary to be detected.

Notes:
C - carcinogenic
[1] The Region III Risk Based Concentrations (RBC) were adjusted downward by a factor of 10 to account for potential noncarcinogenic additive effects. EPA October 1999a.
µg/L - micrograms per liter

TABLE 6-41

SUMMARY OF INORGANIC ANALYTES THAT EXCEEDED 2X AVERAGE DETECTED BACKGROUND CONCENTRATIONS FOR AREAS A, B, AND C
SWMU 9 (TANKS 212 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Area	Surface Soil	Subsurface Soil	Groundwater		Sediments	Surface Water
			Total	Dissolved		
A	barium silver selenium	arsenic barium cadmium chromium silver lead	arsenic chromium mercury	mercury lead	NA	NA
B	lead selenium	arsenic barium cadmium lead silver	None	None	NA	NA
C	lead	chromium silver lead	None	None	NA	NA

Notes:
NA - Not Applicable; only one sediment and surface water background sample was collected, therefore, an average could not be calculated. All inorganics detected in sediment and surface were retained and screened against Region III RBCs.

TABLE 6-42

SUMMARY OF PCOCs FOR AREAS A, B, AND C IDENTIFIED
BY SCREENING WITH EPA REGION III RBC CONCENTRATIONS
SWMU 9 (TANKS 212 - 217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Area	Surface Soil	Subsurface Soil	Groundwater		Sediments	Surface Water
			Total	Dissolved		
A	None	arsenic chromium	acetophenone arsenic benzene bis 2-ethylhexyl phthalate chromium ethylbenzene 2-methylnapthalene methylene chloride naphthalene toluene	None	arsenic vanadium	arsenic selenium vanadium
B	None	arsenic	benzene bromodichloromethane bromoform chloroform dibromochloromethane methylene chloride bis(2-ethyhexyl phthalate)	None	arsenic chromium sulfide vanadium	antimony arsenic vanadium
C	None	chromium	1,2 dichloropropane bis(2-ethylhexyl phthalate)	None	arsenic chromium sulfide vanadium	arsenic barium cadmium chromium copper lead vanadium

TABLE 6-43

SHAPIRO WILKES TEST RESULTS AND IDENTIFICATION OF THE EXPOSURE POINT CONCENTRATION
SWMU 9 - AREA A
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

	Normal Distribution?	Lognormal/ Normal 95th UCL[2]	Maximum Concentration	Is the 95th UCL Greater than the Maximum Detected Concentration?	Exposure Point Concentration
Subsurface Soil (mg/kg)					
Arsenic	No	1.26 L	5.0	No	1.26
Chromium	No	16.76 L	50.8	No	16.76
Groundwater (µg/L)					
Arsenic	Yes	21.39 N	29.2	No	21.39
Chromium	No	579,596 L	193	Yes	193
Benzene	No	1.96×10^{12} L	1600	Yes	1600
Ethylbenzene	Yes	194.7 N	160	Yes	160
2 Methylnapthalene	NA[1]	NA[1]	23	Yes	23
Bis(2-ethylhexyl phthalate)	Yes	5.3 N	5	Yes	5
Acetophenone	NA[1]	NA[1]	1	Yes	1
Toluene	No	9.3×10^{19} L	4100	Yes	4100
Sediment (mg/kg)					
Arsenic	NA[1]	NA[1]	1.8	NA[1]	1.8
Surface Water (µg/L)					
Arsenic	NA[1]	NA[1]	38.3	NA[1]	38.3

Notes:

L= Lognormal 95th UCL
N= Normal 95th UCL
[1]NA = Not Available; database not sufficient for statistical analysis.
[2]EPA 1992b

TABLE 6-44

SHAPIRO WILKES TEST RESULTS AND IDENTIFICATION OF THE EXPOSURE POINT CONCENTRATION
SWMU 9 - AREA B
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

	Normal Distribution?	Lognormal/ Normal 95th UCL[2]	Maximum Concentration	Is the 95th UCL Greater than the Maximum Detected Concentration?	Exposure Point Concentration
Subsurface Soil (mg/kg)					
Arsenic	No	92.41 L	2	Yes	2
Groundwater (µg/L)					
Benzene	NA[1]	NA[1]	140	NA[1]	140
Bromodichloromethane	NA[1]	NA[1]	460	NA[1]	460
Bromoform	NA[1]	NA[1]	360	NA[1]	360
Chloroform	NA[1]	NA[1]	1100	NA[1]	1100
Dibromochloromethane	NA[1]	NA[1]	300	NA[1]	300
Methylene chloride	NA[1]	NA[1]	11	NA[1]	11
Bis(2-ethylhexyl phthalate)	Yes	7.34 N	7	Yes	7
Sediment (mg/kg)					
Arsenic	Yes	1.4 N	1.3	Yes	1.3
Chromium	Yes	29.9 N	28	Yes	28
Sulfide	Yes	360.3 N	250	Yes	250
Vanadium	Yes	199.1 N	180	Yes	180
Surface Water (µg/L)					
Antimony	NA[1]	NA[1]	16.5	NA[1]	16.5
Arsenic	Yes	49.4 N	39.7	Yes	39.7
Nickel	No	57.5	10.1	Yes	10.1
Vanadium	No	358.4	134	Yes	134

Notes:

L= Lognormal 95th UCL
N= Normal 95th UCL
[1]NA = Not Available; database not sufficient for statistical analysis.
[2]EPA 1992b

TABLE 6-45

SHAPIRO WILKES TEST RESULTS AND IDENTIFICATION OF THE EXPOSURE POINT CONCENTRATION
SWMU 9 - AREA C
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

	Normal Distribution?	Lognormal/ Normal 95th UCL[2]	Maximum Concentration	Is the 95th UCL Greater than the Maximum Detected Concentration?	Exposure Point Concentration
Subsurface Soil (mg/kg)					
Chromium	NA[1]	NA[1]	28.3	NA[1]	28.3
Groundwater (μg/L)					
1,2 Dichloropropane	NA[1]	NA[1]	2	NA[1]	2
Bis(2-ethylhexyl phthalate)	NA[1]	NA[1]	38	NA[1]	38
Sediment (mg/kg)					
Arsenic	NA[1]	NA[1]	4.6	NA[1]	4.6
Chromium	NA[1]	NA[1]	30	NA[1]	30
Sulfide	NA[1]	NA[1]	290	NA[1]	290
Vanadium	NA[1]	NA[1]	180	NA[1]	180
Surface Water (μg/L)					
Arsenic	NA[1]	NA[1]	60.8	NA[1]	60.8
Barium	NA[1]	NA[1]	341	NA[1]	341
Cadmium	NA[1]	NA[1]	3.3	NA[1]	3.3
Chromium	NA[1]	NA[1]	155	NA[1]	155
Copper	NA[1]	NA[1]	389	NA[1]	389
Lead	NA[1]	NA[1]	130	NA[1]	130
Vanadium	NA[1]	NA[1]	1070	NA[1]	1070

Notes:

[1]NA = Not Available; database not sufficient for statistical analysis.
[2]EPA 1992b

TABLE 6-46

FUTURE AND CURRENT EXPOSURES TO ENVIRONMENTAL MEDIA AT
SWMU 9
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

		Future			Current/Future
		Residential-Military		Construction Worker	On-Site Worker
		Adult	Child (1-6)	Adult	Adult
Subsurface Soil	incidental ingestion			X	
	dermal contact			X	
	inhalation of particulates			X	
	inhalation of volatiles			X	
Groundwater-Beneficial Use	incidental ingestion	X	X	X	
	dermal contact	X	X	X	
Surface Water	incidental ingestion	X	X		X
	dermal contact	X	X		X
Sediments	incidental ingestion	X	X		X
	dermal contact	X	X		X

TABLE 6-47

NONCARCINOGENIC TOXICITY DATA
SWMU 9, AREA A
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemical of Potential Concern	Oral RfD Value (mg/kg/day)	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (mg/kg/day)	Inhalation RfD mg/kg/day	Sources of RfD[2]
2-methylnaphthalene	2.00E-02	80%	1.60E-02	NA	NCEA
Benzene	3.00E-03	100%	3.00E-03	1.70E-03	IRIS
Ethylbenzene	1.00E-01	92%	9.20E-02	2.90E-01	IRIS
Toluene	2.00E-01	100%	2.00E-01	1.14E-01	IRIS
Methylene Chloride	6.00E-02	100%	6.00E-02	8.60E-01	IRIS
Naphthalene	2.00E-02	50%	1.00E-02	9.00E-04	IRIS
Acetophenone	1.00E-01	100%	1.00E-01	NA	IRIS
Bis(2-ethylhexyl)phthalate	2.00E-02	55%	1.10E-02	NA	IRIS
Arsenic	3.00E-04	95%	2.85E-04	NA	IRIS
Chromium	3.00E-03	1%	3.00E-05	3.00E-05	IRIS
Vanadium	7.00E-03	2%	1.40E-04	NA	HEAST

Notes:

NA = Not Available

(1) EPA 1989a

(2) Integrated Risk Information System (IRIS) EPA 2000.
Health Effects Assessment Summary Tables (HEAST) EPA 1997b.
NCEA EPA 1999f.

TABLE 6-48

CARCINOGENIC TOXICITY DATA -- ORAL/DERMAL
SWMU 9, AREA A
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemical of Potential Concern	Oral Cancer Slope Factor $(mg/kg/day)^{-1}$	Oral to Dermal Adjustment Factor[1]	Adjusted Dermal Cancer Slope Factor	Inhalation Cancer Slope Factor $(mg/kg/day)^{-1}$	Weight of Evidence/ Cancer Guideline Description	Source[2]
2-methylnaphthalene	NA	80%	NA	NA	NA	NA
Benzene	2.90E-02	100%	2.90E-02	2.90E-02	A	IRIS
Ethylbenzene	NA	92%	NA	NA	D	IRIS
Toluene	NA	100%	NA	NA	D	IRIS
Methylene Chloride	7.50E-03	100%	7.50E-03	1.65E-03	D	IRIS
Naphthalene	NA	50%	NA	NA	D	IRIS
Acetophenone	NA	100%	NA	NA	D	IRIS
Bis(2-ethylhexyl)phthalate	1.40E-02	55%	2.55E-02	1.40E-02	B2	IRIS
Arsenic	1.50E+00	95%	1.58E+00	1.51E+01	A	IRIS
Chromium	NA	1%	NA	4.10E+01	D (o) A (i)	IRIS
Vanadium	NA	2%	NA	NA	D	IRIS

NA = Not Available
EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

[1] EPA 1989a

[2] Integrated Risk Information System (IRIS) EPA 2000.
Health Effects Assessment Summary Tables (HEAST) EPA 1997b.
NCEA EPA 1999f.

TABLE 6-49

NONCARCINOGENIC TOXICITY DATA -- INHALATION
SWMU 9, AREA B
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemical of Potential Concern	Oral RfD Value (mg/kg/day)	Oral to Dermal Adjustment Factor (1)	Dermal RfD (mg/kg/day)	Inhalation RfD (mg/kg/day)	Source
Benzene	3.00E-03	100%	3.00E-03	1.70E-03	NCEA
Bromodichloromethane	2.00E-02	100%	2.00E-02	NA	IRIS
Bromoform	2.00E-02	100%	2.00E-02	NA	IRIS
Chloroform	1.00E-02	100%	1.00E-02	8.60E-05	IRIS
Dibromochloromethane	2.00E-02	100%	2.00E-02	NA	IRIS
Methylene Chloride	6.00E-02	100%	6.00E-02	8.60E-01	IRIS
bis(2-ethylhexyl)phthalate	2.00E-02	55%	1.10E-02	NA	IRIS
Antimony	4.00E-04	10%	4.00E-05	NA	IRIS
Arsenic	3.00E-04	95%	2.85E-04	NA	IRIS
Chromium	3.00E-03	1%	3.00E-05	3.00E-05	IRIS
Sulfide	NA	20%	NA	NA	NA
Vanadium	7.00E-03	2%	1.40E-04	NA	HEAST

Notes:

NA = Not Available

(1) EPA 1989a

(2) Integrated Risk Information System (IRIS) EPA 2000.
Health Effects Assessment Summary Tables (HEAST) EPA 1997b.
NCEA EPA 1999f.

TABLE 6-50

CARCINOGENIC TOXICITY DATA -- ORAL/DERMAL
SWMU 9, AREA B
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemical of Potential Concern	Oral Cancer Slope Factor $(mg/kg/day)^{-1}$	Oral to Dermal Adjustment Factor	Adjusted Dermal Cancer Slope Factor[1] $(mg/kg/day)^{-1}$	Inhalation Cancer Slope Factor $(mg/kg/day)^{-1}$	Weight of Evidence/ Cancer Guideline Description	Source[2]
Benzene	2.90E-02	100%	2.90E-02	2.90E-02	A	IRIS
Bromodichloromethane	6.20E-02	100%	6.20E-02	NA	B2	IRIS
Bromoform	7.90E-03	100%	7.90E-03	3.90E-03	B2	IRIS
Chloroform	6.10E-03	100%	6.10E-03	8.10E-02	B2	IRIS
Dibromochloromethane	8.40E-02	100%	8.40E-02	NA	C	IRIS
Methylene Chloride	7.50E-03	100%	7.50E-03	1.65E-03	B2	IRIS
Bis(2-ethylhexyl)phthalate	1.40E-02	55%	2.55E-02	1.40E-02	B2	IRIS
Antimony	NA	10%	NA	NA	D	NA
Arsenic	1.50E+00	95%	1.58E+00	1.51E+01	A	IRIS
Chromium	NA	1%	NA	4.10E+01	D (o) A (i)	IRIS
Sulfide	NA	20%	NA	NA	NA	NA
Vanadium	NA	2%	NA	NA	NA	NA

Notes:

NA = Not Available
EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

[1] EPA 1989a

[2] Integrated Risk Information System (IRIS) EPA 2000.
Health Effects Assessment Summary Tables (HEAST) EPA 1997b.
NCEA EPA 1999f.

TABLE 6-51

NONCARCINOGENIC TOXICITY DATA -- ORAL/DERMAL
SWMU 9, AREA C
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemical of Potential Concern	Oral RfD Value (mg/kg/day)	Oral to Dermal Adjustment Factor [1]	Dermal RfD (mg/kg/day)	Inhalation RfD (mg/kg/day)	Source[2]
1,2-Dichloropropane	NA	80%	NA	1.14E-03	NA
Bis(2-ethylhexyl)phthalate	2.00E-02	55%	1.10E-02	NA	IRIS
Arsenic	3.00E-04	95%	2.85E-04	NA	IRIS
Barium	7.00E-02	100%	7.00E-02	1.40E-04	IRIS
Cadmium	1.00E-03	5%	5.00E-03	5.70E-05	IRIS
Chromium	3.00E-03	1%	3.00E-05	3.00E-05	IRIS
Sulfide	NA	NA	NA	NA	NA
Vanadium	7.00E-03	2%	1.40E-04	NA	HEAST

Notes:

NA = Not Available

[1] EPA 1989a

[2] Integrated Risk Information System (IRIS) EPA 2000.
Health Effects Assessment Summary Tables (HEAST) EPA 1997b.
NCEA EPA 1999f.

TABLE 6-52

CARCINOGENIC TOXICITY DATA -- ORAL/DERMAL
SWMU 9, AREA C
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemical of Potential Concern	Oral Cancer Slope Factor $(mg/kg/day)^{-1}$	Oral to Dermal Adjustment Factor[1]	Adjusted Dermal Cancer Slope Factor $(mg/kg/day)^{-1}$	Inhalation Cancer Slope Factor $(mg/kg/day)^{-1}$	Weight of Evidence	Source
1,2-Dichloropropane	6.80E-02	80%	8.50E-02	NA	NA	IRIS
Bis(2-ethylhexyl)phthalate	1.40E-02	50%	2.80E-02	1.40E-02	B2	IRIS
Arsenic	1.50E+00	95%	1.58E+00	1.51E+01	A	IRIS
Barium	NA	100%	NA	NA	D	IRIS
Cadmium	NA	3%	NA	6.30E+00	B1	IRIS
Chromium	NA	1%	NA	4.10E+01	D (o) A (i)	NA
Sulfide	#N/A	#N/A	#N/A	#N/A	NA	#N/A
Vanadium	NA	2%	NA	NA	NA	NA

NA = Not Available

Notes:

[1] EPA 1989a

[2] Integrated Risk Information System (IRIS) EPA 2000.
Health Effects Assessment Summary Tables (HEAST) EPA 1997b.
NCEA EPA 1999f.

A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE 6-53

INCREMENTAL LIFETIME CANCER RISKS (ILCRs) AND HAZARD INDICIES (HIs)
FOR FUTURE MILITARY ADULT AND YOUNG CHILD RESIDENTS - RME
SWMU 9, AREA A
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Pathway	Future Military Adult Residents		Future Military Young Child Residents		Total Lifetime Future Residents
	ILCR	HI	ILCR	HI	ILCR
Groundwater					
Ingestion	3.4E-06	0.07	3.2E-06	0.33	6.6E-06
Dermal Contact	5.5E-06	0.38	1.8E-06	0.62	7.2E-06
Subtotal	8.9E-06	0.45	5.0E-06	0.94	1.4E-05
Surface Water					
Ingestion	2.5E-06	0.01	2.3E-06	0.07	4.8E-06
Dermal Contact	9.2E-07	0.03	3.0E-07	0.04	1.2E-06
Subtotal	3.4E-06	0.04	2.6E-06	0.11	6.1E-06
Sediment					
Ingestion	1.2E-07	0.001	2.2E-07	0.01	3.4E-07
Dermal Contact	4.6E-07	0.00	1.5E-07	0.00	6.1E-07
Subtotal	5.8E-07	0.00	3.7E-07	0.01	9.5E-07
Total	1.3E-05	0.50	8.0E-06	1.06	2.1E-05

Notes:

Bolding indicates exceedances of USEPA acceptable target risk criteria by pathway exposures
Shading indicates exceedances of USEPA acceptable target risk criteria by subtotal and total risk value

TABLE 6-54

INCREMENTAL LIFETIME CANCER RISKS (ILCRs) AND HAZARD INDICIES (HIs) FOR CURRENT ON-SITE WORKERS SWMU 9, AREA A NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Pathway	Current On-Site Workers	
	ILCR	HI
Surface Water		
Ingestion	2.5E-06	0.01
Dermal Contact	6.4E-07	0.02
Subtotal	3.1E-06	0.03
Sediment		
Ingestion	1.2E-07	0.00
Dermal Contact	3.2E-07	0.00
Subtotal	4.4E-07	0.00
Total	3.6E-06	0.04

Notes:

Bolding indicates exceedances of USEPA acceptable target risk criteria by pathway exposures
Shading indicates exceedances of USEPA acceptable target risk criteria by subtotal and total risk value

TABLE 6-55

INCREMENTAL LIFETIME CANCER RISKS (ILCRs) AND HAZARD INDICIES (HIs) FOR FUTURE CONSTRUCTION WORKERS SWMU 9, AREA A NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Pathway	Future Construction Workers	
	ILCR	HI
Subsurface Soil		
Ingestion	9.1E-08	0.03
Dermal Contact	2.0E-08	0.13
Inhalation	5.4E-10	0.00003
Subtotal	1.1E-07	0.16
Groundwater		
Ingestion	4.0E-07	0.24
Dermal Contact	3.4E-07	0.71
Subtotal	7.3E-07	0.95
Total	8.4E-07	1.11

Notes:

Bolding indicates exceedances of USEPA acceptable target risk criteria by pathway exposures
Shading indicates exceedances of USEPA acceptable target risk criteria by subtotal and total risk value

TABLE 6-56

INCREMENTAL LIFETIME CANCER RISKS (ILCRs) AND HAZARD INDICIES (HIs)
FOR FUTURE MILITARY ADULT AND YOUNG CHILD RESIDENTS - RME
SWMU 9, AREA B
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

	Future Military Adult Residents		Future Military Young Child Residents		Total Lifetime Future Residents
Pathway	ILCR	HI	ILCR	HI	ILCR
Groundwater					
Ingestion	1.6E-06	0.01	1.4E-06	0.07	3.0E-06
Dermal Contact	1.0E-06	0.01	3.4E-07	0.02	1.4E-06
Subtotal	2.6E-06	0.03	1.8E-06	0.09	4.4E-06
Surface Water					
Ingestion	4.0E-06	0.02	7.4E-07	0.02	4.7E-06
Dermal Contact	1.5E-06	0.01	4.7E-07	0.02	1.9E-06
Subtotal	5.4E-06	0.03	1.2E-06	0.04	6.6E-06
Sediment					
Ingestion	3.0E-07	0.01	5.6E-07	0.05	8.6E-07
Dermal Contact	1.2E-06	0.28	3.8E-07	0.45	1.6E-06
Subtotal	1.5E-06	0.28	9.4E-07	0.49	2.4E-06
Total	9.5E-06	0.34	3.9E-06	0.63	1.3E-05

Notes:

Bolding indicates exceedances of USEPA acceptable target risk criteria by pathway exposures
Shading indicates exceedances of USEPA acceptable target risk criteria by subtotal and total risk value

TABLE 6-57

INCREMENTAL LIFETIME CANCER RISKS (ILCRs) AND HAZARD INDICIES (HIs) FOR CURRENT ON-SITE WORKERS
SWMU 9, AREA B
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Pathway	Current On-Site Workers	
	ILCR	HI
Surface Water		
Ingestion	2.6E-06	0.02
Dermal Contact	6.6E-07	0.04
Subtotal	3.3E-06	0.06
Sediment		
Ingestion	8.5E-08	0.004
Dermal Contact	2.3E-07	0.18
Subtotal	3.2E-07	0.19
Total	3.6E-06	0.25

Notes:

Bolding indicates exceedances of USEPA acceptable target risk criteria by pathway exposures
Shading indicates exceedances of USEPA acceptable target risk criteria by subtotal and total risk value

TABLE 6-58

INCREMENTAL LIFETIME CANCER RISKS (ILCRs) AND HAZARD INDICIES (HIs)
FOR FUTURE CONSTRUCTION WORKERS
SWMU 9, AREA B
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Pathway	Future Construction Workers	
	ILCR	HI
Subsurface Soil		
Ingestion	1.4E-07	0.02
Dermal Contact	3.2E-08	0.00
Inhalation	2.3E-11	0.00
Subtotal	1.8E-07	0.03
Groundwater		
Ingestion	3.4E-07	0.08
Dermal Contact	1.3E-07	0.05
Inhalation		
Subtotal	4.7E-07	0.12
Total	6.5E-07	0.15

Notes:

Bolding indicates exceedances of USEPA acceptable target risk criteria by pathway exposures
Shading indicates exceedances of USEPA acceptable target risk criteria by subtotal and total risk value

TABLE 6-59

INCREMENTAL LIFETIME CANCER RISKS (ILCRs) AND HAZARD INDICIES (HIs) FOR FUTURE MILITARY ADULT AND YOUNG CHILD RESIDENTS - RME
SWMU 9, AREA C
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

	Future Military Adult Residents		Future Military Young Child Residents		Total Lifetime Future Residents
Pathway	ILCR	HI	ILCR	HI	ILCR
Groundwater					
Ingestion	2.9E-08	0.0002	2.7E-08	0.0009	5.6E-08
Dermal Contact	1.7E-07	0.0013	5.5E-08	0.0022	2.2E-07
Subtotal	2.0E-07	0.0015	8.2E-08	0.0031	2.8E-07
Surface Water					
Ingestion	4.0E-06	0.04	7.4E-07	0.04	4.7E-06
Dermal Contact	1.5E-06	0.47	4.7E-07	0.75	1.9E-06
Subtotal	5.4E-06	0.51	1.2E-06	0.79	6.6E-06
Sediment					
Ingestion	3.0E-07	0.01	5.6E-07	0.05	8.6E-07
Dermal Contact	1.2E-06	0.28	3.8E-07	0.45	1.6E-06
Subtotal	1.5E-06	0.28	9.4E-07	0.49	2.4E-06
Total	7.1E-06	0.79	2.2E-06	1.29	9.3E-06

Notes:

Bolding indicates exceedances of USEPA acceptable target risk criteria by pathway exposures
Shading indicates exceedances of USEPA acceptable target risk criteria by subtotal and total risk value

TABLE 6-60

INCREMENTAL LIFETIME CANCER RISKS (ILCRs) AND HAZARD INDICIES (HIs)
FOR CURRENT ON-SITE WORKERS
SWMU 9, AREA C
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Pathway	Current On-Site Workers	
	ILCR	HI
Surface Water		
Ingestion	4.0E-06	0.04
Dermal Contact	1.0E-06	0.33
Subtotal	5.0E-06	0.37
Sediment		
Ingestion	3.0E-07	0.01
Dermal Contact	8.2E-07	0.19
Subtotal	1.1E-06	0.20
Total	6.1E-06	0.57

Notes:

Bolding indicates exceedances of USEPA acceptable target risk criteria by pathway exposures
Shading indicates exceedances of USEPA acceptable target risk criteria by subtotal and total risk value

TABLE 6-61

INCREMENTAL LIFETIME CANCER RISKS (ILCRs) AND HAZARD INDICIES (HIs) FOR FUTURE CONSTRUCTION WORKERS
SWMU 9, AREA C
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Pathway	Future Construction Workers	
	ILCR	HI
Subsurface Soil		
Ingestion	0.0E+00	0.03
Dermal Contact	0.0E+00	0.21
Inhalation	8.8E-10	0.00005
Subtotal	8.8E-10	0.24
Groundwater		
Ingestion	3.4E-09	0.001
Dermal Contact	1.0E-08	0.002
Subtotal	1.4E-08	0.00
Total	1.5E-08	0.25

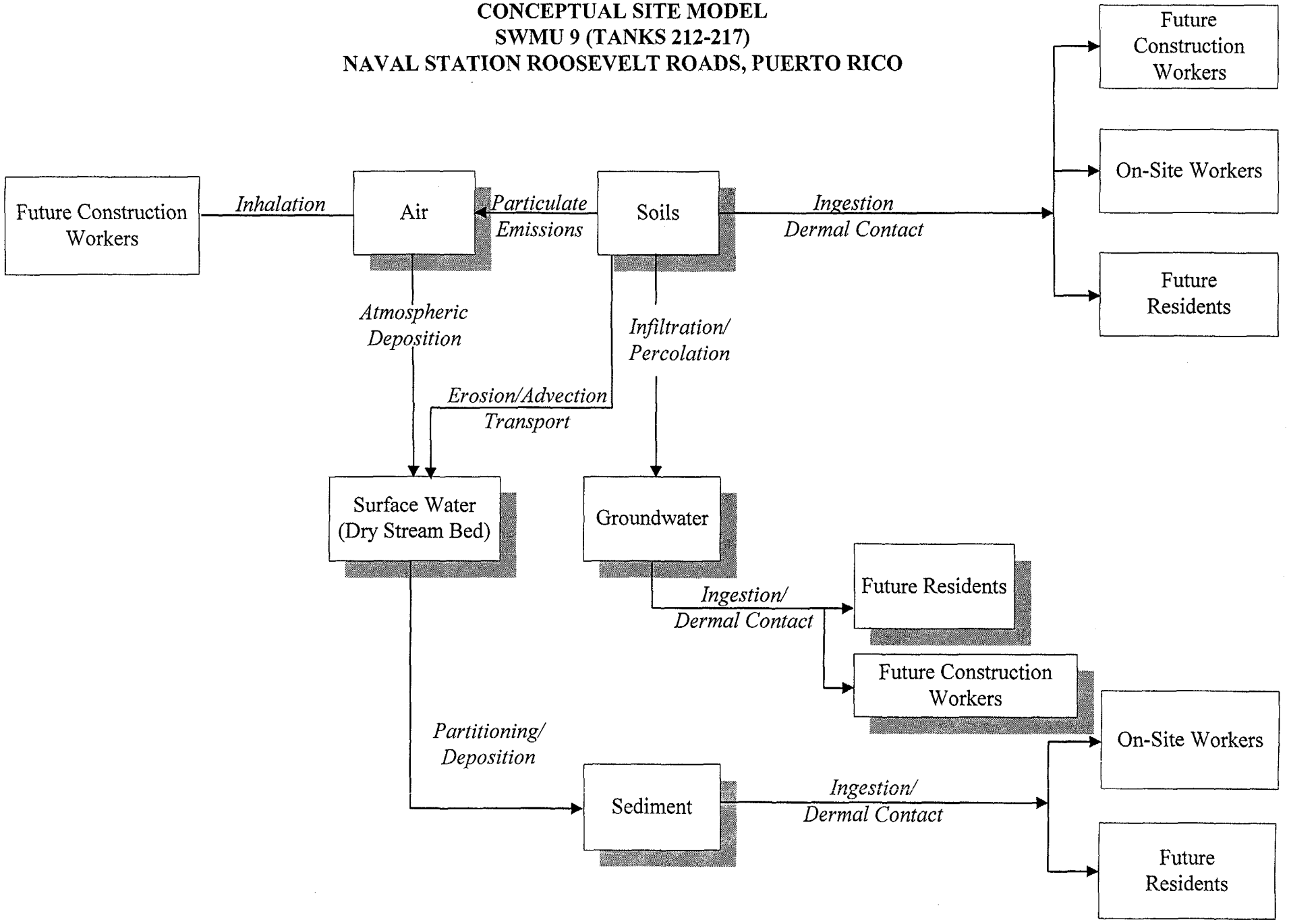
Notes:

Bolding indicates exceedances of USEPA acceptable target risk criteria by pathway exposures
Shading indicates exceedances of USEPA acceptable target risk criteria by subtotal and total risk value

SECTION 6.0
FIGURES

FIGURE 6-1

CONCEPTUAL SITE MODEL
SWMU 9 (TANKS 212-217)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO



7.0 SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT

A screening-level ecological risk assessment (screening-level ERA) was conducted at SWMU 9 to assess potential impacts to ecological receptors from chemicals detected in environmental media at three UST locations (Areas A, B, and C). Separate screening-level ERAs were conducted at each UST location using the process outlined in the EPA document entitled Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final (EPA 1997c) and the Chief of Naval Operations document entitled Navy Policy for Conducting Ecological Risk Assessments (CNO 1999).

The EPA and CNO risk assessment guidance contain the same eight-step process for conducting ecological risk assessments; however, the CNO policy clearly defines exit points and sub-steps that are present, but not clearly defined in the EPA guidance. The specific components of the EPA and CNO eight-step process are:

- Screening-level problem formulation and ecological effects evaluation (Step 1)
- Screening-level preliminary exposure estimate and risk calculation (Step 2)
- Baseline risk assessment problem formulation (Step 3)
- Study design and data quality objective process (Step 4)
- Field verification of sampling design (Step 5)
- Site investigation and analysis phase (Step 6)
- Risk characterization (Step 7)
- Risk management (Step 8)

Given that this is a screening-level ERA, it covers the first two steps of the EPA and CNO eight-step process. The purpose of the screening-level ERA is to determine if a more site-specific investigation is warranted (i.e., Step 3 through Step 8 of the EPA and CNO guidance). This screening-level ERA also includes Sub-Step 3a of the CNO policy. In this sub-step, the conservative exposure assumptions defined in the screening-level preliminary exposure estimate were refined and risk estimates were re-calculated using the same conceptual model defined in Step 1 (see Section 7.1.4). In the CNO guidance, Step 3a precedes the baseline risk assessment problem formulation, and is conducted to determine if risks detected in Step 2 are the result of the overly conservative exposure assumptions (see Section 7.3) required by the EPA guidance.

Although the EPA and CNO guidance combine the screening-level problem formulation and screening-level ecological effects evaluation together as Step 1 and the screening-level exposure estimate and screening-level risk calculation together as Step 2, each component of Step 1 and Step 2, as well as Step 3a of the CNO guidance, are presented separately in this screening-level ERA. As such, this screening-level ERA is organized as follows.

- Section 7.1 – Screening-level problem formulation
- Section 7.2 – Screening-level effects evaluation
- Section 7.3 – Screening-level exposure estimate
- Section 7.4 – Screening-level risk calculation
- Section 7.5 – Screening-level uncertainty analysis
- Section 7.6 – Screening-level conclusions
- Section 7.7 – Refinement of conservative exposure assumptions

7.1 Screening-Level Problem Formulation

The screening-level problem formulation involves the development of a preliminary conceptual model that provides the basic framework for the screening-level ERA. The preliminary conceptual model addresses the following issues, which are discussed in the sections that follow:

- The environmental setting
- Chemicals known or suspected to exist at the site
- Chemical fate and transport mechanisms
- Complete exposure pathways that might exist at the site
- The likely ecological receptors that may be affected by chemicals detected at the site
- Assessment and measurement endpoints used to evaluate potential ecological risks

7.1.1 Environmental Setting

The sections that follow provide a brief description of the site history, as well as a general description of site habitats and biota. A habitat characterization was not been performed at SWMU 9; therefore, detailed information regarding site habitats and the specific ecological receptors that may reside or forage within them are not known. As a result, general, literature-based information for Puerto Rico and the entire landmass of NSRR served as the basis for identifying potential ecological receptors that may be impacted by chemicals detected in site media.

7.1.1.1 Site History

As discussed in Section 2.2, SWMU 9 is comprised of six, concrete USTs located in three separate areas:

- Area A – Tanks 212 and 213
- Area B – Tanks 214 and 215
- Area C – Tanks 216 and 217

These tanks were originally constructed in 1948 for the storage of AVGAS. Tanks 212 and 213 are currently used for the storage of diesel fuel and unleaded gasoline, respectively. Tanks 214 and 215 were changed from AVGAS storage to marine diesel fuel and are currently out of service. Tank 216 was most recently used for the storage of unleaded gasoline but is currently out of service. It is not clear if Tank 217 was used for the storage of any fuel other than AVGAS. Previous investigations have indicated that this tank may have been used for the storage of marine diesel fuel and JP-5.

Previous reports indicate that each storage tank was cleaned of sludge material every five years until 1978. Sludge material was reportedly disposed in excavated pits adjacent to the individual tanks. Since 1978, sludge materials have been removed and disposed off-site by a licensed contractor.

7.1.1.2 Terrestrial and Marine Habitats

The upland habitat bounded by NSRR is classified as subtropical dry forest (Ewel and Witmore 1973). Similar to other forested areas of Puerto Rico, this region was previously clear-cut in the early part of the century, primarily for pasture land (Geo-Marine, Inc. 1998). After acquisition by the Navy, a secondary growth of thick scrub, dominated by leadtree (*Leucaena spp.*), box briar (*Randia aculeate*), sweet acacia (*Acacia famesiana*), and Australian corkwood (*Sesbania grandiflora*) grew in the previously grazed sections (Geo-Marine, Inc. 1998). Secondary growth exists today throughout the station's undeveloped upland, including the upland habitat within and adjacent to SWMU 9 (Areas A, B, and C); however, the current species composition of the secondary growth vegetation is not known. It is noted that habitat located in the immediate vicinity of each storage tank area consists of a maintained vegetative ground cover of unknown species composition. Without maintenance, the surrounding secondary growth cover would become established within the UST locations.

The marine environment surrounding NSRR includes mudflats, mangroves (black mangrove, white mangrove, and red mangrove), and seagrass beds (turtlegrass and manateegrass). The total area of mudflats, mangroves, and sea grass beds in the offshore manne environment contiguous to NSRR is approximately 161 acres, 2,700 acres, and 1,900 acres, respectively (Geo-Marine, Inc. 1998). Sea grass beds are important grazing areas for the green sea turtle (*Chelonia mydas*) and the West Indian manatee (*Trichechas manatus*). The green sea turtle is a federally-designated threatened species, while the West Indian manatee is a federally-designated endangered species. Both species have been reported in the marine environment surrounding NSRR. Sea grass beds are not contiguous to SWMU 9; however, the site is bordered along its entire length by an extensive mangrove forest (unknown species composition). Mangrove forests serve as nurseries for many marine fish species, and represent safe nesting habitat and foraging habitat for a variety of birds.

7.1.1.3 Biota

A total of 22 terrestrial mammal species are known historically from Puerto Rico; however, all mammals except bats (13 species) have been extirpated (USGS 1999). None of the bats found on Puerto Rico are exclusive to the island. Although the occurrence of bats at NSRR has not been documented, their presence is likely. The West Indian manatee is known to occur in the marine environment surrounding NSRR; however, the absence of sea grass beds contiguous to SWMU 9 likely precludes this mammal as a potential ecological receptor.

Several mammals have been introduced in Puerto Rico, including the black rat (*Rattus rattus*), Norway rat (*Rattus norvegicus*), and mongoose (*Herpestes javanicus*). These nonindigenous mammals have been implicated in the decline of several bird and reptile populations (USGS 1999 and USFWS 1996).

A total of 239 bird species are native to Puerto Rico (Raffaele 1989). This total includes breeding permanent residents and non-breeding migrants. In addition, many nonindigenous bird species have been introduced to Puerto Rico, including the shiny cowbird (*Molothrus bonariensis*) and several parrot species, such as the budgerigar (*Melopsittacus undulates*), orange-fronted parrot (*Aratinga canicularis*), and monk parrot (*Myiopsitta monaqchus*). Of the 239 species native to Puerto Rico, 12 are endemic to the island (Raffaele 1989).

Numerous native and migratory bird species have been reported at NSRR (Geo-Marine, Inc. 1998). It is noted that the known avian occurrences compiled by Geo-Marine, Inc. (1998) was based on literature-based information that pre-dated 1990. Regardless, the list includes the great blue heron (*Ardea herodias*), snowy egret (*Egretta thula*), little blue heron (*Florida caerulea*), black-crowned night heron (*Nycticorax nycticorax*), belted kingfisher (*Ceryle alcyon*), spotted sandpiper (*Actitis macularia*), greater yellowlegs (*Tringa melanoleauca*), black-bellied plover (*Squatarola squatarola*), clapper rail (*Rallus longirostris*), Royal tern (*Thalasseus maximus*), sandwich tern (*Thalasseus sandvicensis*), least tern (*Stema albifrons*), yellow warbler (*Dendroica petechia*), palm warbler (*Dendroica palmarum*), prairie warbler (*Dendroica discolar*), magnolia warbler (*Dendrocia magnolia*), red-legged thrush (*Mimocichla plumbea*), common nighthawk (*Chordeiles minor*), and red-tailed hawk (*Buteo jamaicensis*).

Endemic species reported from NSRR include the Puerto Rican lizard cuckoo (*Saurothera vieilloti*), Puerto Rican flycatcher (*Myiarchus antillarum*), Puerto Rican woodpecker (*Malanerpes portoricensis*), Puerto Rican emerald (*Chlorostilbon maugaeus*), and yellow-shouldered blackbird (*Agelaius xanthomus*).

The yellow-shouldered blackbird is a federally-designated endangered species. One of the principal reasons for the status of this species is attributed to parasitism by the nonindigenous shiny cowbird, which lays its eggs in blackbird nests and sometimes punctures the host's eggs (USFWS 1983). Other factors contributing to the status of this species include nest predation by the introduced black rat, Norway rat, and mongoose, as well as habitat modification and destruction (USFWS 1996). The entire land area of NSRR was declared critical habitat for the yellow-shouldered blackbird in 1976; however, a 1980 agreement with the U.S. Fish and Wildlife Service exempted certain areas from this categorization (Geo-Marine, Inc. 1998). A study conducted by the Naval Facilities Engineering Command (1996) reported that the mangrove forests surrounding NSRR, including those adjacent to SWMU 9, should be considered the most important nesting habitats for the yellow-shouldered blackbird. It is noted that the last reported nesting pair of yellow-shouldered blackbirds at NSRR was in 1986 (USFWS 1996). Other federally-designated bird species that have been reported at NSRR or have the potential to occur are the brown pelican (*Pelecanus occidentalis*), roseate tern (*Sterna dougallii dougallii*), and the piping plover (*Charadrius melodus*) (Geo-Marine, Inc. 1998).

A total of 23 amphibians and 47 reptiles are known from Puerto Rico and the adjacent waters (USGS 1999). Fifteen of the amphibians and 29 of the reptiles are endemic, while four amphibian species and three reptilian species have been introduced (USGS 1999). Puerto Rico's native amphibian species include 16 species of tiny frogs commonly called coquis. Only the Puerto Rican ridge-headed toad and the golden coqui have been listed as threatened under provisions of the Endangered Species Act of 1973. Their occurrence at NSRR is not known. Puerto Rico's native reptilian species include 31 lizards, 8 snakes, 1 freshwater turtle, and 5 sea turtles (USGS 1999). Of the five sea turtles, only the green sea turtle (*Chelonia mydas*), hawksbill sea turtle (*Eretmochelys imbricata*), and loggerhead sea turtle (*Dermochelys coriacea*) nest within Puerto Rico. These three sea turtles, as well as the Puerto Rican boa (*Epicrates inornatus*), have been listed under the provisions of the Endangered Species Act of 1973 (USFWS 1999). They are known to occur or have the potential to occur at NSRR (Geo-Marine, Inc. 1998). It is noted that a comprehensive list of amphibians and reptiles present at NSRR, particularly frogs and lizards, was not available from the literature.

A diverse fish and invertebrate community can be found in the offshore marine environment surrounding NSRR. This can be attributed to the varied habitats that include deep water marine habitat, mud flats, sea grass beds, and mangrove forests. Although too numerous to list individually by species, the fish community is represented by stingrays, herrings, groupers, needlefishes, mullets, barracudas, jacks, snappers, grunts, snooks, lizardfishes, parrotfishes, gobies, filefishes, wrasses, damselfishes, and butterflyfishes (Geo-Marine, Inc. 1998). As discussed in Section 7.1.1.2, the mangrove forest adjacent to SWMU 9 functions as a nursery for many of the fish species found in the surrounding marine environment.

7.1.2 Available Analytical Data

Groundwater, surface soil, and subsurface soil samples have been collected from each SWMU 9 storage tank area. In addition, surface water and sediment samples have been collected from the mangrove forest bordering SWMU 9. Section 5.0 provides a detailed discussion of the nature and extent of contamination within each UST area and the adjacent mangrove forest. As discussed in Section 7.1.4, chemicals detected in groundwater and subsurface soil data were not retained for evaluation in this screening-level ERA due to incomplete exposure pathways for these chemicals.

Tables 7-1, 7-2, and 7-3 summarize the sediment, surface water, and surface soil analytical data, respectively, for SWMU 9. The data are presented as frequency of detection, maximum detected concentrations, and arithmetic mean concentrations. For a given medium, only those chemicals detected in at least one SWMU 9 sample are listed. Analytical data for background sediment, surface water, and surface soil are summarized in Table 7-4. Chemicals detected in site media were not eliminated from evaluation based on a comparison to background data; however, the background data were evaluated in this screening-level ERA. Specifically, estimated risks from potential exposures to chemicals detected in background media were compared to estimated risks from potential exposures to chemicals in site media. This comparison was used to determine if risks detected at SWMU 9 are site-related.

7.1.3 Fate and Transport of Detected Chemicals

A discussion of fate and transport mechanisms for chemicals detected at SWMU 9 is provided in Section 6.2.1.

7.1.4 Identification of Potential Exposure Pathways

In order for an exposure to occur, a complete exposure pathway must exist with the following conditions:

- A source and mechanism of chemical release into the environment
- An environmental transport medium
- A point of potential contact with the medium
- A feasible exposure route at the contact point

This screening-level ERA considered potential receptor exposures to chemicals in groundwater, surface water, sediment, and soil (surface and subsurface soil). Figure 7-1 presents a preliminary conceptual model for SWMU 9 (Areas A, B, and C). A discussion of each potential exposure pathway is presented in the sections that follow.

7.1.1.4 Groundwater Exposure Pathway

The potential release source for the groundwater exposure pathway is contaminated surface soil and subsurface soil, with the release source being leaching/desorption and vertical migration of chemicals from surface to subsurface soil and groundwater (or leaching/desorption directly from subsurface soil to groundwater). Although a potential source and mechanism of release exist, the groundwater exposure pathway does not represent a complete exposure pathway for the following reasons:

- There are no surface expressions of groundwater within SWMU 9 (e.g., seeps, springs, etc.)

- Groundwater is not inhabited by ecological receptors

Ecological receptors may potentially be exposed to chemicals in groundwater only if the chemicals migrate with the groundwater to surface water. Site hydrology at SWMU 9 indicates that groundwater flow is toward the mangrove forest bordering Areas A, B, and C. As a result, ecological receptors residing within or foraging within the adjacent mangrove forest may be exposed to chemicals that have migrated with groundwater. An evaluation of potential exposures resulting from the migration of chemicals with groundwater is addressed in the evaluation of the surface water and sediment exposure pathway, which is presented in the section that follows.

7.1.4.2 Surface Water and Sediment Exposure Pathway

The potential release sources for the surface water and sediment exposure pathway are surface soil and groundwater. Chemicals may migrate to surface water and sediment as a result of soil erosion from unvegetated areas (erosion from storm water run-off and wind erosion) and groundwater discharge. Contaminated sediments may also serve as a release source for adjacent areas if the sediments are

suspended in the water column. Contaminated sediments may also serve as a release source for surface water. Release mechanisms are suspension of sediment and desorption.

There are no permanent or ephemeral freshwater streams or other freshwater bodies (i.e., lakes, ponds, or temporary pools) within or adjacent to SWMU 9. Furthermore, there are no drainage features (i.e., drainage ditches, swales, etc.) within Areas A, B, or C that serve as temporary freshwater habitat or migration pathways to the mangrove forest. The topography at each UST location slopes toward the adjacent mangrove forest. However, the migration of chemicals to surface water from soil erosion (storm water erosion and wind erosion) is minimized by the maintained vegetative cover in the immediate vicinity of the USTs and the band of secondary growth vegetation located between the USTs and the mangrove forest. Therefore, storm water and wind erosion do not represent a significant migration pathway for chemicals detected in surface soil. As discussed in Section 7.1.1.4, the site hydrology indicates that groundwater flow from each UST area is toward the adjacent mangrove forest; therefore, groundwater transport is a likely migration pathway for chemicals detected in groundwater.

Marine aquatic life (invertebrates and fish) may be exposed to chemicals that have potentially migrated to the mangrove forest. Aquatic life may be exposed to chemicals in surface water and sediment through incidental ingestion, dermal absorption, and food chain transfer (ingestion of contaminated food). Piscivorous birds foraging in the mangrove forest may also be exposed to chemicals in surface water and sediment through incidental ingestion, dermal absorption, and food chain transfer. Other receptors that may reside or forage within the mangrove forest include reptiles. The potential exposure pathways for reptiles are also incidental ingestion, dermal absorption, and food chain transfer. Given that surface water within the mangrove forest does not represent a freshwater source for drinking water, the surface water exposure pathway for all potential receptors is incomplete for drinking water exposures. Finally, the mangrove trees may be exposed to chemicals in sediment pore water by direct uptake (root uptake).

It is noted that for all potential receptors, exposures from food chain transfer is limited to those chemicals that bioaccumulate in lower trophic level organisms or biomagnify through successive trophic levels.

7.1.4.3 Subsurface Soil and Surface Soil Exposure Pathway

The release sources for the subsurface and surface soil exposure pathway are the USTs and associated piping and valves. Release mechanisms from the USTs and associated piping and valves are leaks and spills. Contaminated surface soil may also serve as a release source for down gradient areas. The release mechanisms from contaminated surface soil are migration with storm water run-off and fugitive dust. The suspected disposal pits also represent a release source for the subsurface exposure pathway. The release mechanism for the suspected disposal pits is leaching/desorption to the surrounding subsurface soil. As discussed in the paragraphs that follow, complete exposure pathways may exist for soil invertebrates, plants, amphibians, reptiles, birds, and mammals.

Soil invertebrates, such as earthworms, may be exposed to chemicals in surface soil through dermal absorption and ingestion. Because the toxicological database for soil invertebrates are based on *in situ* investigations that represent both exposure pathways, this screening-level ERA will consider both pathways together. Plants may also be exposed to chemicals in surface soil through root uptake. Birds may be exposed to chemicals in surface soil through incidental ingestion and food chain transfer. Dermal absorption is mostly excluded through feather coverings; however, preening will contribute to incidental ingestion. Mammals, reptiles, and amphibians may also be exposed to chemicals in surface soil through incidental ingestion and food chain transfer. For mammals and some reptiles (e.g., snakes), deraml absorption is mostly excluded through fur and scale coverings, respectively. However, similar to preening by birds, grooming by mammals will contribute to incidental ingestion. Identical to the surface water and sediment exposure pathway, exposures from food chain transfer is limited to those chemicals that bioaccumulate in lower trophic level organisms or biomagnify through successive tophic levels.

Subsurface soil is not considered a complete exposure pathway for terrestrial receptors for the following reasons (Suter II 1995):

- The mass of most root systems is within the surface soil
- Most soil heterotrophic activity is within the surface organic layer

- Soil invertebrates occur on the surface or within the oxidized surface layer

7.1.5 Selection of Ecological Receptors

The selection of ecological receptors for evaluation of potential risks at SWMU 9 took into consideration the following criteria:

- The receptors are known to occur or are likely to occur at the site
- The ecological receptors are representative of species known or likely to occur at the site
- Life history information is available from the literature
- Ecological receptors are represented by a complete exposure pathway
- The ecological receptors are valued by society

The specific receptors selected for this screening-level ERA were sediment-associated biota, saltwater aquatic life, soil organisms (terrestrial plants and earthworms), and four bird species (belted kingfisher, great blue heron, American robin, and red-tailed hawk). Identical receptors were selected for the evaluation of ecological risks at each UST area based on the similarities in their available habitat and the presence of the same complete exposure pathways and exposure routes.

Sediment-associated biota and aquatic life were selected as ecological receptors based on their function as lower trophic level organisms in the mangrove forest food web. Fish that utilize the adjacent mangrove forest as a nursery area may also support commercial and sports fisheries in the offshore marine environment. Soil organisms (earthworms and plants) were selected as ecological receptors based on their function as lower trophic level organisms in the on-site terrestrial habitat. Specifically, plants function as primary producers, while earthworms, as well as other soil invertebrates, are an important food source for a variety of terrestrial vertebrates.

The belted kingfisher and great blue heron were selected to represent the numerous piscivorous birds know to occur at NSRR (see Section 7.1.1.3). The belted kingfisher was selected to represent small piscivores, while the great blue heron was selected to represent large piscivores. Both species have been reported at NSSR (Geo-Marine, inc. 1998) and both are represented by complete exposure pathways.

The American robin was selected to represent the numerous insectivorous birds known to occur at NSRR, including the red-legged thrush and the yellow-shouldered blackbird (a federally-designated endangered species), as well as the various flycatcher and warbler species. It is acknowledged that the American robin is not native to Puerto Rico, nor is it a migratory visitor (Raffaele 1989). An indigenous insectivore was not selected based on the limited availability of life history information (i.e., body weights and ingestion rates). Finally, the red-tailed hawk was selected to represent the terrestrial carnivores reported at NSRR. This species is known to occur at NSRR (see Section 7.1.1.3). Life history information for this species is also readily available from the literature (EPA 1993c).

Although numerous shore bird species are known to occur at NSRR, their preferred foraging habitat (mud flats) are not present within the adjacent marine environment. It is acknowledged that aquatic invertebrates may serve as a food source for piscivorous birds such as the great blue heron. Therefore, exclusion of this potential exposure route presents uncertainty in this screening level ERA. A plant or seed-eating bird was not selected as an ecological receptor. Although represented by a few species, primarily pigeons and doves (Geo-Marine, Inc 1998), the vast majority of birds known to occur at NSRR are piscivores and insectivores. Therefore, this screening-level ERA focuses on those species known to be abundant at NSRR.

A mammal was not selected as an ecological receptor for the following reasons:

- With the exception of bats, all native terrestrial mammal species have been extirpated from Puerto Rico

- The nonindigenous terrestrial mammals present on the island, such as the black rat, Norway rat, and mongoose, are nuisance species that have been implicated in the decline of native reptile and bird populations

- Life history information for Puerto Rico's native bat species is severely limited or lacking altogether

- Marine mammals, such as the West Indian manatee, are unlikely to occur in the mangrove forest adjacent to SWMU 9

Although the nonindigenous mammals (rats and mongoose) are considered nuisance species, they may serve as a food source for terrestrial carnivores such as the red-tailed hawk.

Although a potential complete exposure pathway exists for amphibians and reptiles at SWMU 9, they were not selected as receptor species because the toxicological database concerning the effects of chemicals on amphibians and reptiles is severely limited. In addition to being potential receptors, amphibians and reptiles may also represent a food source for birds. BAF factors for small mammals are available from the literature (Sample et al. 1998a); however, BAFs for ground-dwelling amphibians and reptiles have not been established. Based on differences between amphibians/reptiles and vertebrates in terms of physiology and feeding and foraging habits, the mammal BAFs were not applied to amphibians and reptiles. The exclusion of a representative amphibian and reptile species as an ecological receptor, as well as their exclusion as a food source for avian receptors, presents uncertainty to this screening level ERA.

The vegetation (i.e., mangrove trees) growing within the surface water adjacent to SWMU 9 were not selected as ecological receptors in this screening-level ERA due to the lack of threshold screening values for aquatic plants. Surface soil toxicological benchmarks have been established for terrestrial vegetation (Efroymson et al. 1997b). However, given that the surface soil benchmarks were established based on literature data for terrestrial vegetation, they were not applied to the aquatic vegetation.

7.1.6 Assessment Endpoints and Measurement Endpoints

Assessment endpoints are intended to focus the risk assessment on particular components of the ecosystem that could be adversely affected by chemicals from the site. Specifically, assessment endpoints are ecological values designated for protection, such as survival, growth, and reproduction.

Assessment endpoints usually encompass a group of species or populations with some common characteristic, such as a specific exposure route.

Measurement endpoints are measurable ecological characteristics that are related to the ecological values selected as assessment endpoints. The assessment endpoints and measurement endpoints selected for sediment-associated biota, saltwater aquatic life, soil organisms, and the avian receptors identified in Section 7.1.5 are presented in Table 7-5. They were selected based on the ecological receptors evaluated in this screening-level ERA and the potential for receptors to be exposed to the chemicals detected in site media. The availability of toxicity information upon which risk calculations could be based was also considered in their selection.

7.2 Screening-Level Ecological Effects Evaluation

The purpose of the screening-level ecological effects evaluation is the establishment of chemical exposure levels that represent conservative threshold screening values for adverse ecological effects (EPA 1997c). For this screening-level ERA, literature-based threshold screening values were identified for sediment-associated biota, saltwater aquatic life, soil invertebrates (earthworms and plants), and avian receptors. The threshold screening values are identified and discussed in the sections that follow.

7.2.1 Threshold Screening Values for Sediment-Associated Biota

Marine and estuarine sediment quality guidelines were selected as threshold screening values for sediment-associated biota. The specific literature-based marine and estuarine sediment quality guidelines considered for use as threshold screening values in this screening-level ERA are identified below.

- Effects Range-Low (ER-L) and Effects Range-Median (ER-M) marine and estuarine sediment quality guidelines values developed by Long et al. (1995)

- Probable Effects Level (PEL) and Threshold Effects Level (TEL) sediment quality guidelines developed by MacDonald (1994) for Florida coastal waters

- Interim Apparent Effects Threshold (AET) sediment quality guidelines developed by the Washington State Department of Ecology for Puget Sound (Buchman 1999)

ER-M, ER-L, TEL, PEL, and AET values for chemicals detected in the SWMU 9 sediment samples are summarized in Table 7-6. A brief description of the methods utilized in their derivation is provided in the sections that follow. Since multiple sediment quality guidelines were considered for use as threshold screening values, a section is also included that identifies the specific sediment quality guidelines selected as threshold screening values for this screening-level ERA and the rational for their selection.

7.2.1.1 ER-L and ER-M Sediment Quality Guidelines

Long and Morgan (1990) developed effects-based sediment quality guidelines using literature-based data from equilibrium-partitioning (EqP) modeling (EPA 1988), spiked-sediment toxicity tests, and matched sediment chemistry and biological effects measures (co-occurrence analysis). For a given chemical, the data were arranged in ascending order of concentration with each data entry assigned an "effects" or "no-effects" descriptor, and the lower 10th percentile concentration and 50th percentile concentration of the "effects" data were calculated. The 10th and 50th percentiles of the "effects" data represent the ER-L and ER-M concentration, respectively.

The ER-L and ER-M delineate three concentration ranges for a given chemical. The concentrations below the ER-L value represent a minimal effects range (i.e., the concentration range in which effects would be rarely observed). Concentrations equal to or greater than the ER-L, but less than the ER-M, represent a possible effects range within which effects would occasionally occur, while the concentrations equal to and greater than the ER-M represent a probable-effects range within which effects would frequently occur. The ER-L and ER-M values were recalculated by Long et al. (1995) after omitting a small amount of freshwater data included in the original Long and Morgan (1990) calculations and incorporating more recent marine and estuarine data from the literature.

7.2.1.2 PEL and TEL Sediment Quality Guidelines

The updated and revised data set used by Long et al. (1995) was also used by MacDonald (1994) to calculate sediment quality assessment guidelines (TELs and PELs) for Florida coastal waters. Unlike the methodology used by Long et al. (1990) to derive ER-L and ER-M values, the derivation of TELs and PELs took into consideration the "no effects" data set. Specifically, TELs were derived by calculating the geometric mean of the 15th percentile in the "effects" data set and the 50th percentile in the "no effects" data set, while PELs were derived by calculating the geometric mean of the 50th percentile in the "effects" data set and the 85th percentile in the "no effects" data set.

Identical to the ER-L and ER-M sediment quality guidelines, TELs and PELs delineate three concentration ranges for a given chemical. The TEL represents the upper limit of the range of sediment concentrations dominated by "no effects" data. Within this range, concentrations are not considered to represent significant hazards to sediment-associated biota. The PEL represents the lower limit of the range of sediment concentrations that are usually or always associated with adverse biological effects. The range of concentrations that could be associated with biological effects is delineated by the TEL and PEL. Within this range of concentrations, adverse biological effects are possible.

7.2.1.3 AET Sediment Quality Guidelines

The AET method, developed by Tetra Tech, Inc (1986), associates chemical concentrations in sediments with adverse biological effects (lethal and sub-lethal toxicity as measured using sediment toxicity tests or changes in benthic macroinvertebrate abundance and community structure as measured by *in situ* biological surveys). For a given chemical and measurement of biological effect (biological indicator), the AET value represents the sediment concentration above which statistically significant biological effects are always observed. The AET values shown in Table 7-6 represent the lowest AET value from a suite of seven biological indicators (amphipod mortality, oyster larval abnormality, Microtox luminescence, benthic macroinvertebrate abundance, bivalve larvae mortality/abnormality, Echinoderm larvae mortality/abnormality, and juvenile polychaete growth). It is noted that the AET values summarized in Table 7-6 are interim values subject to change (Buchman 1999).

Minimum chemical-specific AET values are used by the Washington Department of Ecology (1995) as sediment management standards for Puget Sound. Minimum AET values are also used by the U.S Army Corp of Engineers (USACE 1998) as "reason to believe" guidance for screening levels for the Dredged Material Management Program (DMMP). The DMMP screening levels are implemented for use in Puget Sound and Grays Harbor/Willapa Bay in the State of Washington. Current Washington State Department of Ecology sediment management standards and USACE DMMP screening levels do not reflect the interim AET values reported by Buchman (1999). It is noted that the interim AETs are more stringent than those used by the Washington State Department of Ecology and USACE for establishment of 1995 sediment management standards and 1998 DMMP screening levels, respectively.

7.2.1.4 Selection of Sediment Threshold Screening Values

The literature-based sediment quality guidelines selected as threshold screening values for arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc were the TEL values developed by MacDonald (1994). As evidenced by Table 7-6, the TELs for these metals represent the lowest sediment threshold screening values available from the literature. The use of TEL values as conservative marine and estuarine screening threshold values is documented in the literature (EPA 1999g and Jones and Suter II 1996).

Interim AET values developed by the Washington State Department of Ecology were selected as sediment screening threshold values for barium, cobalt, selenium, and vanadium. As evidenced by Table 7-6, Long et al. (1995) and MacDonald (1994) did not develop sediment quality guidelines for these four metals. Marine and estuarine sediment quality guidelines for beryllium, tin, acetone, 2-butanone, and carbon disulfide are not available from the literature. It is noted that the sediment quality guidelines selected as threshold screening values for this screening-level ERA do not address the potential for bioaccumulation of persistent chemicals and potential adverse effects on upper trophic level organisms.

7.2.2 Threshold Screening Values for Saltwater Aquatic Life

Saltwater National Ambient Water Quality Criteria (NAWQC) (EPA 1999d) were selected as threshold screening values for saltwater aquatic life. For those chemicals lacking NAWQC, minimum chronic No Observed Effect Concentrations (NOECs) were used as threshold screening values. The use of NAWQC and NOECs as conservative threshold screening values is documented in the literature (Suter II and Tsao 1996).

NAWQC for saltwater aquatic life contain two expressions of allowable magnitude: a criterion maximum concentration (CMC) to protect against acute (short-term) effects and a criterion continuous concentration (CCC) to protect against chronic (long-term) effects. With the exception of barium, cobalt, tin, vanadium, and methylene chloride, saltwater NAWQC have been established for chemicals detected in SWMU 9 surface water samples. Available saltwater NAWQC for metals detected in SWMU 9 surface water samples are summarized in Table 7-7. The criteria are expressed as dissolved and total recoverable concentrations. The total recoverable metals criteria were derived by dividing the dissolved criteria by the appropriate conversion factor (EPA 1999d). Established criteria not shown in Table 7-7 are summarized below.

Chemical	CMC (µg/L)	CCC (µg/L)
Cyanide	1.0	1.0
Antimony	1,500	500

The cyanide criteria are expressed as free cyanide. The antimony criteria are proposed, total recoverable criteria (Buchman 1999). For a given chemical, the specific NAWQC used as the threshold screening valve was the chronic criterion (CCC).

A minimum acute and chronic NOEC has been reported for methylene chloride (Buchman 1999). The acute NOEC and chronic NOEC are 12,000 µg/L and 6,400 µg/L, respectively.

Barium, beryllium, cobalt, vanadium, and tin lack established EPA saltwater NAWQC and literature-based saltwater NOECs. For these chemicals, maximum detected surface water concentrations were

compared to available saltwater toxicity data compiled by the EPA in the Aquatic Toxicity Information Retrieval (AQUIRE) database. AQUIRE is a web-based application available through the EPA ECOTOX search page (EPA 1999h). The types of data that were selected from the AQUIRE database are listed below.

- Acute values from 96-hour tests conducted with embryos and larvae of barnacles, bivalve mollusks (clams, mussels, oysters, and scallops), sea urchins, lobsters, crabs, shrimp, and abalones based on the percentage of organisms with incompletely developed shells plus the percentage of organisms killed (96-hour EC_{50} values), and acute values from 96-hour tests based on the percentage of organisms with incompletely developed shells, (96-hour EC_{50} values). EC_{50} and LC_{50} values from 48-hour tests were also selected from the database.

- Acute values from 96-hour tests with all other animal species (fish) and older life stages of barnacles, bivalve mollusks, sea urchins, lobsters, crabs, shrimps, and abalones based on the percentage of organisms exhibiting loss of equilibrium, plus the percentage of organisms immobilized, plus the percentage or organisms killed (96-hour EC_{50} values) and acute values from 96-hour tests based on the percentage of organisms killed (96-hour LC_{50} values). EC_{50} and LC_{50} values from 48-hour tests were also selected from the database.

- Acute values from 48-hour and 96-hour tests conducted with algae based on such endpoints as reductions in productivity and rate of population growth (48-hour EC_{50} and 96-hour EC_{50} values).

- Chronic values, such as NOECs and Maximum Acceptable Test Concentrations (MATCs) from life-cycle and partial life-cycle toxicity tests based on survival and growth of adults and young, maturation of males and females, eggs spawned per female, and hatchability and chronic values from early life stage tests based on survival and growth.

With the exception of 48-hour acute values for algae, the types of data listed above are recommended by the EPA (1994b) for deriving NAWQC. The EPA recommends the use of 96-hour acute values for algae (reason unknown). Acute values for algae based on a 48-hour endpoint were included in the types of data selected from the AQUIRE database to maximize the literature data used in this screening-level ERA. It is noted that the AQUIRE database does not include detailed information regarding test procedures (e.g., exposure system and exposure conditions); therefore, the methodology used to generate a data entry was not reviewed to determine the acceptability of the reported test endpoint. In many cases, a test endpoint, such as a LC_{50} or EC_{50}, was not identified in the AQUIRE database for a given entry. If a test endpoint was not identified, the test data (effect concentration) from that investigation was not selected.

The AQUIRE database did not contain saltwater toxicity data for beryllium or tin. The available toxicity data for barium, cobalt, and vanadium are summarized in Table 7-8. As evidenced by Table 7-8, the AQUIRE toxicity test data for these metals are limited to total recoverable, acute toxicity test data reported as 48-hour EC_{50}, 96-hour EC_{50}, or 96-hour LC_{50} values. The lowest acute effect concentration for barium (189 μg/L) is a 48-hour EC_{50} value for a mussel (*Mytilus californianus*) (Spangenberg and Cherr 1996). The lowest acute effect concentration for cobalt (4,500 μg/L) is a 96-hour LC_{50} for a copepod (*Nitocra spinipes*) (Bengtsson 1978), while the lowest acute effect concentration for vanadium (620 μg/L) is a 96-hour LC_{50} for the tigerfish (*Therapon jarbua*) (Krishnakumari et al. 1983). Given that LC_{50} and EC_{50} values represent chemical concentrations that kill and adversely effect (kill, immobilize, etc.) 50 percent of exposed organisms, respectively, the acute effect concentrations listed above do not represent minimum acute NOECs. Furthermore, chronic test data for sensitive endpoints, such as growth and reproduction, were not available from the literature. For these reasons, the effect concentration data were not used as threshold screening values.

It is noted that the NAWQC and literature-based NOECs selected as threshold screening values for surface water do not address the potential for bioaccumulation of persistent chemicals and potential adverse effects on upper trophic level organisms.

7.2.3 Threshold Screening Values for Soil Organisms

Surface soil toxicological benchmarks developed by Oak Ridge National Laboratory (ORNL) were used as threshold screening values for soil organisms (earthworms and plants). ORNL has established surface soil screening thresholds for earthworms (Efroymson, et al. 1997a) and plants (Efroymson, et al. 1997b). The method used by ORNL to derive the surface soil screening thresholds was based on the method employed by Long and Morgan (1990) to derive ER-L sediment quality guidelines (see Section 7.2.1.1). Initially, Lowest Observed Effect Concentration (LOEC) values reported in the literature for soil toxicity studies were compiled and rank-ordered. A 20 percent reduction in growth or reproduction (e.g., EC_{20}) was used as the threshold for significant effects. After rank-ordering the LOEC literature values, the tenth percentile of these data was approximated. If there were ten or fewer values for a chemical, the lowest LOEC was used. If there were more than ten values, the tenth percentile LOEC value was used. If the tenth percentile fell between LOEC values, a value was chosen by interpolation.

The surface soil threshold screening values for earthworms and plants are summarized in Table 7-9 for those chemicals detected in SWMU 9 surface soil. Included in Table 7-9 is the level of confidence (low, medium, or high) assigned to each benchmark by Efroymson et al. (1997a and 1997b). The criteria used by Efroymson et al. (1997a and 1997b) to best reflect the confidence in each screening threshold were as follows:

- Low Confidence: screening thresholds based on fewer than 10 literature values
- Moderate Confidence: screening thresholds based on 10 to 20 literature values
- High Confidence: screening thresholds based on over 20 literature values

7.2.4 Threshold Screening Values for Avian Dietary Intake Exposures

Literature-based No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values compiled by Sample et al. (1996) were used as dietary intake threshold screening values for the belted kingfisher, great blue heron, American robin, and red-tailed hawk. A

summary of the available NOAEL and LOAEL values for those chemicals detected in SWMU 9 surface water, sediment, and surface soil, as well as the laboratory test species and chemical form of the material tested, is presented in Table 7-10. As evidenced by Table 7-10, only literature-based NOAELs for avian species were selected as threshold screening values. Mammalian NOAELs were not used given the uncertainty of using data for one Class of organisms (Mammalia) and applying them to species from a second Class (Aves).

All NOAEL and LOAEL values listed in Table 7-10 are based on dietary ingestion exposures. In many cases, Sample et al. (1996) estimated a NOAEL from a reported LOAEL by dividing the LOAEL by a factor of ten. This method of estimation is consistent with EPA (1997c) recommendations. For several chemicals (arsenic, lead, mercury, and selenium), more than one avian NOAEL/LOAEL was identified from the literature. For this screening-level ERA, the lowest arsenic, lead, mercury, and selenium NOAEL and corresponding LOAEL were selected as dietary intake threshold screening values. For selenium and mercury, the lowest toxiciological values identified by Sample et al. (1996) were from studies with organometallic (methylated) forms.

It is noted that the chemical-specific NOAEL and LOAEL values selected as threshold screening values are based on toxicological studies with avian species other than those selected as receptor species for this screening-level ERA. Body-weight scaling factors are typically used for interspecies extrapolation among mammals (Travis and White 1988 and Travis et al. 1990); however, Sample et al. (1996) consider a scaling factor of 1.0 most appropriate for interspecies extrapolation between birds. Therefore, the literature-derived NOAEL and LOAEL values summarized in Table 7-10 were compared directly to estimated dietary intakes for the receptor species.

7.3 Screening-Level Exposure Estimate

The screening-level exposure estimate defines the exposure point concentrations used to evaluate potential risks to the receptors selected for evaluation. Dietary intake models are also developed and exposure assumptions defined.

7.3.1 Exposure Point Concentrations

Maximum detected chemical concentrations in sediment (Table 7-1), surface water (Table 7-2), and surface soil (Table 7-3) were used as exposure point concentrations for direct comparison to threshold screening values for sediment-associated biota, aquatic life, and soil organisms. Maximum detected chemical concentrations in sediment, surface water, and surface soil were also used as exposure point concentrations for the following avian exposure routes:

- Ingestion of water
- Ingestion of sediment
- Ingestion of surface soil

Exposure point concentrations were estimated in the tissue of prey consumed by the avian receptor species (belted kingfisher, great blue heron, American robin, and red-tailed hawk) using maximum measured media concentrations and, when available, conservative literature-based bioconcentration factors (BCFs) and bioaccumulation factors (BAFs). A BCF indicates the degree to which a chemical may accumulate in organisms coincident with the concentration of the chemical in the surrounding media. They are calculated by dividing the concentration of a chemical in the tissue of organisms by the concentration in the surrounding media. In the absence of tissue data for aquatic life, BCF values for organic chemicals can be estimated from their Log K_{ow} value. BCF values do not account for the uptake of chemicals from dietary exposures. BAF values consider both direct exposure to the surrounding media, as well as uptake from dietary exposures. The specific literature-based BCF values and BAF values used to estimated chemical concentrations in the food and prey of avian receptors are summarized in Table 7-11 and discussed in the sections that follow.

7.3.1.1 Estimation of Tissue Concentrations in the Prey of the Belted Kingfisher and Great Blue Heron

For this ecological screening-risk assessment, it was assumed that the diet of the belted kingfisher and the great blue heron is 100 percent fish. The EPA (1995b) has reported that fish consumed by the

belted kingfisher and the great blue heron are from trophic level 3. The tissue concentration of chemicals in trophic level 3 fish was estimated by multiplying maximum detected surface water concentrations by chemical-specific BAF values. BAF values were derived by multiplying the BCF values by an appropriate food chain multiplier (FCM).

The BCF values selected for antimony, arsenic, beryllium, cadmium, chromium, copper, cyanide, lead, nickel, and zinc were maximum BCF values for fish (freshwater or saltwater) reported in Sample et al. (1996). The BCF value for cadmium was taken from this chemical's ambient water quality criterion document (EPA 1984). The BCFs for barium, tin, and vanadium were taken from the Syracuse Research Corporation (SRC) environmental fate database (SRC 2000), while the BCF for cobalt was taken from the EPA Region III BTAG Screening Levels table (EPA 1995d). The tin BCF value is for an organometallic form (tributyltin).

For most inorganic compounds, BCFs and BAFs are assumed to be equal (EPA 1991c, EPA 1995c, and Sample et al. 1996). The BAF values for antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, cyanide, lead, nickel, tin, vanadium, and zinc were estimated by multiplying their respective BCF values by an FCM of 1.0 (Sample et al. 1996). In the case of mercury and selenium, an FCM may be applicable since their organometallic forms biomagnify (Sample et al. 1996). The EPA (1994c) developed a mercury BAF of 27,900 for trophic level 3 fish in the Great Lakes. This BAF assumes that 17 percent of the total mercury is the Great Lakes system is present as methylmercury. Sample et al. (1996) reported an organometallic selenium BAF value of 2,600 for trophic level 3 fish. These conservative BAF values were used in this screening-level ERA to estimate the tissue concentration of mercury and selenium in the prey of the belted kingfisher and great blue heron. The use of methylmercury and methylated selenium BAF values is considered a highly conservative assumption since the form of mercury and selenium detected in surface water and sediment has not been determined.

A BCF value for methylene chloride, the only organic chemical detected in the SWMU 9 surface water samples, was not available from the literature. A BCF value for methylene chloride was estimated from its Log K_{ow} (1.25) using the following regression equation from Veith and Kosian (1983):

$$\text{Log BCF} = (0.79)(\text{Log } K_{ow}) - 0.40$$

A methylene chloride BAF value was derived by multiplying the estimated BCF by a FCM. For organic chemicals, the FCM is dependent on their Log K_{ow} values. For values less than 2.0, the trophic level 3 FCM is assumed to be 1.0 (EPA 1995c). Given that the Log K_{ow} for methylene chloride is 1.25 (EPA 1995e), the FCM used to estimate a trophic level 3 BAF was 1.0.

It is acknowledged that the method described above for estimating chemical concentrations in the tissue of fish does not account for the potential bioaccumulation of chemicals from sediment exposures through dermal absorption and incidental ingestion. For pelagic fish, these exposure routes are likely insignificant.

7.3.1.2 Estimation of Tissue Concentrations in the Prey of the American Robin

For this screening-level ERA, it was assumed that the diet of the American robin is 100 percent earthworms. The tissue concentration of chemicals in earthworms was estimated by multiplying maximum detected surface soil concentrations by chemical-specific soil-earthworm BAF values obtained from Sample et al. (1998b). Sample et al. (1998b) developed earthworm BAF values for ten metals (arsenic, cadmium, chromium, copper, mercury, manganese, nickel, lead, selenium, and zinc) and two organics (PCBs and TCDD) by compiling data from the literature that reported chemical concentrations in co-located earthworm and soil samples. BAF values were calculated for each observation and chemical and summary statistics were generated (mean BAF, median BAF, and 90th percentile BAF values).

The soil-earthworm BAF values used in this screening-level ERA are based on the 90th percentile. Sample et al. (1998b) reported that the 90th percentile BAF significantly overestimates concentrations in earthworms for all analytes except nickel. It is noted that nickel was not detected in any of the SWMU 9 surface soil samples. For chemicals lacking Sample et al (1998b) soil-earthworm BAF values, maximum BAFs reported by Beyer and Stafford (1993) were used to estimate the concentration of chemicals in the tissue of earthworms. For those chemicals lacking a BAF value from Sample et al. (1998b) and Beyer and Stafford (1993), a soil-earthworm BAF of 1.0 was assumed. Under this assumption, the concentration of the chemical in the tissue of earthworms was assumed to equal the concentration of that chemical in site surface soil.

7.3.1.3 Estimation of Tissue Concentrations in Prey of the Red-Tailed Hawk

In this screening-level ERA, it was assumed that the prey of the red-tailed hawk is 100 percent small mammals. The tissue concentration of chemicals in small mammals was estimated by multiplying maximum detected surface soil concentrations by chemical-specific soil-small mammal BAF values obtained from Sample et al. (1998a). Sample et al. (1998a) developed general, insectivore, herbivore, and omnivore trophic group BAF values for thirteen metals (arsenic, barium, cadmium, chromium, cadmium, cobalt, copper, iron, mercury, nickel, lead, selenium, and zinc), fluoride, and two organics (TCDD and TCDF) by compiling data from the literature that reported chemical concentrations in co-located small mammal and soil samples. BAF values were calculated for each observation and chemical and summary statistics were generated (mean BAF, median BAF, and 90th percentile BAF values).

The soil-small mammal BAF values used in this screening-level ERA are based on the 90th percentile. As a measure of conservatism, the maximum 90th percentile values reported from the general, insectivore, herbivore, and omnivore trophic groups were used. For those chemicals lacking a literature-derived small mammal BAF, a soil-small mammal BAF of 1.0 was assumed (i.e., the concentration of the chemical in the tissue of small mammals was assumed to equal the maximum concentration of that chemical in site surface soil).

7.3.2 Avian Dietary Exposure Models

Conservative assumptions were used to estimate the dietary intake of chemicals by the belted kingfisher, great blue heron, American robin, and red-tailed hawk. The specific conservative assumptions applied in this screening-level ERA are listed below:

- Maximum detected sediment, surface water, and surface soil concentrations were used as exposure point concentrations for ingestion of sediment, surface water and surface soil

- The concentration of chemicals in prey consumed by the upper trophic level avian receptors was estimated using maximum detected concentrations for surface water and surface soil and conservative literature-derived BCFs and BAFs (see Section 7.3.1)

- The ratio of site area to home range area (foraging area) was assumed to equal 1.0. That is, it was assumed that receptors obtain 100 percent of there dietary intake from the consumption of prey located within SWMU 9

- All avian receptors were assumed to be permanent residents (i.e., non-migratory)

- If available from the literature, minimum body weights and maximum ingestion rates were used as model input parameters. If food ingestion rates for a given receptor were not available from the literature, values were estimated using conservative assumptions applied to allometric equations (ingestion rates were estimated by allometric equations using literature-based maximum body weights)

The dietary intake models for the belted kingfisher, great blue heron, American robin, and red-tailed hawk are presented in the sections that follow. Species-specific model input parameters are also discussed in the sections below and summarized in Table 7-12.

7.3.2.1 Dietary Intake Model for the Belted Kingfisher and Great Blue Heron

The exposure routes addressed by the dietary intake model for the belted kingfisher and great blue heron were ingestion of prey (fish), ingestion of water, and ingestion of sediment. Although there are no permanent freshwater bodies within or contiguous to SWMU 9, it was conservatively assumed that all water intake for both species would occur while foraging for prey within the mangrove forest adjacent to SWMU 9. The dietary intake of chemicals from fish ingestion, surface water ingestion, and sediment ingestion was estimated using the following equation modified from the EPA (1993b):

$$DI = \frac{[(C_{sw})(BCF_f)(FCM)(IR_f) + (C_{sw})(IR_{sw}) + (C_{sed})(IR_{sed})][H]}{BW}$$

Where:

DI	=	Dietary intake (dose) of chemical (mg chemical/kg body weight/day)
C_{sw}	=	Chemical concentration in surface water (mg/L)
BCF_f	=	Surface water-fish bioconcentration factor (L/kg)
FCM	=	Food chain multiplier (unitless)
IR_f	=	Fish ingestion rate (kg/day)
IR_{sw}	=	Surface water ingestion rate (L/day)
C_{sed}	=	Chemical concentration in sediment (mg/kg)
IR_{sed}	=	Sediment ingestion rate (kg/day)
H	=	Ratio of site area to home range area (unitless)
BW	=	Body weight (kg)

As discussed in section 7.3.1.2, this screening-level ERA assumes that the belted kingfisher and great blue heron consume trophic level 3 fish. The body weight, fish ingestion rate, surface water ingestion rate, and sediment ingestion rate used in the dietary intake model for the belted kingfisher was 0.125 kg, 0.1075 kg/day (dry weight), 0.02107 L/day, and 0.01075 kg/day (dry weight), respectively. The body weight used in this screening-level ERA represents a minimum body weight (unpublished data from Powdermill Nature Center as cited in EPA 1993b). The fish ingestion rate was estimated from a maximum ingestion rate of 0.5 g/g-day (Alexander 1977 as cited in EPA 1993b) and a maximum body weight of 0.215 kg (unpublished data from Powdermill Nature Center as cited in EPA 1993b). The water ingestion rate was estimated from an allometric equation for birds (Calder and Braun 1983) and a maximum body weight of 0.215 kg. There are no data available from the literature regarding sediment ingestion rates for the belted kingfisher or similar species. The sediment ingestion rate utilized in this screening-level ERA corresponds to 10 percent of the total fish ingestion rate. This percentage was arbitrarily selected to represent a conservative value.

The body weight, fish ingestion rate, water ingestion rate, and sediment ingestion rate used in the dietary intake model for the great blue heron was 2.204 kg, 0.45183 kg/day (dry weight), 0.11122 L/day, and 0.045183 kg/day (dry weight), respectively. The body weight used in this screening-level ERA represents a minimum body weight (Hartman 1961 as cited in EPA 1993b). The ingestion rate was estimated using an allometric equation for wading birds (Kushlan 1978) and a maximum body

weight of 2.576 kg (Hartman 1961 as cited in EPA 1993b). The drinking water ingestion rate was estimated using an allometric equation for birds (Calder and Braun 1983) and a maximum body weight of 2.576 kg. There are no data available from the literature regarding sediment ingestion rates for the great blue heron or similar species. The sediment ingestion rate utilized in this screening-level ERA corresponds to 10 percent of the total fish ingestion rate. The percentage was estimated from data for waterfowl (Beyer et al. 1994). Identical to the belted kingfisher, this percentage was arbitrarily selected to represent a conservative value.

7.3.2.2 Dietary Intake Model for the American Robin

The exposure routes addressed by the dietary intake model for the American robin were ingestion of prey (earthworms) and ingestion of soil. Because there are no freshwater bodies within or contiguous to SWMU 9, ingestion of water is not considered to be an exposure route for the American robin or other terrestrial birds. As such, this exposure route is not included in the dietary intake model. The dietary intake of chemicals from earthworm ingestion and surface soil ingestion was estimated using the following equation modified from the EPA (1993b):

$$DI = \frac{[(C_{soil})(BAF_w)(IR_w) + (C_{soil})(IR_{soil})][H]}{BW}$$

Where:

DI	=	Dietary intake (dose) of chemical (mg chemical/kg body weight/day)
C_{soil}	=	Chemical concentration in surface soil (mg/kg)
BAF_w	=	Soil-earthworm bioaccumulation factor (unitless)
IR_w	=	Earthworm ingestion rate (kg/day)
IR_{soil}	=	Surface soil ingestion rate (kg/day)
H	=	Ratio of site area to home range area (unitless)
BW	=	Body weight (kg)

As discussed in Section 7.3.1.2, it was assumed that the diet of the American robin was 100 percent earthworms. The body weight, earthworm ingestion rate, and surface soil ingestion rate used in the dietary intake model was 0.0635 kg, 0.02045 kg/day (dry weight), and 0.00213 kg/day (dry weight),

respectively. The body weight represents a minimum body weight reported by Clench and Leberman (1978). The earthworm ingestion rate was estimated using an allometric equation for passerine birds (Nagy 1987) and a maximum body weight of 0.103 kg (Clench and Leberman 1978). The surface soil ingestion rate was estimated from data for the American woodcock (Beyer et al.1994). The surface soil ingestion rate corresponds to 10.4 percent of the total earthworm ingestion rate.

7.3.2.3 Dietary Intake Model for the Red-Tailed Hawk

The exposure routes addressed by the dietary intake model for the red-tailed hawk are ingestion of prey (small mammals) and ingestion of surface soil. Identical to the American robin, surface water ingestion is not considered to be an exposure route due to the absence of freshwater bodies within or contiguous to SWMU 9. The dietary intake of chemicals by the red-tailed hawk was estimated using the following equation modified from the EPA (1993b):

$$DI = \frac{[(C_{soil})(BAF_m)(IR_m) + (C_{soil})(IR_{soil})][H]}{BW}$$

Where:

DI	=	Dietary intake (dose) of chemical (mg chemical/kg body weight/day)
C_{soil}	=	Chemical concentration in surface soil (mg/kg)
BAF_m	=	Soil-small mammal bioaccumulation factor (unitless)
IR_m	=	Small mammal ingestion rate (kg/day)
IR_{soil}	=	Surface soil ingestion rate (kg/day)
H	=	Ratio of site area to home range area (unitless)
BW	=	Body weight (kg)

The body weight, small mammal ingestion rate, and soil ingestion rate used in the dietary intake model was 0.957 kg, 0.13585 kg/day (dry weight), and 0.013585 kg/day (dry weight). The body weight used in this screening-level ERA represents a minimum body weight (Steenhof 1983 as cited in EPA 1993b). The small mammal ingestion rate was estimated from a maximum ingestion rate of 0.11 g/g-day (Craighead and Craighead 1956 as cited in EPA 1993b) and a maximum body weight of 1.235 kg (Springer and Osborne 1983 as cited in EPA 1993b). There are no data available from the

literature regarding surface soil ingestion rates for the red-tailed hawk or similar species. The surface soil ingestion rate utilized in this screening-level ERA corresponds to 10 percent of the total small mammal rate. This percentage was arbitrarily selected to represent a conservative value.

7.4 Screening-Level Risk Calculation

As discussed in Section 7.3, maximum detected chemical concentrations in sediment, surface water, and surface soil were used as exposure point concentrations for sediment-associated biota, saltwater aquatic life, and soil organisms, respectively. For each detected chemical in a given medium, a Hazard Quotient (HQ) was calculated to estimate risk. The HQ was calculated using the following equation (EPA 1997c):

$$HQ = \text{Maximum Detected Concentration}/\text{Threshold Screening Value}$$

As was previously discussed in Section 7.2.1.4, the threshold screening values for sediment-associated biota were TEL values developed by MacDonald (1994) or AET values developed by the Washington State Department of Ecology (Buchman 1999). AETs were used only for those chemicals lacking a TEL. The surface water threshold screening values used in this screening-level ERA were chronic NAWQC (CCC values) for saltwater aquatic life (EPA 1999d) and chronic NOECs. For those chemicals lacking NAWQC and literature-based NOECs (barium, cobalt, and vanadium), literature-based effect concentrations were considered for use as threshold screening values. However, because the available effect concentration data for barium, cobalt, and vanadium do not represent conservative threshold screening values (See Section 7.2.2), HQ values for these metals were not calculated. The surface soil threshold screening values used for soil organisms were toxicological benchmarks for earthworms and plants (Efroymson et al. 1997a and 1997b, respectively).

Those chemicals detected at concentrations exceeding their respective threshold screening values (i.e., chemicals with HQ values greater than 1.0) were considered to present an unacceptable risk to the associated ecological receptors. A chemical with a HQ value less than one indicates that the chemical alone presents negligible risk to the associated ecological receptors. Chemicals with HQ values greater than 1.0, as well as chemicals lacking conservative threshold screening values, were retained as ecological COPCs in this screening-level ERA.

HQ values were also calculated for avian receptor dietary intakes using the following equation (EPA 1997c):

$$HQ = \text{Estimated Dietary Intake/Literature-Based NOAEL or LOAEL}$$

NOAEL and LOAEL values, discussed in Section 7.2.4, were taken from Sample et al. (1996). Only NOAEL-based HQ values were used to identify chemicals that present unacceptable risk. Therefore, the HQ values referred to in this screening-level risk calculation for avian receptors are NOAEL-based values.

HQ values for avian dietary exposures were interpreted in an identical manner as those calculated for sediment-associated biota, saltwater aquatic life, and soil organisms. Specifically, HQ values greater than 1.0 indicate that associated chemicals present an unacceptable risk, while HQ values less than 1.0 indicate negligible risk. Chemicals with HQ values greater than 1.0, as well as chemicals lacking NOAELs, were retained as ecological COPCs for avian receptors.

In addition to HQ values, Hazard Index (HI) values were calculated for each receptor. HI values were calculated for a given receptor by summing the individual chemical-specific HQ values. For this screening-level ERA, HI values were calculated separately for inorganics, volatile organics, and semi-volatile organics. It is noted that the HI values should only be calculated for those chemicals that produce the same toxic mechanisms. The specific toxic mechanism of many chemicals is not known; therefore, the HI values presented in this screening-level ERA may not represent realistic combined risks from simultaneous exposures to chemicals detected in site media. For this reason, they are presented on the summary tables referenced in the sections that follow, but excluded from the discussion of potential risks.

7.4.1 Screening-Level Risk Calculation for Areas A, B, and C

HQ and HI values for Areas A, B, and C sediment-associated biota, saltwater aquatic life, soil organisms, and avian receptors are presented in Tables 7-13 through 7-24, while HQ and HI values for background conditions are presented in Tables 7-25 through 7-28. Dietary intake calculations for the avian receptors are included as Appendix N. The sections that follow provide a summary of the

screening-level risk calculation. The reader is referred to the referenced tables for more detail, including HQ values for chemicals that present negligible risk (i.e., HQ values less than 1.0) and HI values for classes of chemicals (i.e., HI values for metals, volatile organic chemicals, and semi-volatile organic chemicals). The summary tables for avian receptors also contain LOAEL-based HQ and HI values. As discussed in Section 7.4, only NOAEL-based HQ values were used to identify chemicals that present unacceptable risks to avian receptors.

To determine if risks presented by chemicals at Areas A, B, and C are site-related, site HQ values were compared to background HQ values. For a given receptor, a chemical was considered to present a site-related risk if the site HQ value was greater than the background HQ value.

7.4.1.1 Summary of Area A Screening-Level Risk Calculation

HQ and HI values for Area A sediment-associated biota, saltwater aquatic life, soil organisms and avian receptors are presented as Tables 7-13, 7-14, 7-15, and 7-16, respectively. Chemicals that present a risk to ecological receptors (i.e., HQ values greater than 1.0) are summarized below by receptor. Chemicals with HQ values greater than 1.0, as well as those lacking conservative threshold screening values, were selected as ecological COPCs for Area A (see Table 7-29). The chemicals listed below in italicized print are those with site HQ values that are less than background HQ values. The risks presented by these chemicals are not considered to be site-related.

- Sediment-Associated Biota - Copper (HQ = 3.37) and Vanadium (HQ = 3.16)
- Saltwater Aquatic Life - Arsenic (HQ = 1.06)
- Earthworms - *Chromium (HQ = 74.3)*
- Plants - Selenium (HQ = 1.60) and *Chromium (HQ = 29.7)*
- Belted Kingfisher - Chromium (HQ = 1.81), Mercury (HQ = 1.05), Selenium (HQ = 27.7), and Vanadium (HQ = 2.38)

- Great Blue Heron - Selenium (HQ = 6.60)

- American Robin - Barium (HQ = 3.97) , *Chromium (HQ = 31.2), Lead (HQ = 7.23)* and Selenium (HQ = 1.86)

- Red-Tailed Hawk - *Chromium (HQ = 1.89)*

7.4.1.2 Screening-Level Risk Calculation for Area B

HQ and HI values for Area B sediment-associated biota, saltwater aquatic life, soil organisms, and avian receptors are presented as Tables 7-17, 7-18, 7-19, and 7-20, respectively. Chemicals that present a risk to ecological receptors (i.e., HQ values greater than 1.0) are summarized below by receptor. Chemicals with HQ values greater than 1.0, as well as those lacking conservative threshold screening values, were selected as ecological COPCs for Area B (see Table 7-29). The chemicals listed below in italicized print are those with site HQ values that are less than background HQ values. The risks presented by these chemicals are not considered to be site-related.

- Sediment-Associated Biota: Cobalt (HQ = 1.20), copper (HQ = 6.42), lead (HQ = 1.56), vanadium (HQ = 3.16)

- Saltwater Aquatic Life: Arsenic (HQ = 1.10), copper (HQ = 15.0), cyanide (HQ = 6.10), and nickel (HQ = 1.22)

- Earthworms: Chromium (HQ = 33.0)

- Plants: *Chromium (HQ = 13.2)*, Lead (HQ = 5.16), and selenium (HQ = 1.10)

- Belted Kingfisher: Cadmium (HQ = 1.98), Chromium (HQ = 2.43), Lead (HQ = 3.76), Mercury (HQ = 1.34), Vanadium (HQ = 2.91), and Zinc (HQ = 1.94)

- Great Blue Heron: None

- American Robin: *Cadmium (HQ = 3.81)*, *Chromium (HQ = 13.9)*, Barium (HQ = 1.97), Lead (HQ = 120), and Selenium (HQ = 1.28)

- Red-Tailed Hawk: Lead (HQ = 14.2)

7.4.1.3 Screening-Level Risk Calculation for Area C

HQ and HI values for Area C sediment-associated biota, saltwater aquatic life, soil organisms, and avian receptors are presented as Tables 7-21, 7-22, 7-23, and 7-24, respectively. Chemicals that present a risk to ecological receptors (i.e., HQ values greater than 1.0) are summarized below by receptor. Chemicals with HQ values greater than 1.0, as well as those lacking conservative threshold screening values, were selected as ecological COPCs for Area C (see Table 7-29). The chemicals listed below in italicized print are those with site HQ values that are less than background HQ values. The risks presented by these chemicals are not considered to be site-related.

- Sediment-Associated Biota: Barium (HQ = 1.67), Cobalt (HQ = 2.20*), Copper (HQ=2.62)* and vanadium (HQ = 3.16)

- Saltwater Aquatic Life: Arsenic (HQ = 1.69), Chromium (HQ = 3.08), Copper (HQ=105), Lead (HQ = 15.3), Nickel (HQ = 7.64), and Zinc (HQ = 4.96)

- Earthworms: *Chromium (HQ = 76.0)*

- Plants: *Chromium (HQ = 30.4)* and Lead (HQ = 1.05)

- Belted Kingfisher: Barium (HQ = 1.67), Cadmium (HQ = 4.33), Chromium (HQ = 3.01), Copper (HQ = 2.16), Lead (HQ = 6.15), Mercury (HQ = 2,210), Vanadium (HQ = 13.7), and Zinc (HQ = 24.7)

- Great Blue Heron: Cadmium (HQ = 1.03), Lead (HQ = 1.47), Mercury (HQ = 527), Vanadium (HQ = 3.27), and Zinc (HQ = 5.88)

- American Robin: *Barium (HQ = 1.88)*, *Chromium (HQ = 32.0)*, and Lead (HQ = 24.3)

- Red-Tailed Hawk: *Chromium (HQ = 1.94)* and Lead (HQ = 2.90)

7.5 Screening-Level Uncertainty Analysis

The procedures used in this ecological screening evaluation are subject to several uncertainties. These uncertainties are discussed in the sections that follow.

7.5.1 Threshold Screening Values

The surface soil threshold screening values used in this screening-level ERA are based on a limited number of studies (primarily laboratory studies) with earthworms and plants. As a result, the confidence associated with many of these benchmarks is low (see Table 7-9). Furthermore, the studies used to derive the surface soil threshold screening values most often reported nominal concentrations of a soluble, highly bioavailable form of the chemical added to the soil. Site-specific soil characteristics, including pH and total organic carbon, will influence the bioavailability and, therefore, toxicity of metals and organic compounds detected in the SWMU 9 surface soil samples. Therefore, depending on site-specific soil characteristics, the surface soil screening threshold values utilized in this ecological screening evaluation may have resulted in an overestimation or underestimation of risks to earthworms and plants.

Threshold screening values have not been established for several chemicals detected in SWMU 9 sediment samples (beryllium, tin, acetone, 2-butanone, and carbon disulfide) and surface soil samples (barium, silver, acetone, benzo(b)fluoranthene, benzyl alcohol, chrysene diethylphthalate, di-n-butylphthalate, and pyrene for earthworms and acetone, benzyl alcohol, benzo(b)fluoranthene, chrysene, and pyrene for plants) with complete exposure pathways. Therefore, potential risks to soil organisms and sediment-associated biota could not be evaluated for these chemicals.

EPA Saltwater NAWQC or minimum NOECs have not been established for barium, beryllium, cobalt, tin, and vanadium. Therefore, potential impacts to aquatic life were evaluated by comparing SWMU 9 surface water data to literature-based effect concentrations. The literature-based effect concentrations for barium, cobalt, and vanadium were limited to acute endpoints for a small number of species. Given the low number of toxicity values, sensitive species may not have been tested. Furthermore, chronic toxicity test data for sensitive endpoints (e.g., growth and reproduction) were not available from the literature; therefore, it is not known if detected concentrations less than minimum acute effect concentrations are less than or greater than chronic effect concentrations. Those chemicals with literature-based effect concentrations were retained as ecological COPCs based on the limited database even though they may not present a risk to saltwater aquatic life. Beryllium and tin effect concentrations were not available from the literature; therefore, potential risks presented by these chemicals could not be evaluated.

The toxicological data used by the EPA to derive saltwater NAWQC, as well as the literature-based NOECs and effect concentrations, may have been generated using test species that are not indigenous to Puerto Rico's offshore marine environment. Depending on the sensitivity of the tested species to regional species, the NAWQC, NOECs, and literature-based effect concentrations used in this screening-level ERA may overestimate or underestimate site-specific threshold values and minimum effect concentrations.

Site-specific sediment quality characteristics, such as total organic carbon (TOC), and acid volatile sulfides, and water quality characteristics, such as pH, suspended solids, and TOC may influence the toxicity of chemicals to sediment-associated biota and saltwater aquatic life, respectively. Depending on site-specific sediment and water quality characteristics, the sediment and surface water threshold screening values may have overestimated or underestimated risks for these receptors.

Avian-based NOAELs were not available from the literature for antimony, beryllium, cobalt, silver, acetone, 2-butanone, carbon disulfide, methylene chloride, benzyl alcohol, benzo(b)fluoranthene, chrysene, diethylphthalate, di-n-butylphthalate, and chrysene. These chemicals have complete exposure pathways for one or more of the birds selected as ecological receptors in this screening-level ERA. As a result, their potential risk to receptors with complete exposure pathways could not be evaluated.

Avian NOAELs were generated in laboratory studies using species other than those selected as ecological receptors in this screening-level ERA. Because the toxicity of chemicals may be affected by differences in physiology, metabolism, and body weight, the literature-derived NOAELs may overestimate or underestimate risks to the avian receptors evaluated in this screening-level ERA.

The chemical form of test material used to generate the NOAEL values selected as threshold screening values in this screening-level ERA may be different then the forms that exist at the site. This is a source of uncertainty since toxicity may vary with the form of the toxicant in the environment. For example, a NOAEL for a methylated form of mercury (0.0064 mg/kg/day) was used as a threshold screening value for the belted kingfisher and great blue heron. The NOAEL for an inorganic form of mercury (mercuric chloride) is two orders of magnitude less toxic (0.45 mg/kg/day). The use of the most conservative NOAEL in this screening-level ERA may have resulted in the overestimation of risk to the belted kingfisher and great blue heron by two orders of magnitude if the total mercury detected in sediment and surface water is inorganic mercury.

7.5.2 Ecological Receptors

The American robin was selected as a receptor representative of insectivorous birds. This species is not native to Puerto Rico, nor is it a migratory visitor. It was selected as an ecological receptor because life history information for insectivores known to occur at NSRR was not available from the literature. Physiological differences between the American robin and those insectivores indigenous to Puerto Rico may have resulted in an overestimation or underestimation of risks.

A plant or seed-eating bird was not selected as an ecological receptor for this screening-level ERA. This decision was based on available information that indicates that piscivores and insectivores are the dominant avian receptors utilizing habitat at NSRR. Although potential complete exposure pathways may exist for amphibians and reptiles at the site, they were not selected as an ecological receptor for this screening-level ERA based on the limited toxicological database regarding chemical effects. Finally, due to the lack of threshold screening values for aquatic vegetation, the plants within the mangrove forest adjacent to SWMU 9 were not selected as ecological receptors

7.5.3 Dietary Intake Models

Allometric equations were used to estimate ingestion rates for the belted kingfisher, great blue heron, American robin, and red-tailed hawk. Use of ingestion rates estimated from allometric equations may result in an overestimation or underestimation of actual ingestion rates and, therefore, an overestimation or underestimation of dietary intake and risk.

Various assumptions were made regarding the dietary content of avian receptors. For example, the American robin and great blue heron's diet was assumed to be 100 percent earthworms and trophic level 3 fish, respectively. However, literature-derived information indicates that their diet includes other food items (EPA 1993b). In the case of the great blue heron, aquatic invertebrates may serve as a source of food. Potential exposures from the ingestion of other food sources were not evaluated in this screening-level ERA.

An assumed BCF/BAF of 1.0 was used to estimate tissue concentrations in the prey of avian receptors when literature-based values were unavailable. An assumed value of 1.0 may overestimate tissue concentrations for those chemicals that do not bioaccumulate or underestimate tissue concentrations for those chemicals that bioaccumulate.

The estimation of mercury and selenium tissue concentrations in fish assumed that organometallic (methylated) forms were present. This assumption most likely resulted in a gross overestimation of fish tissue concentrations and subsequent risks to the belted kingfisher and great blue heron.

7.5.4 Sampling and Analytical Program

The analytical data for the surface water sample collected from Area C suggests that accidental inclusion of sediment in the sample may have contributed to the total recoverable metals concentrations that were detected.

For most environmental media, a limited number of samples were collected and subjected to laboratory analysis. For example, only a single surface water and sediment sample was collected from Area A. In the case of surface soil, samples were collected from areas of suspected contamination

(i.e., adjacent to the USTs). Given that the combined surface area of Area A and Area B is 39 acres and the surface area C is 6 acres, the limited number of samples collected and, in the case of surface soil, the location samples were collected from may not provide an accurate portrayal of site conditions and potential exposures.

7.6 Screening-Level Conclusions

A screening-level ERA was performed at SWMU 9 to assess potential impacts to ecological receptors from chemicals detected in sediment, surface water, and surface soil at three UST locations (Areas A, B, and C). Separate screening-level ERAs were conducted at each storage tank location using components of the EPA (1997c) and CNO (1999) guidance that contains an eight-step process for risk assessments. The specific steps covered by this screening-level ERA were:

- Screening-level problem formulation and ecological effects evaluation (Step 1)
- Screening-level preliminary exposure estimate and risk calculation (Step 2)

The ecological receptors selected for evaluation were sediment-associated biota, saltwater aquatic life, soil organisms (earthworms and plants), and upper trophic level bird species (belted kingfisher, great blue heron, American robin, and red-tailed hawk). Rational for selection of the ecological receptors was provided in Section 7.1.4.1.

Conservative screening-level HQs were calculated for sediment-associated biota, saltwater aquatic life, and soil organisms by dividing maximum detected sediment, surface water, and surface soil concentrations by threshold screening values. TEL and AET values developed by MacDonald (1994) and the Washington State Department of Ecology (Buchman 1999), respectively, were used as threshold screening values for sediment-associated biota. EPA NAWQC and minimum literature-based NOECs were used as threshold screening values for aquatic life, while toxicological benchmarks for earthworms (Efroymson et al. 1997a) and plants (Efroymson et al. 1997b) were used as threshold screening values for soil organisms. For the upper trophic level avian species, conservative dietary HQ values were calculated by dividing estimated dietary intakes (doses) by literature-based NOAELs. Chemicals with HQ values less than 1.0 were considered to present

negligible risk to ecological receptors, while HQ values greater than 1.0 were considered to present an unacceptable risk.

For each storage tank area and receptor, there were several chemicals associated with HQ values greater than 1.0. (Table 7-13 through Table 7-24). Chemicals with HQ values greater than 1.0, as well as chemicals lacking conservative threshold screening values, were retained as ecological COPCs (Table 7-29). For many of the chemicals, the risk presented at the background stations was greater than the risk presented at a given SWMU 9 storage tank area. That is, the background HQ was greater than the site HQ.

The screening-level ERA indicates that the assessment endpoints presented in Table 7-5 were not met (i.e., the screening-level ERA indicates that site-related chemicals may impact the growth, survival, and/or reproduction of the ecological receptors). As such, the results of this screening-level ERA are not sufficient to conclude that risks to the ecological receptors at each SWMU 9 UST tank area are negligible. For all receptor species, there were multiple chemicals with HQ values greater than 1.0. In addition, many chemicals could not be evaluated due to the lack of threshold screening values. Therefore, the ERA proceeded to Step 3a of the CNO guidance. Specifically, the conservative exposure assumptions utilized in the screening-level ERA were refined and HQ values were recalculated using the same conceptual site model developed for the screening-level ERA (i.e., same exposure pathways and receptors). The refinement of exposure assumptions and recalculation of HQ values is presented in the section that follows.

7.7 Refinement of Conservative Exposure Assumptions and Recalculation of Risk Estimates

Based on a set of conservative exposure assumptions, the screening-level ERA indicated that multiple chemicals might present a risk to ecological receptors at SWMU 9 (see Table 7-29). Therefore, in accordance with Step 3a of the CNO guidance, the conservative exposure assumptions applied in the screening-level ERA were refined and risk estimates (HQ values) were recalculated using the same conceptual model for the site. The refinement of exposure assumptions and recalculation of HQ values is presented in the sections that follow.

7.7.1 Refinement of Exposure Assumptions

The following modifications were made to the conservative exposure assumptions utilized in the screening-level ERA:

- In place of maximum detected concentrations, arithmatic mean sediment, surface water, and surface soil concentrations were used as exposure point concentrations for direct comparison to threshold screening values for sediment-associated biota, aquatic life, and soil organisms, respectively (see Tables 7-1, 7-2, and 7-3 for a summary of maximum detected and arithmetic mean concentrations). For mobile aquatic life, such as fish, mean chemical concentrations provide a more reasonable estimate of exposure levels. It is acknowledged that sediment-associated biota and soil organisms are relatively immobile; therefore, an exceedence of threshold screening values at any location would imply a potential risk to some individual receptors. However, use of mean chemical concentrations is more indicative of the level of impact that might be expected at the population level.

- Avian receptors would be expected to forage at several locations within each storage tank area. Therefore, in place of maximum detected concentrations, arithmatic mean sediment, surface water, and surface soil concentrations were used as exposure point concentrations for avian dietary exposures to chemicals in these media.

- In place of maximum detected surface soil concentrations and 90th percentile BAF values, the tissue concentration of chemicals in the prey of the American robin and red-tailed hawk (earthworms and small mammals, respectively) was estimated using arithmetic mean surface soil concentrations and log-linear regression models developed by Sample et al. (1998a and 1998b). For those chemicals lacking a regression model or a regression model with significant fit, median literature-based BAF values were used in place of 90th percentile BAF values (Sample et al. 1998a and 1998b and Beyer and Stafford 1993). For those chemicals lacking a literature-based log-linear regression model or BAF value, a BAF value of 1.0 was used. Soil-

earthworm and soil-small mammal BAF values utilized in the refinement and recalculation of risks are summarized in Table 7-30.

- Average body weights, food ingestion rates, and drinking water ingestion rates (Table 7-31) were used in place of maximum body weights, food ingestion rates, and drinking water ingestion rates (Table 7-12) for the estimation of avian receptor dietary intakes. The use of average exposure parameters more closely represents the characteristics of a greater number of individuals within the population.

Conservative assumptions were still applied to the recalculation of risks. For example, the ratio of site area to home range areas for avian receptors was assumed to be 1.0. Maximum BCF values were also used to estimate the tissue concentrations of chemicals in the prey of the belted kingfisher and great blue heron. Furthermore, it was assumed that all avian receptors are permanent residents (i.e., non-migratory). This assumption is not unreasonable given that the receptor species evaluated in this ERA are either permanent residents of Puerto Rico (Raffaele 1989) or are representative of permanent residents.

7.7.2 Recalculation of Risk Estimates Using Refined Exposure Assumptions

SWMU 9 (Areas A B, and C) HQ and HI values based on the less conservative exposure assumptions identified in Section 7.7.1 are presented in Tables 7-32 through 7-43. Background HQ and HI values are presented in Tables 7-44 through 7-47. Calculation worksheets for the avian dietary intake models are included as Appendix O. A comparison of sediment-associated biota, saltwater aquatic life, soil organism, and avian receptor screening-level ERA HQ values and HI values to HQ and HI values calculated following the refinement of exposure assumptions is presented in Appendix P (Tables P-1 through P-8). The results of the risk calculation using less conservative exposure assumptions are discussed in the sections that follow. It is noted that the chemicals identified in the screening-level ERA that lack a threshold screening value are omitted from the discussion. These chemicals, as well as those with calculated HQ values greater than 1.0 following the refinement of exposure assumptions, are retained as ecological COPCs.

Identical to the screening-level ERA, a comparison of SWMU 9 (Areas A, B, and C) HQ and HI values to background HQ and HI was conducted to determine if risks presented by chemicals at SWMU 9 are site-related. The comparison of SWMU 9 HQ and HI values to background HQ and HI values for sediment-associated biota, saltwater aquatic life, and soil organisms is presented in Tables 7-48, 7-49, and 7-50, respectively. A comparison of Areas A B, and C avian receptor HQ and HI values to background HQ and HI values is presented in Tables 7-51, 7-52, and 7-53, respectively.

7.7.2.1 Risk Calculation for Area A

Area A HQ and HI values are presented in Tables 7-32, 7-33, 7-34, and 7-35 for sediment-associated biota, saltwater aquatic life, soil organisms, and avian receptors, respectively. Chemicals with HQ values greater than 1.0 following the refinement of the conservative exposure assumptions are identified below by receptor. The chemicals listed below in italicized print are those with site HQ values that are less than background HQ values. The risks presented by these chemicals are not considered to be site-related.

- Sediment-Associated Biota: Copper (HQ = 3.37) and Vanadium (HQ = 3.16)
- Aquatic Life: Arsenic (HQ = 1.06)
- Earthworms: *Chromium (HQ = 39.3)*
- Plants: *Chromium (HQ = 15.7)*
- Belted Kingfisher: Chromium (HQ = 1.05), Selenium (HQ = 16.1), and Vanadium (HQ = 1.38)
- Great Blue Heron: Selenium (HQ = 5.68)

- American Robin: *Chromium (HQ = 1.38)* and Lead (HQ = 1.05)

- Red-Tailed Hawk: None

The risk presented by selenium to the belted kingfisher, as well as the great blue heron, can be attributed to conservative exposure assumptions that were still applied to the "refined" risk calculation. The BCF value (2,600 L/kg) and NOAEL values (0.4 mg/kg/day for the belted kingfisher and 0.44 mg/kg/day for the great blue heron) that were used in the dietary intake models are for an organometallic (methylated) form. If methylated selenium is not present in the surface water adjacent to Area A, the risk presented by this chemical is likely to be overestimated.

7.7.2.2 Risk Calculation for Area B

Area B HQ and HI values are presented in Tables 7-36, 7-37, 7-38, and 7-39 for sediment-associated biota, saltwater aquatic life, soil organisms, and avian receptors, respectively. Chemicals with HQ values greater than 1.0 following the refinement of the conservative exposure assumptions are identified below by receptor. The chemicals listed below in italicized print are those with site HQ values that are less than background HQ values. The risks presented by these chemicals are not considered to be site-related.

- Sediment-Associated Biota: Copper (HQ = 5.35) and Vanadium (2.75)

- Aquatic Life: Copper (HQ = 11.4) and Cyanide (5.40)

- Earthworms: *Chromium (HQ = 26.8)*

- Plants: *Chromium (HQ = 10.7)* and Lead (HQ = 2.02)

- Belted kingfisher: Chromium (HQ = 1.30), Lead (HQ = 1.19), and Vanadium (HQ = 1.31)

- Great Blue Heron: None

- American Robin: Lead (HQ = 8.05)

- Red-Tailed Hawk: Lead (HQ = 1.61)

7.7.2.3 Risk Calculation for Area C

Area C HQ and HI values are presented in Tables 7-40, 7-41, 7-42, and 7-43 for sediment-associated biota, saltwater aquatic life, soil organisms, and avian receptors, respectively. Chemicals with HQ values greater than 1.0 following the refinement of the conservative exposure assumptions are identified below by receptor. The chemicals listed below in italicized print are those with site HQ values that are less than background HQ values. The risks presented by these chemicals are not considered to be site-related.

- Sediment-Associated Biota: Barium (HQ = 1.14), Cobalt (HQ = 1.48), *Copper (HQ = 2.06)*, and Vanadium (2.16)

- Aquatic Life: Chromium (HQ = 2.56), Copper (HQ = 102), Lead (HQ = 12.4), Nickel (HQ = 7.05), and Zinc (HQ = 3.93)

- Earthworms: Chromium (HQ = 61.0)

- Plants: Chromium (HQ = 24.4)

- Belted kingfisher: Cadmium (HQ = 1.76), Chromium (HQ = 1.19), Copper (HQ = 1.21), Lead (HQ = 2.77), Mercury (HQ = 1,200), Vanadium (HQ = 6.35), and Zinc (HQ = 11.3)

- Great Blue Heron: Mercury (HQ = 419), Vanadium (HQ = 2.24), and Zinc (HQ = 3.98)

- American Robin: Chromium (HQ = 2.15) and Lead (2.49)

- Red-Tailed Hawk: None

The calculated risk presented by mercury to the belted kingfisher and great blue heron can be attributed to conservative exposure assumptions that were still applied to the "refined" risk calculation. The BCF value (27,900 L/kg) and NOAEL value (0.0064 mg/kg/day) used in the avian piscivore dietary intake models are based on an organometallic (methylated) form. If methylated mercury is not present in the surface water adjacent to Area C, use of a BCF value and NOAEL for inorganic mercury (2,998 L/kg and 0.45 mg/kg/day, respectively) would be more appropriate for the determination of potential risks. Use of a BCF value and NOAEL for inorganic mercury would reduce the calculated risks to these receptors by three orders of magnitude. This ERA also assumes that 100 percent of the mercury, as well as 100 percent of all chemicals detected in site media, are bioavailable. In this assumption, total recoverable mercury data were used to estimate the tissue concentration of mercury in the prey of the belted kingfisher and great blue heron. Use of the biologically available fraction (i.e., dissolved fraction) would provide a more realistic estimation of fish tissue concentrations, and, therefore, a more realistic estimation of dietary intakes. It is noted that dissolved metals data were not available for use in the refinement of conservative exposure assumptions.

7.7.3 Uncertainty Analysis Related to Refinement of Exposure Assumptions and Recalculation of Risk Estimates

Throughout the ERA (screening-level ERA and refinement), it was assumed that chemicals detected in sediment, surface water, and surface soil are 100 percent bioavailable to sediment-associated biota, aquatic life, and soil organisms, respectively. This assumption likely resulted in an overestimation of risk to these receptors. For example, total recoverable metals data were used to derive HQ values for aquatic life. Total recoverable metals data were also used to estimate the tissue concentration of metals in the prey of the belted kingfisher and great blue heron. However, the EPA recognizes that dissolved metals more closely approximate the bioavailable fraction of metals in the water column (EPA 1999d and EPA 1995f). Therefore, the use of total recoverable metals data likely resulted in the overestimation of risks to aquatic life and avian piscivores. It is noted that dissolved metals data were not available for use in the refinement of exposure assumptions and the recalculation of risks.

It was conservatively assumed that detected mercury and selenium were present as organometallic forms. If organometallic forms of mercury and selenium are not present, the NOAEL values used for the calculation of avian HQ values and the BCF values used to estimate their tissue concentration in the prey of the belted kingfisher and great blue heron may be overly conservative. For example, if organometallic forms of mercury are not present in the surface water adjacent to Area C, a NOAEL and BCF value for inorganic mercury (0.45 mg/kg/day from Sample et al. 1996 and 2,998 L/kg from EPA 1994c) would provide a more realistic estimate of risk. The NOAEL for inorganic mercury is two orders of magnitude higher than the NOAEL for methylated mercury used in this screening-level ERA (0.0064 mg/kg/day), while the BCF for inorganic mercury is an order of magnitude lower than the BAF for methylmercury (27,900 l/kg).

The ratio of site area to home range area for avian receptors was assumed to be 1.0 throughout this ERA. This is an extremely conservative assumption since the avian receptors likely would spend a significant percentage of time foraging off-site or foraging on-site where the level of chemical contamination is expected to be significantly lower. This assumption likely resulted in an overestimation of risks for the belted kingfisher, great blue heron, American robin, and red-tailed hawk.

Finally, many of the NOAEL values used to calculate the avian receptor HQ values were estimated from LOAEL values by applying a safety factor of ten to the LOAEL values. Dourson and Stara (1983 cited in EPA 1997c) determined that 96 percent of chemicals included in a data review had LOAEL/NOAEL ratios of five or less. This suggests that the NOAEL values estimated from LOAEL values by applying a safety factor of 10 added a level of conservatism to this ERA.

7.7.4 Conclusions from the Refinement of Exposure Assumptions and Recalculation of Risk Estimates

Based on the refinement of conservative exposure assumptions, it cannot be concluded that there is no potential for ecological risk from receptor exposures to chemicals detected in sediment, surface water, and surface soil. Several inorganics were detected in sediment, surface water, and surface soil collected from Areas A, B, and C that present a risk to the ecological receptors evaluated in this ERA (see Section 7.7.2). However, most HQ values were low. In addition, background HQ values for

many chemicals, most notably chromium HQ values for soil organisms and the American robin, are similar to or exceed site HQ values.

The highest site-related risks were calculated for aquatic life and avian piscivores. This result is most likely attributable to several conservative exposure assumptions, including the use of total recoverable metals data in the calculation of HQ values for aquatic life. Total recoverable metals data were also used to estimate the chemical concentration of metals in the tissue of prey consumed by the belted kingfisher and great blue heron. It was also assumed that the total mercury and selenium detected in site media existed as organometallic forms. It is recommended that additional surface water samples be collected from each area and analyzed for total recoverable metals and dissolved metals. It is also recommended that surface water samples be analyzed to determine if organometallic forms of mercury and selenium are present. These data would be used to further refine the exposure assumptions for saltwater aquatic life and avian piscivores.

In conclusion, the results of this ERA must be considered in conjunction with the sources of uncertainty discussed in Section 7.5 and Section 7.7.3. Some uncertainty could lead to an underestimation of risk, but other sources of uncertainty would lead to overestimation of risks. Based upon the uncertainty discussed in Section 7.5 and Section 7.7.3, overestimation of risks likely prevailed in this ERA.

SECTION 7.0
TABLES

TABLE 7-1

SUMMARY OF SWMU 9 (AREA A, B, AND C) SEDIMENT ANALYTICAL DATA: FREQUENCY OF DETECTION, MAXIMUM POSITIVE DETECTIONS, AND ARITHMATIC MEAN CONCENTRATIONS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical [1]	Area A (Tanks 212-213)			Area B (Tanks 214-215)			Area C (Tanks 216-217)		
	Frequency of Detection	Maximum Positive Detection	Arithmatic Mean	Frequency of Detection	Maximum Positive Detection	Arithmatic Mean [2]	Frequency of Detection	Maximum Positive Detection	Arithmatic Mean [2]
Inorganics (mg/kg):									
Arsenic	1/1	1.8 J	1.8	3/3	1.3 J	1.2	2/2	4.6 J	3.5
Barium	1/1	14	14	3/3	20	16.3	2/2	80	54.5
Beryllium	1/1	0.29 J	0.29	3/3	0.16 J	0.14	2/2	0.097 J	0.087
Cadmium	0/1	NA	NA	2/3	0.14 J	0.11	0/2	NA	NA
Chromium	1/1	21	21	3/3	28	25.7	2/2	30	19.6
Cobalt	1/1	6.9	6.9	3/3	12	9.4	2/2	22	14.8
Copper	1/1	63 J	63	3/3	120 J	100	2/2	49 J	38.5
Lead	1/1	12 J	12	3/3	47 J	25.4	2/2	22 J	15.1
Mercury	1/1	0.078 J	0.078	3/3	0.1 J	0.09	2/2	0.049 J	0.032
Nickel	1/1	6.6 J	6.6	3/3	9.8	8.2	2/2	7 J	5.7
Selenium	0/1	NA	NA	0/3	NA	NA	1/2	0.68 J	0.44
Tin	1/1	4.3 J	4.3	3/3	4.7	4.2	2/2	6 J	4.8
Vanadium	1/1	180	180	3/3	180	157	2/2	180	123
Zinc	1/1	64 J	64	3/3	63 J	53.7	1/2	52 J	31
Volatiles (ug/kg):									
Acetone	1/1	130 J	130	3/3	200	157	2/2	290	182
2-Butanone	0/1	NA	NA	2/3	39 J	32.7	1/2	68 J	49.8
Carbon disulfide	0/1	NA	NA	2/3	8.9 J	6.7	1/2	16	13.0

Notes:

NA = Not Applicable (chemical was not detected)
J = Estimated Value

[1] The chemicals listed are those detected in at least one SWMU 9 surface water sample.

[2] One-half the detection limit was used to calculate arithmatic means for chemicals with non-detected results.

TABLE 7-2

SUMMARY OF SWMU 9 (AREA A, B, AND C) SURFACE WATER ANALYTICAL DATA: FREQUENCY OF DETECTION, MAXIMUM POSITIVE DETECTIONS, AND ARITHMATIC MEAN CONCENTRATIONS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical [1]	Area A (Tanks 212-213)			Area B (Tanks 214-215)			Area C (Tanks 216-217)		
	Frequency of Detection	Maximum Positive Detection	Arithmatic Mean	Frequency of Detection	Maximum Positive Detection	Arithmatic Mean [2]	Frequency of Detection	Maximum Positive Detection	Arithmatic Mean [2]
Inorganics (ug/L):									
Antimony	0/1	NA	NA	1/3	16.5	6.4	0/2	NA	NA
Arsenic	1/1	38.3 J	38.3	3/3	39.7 J	30.3	2/2	60.8 J	34.8
Barium	1/1	50.5	50.5	3/3	61.1	56.7	2/2	341	308
Beryllium	0/1	NA	NA	2/3	0.73	0.3	2/2	2.4	2.4
Cadmium	1/1	0.7 J	0.7	2/3	1.5 J	1.2	1/2	3.3	2.3
Chromium	0/1	NA	NA	2/3	8.5	6.8	2/2	155	129
Cobalt	1/1	0.96 J	0.96	3/3	4.4 J	4.0	2/2	145	113
Copper	0/1	NA	NA	2/3	55.6 J	42.2	2/2	389	379
Cyanide	0/1	NA	NA	1/3	6.1	5.4	0/2	NA	NA
Lead	0/1	NA	NA	1/3	5.4 J	3.3	2/2	130 J	105
Mercury	0/1	NA	NA	0/1	NA	NA	2/2	0.59	0.55
Nickel	0/1	NA	NA	2/3	10.1	6.3	2/2	63.4	58.5
Selenium	1/1	22.3 J	22.3	0/1	NA	NA	0/2	NA	NA
Tin	1/1	2.7 J	2.7	3/3	9.2	6.0	2/2	13	12.3
Vanadium	1/1	88.5	88.5	3/3	134	92.4	2/2	1,070	865
Zinc	1/1	6.3 J	6.3	3/3	27.4	20.6	2/2	425	336
Volatiles (ug/L):									
Methylene Chloride	0/1	NA	NA	0/3	NA	NA	1/2	2.9 J	2.7

Notes:

NA = Not Applicable (chemical was not detected)
J = Estimated Value

[1] The chemicals listed are those detected in at least one SWMU 9 surface water sample.

[2] One-half the detection limit was used to calculate arithmatic means for chemicals with non-detected results.

TABLE 7-3

SUMMARY OF SWMU 9 (AREA A, B, AND C) SURFACE SOIL ANALYTICAL DATA: FREQUENCY OF DETECTION, MAXIMUM POSITIVE DETECTIONS, AND ARITHMATIC MEAN CONCENTRATIONS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical [1]	Area A (Tanks 212-213)			Area B (Tanks 214-215)			Area C (Tanks 216-217)		
	Frequency of Detection	Maximum Positive Detection	Arithmatic Mean [2]	Frequency of Detection	Maximum Positive Detection	Arithmatic Mean [2]	Frequency of Detection	Maximum Positive Detection	Arithmatic Mean [2]
Inorganics (mg/kg):									
Arsenic	4/4	3.7	1.8	3/3	2.0	1.67	0/3	NA	NA
Barium	4/4	232	118	3/3	115	85.4	3/3	110	74.1
Cadmium	0/4	NA	NA	1/3	0.42	0.21	0/3	NA	NA
Chromium	4/4	29.7 J	15.7	3/3	13.2 J	10.7	3/3	30.4 J	24.4
Lead	4/4	15.6	9.1	3/3	258	101	3/3	52.5	25.4
Selenium	2/4	1.6 J	0.66	2/3	1.1 J	0.72	0/3	NA	NA
Silver	1/4	0.35	0.21	0/3	NA	NA	0/3	NA	NA
Volatiles (ug/kg)::									
Acetone	1/4	12 J	7.3	2/3	22 J	13.8	0/3	NA	NA
Semi-Volatiles (ug/kg):									
Benzo(b)fluoranthene	0/4	NA	NA	0/3	NA	NA	1/3	59 J	134.7 [3]
Benzyl alcohol	1/4	440 J	250	0/3	NA	NA	0/3	NA	NA
Chrysene	0/4	NA	NA	0/3	NA	NA	1/3	45 J	130 [3]
Diethylphthalate	1/4	40 J	155 [3]	0/3	NA	NA	0/3	NA	NA
Di-n-butylphthalate	0/4	NA	NA	1/3	40 J	132 [3]	1/3	100 J	148.3 [3]
Pyrene	0/4	NA	NA	0/3	NA	NA	1/3	56 J	133.7 [3]

Notes:

NA = Not Applicable (chemical was not detected)
J = Estimated Value

[1] The chemicals listed are those detected in at least one SWMU 9 surface water sample.

[2] One-half the detection limit was used to calculate arithmatic means for chemicals with non-detected results.

[3] The arithmatic mean exceeds the maximum detected result. This can be attributed to a single positive result that was reported below the analytical laboratory's reporting limit.

TABLE 7-4

SUMMARY OF BACKGROUND SURFACE WATER, SEDIMENT, AND SURFACE SOIL ANALYTICAL DATA
FREQUENCY OF DETECTION, MAXIMUM POSITIVE DETECTIONS, AND ARITHMATIC MEAN CONCENTRATIONS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Background Surface Water			Background Sediment			Background Surface Soil		
	Frequency of Detection	Maximum Positive Detection	Arithmatic Mean (ug/L)	Frequency of Detection	Maximum Positive Detection	Arithmatic Mean (mg/kg)	Frequency of Detection	Maximum Positive Detection	Arithmatic Mean [1] (mg/kg)
Inorganics:									
Arsenic	1/1	35.1 J	35.1	1/1	1.3 J	1.3	5/5	2.5 J	1.9
Barium	1/1	55.9	55.9	1/1	8.1	8.1	5/5	110	76.4
Beryllium	0/1	NA	NA	1/1	0.047 J	0.047	5/5	0.36 J	0.24
Cadmium	0/1	NA	NA	0/1	NA	NA	2/5	0.92 J	0.24
Chromium	1/1	9.1 J	9.1	1/1	16	16	5/5	34	19.5
Cobalt	1/1	3.2 J	3.2	1/1	4.7	4.7	5/5	64	33.4
Copper	0/1	NA	NA	1/1	58 J	58	5/5	100 J	75.6
Lead	0/1	NA	NA	1/1	4.6 J	4.6	5/5	21 J	10.5
Mercury	0/1	NA	NA	1/1	0.041 J	0.041	5/5	0.12 J	0.062
Nickel	0/1	NA	NA	1/1	4.8 J	4.8	5/5	17	9.7
Tin	1/1	2.7 J	2.7	1/1	4.2 J	4.2	5/5	2.3 J	2.0
Vanadium	1/1	48.4 J	48.4	1/1	110	110	5/5	270	196
Zinc	1/1	11.9 J	11.9	0/1	NA	NA	5/5	67 J	52.6
Volatiles:									
Acetone	0/1	NA	NA	1/1	0.140	0.140	0/1	NA	NA

Notes:

NA = Not Applicable (chemical was not detected)
J = Estimated Value

[1] One-half the detection limit was used to calculate arithmatic means for chemicals with non-detected results.

TABLE 7-5

ASSESSMENT ENDPOINTS, RISK HYPOTHESIS, MEASURMENT ENDPOINTS AND RECEPTORS
SWMU 9 (TANKS 212 – 217)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Receptor Species
Protection of sediment-associated biota from the toxic effects (on survival and growth) of site-related chemicals present in surface water.	Are levels of site-related chemicals present in sediment sufficient to cause adverse effects on the survival and growth of sediment-associated biota at the site?	Comparison of exposure HQs to a reference HQ of 1.0. Exposure HQs are calculated for individual chemicals by dividing the sediment concentrations by sediment threshold screening values. A reference HQ of 1.0 represents a condition where the sediment concentration is equal to the screening threshold value.	Sediment-associated aquatic life (invertebrates)
Protection of saltwater aquatic life within from the toxic effects (on survival, growth, and reproduction) of site-related chemicals present in surface water.	Are levels of site-related chemicals present in surface water sufficient to cause adverse effects on the survival, growth, and reproduction of saltwater aquatic life at the site?	Comparison of exposure HQs to a reference HQ of 1.0. Exposure HQs are calculated for individual chemicals by dividing the surface water concentrations by surface water screening threshold values. A reference HQ of 1.0 represents a condition where the surface water concentration is equal to the screening threshold value.	Saltwater aquatic life (invertebrates and fish)
Protection of soil invertebrate and plant communities from the toxic effects (on survival and growth) of site-related chemicals present in SWMU 9 surface soil.	Are levels of site-related chemicals present in surface soils sufficient to cause adverse effects on the survival and growth of soil invertebrates and plants at the site?	Comparison of exposure HQs to a reference HQ of 1.0. Exposure HQs are calculated for individual chemicals by dividing the soil concentrations by invertebrate, microorganism, or plant-based soil screening threshold values. A reference HQ of 1.0 represents a condition where the soil concentration is equal to the screening threshold value.	Soil invertebrates and plants

TABLE 7-5
(Continued)

ASSESSMENT ENDPOINTS, RISK HYPOTHESIS, MEASURMENT ENDPOINTS AND RECEPTORS
SWMU 9 (TANKS 212 – 217)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Receptor Species
Protection of piscivorous birds consuming fish to ensure that ingestion of chemicals in surface water, sediment, and prey does not have a negative impact on survival, growth, and reproduction.	Are levels of site chemicals in surface water, sediment, and prey sufficient to cause adverse effects on the survival, growth, and reproductive success of piscivorous birds utilizing the site?	Comparison of dietary intake HQs to a reference of 1.0. Dietary HQs are calculated for individual chemicals by dividing an estimated level of exposure by an ecotoxicity value that is associated with a NOAEL. A reference HQ of 1.0 represents a dietary dose that is equal to the NOAEL ecotoxicity value.	Great Blue Heron Belted Kingfisher
Protection of insectivorous birds consuming soil arthropods to ensure that ingestion of chemicals in soil and prey does not have a negative impact on survival, growth, and reproduction.	Are levels of site chemicals in soil and prey (soil arthropods) sufficient to cause adverse effects on the growth, survival, and reproductive success of insectivorous birds using the site?	Comparison of dietary HQs to a reference of 1.0. Dietary HQs are calculated for individual chemicals by dividing an estimated level of exposure by an ecotoxicity value that is associated with a NOAEL. A reference HQ of 1.0 represents a dietary dose that is equal to the NOAEL ecotoxicity value.	American Robin
Protection of carnivorous birds consuming small mammals to ensure that ingestion of chemicals in soil and prey does not have a negative impact on survival, growth, and reproduction.	Are levels of site contaminants in soils and prey (small mammals) sufficient to cause adverse effects on the growth, survival, and reproductive success of carnivorous birds using the site?	Comparison of dietary HQs to a reference of 1.0. Dietary HQs are calculated for individual chemicals by dividing an estimated level of exposure by an ecotoxicity value that is associated with a NOAEL. A reference HQ of 1.0 represents a dietary dose that is equal to the NOAEL ecotoxicity value.	Red-Tailed Hawk

TABLE 7-6

SEDIMENT THRESHOLD SCREENING VALUES FOR CHEMICALS DETECTED IN SWMU 9 AND BACKGROUND SEDIMENT SAMPLES
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Long et. al. Sediment Quality Guidelines [1]		FDEP Sediment Quality Guidelines [2]		Washington State Sediment Quality Guidelines [3]
	ER-M	ER-L	PEL	TEL	AET
Inorganics (mg/kg):					
Arsenic	70	8.2	41.6	7.24	35
Barium	NE	NE	NE	NE	48
Beryllium	NE	NE	NE	NE	NE
Cadmium	9.6	1.2	4.21	0.676	3
Chromium	370	81	160	52.3	62
Cobalt	NE	NE	NE	NE	10
Copper	270	34	108	18.7	390
Lead	218	46.7	112	30.2	400
Mercury	0.71	0.15	0.696	0.13	0.41
Nickel	51.6	20.9	42.8	15.9	110
Selenium	NE	NE	NE	NE	1
Tin	NE	NE	NE	NE	NE
Vanadium	NE	NE	NE	NE	57
Zinc	410	150	271	124	410
Volatiles (ug/kg):					
Acetone	NE	NE	NE	NE	NE
2-Butanone	NE	NE	NE	NE	NE
Carbon disulfide	NE	NE	NE	NE	NE

Notes:

ER-M = Effects Range-Median
ER-L = Effects Range-Low
FDEP - Florida Department of Environmental Protection
PEL = Probable Effects Level
TEL = Threshold Effects Level
AET = Apparent Effects Threshold
NE = Not Established

[1] Sediment quality guidelines taken from Long et al. (1995).
[2] Sediment quality guidelines taken from MacDonald (1994).
[3] Sediment quality guidelines taken from Buchman (1999).

TABLE 7-7

EPA SALTWATER NATIONAL AMBIENT WATER QUALITY CRITERIA FOR METALS DETECTED IN SWMU 9 AND BACKGROUND SURFACE WATER SAMPLES
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	EPA Saltwater NAWQC (ug/L)				EPA Saltwater Conversion Factor
	Dissolved Criteria		Total Recoverable Criteria[1]		
	Acute (CMC)	Chronic (CCC)	Acute (CMC)	Chronic (CCC)	
Antimony	NE	NE	NE	NE	NE
Arsenic	69 [2]	36 [2]	69 [2]	36 [2]	1.000
Barium	NE	NE	NE	NE	NE
Beryllium	NE	NE	NE	NE	NE
Cadmium	42	9.3	42.3	9.4	0.994
Chromium	1,100 [3]	50 [3]	1,108 [3]	50.3 [3]	0.993 [4]
Cobalt	NE	NE	NE	NE	NE
Copper	4.8	3.1	5.8	3.7	0.830
Lead	210	8.1	220.8	8.5	0.951
Mercury	1.8 [5]	0.94 [5]	2.1 [5]	1.1 [5]	0.850
Nickel	74	8.2	74.7	8.3	0.990
Selenium	290	71	290.6	71.1	0.990
Tin	NE	NE	NE	NE	NE
Vanadium	NE	NE	NE	NE	NE
Zinc	90	81	95.1	85.6	0.946

Notes:

EPA = Environmental Protection Agency
NAWQC = National Ambient Water Quality Criteria
CMC = Criteria Maximum Concentration
CCC = Criteria Continuous Concentration
NE = Not Established

[1] Total recoverable criteria were calculated by dividing the dissolved metal criteria by the appropriate EPA Conversion Factor (EPA 1999d).

[2] The criterion shown was derived from data for trivalent arsenic, and applied to total arsenic (EPA 1999d).

[3] The criterion shown is for hexavalent chromium.

[4] The conversion factor shown is for hexavalent chromium.

[5] The criterion was derived from data for inorganic mercury (II), and applied to total mercury (EPA 1999d).

TABLE 7-8

AQUIRE DATABASE TOXICITY TEST DATA FOR CONSTITUENTS DETECTED IN SWMU 9 AND BACKGROUND SURFACE WATER SAMPLES THAT LACK ESTABLISHED EPA SALTWATER NATIONAL AMBIENT WATER QUALITY CRITERIA
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Test Organism	Test Material	Test Endpoint	Effect Measured	Effect Concentration [1] (ug/L)	Reference
Barium	*Skeletonema costatum* (Diatom)	Barium	96-hour EC_{50}	Photosynthesis	>500,000	USEPA, 1978
	Mytilus californianus (Mussel)	Barium Acetate	48-hour EC_{50}	Development	189	Spangenberg and Cherr, 1996
	Mysidopsis bahia (Opossum Shrimp)	Barium	96-hour LC_{50}	Mortality	>500,000	USEPA, 1978
	Fundulus heteroclitus (Mummichog)	Barium Chloride	96-hour LC_{50}	Mortality	>1,000,000	Dorfman, 1977
		Barium Chloride	96-hour LC_{50}	Mortality	>1,000,000	Dorfman, 1977
	Cyprinodon variegatus (Sheepshead Minnow)	Barium	96-hour LC_{50}	Mortality	>500,000 (NOEC = 500,000)	Heitmuller et. al., 1981
Cobalt	*Phaeodactylum tricornutum* (Diatom)	Cobalt Sulfate	48-hour EC_{50}	Growth	10,200	Rosko and Rachlin, 1975
		Cobalt Sulfate	48-hour EC_{50}	Growth	23,600	Rosko and Rachlin, 1975
	Monhystera disjuncta (Nematode)	Cobalt Chloride	96-hour LC_{50}	Mortality	94,000 (NOEC = 10,000)	Vranken, et. al., 1991
	Nitocra spinipes (Copepod)	Cobalt Chloride	96-hour LC_{50}	Mortality	4,500 (3,000 - 6,800) [2]	Bengtsson, 1978
	Carcinus maenas (Green Shore Crab)	Cobalt Chloride	96-hour LC_{50}	Mortality	22,700	Amiard, 1976
	Fundulus heteroclitus (Mummichog)	Cobalt Chloride	96-hour LC_{50}	Mortality	275,000	Dorfman, 1977

TABLE 7-8 (continued)

AQUIRE DATABASE TOXICITY TEST DATA FOR CONSTITUENTS DETECTED IN SWMU 9 SURFACE WATER SAMPLES THAT LACK ESTABLISHED EPA SALTWATER NATIONAL AMBIENT WATER QUALITY CRITERIA
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Test Organism	Test Material	Test Endpoint	Effect Measured	Effect Concentration [1] (ug/L)	Reference
Cobalt (continued)	*Fundulus heteroclitus* (Mummichog)	Cabonic Acid, Cobalt Salt	96-hour LC_{50}	Mortality	>1,000,000	Dorfman, 1977
		Cabonic Acid, Cobalt Salt	96-hour LC_{50}	Mortality	>1,000,000	Dorfman, 1977
	Therapon jarbua (Tigerfish)	Cobalt Sulfate	96-Hour LC_{50}	Mortality	52,500	Krishnakumari et. al., 1983
Vanadium	*Gymnodinium splendens* (Dinoflagellate)	Vanadium	48-hour EC_{50}	Growth	1,800 - 42,000 [3]	Wilson and Freeburg, 1980
	Thalassiosira guillardii (Diatom)	Vanadium	48-hour EC_{50}	Growth	12,000 - 37,000 [4]	Wilson and Freeburg, 1980
	Therapon jarbua (Tigerfish)	Vanadium Pentoxide	96-hour LC_{50}	Mortality	620	Krishnakumari et. al., 1983

Notes:

AQUIRE - Aquatic Toxicity Information Retrieval
EC_{50} = Median Effective Concentration Value
LC_{50} = Median Lethal Concentration Value
NOEC = No Observed Effect Concentration

[1] Effect concentrations are expressed in terms of the total recoverable metal in the water column.

[2] 95 percent confidence interval.

[3] The values shown represent the range of effect concentrations reported for eight tests.

[4] The values shown represent the range of effect concentrations reported for ten tests.

TABLE 7-9

EARTHWORM AND PLANT SURFACE SOIL THRESHOLD SCREENING VALUES FOR CHEMICALS DETECTED IN SWMU 9 AND BACKGROUND SURFACE SOIL SAMPLES
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Earthworms [1]		Plants [2]	
	Screening Threshold Value	Level of Confidence	Screening Threshold Value	Level of Confidence
Inorganics (mg/kg):				
Arsenic	60	Low	10	Moderate
Barium	NE	NE	500	Low
Cadmium	30	Moderate	4.0	High
Chromium	0.4	Low	1.0	Low
Lead	500	Low	50	Moderate
Mercury	0.1	Low	0.3	Low
Selenium	70	Low	1.0	Low
Silver	NE	NE	2.0	Low
Volatile (ug/kg):				
Acetone	NE	NE	NE	NE
Semi-Volatiles (ug/kg):				
Benzyl alcohol	NE	NE	NE	NE
Chrysene	NE	NE	NE	NE
Diethylphthalate	NE	NE	100,000	Low
Di-n-butylphthalate	NE	NE	200,000	NR
Pyrene	NE	NE	NE	NE

NE = Not Established
NR = Not Reported

[1] Screening threshold values and levels of confidence taken from Efroymson et al. (1997a).

[2] Screening threshold values and levels of confidence taken from Efroymson et al. (1997b).

TABLE 7-10

LITERATURE-DERIVED NO OBSERVED EFFECT LEVEL AND LOWEST OBSERVED EFFECT LEVEL THRESHOLD SCRFEENING VALUES FOR AVIAN DIETARY INTAKE EXPOSURES
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Chemical Form	Laboratory Test Species	Test Species NOAEL [1] (mg/kg/day)	Test Species LOAEL [1] (mg/kg/day)	Ecological Receptor
Inorganics:					
Antimony	NA	NA	NE	NE	NA
Arsenic	Copper acetoarsenite	Brown-headed cowbird	2.46	7.38	Kingfisher, heron, robin, and hawk
Barium	Barium hydroxide	Chicken	20.8	41.7	Kingfisher, heron, robin, and hawk
Beryllium	NA	NA	NE	NE	Kingfisher, heron, robin, and hawk
Cadmium	Cadmium chloride	Mallard duck	1.45	20	Kingfisher, heron, robin, and hawk
Chromium	Trivalent chromium as $CrK(SO_4)_2$	Black duck	1	5	Kingfisher, heron, robin, and hawk
Cobalt	NA	NA	NE	NE	Kingfisher, heron, robin, and hawk
Copper	Copper Oxide	Chicken	47	61.7	Kingfisher, heron, robin, and hawk
Cyanide	NA	NA	NE	NE	Kingfisher, heron, robin, and hawk
Lead	Lead acetate	Japanese quail	1.13	11.3	Kingfisher, heron, robin, and hawk
Mercury	Methyl mercury dicyandiamide	Mallard duck	0.0064	0.064	Kingfisher, heron, robin, and hawk
Nickel	Nickel sulfate	Mallard duck	77.4	107	Kingfisher, heron, robin, and hawk
Selenium	Selanomethionine	Mallard duck	0.4	0.8	Kingfisher and robin
	Selanomethionine	Screech owl	0.44	1.5	Hawk
	Selanomethionine	Black-crowned night heron	1.8	11.8 [2]	Heron
Silver	NA	NA	NE	NE	Kingfisher, heron, robin, and hawk
Tin	Bis(tributyltin)oxide	Japanese quail	6.8	16.9	Kingfisher, heron, robin, and hawk
Vanadium	Vanadyl sulfate	Mallard duck	11.4	114 [2]	Kingfisher, heron, robin, and hawk
Zinc	Zinc sulfate	White leghorn hen	14.5	131	Kingfisher, heron, robin, and hawk
Volatiles:					
Acetone	NA	NA	NE	NE	NA
Methylene chloride	NA	NA	NE	NE	NA

TABLE 7-10 (continued)

LITERATURE-DERIVED NO OBSERVED EFFECT LEVEL AND LOWEST OBSERVED EFFECT LEVEL THRESHOLD SCRFEENING VALUES FOR AVIAN DIETARY INTAKE EXPOSURES
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Chemical Form	Laboratory Test Species	Test Species NOAEL [1] (mg/kg/day)	Test Species LOAEL [1] (mg/kg/day)	Ecological Receptor
Semi-Volatiles:					
Benzo(b)fluoranthere	NA	NA	NE	NE	NA
Benzyl alcohol	NA	NA	NE	NE	NA
Chrysene	NA	NA	NE	NE	NA
Diethylphthalate	NA	NA	ME	NE	NA
Di-n-butylphthalate	NA	Ringed Dove	0.11	1.1	Kingfisher, heron, robin, and hawk
Pyrene	NA	NA	NE	NE	NA

Notes:

NOAEL = No Observed Effect Level
LOAEL = Lowest Observed Effect Level
Kingfisher = Belted Kingfisher
Heron = Great Blue Heron
Robin = American Robin
Hawk = Red-Tailed Hawk
NA = Not Applicable
NE = Not Established

[1] NOAEL and LOAEL values taken from Sample et al. (1996).

[2] Value estimated by multiplying the NOAEL reported by Sample et al. (1996) by a factor of ten.

TABLE 7-11

CONSERVATIVE BIOCONCENTRATION/BIOACCUMULATION FACTORS
USED IN THE AVIAN DIETARY INTAKE MODELS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Fish Bioconcentration Factor [1][2]	Food Chain Multiplier [8]	Fish Bioaccumulation Factor [10]	Soil-Earthworm BAF [13]	Soil-Small Mammal BAF [16]
Inorganics:					
Antimony	1	1.0	1	NA	NA
Arsenic	17	1.0	17	0.523	0.0149
Barium	95 [3]	1.0	95	1.0 [14]	0.253
Beryllium	19	1.0	19	NA	NA
Cadmium	2,213 [4]	1.0	2,213	40.69	7.017
Chromium	3 [5]	1.0	3	3.162	0.349
Cobalt	40 [6]	1.0	40	NA	NA
Copper	290	1.0	290	NA	NA
Cyanide	0	1.0	0	NA	NA
Lead	45	1.0	45	1.522	0.339
Mercury	ND	ND	27,900 [11]	20.625	1.046
Nickel	106	1.0	106	NA	NA
Selenium	ND	ND	2,600 [12]	1.34	1.263
Silver	NA	NA	NA	1.0 [14]	1.0 [14]
Tin	85 [3]	1.0	85	NA	NA
Vanadium	153 [3]	1.0	153	NA	NA
Zinc	966	1.0	966	NA	NA
Volatiles:					
Acetone	0.26 [7]	1.0 [9]	0.26	1.0 [14]	1.0 [14]
2-Butanone	0.66 [7]	1.0 [9]	0.66	NA	NA
Carbon disulfide	15 [7]	1.05 [9]	15.8	NA	NA
Methylene Chloride	3.9 [7]	1.0 [9]	3.9	NA	NA

TABLE 7-11 (continued)

CONSERVATIVE BIOCONCENTRATION/BIOACCUMULATION FACTORS
USED IN THE AVIAN DIETARY INTAKE MODELS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Fish Bioconcentration Factor [1][2]	Food Chain Multiplier [8]	Fish Bioaccumulation Factor [10]	Soil-Earthworm BAF [13]	Soil-Small Mammal BAF [16]
Semi-Volatiles:					
Benzyl alcohol	NA	NA	NA	1.0 [14]	1.0 [14]
Benzo(b)fluoranthene	NA	NA	NA	1.0 [15]	1.0 [14]
Chrysene	NA	NA	NA	1.4 [15]	1.0 [14]
Diethylphthalate	NA	NA	NA	1.0 [14]	1.0 [14]
Di-n-butylphthalate	NA	NA	NA	1.0 [14]	1.0 [14]
Pyrene	NA	NA	NA	3.1 [15]	1.0 [14]

Notes:

NA = Not applicable, incomplete exposure pathway for this chemical
ND = Not determined, a literature-based BAF was used in the dietary exposure models.

(1) Maximum BCFs for freshwater and saltwater fish.
(2) Values from Sample et al. (1996) unless otherwise noted.
(3) The value shown is for hexavalent chromium.
(4) The value shown is from EPA (1984).
(5) The value shown is from Syracuse Research Corporation (2000).
(6) The value shown is from EPA (1995d).
(7) The value shown was estimated from the Log K_{ow} using the regression equation from Veith and Kosian (1983).
(8) The values shown are from Sample et al. (1996) unless otherwise noted.
(9) The value shown is from from EPA (1995c).
(10) The BAF values were derived by multiplying the BCF by the food chain multiplier (EPA 1995c) unless otherwise noted.
(11) The value shown represents a BAF derived for the Great Lakes system. The value assumes that 17 percent of the total mercury is methylmercury (EPA 1994d).

TABLE 7-11 (continued)

BIOCONCENTRATION/BIOACCUMULATION FACTORS USED IN THE AVIAN DIETARY INTAKE MODELS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Notes (continued):

(12) The value represents a BAF for an organometallic form (i.e., methylated form) from Sample et. al (1996).

(13) The values shown are 90th percentile values from Sample et al. (1998b) unless otherwise noted.

(14) A value was not available from the literature. The value shown is an assumed value.

(15) The value shown is a maximum value from Beyer and Stafford (1993).

(16) The values shown are 90th percentile values (maximum 90th percentile BAFs reported for general, insectivore, herbivore, or omnivore trophic group) from sample et al. (1998a) unless otherwise noted.

TABLE 7-12

CONSERVATIVE LIFE HISTORY PARAMETERS FOR THE AVIAN DIETARY INTAKE MODELS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Life History Parameters	Belted Kingfisher	Great Blue Heron	American Robin	Red-Tailed Hawk
Diet	100% Trophic Level 3 Fish	100% Trophic Level 3 Fish	100% Earthworms	100% Small Mammals
Body Weight	0.125 kg (1)	2.204 kg (5)	0.0635 kg (9)	0.957 kg (13)
Food Ingestion Rate	0.1075 kg/day (2) (Dry Weight)	0.45183 kg/day (6) (Dry Weight)	0.02045 kg/day (10) (Dry Weight)	0.13585 kg/day (14) (Dry Weight)
Water Ingestion Rate	0.02107 L/day (3)	0.11122 L/day (7)	Not Applicable (11)	Not Applicable (11)
Percent Sediment/Soil in Diet	10% (4) (Dry Weight)	10% (8) (Dry Weight)	10.4% (12) (Dry Weight)	10% (15) (Dry Weight)

Notes:

(1) Minimum body weight reported by Powdermill Nature Center (unpublished data cited in EPA 1993b.

(2) Estimated from an ingestion rate of 0.5 g/g-day (Alexander 1977) and a maximum body weight of 0.215 kg reported by Powdermill Nature Center (unpublished data cited in EPA 1993b).

(3) Estimated using an allometric equation for birds (Calder and Braun 1983) and a maximum body weight of 0.215 kg reported by Powdermill Nature Center (unpublished data cited in EPA 1993b).

(4) Data was not available from the literature. The percentage shown represents a conservative estimate. Given a food ingestion rate of 0.1075 kg/day, this percentage corresponds to a sediment ingestion rate of 0.01075 kg/day.

(5) Minimum average body weight reported by Hartman (1961) for adult females as cited in EPA 1993b.

(6) Estimated using an allometric equation for wading birds (Kushlan 1978) and a maximum body weight of 2.576 kg reported by Hartman (1961) as cited in EPA 1993b.

(7) Estimated using an allometric equation for birds from (Calder and Braun 1983) and a maximum body weight of 2.576 kg reported by Hartman (1961) as cited in EPA 1993b.

(8) Data was not available from the literature. The percentage shown represents a conservative estimate. Given a food ingestion rate of 0.45183 kg/day, this percentage corresponds to a sediment ingestion rate of 0.045183 kg/day.

(9) Minimum body weight reported by Clench and Leberman (1978).

(10) Estimated using an allometric equation for passerine birds (Nagy 1987) and a maximum body weight of 0.103 kg (Clench and Leberman 1978).

(11) Not applicable, the surface water exposure pathway does not represent a complete exposure pathway for this receptor.

(12) Estimated from data reported by Beyer et al. (1994) for the American woodcock. Given a food ingestion rate of 0.02045 kg/day, this percentage corresponds to a soil ingestion rate of 0.00213 kg/day.

TABLE 7-12 (continued)

CONSERVATIVE LIFE HISTORY PARAMETERS FOR THE AVIAN DIETARY INTAKE MODELS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Notes (continued):

(13) Minimum body weight reported by Steenhof (1983) as cited in EPA 1993b.

(14) Estimated from a maximum ingestion rate of 0.11 g/g-day (Craighead and Craighead 1956) as cited in EPA 1993b and a maximum body weight of 1.235 kg reported by Springer and Osborne (1983) as cited in EPA 1993b.

(15) Data was not available from the literature. The percentage shown represents a conservative estimate. Given a food ingestion rate of 0.13585 kg/day, this percentage corresponds to a soil ingestion rate of 0.013585 kg/day.

TABLE 7-13

SEDIMENT HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR SEDIMENT-ASSOCIATED BIOTA
SWMU 9 - AREA A (TANKS 212-213)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Maximum Detected Concentration	Threshold Screening Value [1]	Hazard Quotient [2] (Unitless)
Inorganics (mg/kg):			
Arsenic	1.8	7.24	2.49E-01
Barium	14	48	2.92E-01
Beryllium	0.29	NE	NA
Chromium	21	52.3	4.02E-01
Cobalt	6.9	10	6.90E-01
Copper	63	18.7	**3.37E+00**
Lead	12	30.2	3.97E-01
Mercury	0.078	0.13	6.00E-01
Nickel	6.6	15.9	4.15E-01
Tin	4.3	NE	NA
Vanadium	180	57	**3.16E+00**
Zinc	64	124	5.16E-01
Volatiles (ug/kg):			
Acetone	130	NE	NA

Hazard Index for Inorganics [3]:	**1.01E+01**
Hazard Index for Volatile Organics [3]:	NA

Bold and shaded value indicates a Hazard Quotient or Hazard Index greater than 1.0

Notes:

NE = Not Established
NA = Not Applicable

[1] Sediment screening threshold values from MacDonald (1994) and Buchman (1999).

[2] Hazard Quotient values were calculated by dividing the maximum detected sediment concentration by the sediment screening threshold value.

[3] Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-14

SURFACE WATER HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR SALTWATER AQUATIC LIFE
SWMU 9 - AREA A (TANKS 212-213)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Maximum Detected Concentration	Acute Threshold Screening Value [1][2]	Hazard Quotient [3] (Unitless)	Chronic Threshold Screening Value [1][2]	Hazard Quotient [3] (Unitless)
Inorganics (ug/L):					
Arsenic	38.3	69 [4]	5.55E-01	36 [4]	**1.06E+00**
Barium	50.5	NE	NA	NE	NA
Cadmium	0.7	42.3	1.65E-02	9.4	7.45E-02
Cobalt	0.96	NE	NA	NE	NA
Selenium	22.3	290.6	7.67E-02	71.1	3.14E-01
Tin	2.7	NE	NA	NE	NA
Vanadium	88.5	NE	NA	NE	NA
Zinc	6.3	95.1	6.62E-02	85.6	7.36E-02
Hazard Index for Inorganics [5]:			7.15E-01		**1.52E+00**

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

Notes:

CMC = Criteria Maximum Concentration
CCC = Criteria Continuous Concentration
NE = Not Established
NA = Not Applicable

(1) The values shown are saltwater NAWQC taken from EPA (1999d).

(2) Threshold screening values for metals are expressed as total recoverable concentrations.

(3) Hazard Quotient values were calculated by dividing the maximum detected surface water concentration by the surface water screening threshold value.

(4) The value shown is a criterion derived from data for trivalent arsenic, and applied to total arsenic (EPA 1999d).

(5) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-15

SURFACE SOIL HAZARD QUOTIENT AND HAZARD INDEX
VALUES FOR EARTHWORMS AND PLANTS
SWMU 9 - AREA A (TANKS 212-213)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Maximum Detected Concentration	Earthworms [1]		Plants [2]	
		Threshold Screening Value	Hazard Quotient [3] (unitless)	Threshold Screening Value	Hazard Quotient [3] (Unitless)
Inorganics (mg/kg):					
Arsenic	3.7	60	6.17E-02	10	3.70E-01
Barium	232	NE	NA	500	4.64E-01
Chromium	29.7	0.4	**7.43E+01**	1	**2.97E+01**
Lead	15.6	500	3.12E-02	50	3.12E-01
Selenium	1.6	70	2.29E-02	1	**1.60E+00**
Silver	0.35	NE	NA	2	1.75E-01
Volatiles (ug/kg):					
Acetone	12	NE	NA	NE	NA
Semi-Volatiles (ug/kg):					
Benzyl Alcohol	440	NE	NA	NE	NA
Diethylphthalate	40	NE	NA	100,000	4.00E-04

Hazard Index for Inorganics [4]:	**7.44E+01**		**3.26E+01**
Hazard Index for Volatile Organics [4]:	NA		NA
Hazard Index for Semi-Volatile Organics [4]:	NA		4.00E-04

Bold and shaded value indicates a Hazard Quotient or Hazard Index greater than 1.0

Notes:

NE = Not Established NA = Not Applicable

(1) Surface soil screening threshold values from Efroymson et al. (1997a).

(2) Surface soil screening threshold values from Efroymson et al. (1997b).

(3) Hazard Quotient values were calculated by dividing the maximum detected surface soil concentration by the surface soil screening threshold value

(4) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-16

DIETARY INTAKE HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR AVIAN RECEPTORS
SWMU 9 - AREA A (TANKS 212-213)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Hazard Quotient Values for Area A Avian Receptors (Unitless)							
	Belted Kingfisher		Great Blue Heron		American Robin		Red-Tailed Hawk	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Inorganics:								
Arsenic	2.93E-01	9.77E-02	7.00E-02	2.33E-02	3.04E-01	1.01E-01	2.45E-02	8.18E-03
Barium	2.57E-01	1.28E-01	6.12E-02	3.05E-02	**3.97E+00**	**1.98E+00**	5.59E-01	2.79E-01
Beryllium	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Cadmium	9.19E-01	6.66E-02	2.19E-01	1.59E-02	IEP	IEP	IEP	IEP
Chromium	**1.81E+00**	3.61E-01	4.31E-01	8.61E-02	**3.12E+01**	**6.25E+00**	**1.89E+00**	3.79E-01
Cobalt	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Copper	1.15E-01	8.78E-02	2.75E-02	2.09E-02	IEP	IEP	IEP	IEP
Lead	9.13E-01	9.13E-02	2.18E-01	2.18E-02	**7.23E+00**	**2.72E+00**	8.60E-01	3.24E-01
Mercury	**1.05E+00**	1.05E-01	2.50E-01	2.50E-02	IEP	IEP	IEP	IEP
Nickel	7.33E-03	5.30E-03	1.73E-03	1.26E-03	IEP	IEP	IEP	IEP
Selenium	**2.77E+01**	**4.23E+00**	**6.60E+00**	**1.01E+00**	**1.86E+00**	9.30E-01	7.04E-01	2.06E-01
Silver	IEP	IEP	IEP	IEP	NC	NC	NC	NC
Tin	8.35E-02	3.66E-02	1.99E-02	8.01E-03	IEP	IEP	IEP	IEP
Vanadium	**2.38E+00**	2.38E-01	5.68E-01	5.68E-02	IEP	IEP	IEP	IEP
Zinc	7.41E-01	8.20E-02	1.77E-01	1.95E-02	IEP	IEP	IEP	IEP
Volatiles:								
Acetone	NC	NC	NC	NC	NC	NC	NC	NC
Semi-Volatiles:								
Benzyl Alcohol	IEP	IEP	IEP	IEP	NC	NC	NC	NC
Diethylphthalate	IEP	IEP	IEP	IEP	NC	NC	NC	NC

HI for Inorganics (1):	**3.63E+01**	**5.52E+00**	**8.65E+00**	**1.32E+00**	**4.46E+01**	**1.20E+01**	**4.04E+00**	**1.20E+00**
HI for Volatiles (1):	NA	NA	NA	NA	NA	NA	NA	NA
HI for Semi-Volatiles (1):	IEP	IEP	IEP	IEP	NA	NA	NA	NA

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

TABLE 7-16 (continued)

DIETARY INTAKE HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR AVIAN RECEPTORS
SWMU 9 - AREA A (TANKS 212-213)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Notes:

NC = Not Calculated (an NOAEL was not available from the literature)
IEP = Incomplete Exposure Pathway (dietary intakes for this chemical were not evaluated)
HI = Hazard Index
NA = Not Applicable
NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level

(1) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-17

SEDIMENT HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR SEDIMENT-ASSOCIATED BIOTA
SWMU 9 - AREA B (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Maximum Detected Concentration	Threshold Screening Value [1]	Hazard Quotient [2] (Unitless)
Inorganics (mg/kg):			
Arsenic	1.3	7.24	1.80E-01
Barium	20	48	4.17E-01
Beryllium	0.16	NE	NA
Cadmium	0.14	0.676	2.07E-01
Chromium	28	52.3	5.35E-01
Cobalt	12	10	**1.20E+00**
Copper	120	18.7	**6.42E+00**
Lead	47	30.2	**1.56E+00**
Mercury	0.1	0.13	7.69E-01
Nickel	9.8	15.9	6.16E-01
Tin	4.7	NE	NA
Vanadium	180	57	**3.16E+00**
Zinc	63	124	5.08E-01
Volatiles (ug/kg):			
Acetone	200	NE	NA
2-Butanone	39	NE	NA
Carbon disulfide	8.9	NE	NA

Hazard Index for Inorganics [3]:	**1.56E+01**
Hazard Index for Volatile Organics [3]:	NA

Bold and shaded value indicates a Hazard Quotient or Hazard Index greater than 1.0

Notes:

NE = Not Established
NA = Not Applicable

[1] Sediment screening threshold values from MacDonald (1994) and Buchman (1999).

[2] Hazard Quotient values were calculated by dividing the maximum detected sediment concentration by the sediment screening threshold value.

[3] Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-18

SURFACE WATER HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR SALTWATER AQUATIC LIFE
SWMU 9 - AREA B (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Maximum Detected Concentration	Acute Threshold Screening Value [1][2]	Hazard Quotient [3] (Unitless)	Chronic Threshold Screening Value [1][2]	Hazard Quotient [3] (Unitless)
Inorganics (ug/L):					
Antimony	16.5	1500 [4]	1.10E-02	500 [4]	3.30E-02
Arsenic	39.7	69 [5]	5.75E-01	36 [5]	**1.10E+00**
Barium	61.1	NE	NA	NE	NA
Beryllium	0.73	NE	NA	NE	NA
Cadmium	1.5	42.3	3.55E-02	9.4	1.60E-01
Chromium	8.5	1,108 [6]	7.67E-03	50.3 [6]	1.69E-01
Cobalt	4.4	NE	NA	NE	NA
Copper	55.6	5.8	**9.59E+00**	3.7	**1.50E+01**
Cyanide	6.1	1.0	**6.10E+00**	1.0	**6.10E+00**
Lead	5.4	220.8	2.45E-02	8.5	6.35E-01
Nickel	10.1	74.7	1.35E-01	8.3	**1.22E+00**
Tin	9.2	NE	NA	NE	NA
Vanadium	134	NE	NA	NE	NA
Zinc	27.4	95.1	2.88E-01	85.6	3.20E-01

Hazard Index for Inorganics [7]:		**1.68E+01**		**2.48E+01**

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

Notes:

CMC = Criteria Maximum Concentration
CCC = Criteria Continuous Concentration
NE = Not Established
NA = Not Applicable

(1) The values shown are saltwater NAWQC taken from EPA (1999d) unless otherwise noted.

(2) Threshold screening values metals are expressed as total recoverable concentrations.

(3) Hazard Quotient values were calculated by dividing the maximum detected surface water concentration by the surface water screening threshold value.

(4) The value shown is a proposed saltwater criterion reported by Buchman (1999).

(5) The value shown is a EPA NAWQC derived from data for trivalent arsenic, and applied to total arsenic (EPA 1999d).

(7) The value shown is a EPA NAWQC for hexavalent chromium.

(8) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-19

SURFACE SOIL HAZARD QUOTIENT AND HAZARD INDEX
VALUES FOR EARTHWORMS AND PLANTS
SWMU 9 - AREA B (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Maximum Detected Concentration	Earthworms [1]		Plants [2]	
		Threshold Screening Value	Hazard Quotient [3] (unitless)	Threshold Screening Value	Hazard Quotient [3] (Unitless)
Inorganics (mg/kg):					
Arsenic	2.0	60	3.33E-02	10	2.00E-01
Barium	115	NE	NA	500	2.30E-01
Cadmium	0.42	30	1.40E-02	4	1.05E-01
Chromium	13.2	0.4	**3.30E+01**	1.0	**1.32E+01**
Lead	258	500	5.16E-01	50	**5.16E+00**
Selenium	1.1	70	1.57E-02	1.0	**1.10E+00**
Volatiles (ug/kg):					
Acetone	22	NE	NA	NE	NA
Semi-Volatiles (ug/kg):					
Di-n-butylphthalate	40	NE	NA	200,000	2.00E-04

Hazard Index for Inorganics [4]:	**3.36E+01**		**2.00E+01**
Hazard Index for Volatile Organics [4]:	NA		NA
Hazard Index for Semi-Volatile Organics [4]:	NA		2.00E-04

Bold and shaded value indicates a Hazard Quotient or Hazard Index greater than 1.0

Notes:

NE = Not Established
NA = Not Applicable

(1) Surface soil screening threshold values from Efroymson et al. (1997a).

(2) Surface soil screening threshold values from Efroymson et al. (1997b).

(3) Hazard Quotient values were calculated by dividing the maximum detected surface soil concentration by the surface soil threshold screening value.

(4) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-20

DIETARY INTAKE HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR AVIAN RECEPTORS
SWMU 9 - AREA B (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Hazard Quotient Values for Area B Avian Receptors (Unitless)							
	Belted Kingfisher		Great Blue Heron		American Robin		Red-Tailed Hawk	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Inorganics:								
Antimony	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Arsenic	2.48E-01	9.47E-02	6.79E-02	2.26E-02	1.64E-01	5.47E-02	1.33E-02	4.42E-03
Barium	3.23E-01	1.61E-01	7.71E-02	3.84E-02	**1.97E+00**	9.81E-01	2.77E-01	1.38E-01
Beryllium	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Cadmium	**1.98E+00**	1.43E-01	4.71E-01	3.42E-02	**3.81E+00**	2.76E-01	2.93E-01	2.12E-02
Chromium	**2.43E+00**	4.86E-01	5.80E-01	1.16E-01	**1.39E+01**	**2.78E+00**	8.41E-01	1.68E-01
Cobalt	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Copper	5.15E-01	3.92E-01	1.23E-01	9.35E-02	IEP	IEP	IEP	IEP
Cyanide	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Lead	**3.76E+00**	3.76E-01	8.97E-01	8.97E-02	**1.20E+02**	**4.50E+01**	**1.42E+01**	**5.36E+00**
Mercury	**1.34E+00**	1.34E-01	3.20E-01	3.20E-02	IEP	IEP	IEP	IEP
Nickel	2.28E-02	1.65E-02	5.44E-03	3.93E-03	IEP	IEP	IEP	IEP
Selenium	IEP	IEP	IEP	IEP	**1.28E+00**	6.39E-01	4.84E-01	1.42E-01
Tin	1.59E-01	6.38E-02	3.78E-02	1.52E-02	IEP	IEP	IEP	IEP
Vanadium	**2.91E+00**	2.91E-01	6.93E-01	6.93E-02	IEP	IEP	IEP	IEP
Zinc	**1.94E+00**	2.15E-01	4.63E-01	5.13E-02	IEP	IEP	IEP	IEP
Volatiles:								
Acetone	NC	NC	NC	NC	NC	NC	NC	NC
2-Butanone	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Carbon disulfide	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Semi-Volatiles:								
Di-n-butylphthalate	IEP	IEP	IEP	IEP	1.29E-01	1.29E-02	5.86E-02	5.86E-03

HI for Inorganics (1):	**1.57E+01**	**2.37E+00**	**3.74E+00**	5.66E-01	**1.41E+02**	**4.98E+01**	**1.61E+01**	**5.83E+00**
HI for Volatiles (1):	NA	NA	NA	NA	NA	NA	NA	NA
HI for Semi-Volatiles (1):	IEP	IEP	IEP	IEP	1.29E-01	1.29E-02	5.86E-02	5.86E-03

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

TABLE 7-20 (continued)

DIETARY INTAKE HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR AVIAN RECEPTORS
SWMU 9 - AREA B (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Notes:

NC = Not Calculated (an NOAEL was not available from the literature)
IEP = Incomplete Exposure Pathway (dietary intakes for this chemical were not evaluated)
HI = Hazard Index
NA = Not Applicable
NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level

(1) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-21

SEDIMENT HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR SEDIMENT-ASSOCIATED BIOTA
SWMU 9 - AREA C (TANKS 216-217)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Maximum Detected Concentration	Threshold Screening Value [1]	Hazard Quotient [2] (Unitless)
Inorganics (mg/kg):			
Arsenic	4.6	7.24	6.35E-01
Barium	80	48	**1.67E+00**
Beryllium	0.097	NE	NA
Chromium	30	52.3	5.74E-01
Cobalt	22	10	**2.20E+00**
Copper	49	18.7	**2.62E+00**
Lead	22	30.2	7.28E-01
Mercury	0.049	0.13	3.77E-01
Nickel	7	15.9	4.40E-01
Selenium	0.68	1.0	6.80E-01
Tin	6	NE	NA
Vanadium	180	57	**3.16E+00**
Zinc	52	124	4.19E-01
Volatiles (ug/kg):			
Acetone	290	NE	NA
2-Butanone	68	NE	NA
Carbon disulfide	16	NE	NA

Hazard Index for Inorganics [3]:	**1.35E+01**
Hazard Index for Volatile Organics [3]:	NA

Bold and shaded value indicates a Hazard Quotient or Hazard Index greater than 1.0

Notes:

NE = Not Established
NA = Not Applicable

[1] Sediment screening threshold values from MacDonald (1994) and Buchman (1999).

[2] Hazard Quotient values were calculated by dividing the maximum detected sediment concentration by the sediment screening threshold value.

[3] Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-22

SURFACE WATER HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR SALTWATER AQUATIC LIFE
SWMU 9 - AREA C (TANKS 216-217)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Maximum Detected Concentration	Acute Threshold Screening Value [1][2]	Hazard Quotient [3] (Unitless)	Chronic Threshold Screening Value [1][2]	Hazard Quotient [3] (Unitless)
Inorganics (ug/L):					
Arsenic	60.8	69 [4]	8.81E-01	36 [4]	**1.69E+00**
Barium	341	NE	NA	NE	NA
Beryllium	2.4	NE	NA	NE	NA
Cadmium	3.3	42.3	7.80E-02	9.4	3.51E-01
Chromium	155	1,108 [5]	1.40E-01	50.3 [5]	**3.08E+00**
Cobalt	145	NE	NA	NE	NA
Copper	389	5.8	**6.71E+01**	3.7	**1.05E+02**
Lead	130	220.8	5.89E-01	8.5	**1.53E+01**
Mercury	0.59	2.1 [6]	2.81E-01	1.1 [6]	5.36E-01
Nickel	63.4	74.7	8.49E-01	8.3	**7.64E+00**
Tin	13	NE	NA	NE	NA
Vanadium	1,070	NE	NA	NE	NA
Zinc	425	95.1	**4.47E+00**	85.6	**4.96E+00**
Volatiles (ug/L):					
Methylene Chloride	2.9	12,000 [7]	2.42E-04	6,400 [7]	4.53E-04

Hazard Index for Inorganics [8]:	**7.44E+01**		**1.39E+02**
Hazard Index for Volatile Organics [8]:	2.42E-04		4.53E-04

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

Notes:

CMC = Criteria Maximum Concentration
CCC = Criteria Continuous Concentration
NE = Not Established
NA = Not Applicable

(1) The values shown are saltwater NAWQC taken from EPA (1999d) unless otherwise noted.

(2) Threshold screening values for metals are expressed as total recoverable concentrations.

(3) Hazard Quotient values were calculated by dividing the maximum detected surface water concentration by the surface water screening threshold value.

(4) The value shown is a EPA NAWQC derived from data for trivalent arsenic, and applied to total arsenic (EPA 1999d).

(5) The value shown is a EPA NAWQC for hexavalent chromium.

(6) The value shown is a EPA NAWQC derived from data for inorganic mercury (II), and applied to total mercury (EPA 1999d).

(7) The value shown is a minimum No Observed Effect Concentration for saltwater aquatic life reported by Buchman (1999).

(8) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-23

SURFACE SOIL HAZARD QUOTIENT AND HAZARD INDEX
VALUES FOR EARTHWORMS AND PLANTS
SWMU 9 - AREA C (TANKS 216-217)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Maximum Detected Concentration	Earthworms [1]		Plants [2]	
		Threshold Screening Value	Hazard Quotient [3] (unitless)	Threshold Screening Value	Hazard Quotient [3] (Unitless)
Inorganics (mg/kg):					
Barium	110	NE	NA	500	2.20E-01
Chromium	30.4	0.4	**7.60E+01**	1	**3.04E+01**
Lead	52.5	500	1.05E-01	50	**1.05E+00**
Semi-Volatiles (ug/kg):					
Benzo(b)fluoranthene	59	NE	NA	NE	NA
Chrysene	45	NE	NA	NE	NA
Di-n-butylphthalate	100	NE	NA	200,000	5.00E-04
Pyrene	56	NE	NA	NE	NA
Hazard Index for Inorganics [4]:			**7.61E+01**		**3.17E+01**
Hazard Index for Semi-Volatile Organics [4]:			NA		5.00E-04

Bold and shaded value indicates a Hazard Quotient or Hazard Index greater than 1.0

Notes:

NE = Not Established
NA = Not Applicable

[1] Surface soil screening threshold values from Efroymson et al. (1997a).

[2] Surface soil screening threshold values from Efroymson et al. (1997b).

[3] Hazard Quotient values were calculated by dividing the maximum detected surface soil concentration by the surface soil threshold screening value.

[4] Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-24

DIETARY INTAKE HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR AVIAN RECEPTORS
SWMU 9 - AREA C (TANKS 216-217)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Hazard Quotient Values for Area C Avian Receptors (Unitless)							
	Belted Kingfisher		Great Blue Heron		American Robin		Red-Tailed Hawk	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Inorganics:								
Arsenic	5.26E-01	1.75E-01	1.26E-01	4.19E-02	IEP	IEP	IEP	IEP
Barium	**1.67E+00**	8.34E-01	3.99E-01	1.99E-01	**1.88E+00**	9.38E-01	2.65E-01	1.32E-01
Beryllium	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Cadmium	**4.33E+00**	3.14E-01	**1.03E+00**	7.49E-02	IEP	IEP	IEP	IEP
Chromium	**3.01E+00**	6.01E-01	7.18E-01	1.44E-01	**3.20E+01**	**6.40E+00**	**1.94E+00**	3.88E-01
Cobalt	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Copper	**2.16E+00**	**1.64E+00**	5.14E-01	3.91E-01	IEP	IEP	IEP	IEP
Lead	**6.15E+00**	6.15E-01	**1.47E+00**	1.47E-01	**2.43E+01**	**9.16E+00**	**2.90E+00**	**1.09E+00**
Mercury	**2.21E+03**	**2.21E+02**	**5.27E+02**	5.27E+01	IEP	IEP	IEP	IEP
Nickel	8.26E-02	5.97E-02	1.97E-02	1.42E-02	IEP	IEP	IEP	IEP
Selenium	3.25E-02	4.96E-03	7.74E-03	1.18E-03	IEP	IEP	IEP	IEP
Tin	2.16E-01	8.69E-02	5.15E-02	2.07E-02	IEP	IEP	IEP	IEP
Vanadium	**1.37E+01**	**1.37E+00**	**3.27E+00**	3.27E-01	IEP	IEP	IEP	IEP
Zinc	**2.47E+01**	**2.73E+00**	**5.88E+00**	6.51E-01	IEP	IEP	IEP	IEP
Volatiles:								
Acetone	NC	NC	NC	NC	IEP	IEP	IEP	IEP
2-Butanone	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Carbon disulfide	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Methylene chloride	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Semi-Volatiles:								
Benzo(b)fluoranthene	IEP	IEP	IEP	IEP	NC	NC	NC	NC
Chrysene	IEP	IEP	IEP	IEP	NC	NC	NC	NC
Di-n-butylphthalate	IEP	IEP	IEP	IEP	3.23E-01	3.23E-02	1.42E-01	1.42E-02
Pyrene	IEP	IEP	IEP	IEP	NC	NC	NC	NC

HI for Inorganics (1):	**2.27E+03**	**2.30E+02**	**5.41E+02**	**5.48E+01**	**5.82E+01**	**1.65E+01**	**5.10E+00**	**1.61E+00**
HI for Volatiles (1):	NA	NA	NA	NA	IEP	IEP	IEP	IEP
HI for Semi-Volatiles (1):	IEP	IEP	IEP	IEP	3.23E-01	3.23E-02	1.42E-01	1.42E-02

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

TABLE 7-24 (continued)

DIETARY INTAKE HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR AVIAN RECEPTORS
SWMU 9 - AREA C (TANKS 216-217)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Notes:

NC = Not Calculated (an NOAEL was not available from the literature)
IEP = Incomplete Exposure Pathway (dietary intakes for this chemical were not evaluated)
HI = Hazard Index
NA = Not Applicable
NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level

(1) Hazard Index values calculated by summing the individual Hazard Quotient values.

TABLE 7-25

BACKGROUND SEDIMENT HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR SEDIMENT-ASSOCIATED BIOTA
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Maximum Detected Concentration	Threshold Screening Value [1]	Hazard Quotient [2] (Unitless)
Inorganics (mg/kg):			
Arsenic	1.3	7.24	1.80E-01
Barium	8.1	48	1.69E-01
Beryllium	0.047	NE	NA
Chromium	16	52.3	3.06E-01
Cobalt	4.7	10	4.70E-01
Copper	58	18.7	**3.10E+00**
Lead	4.6	30.2	1.52E-01
Mercury	0.041	0.13	3.15E-01
Nickel	4.8	15.9	3.02E-01
Tin	4.2	NE	NA
Vanadium	110	57	**1.93E+00**
Volatiles (ug/kg):			
Acetone	140	NE	NA

Hazard Index for Inorganics [3]:	**6.93E+00**
Hazard Index for Volatile Organics [3]:	NA

Bold and shaded value indicates a Hazard Quotient or Hazard Index greater than 1.0

Notes:

NE = Not Established
NA = Not Applicable

(1) Sediment screening threshold values from MacDonald (1994) and Buchman (1999).

(2) Hazard Quotient values were calculated by dividing the maximum detected sediment concentration by the sediment screening threshold value.

(3) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-26

BACKGROUND SURFACE WATER HAZARD QUOTIENT AND HAZARD INDEX VALUES
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Maximum Detected Concentration	Acute Threshold Screening Value (1)(2)	Hazard Quotient (3) (Unitless)	Chronic Threshold Screening Value (1)(2)	Hazard Quotient (3) (Unitless)
Inorganics (ug/L):					
Arsenic	35.1	69 (4)	5.09E-01	36 (4)	9.75E-01
Barium	55.9	189 (5)	2.96E-01	NE	NA
Chromium	9.1	1,108 (6)	8.21E-03	50.3 (5)	1.81E-01
Cobalt	3.2	4,500 (5)	7.11E-04	NE	NA
Tin	2.7	NE	NA	NE	NA
Vanadium	48.4	620 (5)	7.81E-02	NE	NA
Zinc	11.9	95.1	1.25E-01	85.6	1.39E-01
Hazard Index for Inorganics (7):			**1.02E+00**		**1.29E+00**

Bold and shaded values indicate a Hazard Index or Hazard Quotient greater than 1.0

Notes:

CMC = Criteria Maximum Concentration
CCC = Criteria Continuous Concentration
NE = Not Established
NA = Not Applicable

(1) The values shown are EPA NAWQC unless otherwise noted.

(2) Threshold screening values for metals are expressed as total recoverable concentrations.

(3) Hazard Quotient values were calculated by dividing the maximum detected surface water concentration by the surface water screening threshold value.

(4) The value shown is a EPA NAWQC derived from data for trivalent arsenic, and applied to total arsenic (EPA 1999d).

(5) The value shown is a minimum acute effect concentration taken from the EPA AQUIRE database.

(6) The value shown is a EPA NAWQC for hexavalent chromium.

(7) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-27

BACKGROUND SURFACE SOIL HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR EARTHWORMS AND PLANTS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical [1]	Maximum Detected Concentration	Earthworms [2]		Plants [3]	
		Threshold Screening Value	Hazard Quotient [4] (unitless)	Threshold Screening Value	Hazard Quotient [4] (Unitless)
Inorganics (mg/kg):					
Arsenic	2.5	60	4.17E-02	10	2.50E-01
Barium	110	NE	NA	500	2.20E-01
Cadmium	0.92	30	3.07E-02	4	2.30E-01
Chromium	34	0.4	**8.50E+01**	1	**3.40E+01**
Lead	21	500	4.20E-02	50	4.20E-01
Mercury	0.12	0.1	**1.20E+00**	0.3	4.00E-01
Hazard Index for Inorganics [5]:			**8.63E+01**		**3.55E+01**

Notes:

Bold and shaded value indicate a Hazard Quotient greater than 1.0

NE = Not Established
NA = Not Applicable

(1) The chemicals shown are those detected in background surface soil samples and analyzed for in the SWMU 9 surface soil samples.

(2) Surface soil screening threshold values from Efroymson et al. (1997a).

(3) Surface soil screening threshold values from Efroymson et al. (1997b).

(4) Hazard Quotient values were calculated by dividing the maximum detected surface soil concentration by the surface soil threshold screening value.

(5) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-28

BACKGROUND DIETARY INTAKE HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR AVIAN RECEPTORS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Hazard Quotient Values for Background Avian Receptors (Unitless)							
	Belted Kingfisher		Great Blue Heron		American Robin		Red-Tailed Hawk	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Inorganics:								
Arsenic	2.56E-01	8.55E-02	6.13E-02	2.04E-02	2.05E-01	6.48E-02	1.66E-02	5.53E-03
Barium	2.54E-01	1.26E-01	6.05E-02	3.02E-02	**1.88E+00**	9.38E-01	2.65E-01	1.32E-01
Beryllium	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Cadmium	IEP	IEP	IEP	IEP	**8.34E+00**	6.04E-01	6.41E-01	4.65E-02
Chromium	**1.40E+00**	2.80E-01	3.34E-01	6.68E-02	**3.58E+01**	**7.15E+00**	**2.17E+00**	4.33E-01
Cobalt	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Copper	1.06E-01	8.08E-02	2.53E-02	1.93E-02	IEP	IEP	IEP	IEP
Lead	3.50E-01	3.50E-02	8.35E-02	8.35E-03	**9.73E+00**	**3.67E+00**	**1.16E+00**	4.36E-01
Mercury	5.51E-01	5.51E-02	1.31E-01	1.31E-02	**1.25E+02**	**1.25E+01**	**3.05E+00**	3.05E-01
Nickel	5.33E-03	3.86E-03	1.27E-03	9.20E-04	IEP	IEP	IEP	IEP
Tin	8.22E-02	3.31E-02	1.96E-02	7.89E-03	IEP	IEP	IEP	IEP
Vanadium	**1.39E+00**	1.39E-01	3.31E-01	3.31E-02	IEP	IEP	IEP	IEP
Zinc	6.82E-01	7.55E-02	1.63E-01	1.80E-02	IEP	IEP	IEP	IEP
Volatiles:								
Acetone	NC	NC	NC	NC	IEP	IEP	IEP	IEP
HI for Inorganics [1]:	**5.08E+00**	9.14E-01	**1.21E+00**	2.18E-01	**1.81E+02**	**2.49E+01**	**7.30E+00**	**1.36E+00**
HI for Volatiles [1]:	NA	NA	NA	NA	IEP	IEP	IEP	IEP

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

Notes:

NC = Not Calculated (an NOAEL was not available from the literature)
IEP = Incomplete Exposure Pathway (dietary intakes for this chemical were not evaluated)
HI = Hazard Index
NA = Not Applicable
NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level

[1] Hazard Index values calculated by summing the individual Hazard Quotient values.

TABLE 7-29

ECOLOGICAL COPCS IDENTIFIED BY THE SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

	Area A		Area B		Area C	
Receptor	Ecological COPC	Reason	Ecological COPC	Reason	Ecological COPC	Reason
Sediment Associated Biota	Copper	HQ > 1.0	Cobalt	HQ > 1.0	Barium	HQ > 1.0
	Vanadium	HQ > 1.0	Copper	HQ > 1.0	Cobalt	HQ > 1.0
	Beryllium	No Threshold Value	Lead	HQ > 1.0	Copper	HQ > 1.0
	Tin	No Threshold Value	Vanadium	HQ > 1.0	Vanadium	HQ > 1.0
	Acetone	No Threshold Value	Beryllium	No Threshold Value	Beryllium	No Threshold Value
			Tin	No Threshold Value	Tin	No Threshold Value
			Acetone	No Threshold Value	Acetone	No Threshold Value
			2-Butanone	No Threshold Value	2-Butanone	No Threshold Value
			Carbon disulfide	No Threshold Value	Carbon disulfide	No Threshold Value
Saltwater Aquatic Life	Arsenic	HQ > 1.0	Arsenic	HQ > 1.0	Arsenic	HQ > 1.0
	Barium	Limited Effect Data	Copper	HQ > 1.0	Chromium	HQ > 1.0
	Cobalt	Limited Effect Data	Cyanide	HQ > 1.0	Copper	HQ > 1.0
	Vanadium	Limited Effect Data	Nickel	HQ > 1.0	Lead	HQ > 1.0
	Tin	No Threshold Value	Barium	Limited Effect Data	Nickel	HQ > 1.0
			Cobalt	Limited Effect Data	Zinc	HQ > 1.0
			Vanadium	Limited Effect Data	Barium [(1)]	Limited Effect Data
			Beryllium	No Threshold Value	Cobalt	Limited Effect Data
			Tin	No Threshold Value	Vanadium [(1)]	Limited Effect Data
					Beryllium	No Threshold Value
					Tin	No Threshold Value
Plants	Chromium	HQ > 1.0	Chromium	HQ > 1.0	Chromium	HQ > 1.0
	Selenium	HQ > 1.0	Lead	HQ > 1.0	Lead	HQ > 1.0
	Acetone	No Threshold Value	Selenium	HQ > 1.0	Benzo(b)fluoranthene	No Threshold Value
	Benzyl Alcohol	No Threshold Value	Acetone	No Threshold Value	Crysene	No Threshold Value
					Pyrene	No Threshold Value
Earthworms	Chromium	HQ > 1.0	Chromium	HQ > 1.0	Chromium	HQ > 1.0
	Barium	No Threshold Value	Barium	No Threshold Value	Barium	No Threshold Value
	Silver	No Threshold Value	Acetone	No Threshold Value	Benzo(b)fluoranthene	No Threshold Value
	Acetone	No Threshold Value	Di-n-butylphthalate	No Threshold Value	Chrysene	No Threshold Value
	Benzyl alcohol	No Threshold Value			Di-n-butylphthalate	No Threshold Value
	Diethylphthalate	No Threshold Value			Pyrene	No Threshold Value

TABLE 7-29 (continued)

ECOLOGICAL COPCS IDENTIFIED BY THE SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

	Area A		Area B		Area C	
Receptor	Ecological COPC	Reason	Ecological COPC	Reason	Ecological COPC	Reason
Belted Kingfisher	Chromium	HQ > 1.0	Cadmium	HQ > 1.0	Barium	HQ > 1.0
	Mercury	HQ > 1.0	Chromium	HQ > 1.0	Cadmium	HQ > 1.0
	Selenium	HQ > 1.0	Lead	HQ > 1.0	Chromium	HQ > 1.0
	Vanadium	HQ > 1.0	Mercury	HQ > 1.0	Copper	HQ > 1.0
	Beryllium	No Threshold Value	Vanadium	HQ > 1.0	Lead	HQ > 1.0
	Cobalt	No Threshold Value	Zinc	HQ > 1.0	Mercury	HQ > 1.0
	Acetone	No Threshold Value	Antimony	No Threshold Value	Vanadium	HQ > 1.0
			Beryllium	No Threshold Value	Zinc	HQ > 1.0
			Cobalt	No Threshold Value	Beryllium	No Threshold Value
			Cyanide	No Threshold Value	Cobalt	No Threshold Value
			Acetone	No Threshold Value	Acetone	No Threshold Value
			2-Butanone	No Threshold Value	2-Butanone	No Threshold Value
			Carbon disulfide	No Threshold Value	Carbon disulfide	No Threshold Value
					Methylene chloride	No Threshold Value
Great Blue Heron	Selenium	HQ > 1.0	Antimony	No Threshold Value	Cadmium	HQ > 1.0
	Beryllium	No Threshold Value	Beryllium	No Threshold Value	Lead	HQ > 1.0
	Cobalt	No Threshold Value	Cobalt	No Threshold Value	Mercury	HQ > 1.0
	Acetone	No Threshold Value	Cyanide	No Threshold Value	Vanadium	HQ > 1.0
			Acetone	No Threshold Value	Zinc	HQ > 1.0
			2-Butanone	No Threshold Value	Beryllium	No Threshold Value
			Carbon disulfide	No Threshold Value	Cobalt	No Threshold Value
					Acetone	No Threshold Value
					2-Butanone	No Threshold Value
					Carbon disulfide	No Threshold Value
					Methylene chloride	No Threshold Value
American Robin	Barium	HQ > 1.0	Barium	HQ > 1.0	Barium	HQ > 1.0
	Chromium	HQ > 1.0	Cadmium	HQ > 1.0	Chromium	HQ > 1.0
	Lead	HQ > 1.0	Chromium	HQ > 1.0	Lead	HQ > 1.0
	Selenium	HQ > 1.0	Lead	HQ > 1.0	Benzo(b)fluoranthene	No Threshold Value
	Silver	No Threshold Value	Selenium	HQ > 1.0	Crysene	No Threshold Value
	Acetone	No Threshold Value	Acetone	No Threshold Value	Pyrene	No Threshold Value
	Benzyl Alcohol	No Threshold Value				
	Diethylphthalate	No Threshold Value				

TABLE 7-29 (continued)

ECOLOGICAL COPCS IDENTIFIED BY THE SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Receptor	Area A		Area B		Area C	
	Ecological COPC	Reason	Ecological COPC	Reason	Ecological COPC	Reason
Red-Tailed Hawk	Chromium	HQ > 1.0	Lead	HQ > 1.0	Chromium	HQ > 1.0
	Silver	No Threshold Value	Acetone	No Threshold Value	Lead	HQ > 1.0
	Acetone	No Threshold Value			Benzo(b)fluoranthene	No Threshold Value
	Benzyl Alcohol	No Threshold Value			Crysene	No Threshold Value
	Diethylphthalate	No Threshold Value			Pyrene	No Threshold Value

Notes:

HQ = Hazard Quotient

(1) In addition to lacking a conservative effect concentration, the maximum detected concentration exceeded the minimum literature-based acute effect concentration.

TABLE 7-30

LESS CONSERVATIVE BIOACCUMULATION FACTORS USED IN THE AMERICAN ROBIN AND RED-TAILED HAWK DIETARY INTAKE MODELS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Soil-Earthworm BAF	Soil-Small Mammal BAF
Inorganics (mg/kg):		
Arsenic	Log-Linear Model (1)	Log-Linear Model (5)
Barium	0.36 (2)	0.0566 (6)
Cadmium	Log-Linear Model (1)	Log-Linear Model (5)
Chromium	0.32 (3)	Log-Linear Model (5)
Lead	Log-Linear Model (1)	Log-Linear Model (5)
Mercury	Log-Linear Model (1)	0.0543 (6)
Selenium	Log-Linear Model (1)	Log-Linear Model (5)
Silver	1.0 (4)	1.0 (4)
Volatiles (ug/kg):		
Acetone	1.0 (4)	1.0 (4)
Semi-Volatiles (ug/kg):		
Benzo(b)fluoranthene	0.12 (2)	1.0 (4)
Benzyl Alcohol	1.0 (4)	1.0 (4)
Chrysene	0.20 (2)	1.0 (4)
Diethylphthalate	1.0 (4)	1.0 (4)
Di-n-buthylphthalate	1.0 (4)	1.0 (4)
Pyrene	0.34 (2)	1.0 (4)

Notes:

BAF = Bioaccumulation Factor

(1) A log-linear regression model (Sample et al. 1998b) was used to estimate the tissue concentration of this chemical in earthworms.

(2) The value shown is a median value from Beyer and Stafford (1993).

(3) The value shown is a median value from Sample et al. (1998b).

(4) A value was not available from the literature. The value shown is an assumed value.

(5) A log-linear regression model (Sample et al. 1998a) was used to estimate the tissue concentration of this chemical in small mammals.

(6) The value shown is a median value from Sample et al. (1998a).

TABLE 7-31

LESS CONSERVATIVE LIFE HISTORY PARAMETERS FOR THE AVIAN DIETARY INTAKE MODELS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Life History Parameters	Belted Kingfisher	Great Blue Heron	American Robin	Red-Tailed Hawk
Diet	100% Trophic Level 3 Fish	100 % Trophic Level 3 Fish	100% Earthwoms	100% Small Mammals
Body Weight	0.148 kg (1)	2.229 kg (5)	0.0773 kg (9)	1.126 kg (13)
Food Ingestion Rate	0.074 kg/day (2) (Dry Weight)	0.39289 kg/day (6) (Dry Weight)	0.01603 kg/day (10) (Dry Weight)	0.111474 kg/day (10) (Dry Weight)
Water Ingestion Rate	0.016403 L/day (3)	0.10095 L/day (7)	Not Applicable (11)	Not Applicable (7)
Percent Sediment/Soil in Diet	10% (4) (Dry Weight)	10% (8) (Dry Weight)	10.4% (12) (Dry Weight)	10% (11) (Dry Weight)

Notes:

(1) Average body weight reported by Powdermill Nature Center (unpublished data cited in EPA 1993b).

(2) Estimated from an ingestion rate of 0.5 g/g-day (Alexander 1977) and an average body weight of 0.148 kg (Powdermill Nature Center as cited in EPA 1993b).

(3) Estimated using an allometric equation for birds (Calder and Braun 1983) and an average body weight of 0.148 kg (unpublished data from Powdermill Nature Center as cited in EPA 1993b).

(4) Data was not available from the literature. The percentage shown represents a conservative estimate. Given a food ingestion rate of 0.074 kg/day, this percentage corresponds to a sediment ingestion rate of 0.0074 kg/day.

(5) Average body weight reported by Quinney (1982).

(6) Estimated using an allometric equation for wading birds (Kushlan 1978) and an average body weight of 2.229 kg (Quinney 1982).

(7) Estimated using an allometric equation for birds (Calder and Braun 1983) and an average body weight of 2.229 kg (Quinney 1982).

(8) Data was not available from the literature. The percentage shown represents a conservative estimate. Given a food ingestion rate of 0.39289 kg/day, this percentage corresponds to a sediment ingestion rate of 0.039289 kg/day.

(9) Average body weight reported by Clench and Leberman (1978).

(10) Estimated using an allometric equation for passerine birds (Nagy 1987) and an average body weight of 0.0773 kg (Clench and Leberman 1978).

(11) Not applicable, the surface water exposure pathway does not represent a complete exposure pathway for this receptor.

(12) Estimated from data for the American woodcock (Beyer et al. 1994). Given a food ingestion rate of 0.01603 kg/day, this percentage corresponds to a soil ingestion rate of 0.00167 kg/day.

TABLE 7-31 (continued)

LESS CONSERVATIVE LIFE HISTORY PARAMETERS FOR THE AVIAN DIETARY INTAKE MODELS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Notes (continued):

(13) Arithmatic average of mean male and female body weights reported by Craighead and Craighead (1956) as cited in EPA 1993b.

(14) Estimated using an arithmatic average (0.099 g/g-day) of mean ingestion rates reported by Craighead and Craighead (1956) as cited in EPA 1993b).

(15) Data was not available from the literature. The percentage shown represents a conservative estimate. Given a food ingestion rate of 0.111474 kg/day, this percentage corresponds to a surface soil ingestion rate of 0.0111474 kg/day.

TABLE 7-32

SEDIMENT HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR SEDIMENT-ASSOCIATED BIOTA FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS
SWMU 9 - AREA A (TANKS 212-213)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Average Concentration	Threshold Screening Value [1]	Hazard Quotient [2] (Unitless)
Inorganics (mg/kg):			
Arsenic	1.8	7.24	2.49E-01
Barium	14	48	2.92E-01
Beryllium	0.29	NE	NA
Chromium	21	52.3	4.02E-01
Cobalt	6.9	10	6.90E-01
Copper	63	18.7	**3.37E+00**
Lead	12	30.2	3.97E-01
Mercury	0.078	0.13	6.00E-01
Nickel	6.6	15.9	4.15E-01
Tin	4.3	NE	NA
Vanadium	180	57	**3.16E+00**
Zinc	64	124	5.16E-01
Volatiles (ug/kg):			
Acetone	130	NE	NA

Hazard Index for Inorganics [3]:	**1.01E+01**
Hazard Index for Volatile Organics [3]:	NA

Bold and shaded value indicates a Hazard Quotient or Hazard Index greater than 1.0

Notes:

NE = Not Established
NA = Not Applicable

[1] Sediment screening threshold values from MacDonald (1994) and Buchman (1999).

[2] Hazard Quotient values were calculated by dividing the average sediment concentration by the sediment screening threshold value.

[3] Hazard Index values calculated by summing the individual Hazard Quotient values.

TABLE 7-33

SURFACE WATER HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR SALTWATER AQUATIC LIFE FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS
SWMU 9 - AREA A (TANKS 212-213)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Average Concentration	Acute Threshold Screening Value [1][2]	Hazard Quotient [3] (Unitless)	Chronic Threshold Screening Value [1][2]	Hazard Quotient [3] (Unitless)
Inorganics (ug/L):					
Arsenic	38.3	69 [4]	5.55E-01	36 [4]	**1.06E+00**
Barium	50.5	NE	NA	NE	NA
Cadmium	0.7	42.3	1.65E-02	9.4	7.45E-02
Cobalt	0.96	NE	NA	NE	NA
Selenium	22.3	290.6	7.67E-02	71.1	3.14E-01
Tin	2.7	NE	NA	NE	NA
Vanadium	88.5	NE	NA	NE	NA
Zinc	6.3	95.1	6.62E-02	85.6	7.36E-02

Hazard Index for Inorganics [5]:	7.15E-01		**1.52E+00**

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

Notes:

CMC = Criteria Maximum Concentration
CCC = Criteria Continuous Concentration
NE = Not Established
NA = Not Applicable

(1) The values shown are saltwater NAWQC taken from EPA (1999d).

(2) Threshold screening values for metals are expressed as total recoverable concentrations.

(3) Hazard Quotient values were calculated by dividing the average surface water concentration by the surface water screening threshold value.

(4) The value shown is a criterion derived from data for trivalent arsenic, and applied to total arsenic (EPA 1999d).

(5) Hazard Index values were calculated by summing the individual Hazard Quotient values.

SURFACE SOIL HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR EARTHWORMS AND PLANTS FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS
SWMU 9 - AREA A (TANKS 212-213)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Average Concentration	Earthworms [1]		Plants [2]	
		Threshold Screening Value	Hazard Quotient [3] (unitless)	Threshold Screening Value	Hazard Quotient [3] (Unitless)
Inorganics (mg/kg):					
Arsenic	1.8	60	3.00E-02	10	1.80E-01
Barium	118	NE	NA	500	2.36E-01
Chromium	15.7	0.4	**3.93E+01**	1	**1.57E+01**
Lead	9.1	500	1.82E-02	50	1.82E-01
Selenium	0.66	70	9.43E-03	1	6.60E-01
Silver	0.21	NE	NA	2	1.05E-01
Volatiles (ug/kg):					
Acetone	7.3	NE	NA	NE	NA
Semi-Volatiles (ug/kg):					
Benzyl Alcohol	250	NE	NA	NE	NA
Diethylphthalate [4]	40	NE	NA	100,000	4.00E-04

Hazard Index for Inorganics [5]:	**3.93E+01**		**1.71E+01**
Hazard Index for Volatile Organics [5]:	NA		NA
Hazard Index for Semi-Volatile Organics [5]:	NA		4.00E-04

Bold and shaded value indicates a Hazard Quotient or Hazard Index greater than 1.0

Notes:

NE = Not Established NA = Not Applicable

(1) Surface soil screening threshold values from Efroymson et al. (1997a).

(2) Surface soil screening threshold values from Efroymson et al. (1997b).

(3) Hazard Quotient values were calculated by dividing the average surface soil concentration by the surface soil screening threshold value

(4) This chemical was detected in a single sample below the laboratory reporting limit; therefore, an average concentration was not calculated. The concentration shown represents the detected result.

(5) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-35

DIETARY INTAKE HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR AVIAN RECEPTORS FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS
SWMU 9 - AREA A (TANKS 212-213)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Hazard Quotient Values for Area A Avian Receptors (Unitless)							
	Belted Kingfisher		Great Blue Heron		American Robin		Red-Tailed Hawk	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Inorganics:								
Arsenic	1.71E-01	5.69E-02	6.03E-02	2.01E-02	4.66E-02	1.55E-02	7.76E-03	2.59E-03
Barium	1.49E-01	7.44E-02	5.26E-02	2.63E-02	5.46E-01	2.72E-01	8.80E-02	4.39E-02
Beryllium	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Cadmium	5.34E-01	3.87E-02	1.88E-01	1.37E-02	IEP	IEP	IEP	IEP
Chromium	**1.05E+00**	2.10E-01	3.70E-01	7.40E-02	**1.38E+00**	2.76E-01	3.29E-01	6.57E-02
Cobalt	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Copper	6.70E-02	5.11E-02	2.36E-02	1.80E-02	IEP	IEP	IEP	IEP
Lead	5.31E-01	5.31E-02	1.87E-01	1.87E-02	**1.05E+00**	3.96E-01	3.31E-01	1.25E-01
Mercury	6.09E-01	6.09E-02	2.15E-01	2.15E-02	IEP	IEP	IEP	IEP
Nickel	4.26E-03	3.08E-03	1.50E-03	1.09E-03	IEP	IEP	IEP	IEP
Selenium	**1.61E+01**	**2.46E+00**	**5.68E+00**	8.66E-01	3.90E-01	1.95E-01	1.42E-01	4.16E-02
Silver	IEP	IEP	IEP	IEP	NC	NC	NC	NC
Tin	4.85E-02	1.95E-02	1.71E-02	6.89E-03	IEP	IEP	IEP	IEP
Vanadium	**1.38E+00**	1.38E-01	4.88E-01	4.88E-02	IEP	IEP	IEP	IEP
Zinc	4.31E-01	4.77E-02	1.52E-01	1.68E-02	IEP	IEP	IEP	IEP
Volatiles:								
Acetone	NC	NC	NC	NC	NC	NC	NC	NC
Semi-Volatiles:								
Benzyl Alcohol	IEP	IEP	IEP	IEP	NC	NC	NC	NC
Diethylphthalate	IEP	IEP	IEP	IEP	NC	NC	NC	NC

HI for Inorganics (1):	**2.11E+01**	**3.21E+00**	**7.43E+00**	**1.13E+00**	**3.41E+00**	**1.16E+00**	8.97E-01	2.78E-01
HI for Volatiles (1):	NA	NA	NA	NA	NA	NA	NA	NA
HI for Semi-Volatiles (1):	NA	NA	NA	NA	NA	NA	NA	NA

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

TABLE 7-35 (continued)

DIETARY INTAKE HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR AVIAN RECEPTORS FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS
SWMU 9 - AREA A (TANKS 212-213)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Notes:

NC = Not Calculated (an NOAEL was not available from the literature)
IEP = Incomplete Exposure Pathway (dietary intakes for this chemical were not evaluated)
HI = Hazard Index
NA = Not Applicable
NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level

(1) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-36

SEDIMENT HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR SEDIMENT-ASSOCIATED BIOTA FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS
SWMU 9 - AREA B (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Average Concentration	Threshold Screening Value [1]	Hazard Quotient [2] (Unitless)
Inorganics (mg/kg):			
Arsenic	1.2	7.24	1.66E-01
Barium	16.3	48	3.40E-01
Beryllium	0.14	NE	NA
Cadmium	0.11	0.676	1.63E-01
Chromium	25.7	52.3	4.91E-01
Cobalt	9.4	10	9.40E-01
Copper	100	18.7	**5.35E+00**
Lead	25.4	30.2	8.41E-01
Mercury	0.09	0.13	6.92E-01
Nickel	8.2	15.9	5.16E-01
Tin	4.2	NE	NA
Vanadium	157	57	**2.75E+00**
Zinc	53.7	124	4.33E-01
Volatiles (ug/kg):			
Acetone	157	NE	NA
2-Butanone	32.7	NE	NA
Carbon disulfide	6.7	NE	NA

Hazard Index for Inorganics [3]:	**1.27E+01**
Hazard Index for Volatile Organics [3]:	NA

Bold and shaded value indicates a Hazard Quotient or Hazard Index greater than 1.0

Notes:

NE = Not Established
NA = Not Applicable

[1] Sediment screening threshold values from MacDonald (1994) and Buchman (1999).

[2] Hazard Quotient values were calculated by dividing the average sediment concentration by the sediment screening threshold value.

[3] Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-37

SURFACE WATER HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR SALTWATER AQUATIC LIFE FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS
SWMU 9 - AREA B (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Average Concentration	Acute Threshold Screening Value [1][2]	Hazard Quotient [3] (Unitless)	Chronic Threshold Screening Value [1][2]	Hazard Quotient [3] (Unitless)
Inorganics (ug/L):					
Antimony	6.4	1,500 [4]	4.27E-03	500 [4]	1.28E-02
Arsenic	30.3	69 [5]	4.39E-01	36 [5]	8.42E-01
Barium	56.7	NE	NA	NE	NA
Beryllium	0.3	NE	NA	NE	NA
Cadmium	1.2	42.3	2.84E-02	9.4	1.28E-01
Chromium	6.8	1,108 [6]	6.14E-03	50.3 [6]	1.35E-01
Cobalt	4.0	NE	NA	NE	NA
Copper	42.2	5.8	**7.28E+00**	3.7	**1.14E+01**
Cyanide	5.4	1.0	**5.40E+00**	1.0	**5.40E+00**
Lead	3.3	220.8	1.49E-02	8.5	3.88E-01
Nickel	6.3	74.7	8.43E-02	8.3	7.59E-01
Tin	6.0	NE	NA	NE	NA
Vanadium	92.4	NE	NA	NE	NA
Zinc	20.6	95.1	2.17E-01	85.6	2.41E-01

Hazard Index for Inorganics [7]:	**1.35E+01**		**1.93E+01**

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

Notes:

CMC = Criteria Maximum Concentration
CCC = Criteria Continuous Concentration
NE = Not Established
NA = Not Applicable

(1) The values shown are saltwater NAWQC taken from EPA (1999d) unless otherwise noted.

(2) Threshold screening values metals are expressed as total recoverable concentrations.

(3) Hazard Quotient values were calculated by dividing the average surface water concentration by the surface water screening threshold value.

(4) The value shown is a proposed saltwater criterion reported by Buchman (1999).

(5) The value shown is a EPA NAWQC derived from data for trivalent arsenic, and applied to total arsenic (EPA 1999d).

(7) The value shown is a EPA NAWQC for hexavalent chromium.

(8) Hazard Index values calculated by summing the individual Hazard Quotient values.

TABLE 7-38

SURFACE SOIL HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR EARTHWORMS AND PLANTS FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS
SWMU 9 - AREA B (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Average Concentration	Earthworms [1]		Plants [2]	
		Threshold Screening Value	Hazard Quotient [3] (unitless)	Threshold Screening Value	Hazard Quotient [3] (Unitless)
Inorganics (mg/kg):					
Arsenic	1.7	60	2.78E-02	10	1.67E-01
Barium	85.4	NE	NE	500	1.71E-01
Cadmium	0.21	30	7.00E-03	4	5.25E-02
Chromium	10.7	0.4	**2.68E+01**	1.0	**1.07E+01**
Lead	101	500	2.02E-01	50	**2.02E+00**
Selenium	0.72	70	1.03E-02	1.0	7.20E-01
Volatiles (ug/kg):					
Acetone	22	NE	NA	NE	NA
Semi-Volatiles (ug/kg):					
Di-n-butylphthalate [4]	40	NE	NA	200,000	2.00E-04

Hazard Index for Inorganics [5]:	**2.70E+01**		**1.38E+01**
Hazard Index for Volatile Organics [5]:	NA		NA
Hazard Index for Semi-Volatile Organics [5]:	NA		2.00E-04

Bold and shaded value indicates a Hazard Quotient or Hazard Index greater than 1.0

Notes:

NE = Not Established NA = Not Applicable

(1) Surface soil screening threshold values from Efroymson et al. (1997a).

(2) Surface soil screening threshold values from Efroymson et al. (1997b).

(3) Hazard Quotient values were calculated by dividing the average surface soil concentration by the surface soil threshold screening value.

(4) This chemical was detected in a single sample below the laboratory reporting limit; therefore, an average concentration was not calculated. The concentration shown represents the detected result.

(5) Hazard Index values calculated by summing the individual Hazard Quotient values.

TABLE 7-39

DIETARY INTAKE HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR AVIAN RECEPTORS FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS
SWMU 9 - AREA B (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Hazard Quotient Values for Area B Avian Receptors (Unitless)							
	Belted Kingfisher		Great Blue Heron		American Robin		Red-Tailed Hawk	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Inorganics:								
Antimony	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Arsenic	1.30E-01	4.35E-02	4.58E-02	1.53E-02	4.39E-02	1.46E-02	7.20E-03	2.40E-03
Barium	1.69E-01	8.43E-02	5.96E-02	2.97E-02	3.95E-01	1.97E-01	6.37E-02	3.18E-02
Beryllium	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Cadmium	9.20E-01	6.67E-02	3.24E-01	2.35E-02	3.46E-01	2.51E-02	2.22E-02	1.61E-03
Chromium	**1.30E+00**	2.59E-01	4.57E-01	9.14E-02	9.41E-01	1.88E-01	2.37E-01	4.73E-02
Cobalt	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Copper	2.37E-01	1.80E-01	8.34E-02	6.36E-02	IEP	IEP	IEP	IEP
Cyanide	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Lead	**1.19E+00**	1.19E-01	4.21E-01	4.21E-02	**8.05E+00**	**3.03E+00**	**1.61E+00**	6.07E-01
Mercury	7.03E-01	7.03E-02	2.48E-01	2.48E-02	IEP	IEP	IEP	IEP
Nickel	9.62E-03	6.96E-03	3.39E-03	2.45E-03	IEP	IEP	IEP	IEP
Selenium	IEP	IEP	IEP	IEP	4.17E-01	1.67E-03	1.47E-01	4.32E-02
Tin	6.85E-02	2.76E-02	2.41E-02	9.72E-03	IEP	IEP	IEP	IEP
Vanadium	**1.31E+00**	1.31E-01	4.62E-01	4.62E-02	IEP	IEP	IEP	IEP
Zinc	8.72E-01	9.65E-02	3.07E-01	3.40E-02	IEP	IEP	IEP	IEP
Volatiles:								
Acetone	NC	NC	NC	NC	NC	NC	NC	NC
2-Butanone	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Carbon disulfide	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Semi-Volatiles:								
Di-n-butylphthalate	IEP	IEP	IEP	IEP	8.33E-02	8.33E-03	3.96E-02	3.96E-03
HI for Inorganics (1):	**6.90E+00**	**1.09E+00**	**2.44E+00**	3.83E-01	**1.02E+01**	**3.46E+00**	**2.09E+00**	7.34E-01
HI for Volatiles (1):	NA	NA	NA	NA	NA	NA	NA	NA
HI for Semi-Volatiles (1):	NA	NA	NA	NA	8.33E-02	8.33E-03	3.96E-02	3.96E-03

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

TABLE 7-39 (continued)

DIETARY INTAKE HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR AVIAN RECEPTORS FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS
SWMU 9 - AREA B (TANKS 214-215)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Notes:

NC = Not Calculated (an NOAEL was not available from the literature)
IEP = Incomplete Exposure Pathway (dietary intakes for this chemical were not evaluated)
HI = Hazard Index
NA = Not Applicable
NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level

(1) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-40

SEDIMENT HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR SEDIMENT-ASSOCIATED BIOTA FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS
SWMU 9 - AREA C (TANKS 216-217)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Average Concentration	Threshold Screening Value [1]	Hazard Quotient [2] (Unitless)
Inorganics (mg/kg):			
Arsenic	3.5	7.24	4.83E-01
Barium	54.5	48	**1.14E+00**
Beryllium	0.087	NE	NA
Chromium	19.6	52.3	3.75E-01
Cobalt	14.8	10	**1.48E+00**
Copper	38.5	18.7	**2.06E+00**
Lead	15.1	30.2	5.00E-01
Mercury	0.032	0.13	2.46E-01
Nickel	5.7	15.9	3.58E-01
Selenium	0.44	1.0	4.40E-01
Tin	4.8	NE	NA
Vanadium	123	57	**2.16E+00**
Zinc	31	124	2.50E-01
Volatiles (ug/kg):			
Acetone	182	NE	NA
2-Butanone	49.8	NE	NA
Carbon disulfide	13	NE	NA

Hazard Index for Inorganics [3]:	**9.48E+00**
Hazard Index for Volatile Organics [3]:	NA

Bold and shaded value indicates a Hazard Quotient or Hazard Index greater than 1.0

Notes:

NE = Not Established
NA = Not Applicable

[1] Sediment screening threshold values from MacDonald (1994) and Buchman (1999).

[2] Hazard Quotient values were calculated by dividing the average sediment concentration by the sediment screening threshold value.

[3] Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-41

SURFACE WATER HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR SALTWATER AQUATIC LIFE FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS
SWMU 9 - AREA C (TANKS 216-217)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Average Concentration	Acute Threshold Screening Value [1][2]	Hazard Quotient [3] (Unitless)	Chronic Threshold Screening Value [1][2]	Hazard Quotient [3] (Unitless)
Inorganics (ug/L):					
Arsenic	34.8	69 [4]	5.04E-01	36 [4]	9.67E-01
Barium	308	NE	NA	NE	NA
Beryllium	2.4	NE	NA	NE	NA
Cadmium	2.3	42.3	5.44E-02	9.4	2.45E-01
Chromium	129	1,108 [5]	1.16E-01	50.3 [5]	**2.56E+00**
Cobalt	113	NE	NA	NE	NA
Copper	379	5.8	**6.53E+01**	3.7	**1.02E+02**
Lead	105	220.8	4.76E-01	8.5	**1.24E+01**
Mercury	0.55	2.1 [6]	2.62E-01	1.1 [6]	5.00E-01
Nickel	58.5	74.7	7.83E-01	8.3	**7.05E+00**
Tin	12.3	NE	NA	NE	NA
Vanadium	865	NE	NA	NE	NA
Zinc	336	95.1	**3.53E+00**	85.6	**3.93E+00**
Volatiles (ug/L):					
Methylene Chloride	2.7	12,000 [7]	2.25E-04	6,400 [7]	4.22E-04

Hazard Index for Inorganics [8]:	**7.11E+01**		**1.30E+02**
Hazard Index for Volatile Organics [8]:	2.25E-04		4.22E-04

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

Notes:

CMC = Criteria Maximum Concentration
CCC = Criteria Continuous Concentration
NE = Not Established
NA = Not Applicable

(1) The values shown are saltwater NAWQC taken from EPA (1999d) unless otherwise noted.

(2) Threshold screening values for metals are expressed as total recoverable concentrations.

(3) Hazard Quotient values were calculated by dividing the average surface water concentration by the surface water screening threshold value.

(4) The value shown is a EPA NAWQC derived from data for trivalent arsenic, and applied to total arsenic (EPA 1999d).

(5) The value shown is a EPA NAWQC for hexavalent chromium.

(6) The value shown is a EPA NAWQC derived from data for inorganic mercury (II), and applied to total mercury (EPA 1999d).

(7) The value shown is a minimum No Observed Effect Concentration for saltwater aquatic life reported by Buchman (1999).

(8) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-42

SURFACE SOIL HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR EARTHWORMS AND PLANTS FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS
SWMU 9 - AREA C (TANKS 216-217)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Average Concentration	Earthworms [1]		Plants [2]	
		Threshold Screening Value	Hazard Quotient [3] (unitless)	Threshold Screening Value	Hazard Quotient [3] (Unitless)
Inorganics (mg/kg):					
Barium	74.1	NE	NA	500	1.48E-01
Chromium	24.4	0.4	**6.10E+01**	1	**2.44E+01**
Lead	25.4	500	5.08E-02	50	5.08E-01
Semi-Volatiles (ug/kg):					
Benzo(b)fluoranthene [4]	59	NE	NA	NE	NA
Chrysene [4]	45	NE	NA	NE	NA
Di-n-butylphthalate [4]	100	NE	NA	200,000	5.00E-04
Pyrene [4]	56	NE	NA	NE	NA

Hazard Index for Inorganics [5]:		**6.11E+01**		**2.51E+01**
Hazard Index for Semi-Volatile Organics [5]:		NA		5.00E-04

Bold and shaded value indicates a Hazard Quotient or Hazard Index greater than 1.0

Notes:

NE = Not Established
NA = Not Applicable

(1) Surface soil screening threshold values from Efroymson et al. (1997a).

(2) Surface soil screening threshold values from Efroymson et al. (1997b).

(3) Hazard Quotient values were calculated by dividing the average surface soil concentration by the surface soil threshold screening value.

(4) This chemical was detected in a single sample below the laboratory reporting limit; therefore, an average concentration was not calculated. The concentration shown represents the detected result.

(5) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-43

DIETARY INTAKE HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR AVIAN RECEPTORS FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS
SWMU 9 - AREA C (TANKS 216-217)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Hazard Quotient Values for Area C Avian Receptors (Unitless)							
	Belted Kingfisher		Great Blue Heron		American Robin		Red-Tailed Hawk	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Inorganics:								
Arsenic	1.93E-01	6.43E-02	6.77E-02	2.26E-02	IEP	IEP	IEP	IEP
Barium	8.36E-01	4.17E-01	2.94E-01	1.47E-01	3.43E-01	1.71E-01	5.52E-02	2.75E-02
Beryllium	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Cadmium	**1.76E+00**	1.27E-01	6.12E-01	4.44E-02	IEP	IEP	IEP	IEP
Chromium	**1.19E+00**	2.38E-01	4.20E-01	8.39E-02	**2.15E+00**	4.29E-01	4.81E-01	9.62E-02
Cobalt	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Copper	**1.21E+00**	9.23E-01	4.26E-01	3.25E-01	IEP	IEP	IEP	IEP
Lead	**2.77E+00**	2.77E-01	9.80E-01	9.80E-02	**2.49E+00**	9.39E-01	6.18E-01	2.33E-01
Mercury	**1.20E+03**	**1.20E+02**	**4.19E+02**	**4.19E+01**	IEP	IEP	IEP	IEP
Nickel	4.38E-02	3.17E-02	1.54E-02	1.12E-02	IEP	IEP	IEP	IEP
Selenium	1.22E-02	1.86E-03	4.31E-03	6.57E-04	IEP	IEP	IEP	IEP
Tin	1.12E-01	4.52E-02	3.94E-02	1.58E-02	IEP	IEP	IEP	IEP
Vanadium	**6.35E+00**	6.35E-01	**2.24E+00**	2.24E-01	IEP	IEP	IEP	IEP
Zinc	**1.13E+01**	**1.25E+00**	**3.98E+00**	4.40E-01	IEP	IEP	IEP	IEP
Volatiles:								
Acetone	NC	NC	NC	NC	IEP	IEP	IEP	IEP
2-Butanone	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Carbon disulfide	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Methylene chloride	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Semi-Volatiles:								
Benzo(b)fluoranthene	IEP	IEP	IEP	IEP	NC	NC	NC	NC
Chrysene	IEP	IEP	IEP	IEP	NC	NC	NC	NC
Di-n-butylphthalate	IEP	IEP	IEP	IEP	2.08E-01	2.08E-02	9.90E-02	9.90E-03
Pyrene	IEP	IEP	IEP	IEP	NC	NC	NC	NC

HI for Inorganics (1):	**1.22E+03**	**1.24E+02**	**4.28E+02**	**4.33E+01**	**4.98E+00**	**1.54E+00**	**1.15E+00**	3.56E-01
HI for Volatiles (1):	NA	NA	NA	NA	NA	NA	NA	NA
HI for Semi-Volatiles (1):	NA	NA	NA	NA	2.08E-01	2.08E-02	9.90E-02	9.90E-03

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

TABLE 7-43 (continued)

DIETARY INTAKE HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR AVIAN RECEPTORS FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS
SWMU 9 - AREA C (TANKS 216-217)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Notes:

NC = Not Calculated (an NOAEL was not available from the literature)
IEP = Incomplete Exposure Pathway (dietary intakes for this chemical were not evaluated)
HI = Hazard Index
NA = Not Applicable
NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level

(1) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-44

BACKGROUND SEDIMENT HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR SEDIMENT-ASSOCIATED BIOTA FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Average Concentration	Threshold Screening Value [1]	Hazard Quotient [2] (Unitless)
Inorganics (mg/kg):			
Arsenic	1.3	7.24	1.80E-01
Barium	8.1	48	1.69E-01
Beryllium	0.047	NE	NA
Chromium	16	52.3	3.06E-01
Cobalt	4.7	10	4.70E-01
Copper	58	18.7	**3.10E+00**
Lead	4.6	30.2	1.52E-01
Mercury	0.041	0.13	3.15E-01
Nickel	4.8	15.9	3.02E-01
Tin	4.2	NE	NA
Vanadium	110	57	**1.93E+00**
Volatiles (ug/kg):			
Acetone	140	NE	NA

Hazard Index for Inorganics [3]:	**6.93E+00**
Hazard Index for Volatile Organics [3]:	NA

Bold and shaded value indicates a Hazard Quotient or Hazard Index greater than 1.0

Notes:

NE = Not Established
NA = Not Applicable

(1) Sediment screening threshold values from MacDonald (1994) and Buchman (1999).

(2) Hazard Quotient values were calculated by dividing the average sediment concentration by the sediment screening threshold value.

(3) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-45

BACKGROUND SURFACE WATER HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR SALTWATER AQUATIC LIFE FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Average Concentration	Acute Threshold Screening Value (1)(2)	Hazard Quotient (3) (Unitless)	Chronic Threshold Screening Value (1)(2)	Hazard Quotient (3) (Unitless)
Inorganics (ug/L):					
Arsenic	35.1	69 (4)	5.09E-01	36 (4)	9.75E-01
Barium	55.9	189 (5)	2.96E-01	NE	NA
Chromium	9.1	1,108 (6)	8.21E-03	50.3 (5)	1.81E-01
Cobalt	3.2	4,500 (5)	7.11E-04	NE	NA
Tin	2.7	NE	NA	NE	NA
Vanadium	48.4	620 (5)	7.81E-02	NE	NA
Zinc	11.9	95.1	1.25E-01	85.6	1.39E-01
Hazard Index for Inorganics (7):			**1.02E+00**		**1.29E+00**

Bold and shaded values indicate a Hazard Index or Hazard Quotient greater than 1.0

Notes:

CMC = Criteria Maximum Concentration
CCC = Criteria Continuous Concentration
NE = Not Established
NA = Not Applicable

(1) The values shown are EPA NAWQC unless otherwise noted.

(2) Threshold screening values for metals are expressed as total recoverable concentrations.

(3) Hazard Quotient values were calculated by dividing the average surface water concentration by the surface water screening threshold value.

(4) The value shown is a EPA NAWQC derived from data for trivalent arsenic, and applied to total arsenic (EPA 1999d).

(5) The value shown is a minimum acute effect concentration taken from the EPA AQUIRE database.

(6) The value shown is a EPA NAWQC for hexavalent chromium.

(7) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-46

BACKGROUND SURFACE SOIL HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR EARTHWORMS AND PLANTS FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical [1]	Average Concentration	Earthworms [2]		Plants [3]	
		Threshold Screening Value	Hazard Quotient [4] (unitless)	Threshold Screening Value	Hazard Quotient [4] (Unitless)
Inorganics (mg/kg):					
Arsenic	1.9	60	3.17E-02	10	1.90E-01
Barium	76.4	NE	NA	500	1.53E-01
Cadmium	0.24	30	8.00E-03	4	6.00E-02
Chromium	19.5	0.4	**4.88E+01**	1	**1.95E+01**
Lead	10.5	500	2.10E-02	50	2.10E-01
Mercury	0.062	0.1	6.20E-01	0.3	2.07E-01
Hazard Index for Inorganics [5]:			**4.94E+01**		**2.03E+01**

Notes:

Bold and shaded value indicate a Hazard Quotient greater than 1.0

NE = Not Established
NA = Not Applicable

(1) The chemicals shown are those detected in background surface soil samples and analyzed for in the SWMU 9 surface soil samples.

(2) Surface soil screening threshold values from Efroymson et al. (1997a).

(3) Surface soil screening threshold values from Efroymson et al. (1997b).

(4) Hazard Quotient values were calculated by dividing the average surface soil concentration by the surface soil threshold screening value.

(5) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-47

BACKGROUND DIETARY INTAKE HAZARD QUOTIENT AND HAZARD INDEX VALUES FOR AVIAN RECEPTORS FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Hazard Quotient Values for Background Avian Receptors (Unitless)							
	Belted Kingfisher		Great Blue Heron		American Robin		Red-Tailed Hawk	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Inorganics:								
Arsenic	1.49E-01	4.98E-02	5.27E-02	1.76E-02	4.87E-02	1.62E-02	8.18E-03	2.73E-03
Barium	1.47E-01	7.35E-02	5.20E-02	2.59E-02	3.54E-01	1.76E-01	5.69E-02	2.84E-02
Beryllium	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Cadmium	IEP	IEP	IEP	IEP	3.84E-01	2.78E-02	2.38E-02	1.73E-03
Chromium	8.15E-01	1.63E-01	2.87E-01	5.75E-02	**1.72E+00**	3.43E-01	3.96E-01	7.93E-02
Cobalt	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Copper	6.17E-02	4.70E-02	2.18E-02	1.66E-02	IEP	IEP	IEP	IEP
Lead	2.04E-01	2.04E-02	7.18E-02	7.18E-03	**1.19E+00**	4.50E-01	3.59E-01	1.35E-01
Mercury	3.20E-01	3.20E-02	1.13E-01	1.13E-02	**1.39E+01**	**1.39E+00**	1.48E-01	1.48E-02
Nickel	3.10E-03	2.24E-03	1.09E-03	7.91E-04	IEP	IEP	IEP	IEP
Tin	4.78E-02	1.92E-02	1.69E-02	6.78E-03	IEP	IEP	IEP	IEP
Vanadium	8.08E-01	8.08E-02	2.85E-01	2.85E-02	IEP	IEP	IEP	IEP
Zinc	3.96E-01	4.39E-02	1.40E-01	1.55E-02	IEP	IEP	IEP	IEP
Volatiles:								
Acetone	NC	NC	NC	NC	IEP	IEP	IEP	IEP
HI for Inorganics [1]:	**2.95E+00**	5.32E-01	**1.04E+00**	1.88E-01	**1.76E+01**	**2.41E+00**	9.93E-01	2.62E-01
HI for Volatiles [1]:	NA	NA	NA	NA	IEP	IEP	IEP	IEP

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

Notes:

NC = Not Calculated (an NOAEL was not available from the literature)
IEP = Incomplete Exposure Pathway (dietary intakes for this chemical were not evaluated)
HI = Hazard Index
NA = Not Applicable
NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level

[1] Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-48

COMPARISON OF SWMU 9, AREA A, B, AND C HAZARD QUOTIENT AND HAZARD INDEX VALUES TO BACKGROUND HAZARD QUOTIENT AND HAZARD INDEX VALUES FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS: SEDIMENT-ASSOCIATED BIOTA
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Hazard Quotient Values for Sediment-Associated Biota (Unitless)			
	Area A	Area B	Area C	Background
Inorganics (mg/kg):				
Arsenic	2.49E-01	1.66E-01	4.83E-01	1.80E-01
Barium	2.92E-01	3.40E-01	**1.14E+00**	1.69E-01
Beryllium	NC	NC	NC	NC
Cadmium	IEP	1.63E-01	IEP	IEP
Chromium	4.02E-01	4.91E-01	3.75E-01	3.06E-01
Cobalt	6.90E-01	9.40E-01	**1.48E+00**	4.70E-01
Copper	**3.37E+00**	**5.35E+00**	**2.06E+00**	**3.10E+00**
Lead	3.97E-01	8.41E-01	5.00E-01	1.52E-01
Mercury	6.00E-01	6.92E-01	2.46E-01	3.15E-01
Nickel	4.15E-01	5.16E-01	3.58E-01	3.02E-01
Selenium	IEP	IEP	4.40E-01	IEP
Tin	NC	NC	NC	NC
Vanadium	**3.16E+00**	**2.75E+00**	**2.16E+00**	**1.93E+00**
Zinc	5.16E-01	4.33E-01	2.50E-01	IEP
Volatiles (ug/kg):				
Acetone	NC	NC	NC	NC
2-Butanone	IEP	NC	NC	IEP
Carbon disulfide	IEP	NC	NC	IEP

HI for Inorganics (2):	**1.01E+01**	**1.27E+01**	**9.48E+00**	**6.93E+00**
HI for Volatiles (2):	NA	NA	NA	NA

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

Notes:

NC = Not Calculated (a threshold screening value was not available from the literature)
IEP = Incomplete Exposure Pathway
HI = Hazard Index
NA = Not Applicable

(1) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-49

COMPARISON OF SWMU 9, AREA A, B, AND C HAZARD QUOTIENT AND HAZARD INDEX VALUES TO BACKGROUND HAZARD QUOTIENT AND HAZARD INDEX VALUES FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS: SALTWATER AQAUTIC LIFE
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Hazard Quotient Values for Saltwater Aquatic Life (Unitless) [1]			
	Area A	Area B	Area C	Background
Inorganics (mg/kg):				
Antimony	IEP	1.28E-02	IEP	IEP
Arsenic	**1.06E+00**	8.42E-01	9.67E-01	9.75E-01
Barium	NC	NC	NC	NC
Beryllium	IEP	NC	NC	IEP
Cadmium	7.45E-02	1.28E-01	2.45E-01	IEP
Chromium	IEP	1.35E-01	**2.56E+00**	1.81E-01
Cobalt	NC	NC	NC	NC
Copper	IEP	**1.14E+01**	**1.02E+02**	IEP
Cyanide	IEP	**5.40E+00**	IEP	IEP
Lead	IEP	3.88E-01	**1.24E+01**	IEP
Mercury	IEP	IEP	5.00E-01	IEP
Nickel	IEP	7.59E-01	**7.05E+00**	IEP
Selenium	3.14E-01	IEP	IEP	IEP
Tin	NC	NC	NC	NC
Vanadium	NC	NC	NC	NC
Zinc	7.36E-02	2.41E-01	**3.93E+00**	1.39E-01
Volatiles (ug/kg):				
Methylene chloride	IEP	IEP	4.22E-04	IEP

HI for Inorganics [1]:	**1.52**	**19.3**	**1.3**	**1.29**
HI for Volatiles [1]:	NA	NA	4.22E-04	NA

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

Notes:

NC = Not Calculated (a threshold screening value was not available from the literature)
IEP = Incomplete Exposure Pathway
HI = Hazard Index
NA = Not Applicable

[1] Hazard Quotient values are based on chronic threshold screening values.

[2] Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-50

COMPARISON OF SWMU 9, AREA A, B, AND C HAZARD QUOTIENT AND HAZARD INDEX VALUES TO BACKGROUND HAZARD QUOTIENT AND HAZARD INDEX VALUES FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS: EARTHWORMS AND PLANTS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Hazard Quotient Values for Soil Organisms (Unitless)							
	Area A		Area B		Area C		Background	
	Earthworms	Plants	Earthworms	Plants	Earthworms	Plants	Earthworms	Plants
Inorganics (mg/kg):								
Arsenic	3.00E-02	1.80E-01	2.78E-02	1.67E-01	IEP	IEP	3.17E-02	1.90E-01
Barium	NC	2.36E-01	NC	1.71E-01	NC	1.48E-01	NC	1.53E-01
Beryllium	IEP	IEP	IEP	IEP	IEP	IEP	IEP	IEP
Cadmium	IEP	IEP	7.00E-03	5.25E-02	IEP	IEP	8.00E-03	6.00E-02
Chromium	**3.93E+01**	**1.57E+01**	**2.68E+01**	**1.07E+01**	**6.10E+01**	**2.44E+01**	**4.88E+01**	**1.95E+01**
Cobalt	IEP	IEP	IEP	IEP	IEP	IEP	IEP	IEP
Copper	IEP	IEP	IEP	IEP	IEP	IEP	IEP	IEP
Lead	1.82E-02	1.82E-01	2.02E-01	**2.02E+00**	5.08E-02	5.08E-01	2.10E-02	2.10E-01
Mercury	IEP	IEP	IEP	IEP	IEP	IEP	6.20E-01	2.07E-01
Nickel	IEP	IEP	IEP	IEP	IEP	IEP	IEP	IEP
Selenium	9.43E-03	6.60E-01	1.03E-02	7.20E-01	IEP	IEP	IEP	IEP
Silver	NC	1.05E-01	IEP	IEP	IEP	IEP	IEP	IEP
Tin	IEP	IEP	IEP	IEP	IEP	IEP	IEP	IEP
Vanadium	IEP	IEP	IEP	IEP	IEP	IEP	IEP	IEP
Zinc	IEP	IEP	IEP	IEP	IEP	IEP	IEP	IEP
Volatiles (ug/kg):								
Acetone	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Semi-Volatiles (ug/kg):								
Benzo(b)fluoranthene	IEP	IEP	IEP	IEP	NC	NC	IEP	IEP
Benzyl Alcohol	NC	NC	IEP	IEP	IEP	IEP	IEP	IEP
Chrysene	IEP	IEP	IEP	IEP	NC	NC	IEP	IEP
Diethylphthalate	NC	4.00E-04	IEP	IEP	IEP	IEP	IEP	IEP
Di-n-buthylphthalate	IEP	IEP	NC	2.00E-04	NC	5.00E-04	IEP	IEP
Pyrene	IEP	IEP	IEP	IEP	NC	NC	IEP	IEP

HI for Inorganics (1):	**3.93E+01**	**1.71E+01**	**2.70E+01**	**1.38E+01**	**6.11E+01**	**2.51E+01**	**4.94E+01**	**2.03E+01**
HI for Volatiles (1):	NA	NA	NA	NA	IEP	IEP	IEP	IEP
HI for Semi-Volatiles (1):	NA	4.00E-04	NA	2.00E-04	NA	5.00E-04	IEP	IEP

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

TABLE 7-50 (continued)

COMPARISON OF SWMU 9, AREA A, B, AND C HAZARD QUOTIENT AND HAZARD INDEX VALUES TO BACKGROUND HAZARD QUOTIENT AND HAZARD INDEX VALUES FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS: EARTHWORMS AND PLANTS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Notes:

NC = Not Calculated (a threshold screening value was not available from the literature)
IEP = Incomplete Exposure Pathway
HI = Hazard Index
NA = Not Applicable

(1) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-51

COMPARISON OF SWMU 9, AREA A HAZARD QUOTIENT AND HAZARD INDEX VALUES TO BACKGROUND HAZARD INDEX AND HAZARD QUOTIENT VALUES FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS: AVIAN RECEPTORS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Hazard Quotient Values for Area A and Background Avian Receptors (Unitless) [1]							
	Belted Kingfisher		Great Blue Heron		American Robin		Red-Tailed Hawk	
	Area A	Background	Area A	Background	Area A	Background	Area A	Background
Inorganics:								
Arsenic	1.71E-01	1.49E-01	6.03E-02	5.27E-02	4.66E-02	4.87E-02	7.76E-03	8.18E-03
Barium	1.49E-01	1.47E-01	5.26E-02	5.20E-02	5.46E-01	3.54E-01	8.80E-02	5.69E-02
Beryllium	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Cadmium	5.34E-01	IEP	1.88E-01	IEP	IEP	3.84E-01	IEP	2.38E-02
Chromium	**1.05E+00**	8.15E-01	3.70E-01	2.87E-01	**1.38E+00**	**1.72E+00**	3.29E-01	3.96E-01
Cobalt	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Copper	6.70E-02	6.17E-02	2.36E-02	2.18E-02	IEP	IEP	IEP	IEP
Lead	5.31E-01	2.04E-01	1.87E-01	7.18E-02	**1.05E+00**	**1.19E+00**	3.31E-01	3.59E-01
Mercury	6.09E-01	3.20E-01	2.15E-01	1.13E-01	IEP	**1.39E+01**	IEP	1.48E-01
Nickel	4.26E-03	3.10E-03	1.50E-03	1.09E-03	IEP	IEP	IEP	IEP
Selenium	**1.61E+01**	IEP	**5.68E+00**	IEP	3.90E-01	IEP	1.42E-01	IEP
Silver	IEP	IEP	IEP	IEP	NC	IEP	NC	IEP
Tin	4.85E-02	4.78E-02	1.71E-02	1.69E-02	IEP	IEP	IEP	IEP
Vanadium	**1.38E+00**	8.08E-01	4.88E-01	2.85E-01	IEP	IEP	IEP	IEP
Zinc	4.31E-01	3.96E-01	1.52E-01	1.40E-01	IEP	IEP	IEP	IEP
Volatiles:								
Acetone	NC	NC	NC	NC	NC	IEP	NC	IEP
Semi-Volatiles:								
Benzyl Alcohol	IEP	IEP	IEP	IEP	NC	IEP	NC	IEP
Diethylphthalate	IEP	IEP	IEP	IEP	NC	IEP	NC	IEP

HI for Inorganics [2]:	**2.11E+01**	**2.95E+00**	**7.43E+00**	**1.04E+00**	**3.41E+00**	**1.76E+01**	8.97E-01	9.93E-01
HI for Volatiles [2]:	NA	NA	NA	NA	NA	NA	NA	NA
HI for Semi-Volatiles [2]:	NA	NA	NA	NA	NA	NA	NA	NA

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

TABLE 7-51 (continued)

COMPARISON OF SWMU 9, AREA A HAZARD QUOTIENT AND HAZARD INDEX VALUES TO BACKGROUND HAZARD INDEX AND HAZARD QUOTIENT VALUES FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS: AVIAN RECEPTORS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Notes:

NC = Not Calculated (an NOAEL was not available from the literature)
IEP = Incomplete Exposure Pathway
HI = Hazard Index
NA = Not Applicable
NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level

(1) Hazard Quotient values based on NOAEL values.

(2) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-52

COMPARISON OF SWMU 9, AREA B HAZARD QUOTIENT AND HAZARD INDEX VALUES TO BACKGROUND HAZARD INDEX AND HAZARD QUOTIENT VALUES FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS: AVIAN RECEPTORS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Hazard Quotient Values for Area B and Background Avian Receptors (Unitless) [1]							
	Belted Kingfisher		Great Blue Heron		American Robin		Red-Tailed Hawk	
	Area B	Background	Area B	Background	Area B	Background	Area B	Background
Inorganics:								
Antimony	NC	IEP	NC	IEP	IEP	IEP	IEP	IEP
Arsenic	1.30E-01	1.49E-01	4.58E-02	5.27E-02	4.39E-02	4.87E-02	7.20E-03	8.18E-03
Barium	1.69E-01	1.47E-01	5.96E-02	5.20E-02	3.95E-01	3.54E-01	6.37E-02	5.69E-02
Beryllium	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Cadmium	9.20E-01	IEP	3.24E-01	IEP	3.46E-01	3.84E-01	2.22E-02	2.38E-02
Chromium	**1.30E+00**	8.15E-01	4.57E-01	2.87E-01	9.41E-01	**1.72E+00**	2.37E-01	3.96E-01
Cobalt	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Copper	2.37E-01	6.17E-02	8.34E-02	2.18E-02	IEP	IEP	IEP	IEP
Cyanide	NC	IEP	NC	IEP	IEP	IEP	IEP	IEP
Lead	**1.19E+00**	2.04E-01	4.21E-01	7.18E-02	**8.05E+00**	**1.19E+00**	**1.61E+00**	3.59E-01
Mercury	7.03E-01	3.20E-01	2.48E-01	1.13E-01	IEP	**1.39E+01**	IEP	1.48E-01
Nickel	9.62E-03	3.10E-03	3.39E-03	1.09E-03	IEP	IEP	IEP	IEP
Selenium	IEP	IEP	IEP	IEP	4.17E-01	IEP	1.47E-01	IEP
Tin	6.85E-02	4.78E-02	2.41E-02	1.69E-02	IEP	IEP	IEP	IEP
Vanadium	**1.31E+00**	8.08E-01	4.62E-01	2.85E-01	IEP	IEP	IEP	IEP
Zinc	8.72E-01	3.96E-01	3.07E-01	1.40E-01	IEP	IEP	IEP	IEP
Volatiles (ug/kg):								
Acetone	NC	NC	NC	NC	NC	IEP	NC	IEP
2-Butanone	NC	IEP	NC	IEP	IEP	IEP	IEP	IEP
Carbon disulfide	NC	IEP	NC	IEP	IEP	IEP	IEP	IEP
Semi-Volatiles (ug/kg):								
Di-n-butylphthalate	IEP	IEP	IEP	IEP	8.33E-02	IEP	3.96E-02	IEP

HI for Inorganics [2]:	**6.90E+00**	**2.95E+00**	**2.44E+00**	**1.04E+00**	**1.02E+01**	**1.76E+01**	2.09E+00	9.93E-01
HI for Volatiles [2]:	NA	NA	NA	NA	NA	NA	NA	NA
HI for Semi-Volatiles [2]:	NA	NA	NA	NA	8.33E-02	NA	3.96E-02	NA

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

TABLE 7-52 (continued)

COMPARISON OF SWMU 9, AREA B HAZARD QUOTIENT AND HAZARD INDEX VALUES TO BACKGROUND HAZARD INDEX AND HAZARD QUOTIENT VALUES FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS: AVIAN RECEPTORS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Notes:

NC = Not Calculated (an NOAEL was not available from the literature)
IEP = Incomplete Exposure Pathway
HI = Hazard Index
NA = Not Applicable
NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level

(1) Hazard Quotient values based on NOAEL values.

(2) Hazard Index values were calculated by summing the individual Hazard Quotient values.

TABLE 7-53

COMPARISON OF SWMU 9, AREA C HAZARD QUOTIENT AND HAZARD INDEX VALUES TO BACKGROUND HAZARD INDEX AND HAZARD QUOTIENT VALUES FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS: AVIAN RECEPTORS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Chemical	Hazard Quotient Values for Area C and Background Avian Receptors (Unitless) [1]							
	Belted Kingfisher		Great Blue Heron		American Robin		Red-Tailed Hawk	
	Area C	Background	Area C	Background	Area C	Background	Area C	Background
Inorganics:								
Arsenic	1.93E-01	1.49E-01	6.77E-02	5.27E-02	IEP	4.87E-02	IEP	8.18E-03
Barium	8.36E-01	1.47E-01	2.94E-01	5.20E-02	3.43E-01	3.54E-01	5.52E-02	5.69E-02
Beryllium	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Cadmium	**1.76E+00**	IEP	6.12E-01	IEP	IEP	3.84E-01	IEP	2.38E-02
Chromium	**1.19E+00**	8.15E-01	4.20E-01	2.87E-01	**2.15E+00**	**1.72E+00**	4.81E-01	3.96E-01
Cobalt	NC	NC	NC	NC	IEP	IEP	IEP	IEP
Copper	**1.21E+00**	6.17E-02	4.26E-01	2.18E-02	IEP	IEP	IEP	IEP
Lead	**2.77E+00**	2.04E-01	9.80E-01	7.18E-02	**2.49E+00**	**1.19E+00**	6.18E-01	3.59E-01
Mercury	**1.20E+03**	3.20E-01	**4.19E+02**	1.13E-01	IEP	**1.39E+01**	IEP	1.48E-01
Nickel	4.38E-02	3.10E-03	1.54E-02	1.09E-03	IEP	IEP	IEP	IEP
Selenium	1.22E-02	IEP	4.31E-03	IEP	IEP	IEP	IEP	IEP
Tin	1.12E-01	4.78E-02	3.94E-02	1.69E-02	IEP	IEP	IEP	IEP
Vanadium	**6.35E+00**	8.08E-01	**2.24E+00**	2.85E-01	IEP	IEP	IEP	IEP
Zinc	**1.13E+01**	3.96E-01	**3.98E+00**	1.40E-01	IEP	IEP	IEP	IEP
Volatiles (ug/kg):								
Acetone	NC	NC	NC	NC	IEP	IEP	IEP	IEP
2-Butanone	NC	IEP	NC	IEP	IEP	IEP	IEP	IEP
Carbon disulfide	NC	IEP	NC	IEP	IEP	IEP	IEP	IEP
Methylene chloride	NC	IEP	NC	IEP	IEP	IEP	IEP	IEP
Semi-Volatiles (ug/kg):								
Benzo(b)fluoranthene	IEP	IEP	IEP	IEP	NC	IEP	NC	IEP
Chrysene	IEP	IEP	IEP	IEP	NC	IEP	NC	IEP
Di-n-buthylphthalate	IEP	IEP	IEP	IEP	2.08E-01	IEP	9.90E-02	IEP
Pyrene	IEP	IEP	IEP	IEP	NC	IEP	NC	IEP
HI for Inorganics [2]:	**1.23E+03**	**2.95E+00**	**4.28E+02**	**1.04E+00**	**4.98E+00**	**1.76E+01**	**1.15E+00**	9.93E-01
HI for Volatiles [2]:	NA	NA	NA	NA	NA	NA	NA	NA
HI for Semi-Volatiles [2]:	NA	NA	NA	NA	2.08E-01	NA	9.90E-02	NA

Bold and shaded values indicate a Hazard Quotient or Hazard Index greater than 1.0

TABLE 7-53 (continued)

COMPARISON OF SWMU 9, AREA C HAZARD QUOTIENT AND HAZARD INDEX VALUES TO BACKGROUND HAZARD INDEX AND HAZARD QUOTIENT VALUES FOLLOWING THE REFINEMENT OF EXPOSURE ASSUMPTIONS: AVIAN RECEPTORS
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Notes:

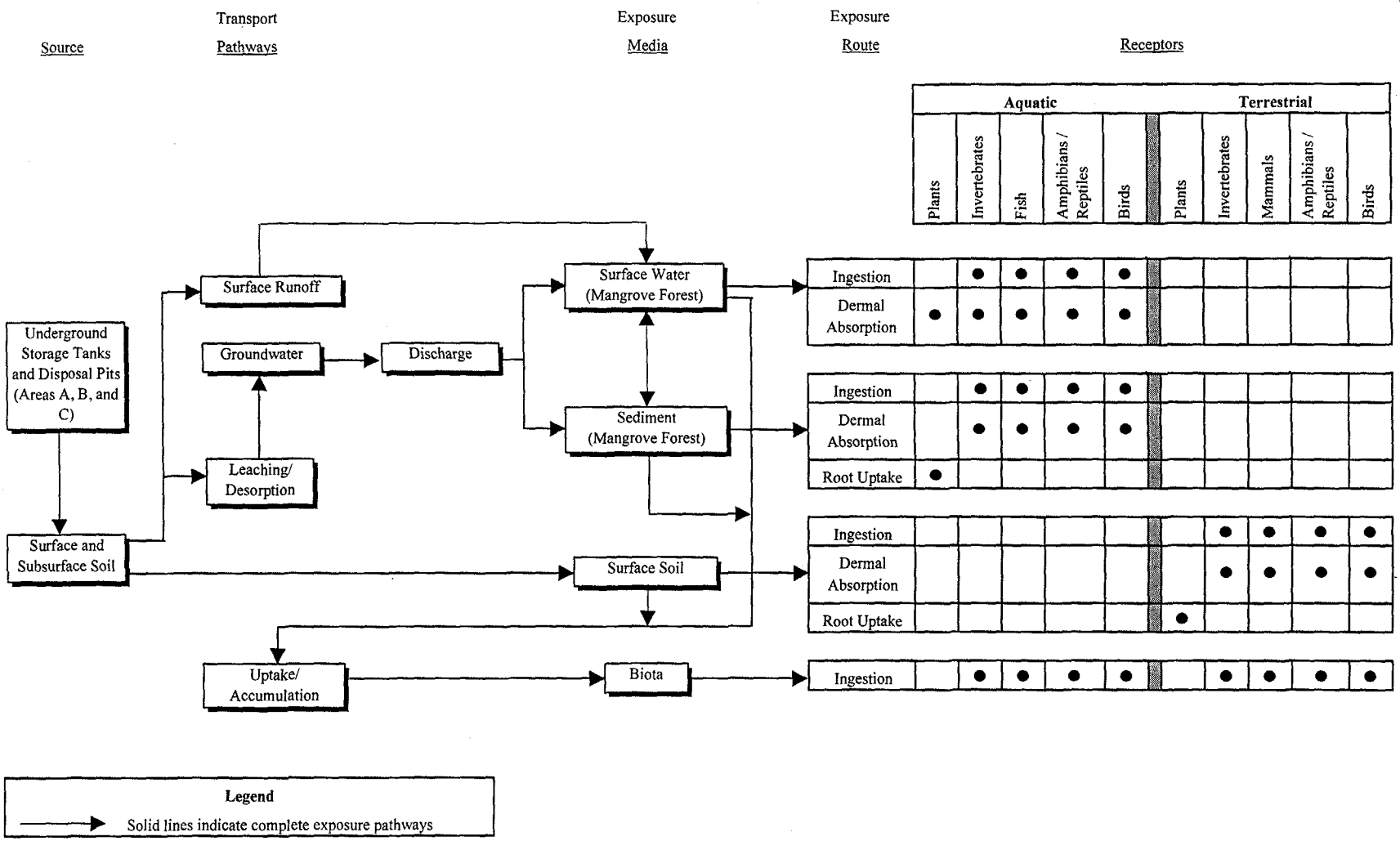
NC = Not Calculated (an NOAEL was not available from the literature)
IEP = Incomplete Exposure Pathway
HI = Hazard Index
NA = Not Applicable
NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level

(1) Hazard Quotient values based on NOAEL values.

(2) Hazard Index values were calculated by summing the individual Hazard Quotient values.

SECTION 7.0
FIGURES

FIGURE 7-1
SCREENING-LEVEL ERA PRELIMINARY CONCEPTUAL MODEL FOR SWMU 9 - AREAS A, B, AND C
SWMU 9 - TANKS 212-217
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO



8.0 CONCLUSIONS AND RECOMMENDATIONS

The following provides the conclusions and recommendations separately for Areas A, B, and C as determined from the findings of the investigations discussed in the previous sections.

8.1 Introduction

This section of the report provides overall conclusions regarding the areas within SWMU 9 based on analysis of the RFI findings. Recommendations are provided in response to the conclusions. It should be noted that detailed summaries of investigation results, human health risk assessment and screening level ecological risk assessment conclusions are provided in Sections 5.0, 6.0, and 7.0, respectively.

8.2 Conclusions by Area

The various areas within SWMU 9 are separated by distance and topography and are best addressed individually.

8.2.1 Area A

The three phases of investigation data would appear to indicate that the site has been impacted by past site fuel management activities. There is evidence of environmental impacts related to fuel storage operations at Area A. BTEX and TPH constituents were detected in several subsurface soil samples. Primarily BTEX constituents and gasoline range TPH were observed in samples from the vicinity of a valve pit near monitoring well 9-MW02R. Only one subsurface soil sample contained a fuel-related compound that exceeded any screening criteria. BTEX constituents, as well as diesel and gasoline range TPH were detected in samples located immediately down slope of Tank 212 and the suspected sludge disposal pit location. None of these detections exceeded screening criteria.

BTEX groundwater contaminant plumes are also evident. One plume is located downgradient of Tank 212 and the suspected sludge disposal pit. A second BTEX plume is evident in the vicinity of well 9-W02R. The plume appears to extend radially from the nearby valve pit.

Lead, which can be associated with gasoline, was detected above screening criteria in subsurface soil sample locations coincident with detections of fuel related compounds. Arsenic was detected above screening criteria in most media sampled, but is generally below background screening criteria. Arsenic appears to be naturally occurring at concentrations above RBCs. Other inorganics in Area A exceeding the background comparison criteria do not appear to be site related as they are not associated with diesel fuel and gasoline.

The analytical data suggests that ambient groundwater quality is relatively low. Iron, manganese, sulfate, and total dissolved solids were detected above Federal Secondary MCLs in groundwater samples from Area A. The widespread presence of these compounds, as well as poor groundwater color, causes the groundwater to be undesirable for human use if untreated.

The following summarizes COPCs that were identified in the HHRA from surface soil, subsurface soil groundwater sediment, and surface water samples collected throughout Area A.

Surface Soil	none
Subsurface Soil	arsenic and chromium
Groundwater	acetophenone, benzene, bis (2-ethylhexyl phthalate), ethylbenzene, 2 methylnapthalene, methylene chloride, naphthalene, toluene, arsenic, and chromium
Sediment	arsenic and vanadium
Surface Water	arsenic, selenium and vanadium

The Human Health Risk Assessment (HHRA) did not identify an incremental lifetime cancer risk greater than the acceptable EPA limits in Area A.

Noncarcinogenic risk may exist for future young child military residents with a total HI of 1.06 in Area A. Almost forty-percent of the risk can be attributed to exposures to chromium in groundwater. As mentioned previously in the uncertainty section, assuming that 100% of the chromium detected is Cr (VI) may overestimate the risk by 3 fold.

Benzene is the second leading contaminant driving an increase in risk at Area A, contributing forty-three percent of the risk from ingestion and dermal contact with groundwater. The risk associated with benzene was based on a provisional RfD established by the National Center for Exposure Assessment, and has not been adopted into the EPA IRIS database (EPA, 2000). As a result it is not appropriate to sum the chromium and benzene values because benzene affects the blood and chromium affects the gastrointestinal tract.

Future construction workers in Area A may potentially be at risk with a HI of 1.11. This HI is primarily the result of exposures to chromium in subsurface soil and groundwater and benzene in groundwater. Chromium in soil and groundwater contributes fifty-nine percent of the risk and benzene contributes thirty-nine percent of the risk. Also, the assumption that chromium is in the +VI oxidation state likely overestimates the risk to chromium. Because benzene likely affects the blood and chromium affects the gastrointestinal tract, HQ values should not be summed and unacceptable systemic health affects are not likely to occur.

No other unacceptable noncarcinogenic risks associated with exposures to contaminants detected in Area A were estimated in the HHRA. The HHRA concludes that a minimal noncarcinogenic risk may potentially exist for future military child resident and future construction worker in Area A; no increase in carcinogenic risk would be expected in any Area located at SMWU 9.

The screening-level ERA indicated that the assessment endpoints for Area A were not met. As such, the results of the screening-level ERA are not sufficient to conclude that risks to the ecological receptors at the Area A are negligible. For all receptor species, there were multiple chemicals with HQ values greater than 1.0. In addition, many chemicals could not be evaluated due to the lack of threshold screening values. The conservative exposure assumptions utilized in the screening-level ERA were refined and HQ values for Area A were recalculated using the same conceptual site model that was developed for the screening-level ERA (i.e., same exposure pathways and receptors). With the exception of the red-tailed hawk, one or more chemicals was shown to present a risk to each technological receptor following the refinement of exposure assumptions. As such, it cannot be concluded that risks to ecological receptors at Area A following the refinement of exposure assumptions is negligible.

Area A HQ values for individual receptors following the refinement of exposure assumptions are summarized below. The chemicals listed in italicized print are those with site HQ values that are less than background HA values. The risks presented by these chemicals are not considered to be site related.

Sediment-Associated Biota	Copper (HQ = 3.37) and Vanadium (HQ = 3.16)
Aquatic Life	Arsenic (HQ = 1.06)
Earthworms	*Chromium (HQ = 39.3)*
Plants	*Chromium (HQ = 15.7)*
Belted Kingfisher	Chromium (HQ = 1.05), Selenium (HQ = 16.1), and Vanadium (HQ = 1.38)
Great Blue Heron	Selenium (HQ = 5.68)
American Robin	*Chromium (HQ = 1.38)* and Lead (HQ = 1.05)
Red-Tailed Hawk	None

8.2.2 Area B

There is evidence of environmental impacts related to fuel storage operations at Area B. There is some evidence of the impact of past site operations on subsurface soil. TPH (diesel and gasoline range organics) were detected in a test pit up-slope of Tank 214, approximately 40 feet from the valve pit and a test pit 9TP02 immediately down-slope of Tank 215. The SVOC detections are limited, do not exceed RBCs, and are not associated with fuel storage operations. The inorganics detected in subsurface soil samples above background screening criteria are not associated with AVGAS or DFM. Lead is associated with gasoline, however lead exceeded background-screening criteria in only one sample located up-slope of Tank 215. Arsenic samples that exceeded the residential RBC can be associated with natural occurrence. The distribution pattern of arsenic in subsurface soil shows the highest concentrations north of Tank 215 with lesser concentrations east and south of Tank 215. The other inorganics in Area B, while in some instances exceeding the background comparison criteria, generally appear in concentrations similar to those in Area A.

There is evidence of the impact of past site operations on groundwater. BTEX compounds were detected in several of the temporary monitoring wells located downgradient of Tanks 214 and 215.

A BTEX plume is evident downgradient of Tank 214, between the tank and the mangrove swamp. The location of the plume is consistent with past leaks or spills during the operation of Tank 214. BTEX concentrations were observed as high as 30,200 μg/L. The other plume is located southwest of Tank 215, and is smaller in area and exhibits lower BTEX concentrations. Arsenic was detected sampled above screening criteria in most media, but is generally below background screening criteria.

A much smaller plume with lower concentrations is located southwest of Tank 215. Again, its location is consistent with past leaks or spills during the operation of Tank 215. TPH gasoline range compounds were also detected in two permanent monitoring wells, (13GW04 and 13GW05). These locations are consistent with the locations of the BTEX plumes. Other organic compounds were detected in groundwater, but are not associated with fuel storage operations. Cadmium was detected in groundwater in excess of the Tap Water MCL, but not background screening criteria. Cadmium is not associated with fuel storage operations.

The analytical data suggests that ambient groundwater quality is low. A comparison of water quality parameters to federal standards shows several exceedences. These exceedences include several metals, as well as sulfate, color, and TDS. The widespread presence of these compounds, as well as poor groundwater color, causes the groundwater to be undesireable for human use if untreated.

There is limited evidence of the impact of past site operations on surface water and sediment. Several VOCs were detected in sediments, but all were below screening criteria. Many inorganic compounds were detected in surface water and sediment, and many exceeded the background screening criteria. However, most of the inorganic compounds are not associated with fuel storage operations. Lead is typically associated with fuel storage operations, and was detected in surface water and sediment above screening criteria. Arsenic was detected in surface water and sediment, but only one surface water sample exhibited detections above screening criteria.

The following summarizes COPCs that were identified in the HHRA from surface soil, subsurface soil, groundwater, sediment, and surface water samples collected throughout Area B.

Surface Soil	none
Subsurface Soil	arsenic
Groundwater	benzene, bromodichloromethane, bromoform, chloroform, dibromochloromethane, methylene chloride, and bis (2-ethyhexyl phthalate)
Sediment	arsenic, chromium, sulfide, and vanadium
Surface Water	antimony, arsenic, and vanadium

The HHRA did not identify an incremental lifetime cancer risk greater than the acceptable EPA limits in Area B. There were no unacceptable noncarcinogenic risks associated with exposures to contaminants detected in Area B as estimated in the HHRA.

The screening-level ERA indicated that the assessment endpoints for Area B were not met. As such, the results of the screening-level ERA are not sufficient to conclude that risks to the ecological receptors at the Area B are negligible. For all receptor species, there were multiple chemicals with HQ values greater than 1.0. In addition, many chemicals could not be evaluated due to the lack of threshold screening values. The conservative exposure assumptions utilized in the screening-level ERA were refined and HQ values were recalculated using the same conceptual site model that was developed for the screening-level ERA (i.e., same exposure pathways and receptors). With the exception of the great blue heron, one or more chemicals was shown to present a risk to each ecological receptor following the refinement of exposure assumptions. As such, it cannot be concluded that risks to ecological receptors at Area B following the refinement of exposure assumptions are negligible.

HQ values for individual receptors following the refinement of exposure assumptions are summarized below. The chemicals listed in italicized print are those with site HQ values that are less than background HQ values. The risks presented by these chemicals are not considered to be site related.

Sediment-Associated Biota	Copper (HQ = 5.35) and Vanadium (2.75)
Aquatic Life	Copper (HQ = 11.4) and Cyanide (5.40)
Earthworms	*Chromium (HQ = 26.8)*

Plants	*Chromium (HQ = 10.7)* and Lead (HQ = 2.02)
Belted kingfisher	Chromium (HQ = 1.30), Lead (HQ = 1.19), and Vanadium (HQ = 1.31)
Great Blue Heron	None
American Robin	Lead (HQ = 8.05)
Red-Tailed Hawk	Lead (HQ = 1.61)

8.2.3 Area C

Evidence of the impact of past site operations on surface soil is limited. Four SVOCs were detected in only one surface soil sample located down slope of Tanks 216 and 217. However, detected concentrations were below RBCs. These SVOCs are typically associated with tars, greases, heavy oils, and poorly refined fuels. Their presence may be related to site operations, but are limited in extent and concentration. Lead concentrations exceeded background screening criteria in only one sample and low levels of gasoline-range TPH were also detected in the same sample.

There is also limited evidence of the impact of past site operations on subsurface soil. Lead concentrations exceeded background screening criteria but did not exceed either the residential or industrial RBCs. Lead can be associated with leaded gasoline and its presence can be attributable to former site operations. Silver concentrations exceeded background-screening criteria but did not exceed either the residential or industrial RBCs. Silver is not associated with fuel storage operations and may be related to ambient soil conditions. Organic compound detections in subsurface soils are limited and do not exceed RBCs.

There is no evidence of the impact of past site operations on groundwater. Detection of organic compounds is sporadic, both temporally and spatially. Additionally, the organic compounds were detected at low levels. In terms of inorganic compounds, only barium and cadmium were detected. Cadmium exceeded only the Federal MCL, and is not typically associated with fuel storage operations.

The analytical data suggests that ambient groundwater quality is low. A comparison of water quality parameters to federal standards shows several exceedences. These exceedences include several metals, as well as sulfate, color, and TDS. The widespread presence of these compounds, as well as

poor groundwater color, causes the groundwater to be undesireable for human use if untreated.

There is limited evidence of the impact of past site operations on surface water and sediment. Several VOCs were detected, but all were below screening criteria. Most inorganic analytes were detected in surface water and sediment, and many exceeded screening criteria. However, most of the inorganic compounds are not associated with fuel storage operations. Lead can be associated with fuel storage operations (leaded gasoline). Lead was detected in both surface water and sediment above screening criteria. The presence of arsenic may be associated with potential pesticide use. Arsenic was detected in surface water above the NAWQC CCC.

The following summarizes COPCs that were identified in the HHRA from surface soil, subsurface soil, groundwater, sediment, and surface water samples collected throughout Area C.

Surface Soil	none
Subsurface Soil	chromium
Groundwater	1,2 dichloropropane and bis(2-ethylhexyl phthalate)
Sediment	arsenic, chromium, sulfide, and vanadium
Surface Water	arsenic, barium, cadmium, chromium, copper, lead, and vanadium

The HHRA did not identify an incremental lifetime cancer risk greater than the acceptable EPA limits in Area C.

Future young child military residents in Area C may also potentially be at risk with a total HI of 1.29. In Area C contaminants in groundwater contribute less than one percent of the noncarcinogenic risk. Chromium and vanadium in surface water and sediment drive ninety-four percent of the risk (thirty-eight percent chromium, and fifty-six percent vanadium). Similar to observance made in Area A, assuming total chromium may have overestimated the noncarcinogenic risk.

No other unacceptable noncarcinogenic risks associated with exposures to contaminants detected in Area C were estimated in the HHRA. The HHRA concludes that a minimal noncarcinogenic risk may potentially exist for future young child military resident in Area C.

The screening-level ERA indicated that the assessment endpoints for Area C were not met. As such, the results of the screening-level ERA are not sufficient to conclude that risks to the ecological receptors at the Area C are negligible. For all receptor species, there were multiple chemicals with HQ values greater than 1.0. In addition, many chemicals could not be evaluated due to the lack of threshold screening values. The conservative exposure assumptions utilized in the screening-level ERA were refined and HQ values were recalculated using the same conceptual site model that was developed for the screening-level ERA (i.e., same exposure pathways and receptors). With the exception of the great blue heron, one or more chemicals was shown to present a risk to each ecological receptor following the refinement of exposure assumptions. As such, it cannot be concluded that risks to ecological receptors at Area C following the refinement of exposure assumptions are negligible.

HQ values for individual receptors following the refinement of exposure assumptions are summarized below. The chemicals listed in italicized print are those with site HQ values that are less than background HA values. The risks presented by these chemicals are not considered to be site related.

Sediment-Associated Biota	Barium (HQ = 1.14), Cobalt (HQ = 1.48), *Copper (HQ = 2.06)*, and Vanadium (2.16)
Aquatic Life: Chromium	(HQ = 2.56), Copper (HQ = 102), Lead (HQ = 12.4), Nickel (HQ = 7.05), and Zinc (HQ = 3.93)
Earthworms	Chromium (HQ = 61.0)
Plants	Chromium (HQ = 24.4)
Belted kingfisher	Cadmium (HQ = 1.76), Chromium (HQ = 1.19), Copper (HQ = 1.21), Lead (HQ = 2.77), Mercury (HQ = 1,200), Vanadium (HQ = 6.35), and Zinc (HQ = 11.3)
Great Blue Heron	Mercury (HQ = 419), Vanadium (HQ = 2.24), and Zinc (HQ = 3.98)

American Robin	Chromium (HQ = 2.15) and Lead (2.49)
Red-Tailed Hawk	None

The calculated risk presented by mercury to the belted kingfisher and great blue heron at Area C, as well as Area B, can be attributed to conservative exposure assumptions that were still applied to the "refined" risk calculation. The BCF value (27,900 L/kg) and NOAEL value (0.0064 mg/kg/day) used in the avian piscivore dietary intake models are based on an organometallic (methylated) form. If methylated mercury is not present in the surface water adjacent to Area C, use of a BCF value and NOAEL for inorganic mercury (2,998 L/kg and 0.45 mg/kg/day, respectively) would be more appropriate for the determination of potential risks. Use of a BCF value and NOAEL for inorganic mercury would reduce the calculated risks to these receptors by three orders of magnitude. This ERA also assumes that 100 percent of the mercury, as well as 100 percent of all chemicals detected in site media, are bioavailable. In this assumption, total recoverable mercury data were used to estimate the tissue concentration of mercury in the prey of the belted kingfisher and great blue heron. Use of the biologically available fraction (i.e., dissolved fraction) would provide a more realistic estimation of fish tissue concentrations, and, therefore, a more realistic estimation of dietary intakes. It is noted that dissolved metals data were not available for use in the refinement of conservative exposure assumptions.

8.3 Recommendations by Area

The following provides the recommendations separately for Areas A, B, and C.

8.3.1 Area A

It is recommended that a minimum of three additional surface water samples be collected from the adjacent Mangrove forest in the vicinity of Area A. These samples will be analyzed for total recoverable and dissolved metals. In addition, analyses are recommended to determine if methylated forms of mercury and selenium are present. These analyses will assist in further refinement of exposure assumptions for aquatic life and avian piscivores at Area A. It is also recommended that three additional background samples be collected for the same analyses. The background data will be used to determine if calculated risks at Area A are site related.

8.3.2 Area B

It is recommended that a minimum of three additional surface water samples be collected from the adjacent Mangrove forest in the vicinity of Area B. These samples will be analyzed for total recoverable and dissolved metals. In addition, analyses are recommended to determine if methylated forms of mercury and selenium are present. These analyses will assist in further refinement of exposure assumptions for aquatic life and avian piscivores at Area B. It is also recommended that three additional background samples be collected for the same analyses. The background data will be used to determine if calculated risks at Area B are site related.

8.3.3 Area C

It is recommended that a minimum of three additional surface water samples be collected from the adjacent Mangrove forest in the vicinity of Area C. These samples will be analyzed for total recoverable and dissolved metals. In addition, analyses are recommended to determine if methylated forms of mercury and selenium are present. These analyses will assist in further refinement of exposure assumptions for aquatic life and avian piscivores at Area C. It is also recommended that three additional background samples be collected for the same analyses. The background data will be used to determine if calculated risks at Area C are site related.

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