Second Five-Year Review Report
for
Various Operable Units

Former Naval Warfare Center Warminster
Warminster, Pennsylvania

Naval Facilities Engineering Command MidAtlantic

Contract Number N62472-03-D-0057

Contract Task Order 041

November 2006

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

August 14, 2007

Mr. Robert F. Lewandowski
BRAC Environmental Coordinator
BRAC PMO Northeast
4911 South Broad Street
Bldg 679, PNBC
Philadelphia, PA 19112

Re: Second Five Year Review Report, Various Operable Units
Former Naval Warfare Center Warminster

Dear Mr. Lewandowski:

The U.S. Environmental Protection Agency (EPA) Region III has reviewed the report entitled "Second Five Year Review Report for Various Operable Units Former Naval Warfare Center Warminster". The report was prepared to address the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Section 121 (c) five-year review requirements. EPA has reviewed this five-year review report and has compared it to the OSWER Directive 9355.7-03B-P, *Comprehensive Five-Year Review Guidance* (EPA, June 2001). EPA concurs with the Navy's determination that the remedies in place are protective of human health and the environment.

EPA's Region III would like to congratulate the Navy in preparing a multi-site five-year review report that meets the intent of EPA's Five-Year Review Guidance Document.

If you have any questions, please contact Dennis Orenshaw at (215) 814-3361.

Sincerely,

James J. Burke

James J. Burke, Director
Hazardous Site Cleanup Division

cc: Mr. Sheehan, Pennsylvania Dept of Environmental Protection

Printed on 100% recycled/recyclable paper with 100% post-consumer fiber and process chlorine free.
Customer Service Hotline: 1-800-438-2474

110612/P

SECOND FIVE-YEAR REVIEW REPORT

FOR

VARIOUS OPERABLE UNITS

FORMER NAVAL WARFARE CENTER
WARMINSTER
WARMINSTER, PENNSYLVANIA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Naval Facilities Engineering Command MidAtlantic
9742 Maryland Avenue
Norfolk, Virginia 23511

Submitted by:
Tetra Tech NUS, Inc.
600 Clark Avenue, Suite 3
King of Prussia, Pennsylvania 19406-1433

CONTRACT NUMBER N62472-03-D-0057
CONTRACT TASK ORDER 041

NOVEMBER 2006

PREPARED UNDER DIRECTION OF:

JEFFREY P. ORIENT, P.G.
PROJECT MANAGER
TETRA TECH NUS, INC.
PITTSBURGH, PENNSYLVANIA

APPROVED FOR SUBMISSION BY:

JOHN J. TREPANOWSKI, P.E.
PROGRAM MANAGER
TETRA TECH NUS, INC.
KING OF PRUSSIA, PENNSYLVANIA

TABLE OF CONTENTS

SECTION **PAGE NO.**

ACRONYMS ..... **xi**

FIVE-YEAR REVIEW SUMMARY FORM ..... **xiv**

EXECUTIVE SUMMARY **ES-1**

1.0 INTRODUCTION **1-1**
1.1 INTRODUCTION 1-1
1.2 SITE CHRONOLOGY 1-4
1.3 FACILITY DESCRIPTION AND HISTORY 1-5
1.3.1 Facility Description 1-5
1.3.2 Facility History 1-6
1.4 ARAR AND SITE-SPECIFIC ACTION LEVEL CHANGES 1-7

2.0 AREA DESCRIPTIONS AND BACKGROUND **2-1**
2.1 AREA A 2-1
2.1.1 Area A Site Descriptions 2-3
2.1.2 Land and Resource Uses 2-5
2.1.3 Investigations and Initial Response Actions 2-5
2.1.4 Nature and Extent of Contamination 2-9
2.1.5 Assessment of Risks 2-13
2.1.6 Current Status 2-16
2.2 AREA B 2-16
2.2.1 Area B Site Descriptions 2-18
2.2.2 Land and Resource Uses 2-19
2.2.3 Investigations and Initial Response Actions 2-20
2.2.4 Nature and Extent of Contamination 2-23
2.2.5 Assessment of Risks 2-26
2.2.6 Current Status 2-29
2.3 AREA C 2-29
2.3.1 Area C Site Descriptions 2-31
2.3.2 Land and Resource Uses 2-32
2.3.3 Investigations and Initial Response Actions 2-32
2.3.4 Nature and Extent of Contamination 2-34
2.3.5 Assessment of Risks 2-36
2.3.6 Current Status 2-37
2.4 AREA D 2-38
2.4.1 Area D Site Description 2-38
2.4.2 Land and Resource Uses 2-39
2.4.3 Investigations and Initial Response Actions 2-39
2.4.4 Nature and Extent of Contamination 2-41
2.4.5 Assessment of Risks 2-43
2.4.6 Current Status 2-44

TABLE OF CONTENTS (Continued)

SECTION **PAGE NO.**

3.0 OPERABLE UNITS 1, 1A, AND 1B 3-1
3.1 INTRODUCTION 3-1
3.2 SITE BACKGROUND AND CHRONOLOGY 3-1
3.3 REMEDIAL ACTIONS 3-2
3.3.1 Remedy Selection for OU-1 3-2
3.3.2 Remedy Selection for OU-1A 3-3
3.3.3 Remedy Selection for OU-1B 3-5
3.3.4 Remedy Implementation for OU-1 and OU-1A 3-6
3.3.5 Remedy Cost 3-8
3.3.6 System Operations/Operation and Maintenance 3-9
3.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW 3-10
3.5 FIVE-YEAR REVIEW PROCESS 3-11
3.5.1 Document and Analytical Data Review 3-11
3.5.2 Site Inspection 3-11
3.6 TECHNICAL ASSESSMENT 3-11
3.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents? 3-11
3.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid? 3-12
3.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy? 3-13
3.6.4 Technical Assessment Summary 3-13
3.7 ISSUES 3-13
3.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS 3-14
3.9 PROTECTIVENESS STATEMENT 3-14

4.0 OPERABLE UNIT 2 4-1
4.1 INTRODUCTION 4-1
4.2 SITE BACKGROUND AND CHRONOLOGY 4-1
4.3 REMEDIAL ACTIONS 4-2
4.3.1 Remedy Selection 4-2
4.3.2 Remedy Implementation 4-2
4.3.3 Remedy Cost 4-3
4.3.4 System Operations/Operation and Maintenance 4-3
4.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW 4-3
4.5 FIVE-YEAR REVIEW PROCESS 4-3
4.5.1 Document and Analytical Data Review 4-3
4.5.2 Site Inspection 4-3
4.6 TECHNICAL ASSESSMENT 4-4
4.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents? 4-4
4.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid? 4-4
4.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy? 4-4
4.6.4 Technical Assessment Summary 4-4
4.7 ISSUES 4-4
4.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS 4-4
4.9 PROTECTIVENESS STATEMENT 4-5

TABLE OF CONTENTS (Continued)

SECTION **PAGE NO.**

5.0 OPERABLE UNIT 3 5-1
5.1 INTRODUCTION 5-1
5.2 SITE BACKGROUND AND CHRONOLOGY 5-1
5.3 REMEDIAL ACTIONS 5-2
5.3.1 Remedy Selection 5-2
5.3.2 Remedy Implementation 5-3
5.3.3 Remedy Cost 5-4
5.3.4 System Operations/Operation and Maintenance 5-4
5.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW 5-7
5.5 FIVE-YEAR REVIEW PROCESS 5-7
5.5.1 Document and Analytical Data Review 5-7
5.5.2 Site Inspection 5-7
5.6 TECHNICAL ASSESSMENT 5-8
5.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents? 5-8
5.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid? 5-9
5.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy? 5-10
5.6.4 Technical Assessment Summary 5-10
5.7 ISSUES 5-10
5.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS 5-11
5.9 PROTECTIVENESS STATEMENT 5-12

6.0 OPERABLE UNIT 4 6-1
6.1 INTRODUCTION 6-1
6.2 SITE BACKGROUND AND CHRONOLOGY 6-1
6.3 REMEDIAL ACTIONS 6-2
6.3.1 Remedy Selection 6-2
6.3.2 Remedy Implementation 6-5
6.3.3 Remedy Cost 6-5
6.3.4 System Operations/Operation and Maintenance 6-6
6.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW 6-7
6.5 FIVE-YEAR REVIEW PROCESS 6-8
6.5.1 Document and Analytical Data Review 6-8
6.5.2 Site Inspection 6-8
6.6 TECHNICAL ASSESSMENT 6-9
6.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents? 6-9
6.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid? 6-10
6.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy? 6-10
6.6.4 Technical Assessment Summary 6-10
6.7 ISSUES 6-11
6.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS 6-11
6.9 PROTECTIVENESS STATEMENT 6-12

TABLE OF CONTENTS (Continued)

SECTION **PAGE NO.**

7.0 OPERABLE UNIT 5 7-1
7.1 INTRODUCTION 7-1
7.2 SITE BACKGROUND AND CHRONOLOGY 7-1
7.3 REMEDIAL ACTIONS 7-2
7.3.1 Remedy Selection 7-2
7.3.2 Remedy Implementation 7-2
7.3.3 Remedy Cost 7-2
7.3.4 System Operations/Operation and Maintenance 7-2
7.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW 7-2
7.5 FIVE-YEAR REVIEW PROCESS 7-3
7.5.1 Document and Analytical Data Review 7-3
7.5.2 Site Inspection 7-3
7.6 TECHNICAL ASSESSMENT 7-3
7.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents? 7-3
7.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid? 7-3
7.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy? 7-3
7.6.4 Technical Assessment Summary 7-4
7.7 ISSUES 7-4
7.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS 7-4
7.9 PROTECTIVENESS STATEMENT 7-4

8.0 OPERABLE UNIT 6 8-1
8.1 INTRODUCTION 8-1
8.2 SITE BACKGROUND AND CHRONOLOGY 8-1
8.3 REMEDIAL ACTIONS 8-2
8.3.1 Remedy Selection 8-2
8.3.2 Remedy Implementation 8-2
8.3.3 Remedy Cost 8-2
8.3.4 System Operations/Operation and Maintenance 8-2
8.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW 8-2
8.5 FIVE-YEAR REVIEW PROCESS 8-3
8.5.1 Document and Analytical Data Review 8-3
8.5.2 Site Inspection 8-3
8.6 TECHNICAL ASSESSMENT 8-3
8.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents? 8-3
8.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid? 8-3
8.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy? 8-3
8.6.4 Technical Assessment Summary 8-4
8.7 ISSUES 8-4
8.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS 8-4
8.9 PROTECTIVENESS STATEMENT 8-4

TABLE OF CONTENTS (Continued)

SECTION			PAGE NO.
9.0	**OPERABLE UNIT 7**		**9-1**
	9.1	INTRODUCTION	9-1
	9.2	SITE BACKGROUND AND CHRONOLOGY	9-1
	9.3	REMEDIAL ACTIONS	9-2
	9.3.1	Remedy Selection	9-2
	9.3.2	Remedy Implementation	9-4
	9.3.3	Remedy Cost	9-5
	9.3.4	System Operations/Operation and Maintenance	9-5
	9.4	PROGRESS SINCE THE LAST FIVE-YEAR REVIEW	9-7
	9.5	FIVE-YEAR REVIEW PROCESS	9-7
	9.5.1	Document and Analytical Data Review	9-7
	9.5.2	Site Inspection	9-7
	9.6	TECHNICAL ASSESSMENT	9-8
	9.6.1	Question A: Is the Remedy Functioning as Intended by Decision Documents?	9-8
	9.6.2	Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid?	9-8
	9.6.3	Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?	9-8
	9.6.4	Technical Assessment Summary	9-8
	9.7	ISSUES	9-9
	9.8	RECOMMENDATIONS AND FOLLOW-UP ACTIONS	9-9
	9.9	PROTECTIVENESS STATEMENT	9-10
10.0	**OPERABLE UNIT 8**		**10-1**
	10.1	INTRODUCTION	10-1
	10.2	SITE BACKGROUND AND CHRONOLOGY	10-1
	10.3	REMEDIAL ACTIONS	10-2
	10.3.1	Remedy Selection	10-2
	10.3.2	Remedy Implementation	10-2
	10.3.3	Remedy Cost	10-2
	10.3.4	System Operations/Operation and Maintenance	10-2
	10.4	PROGRESS SINCE THE LAST FIVE-YEAR REVIEW	10-2
	10.5	FIVE-YEAR REVIEW PROCESS	10-2
	10.5.1	Document and Analytical Data Review	10-2
	10.5.2	Site Inspection	10-3
	10.6	TECHNICAL ASSESSMENT	10-3
	10.6.1	Question A: Is the Remedy Functioning as Intended by Decision Documents?	10-3
	10.6.2	Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid?	10-3
	10.6.3	Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?	10-3
	10.6.4	Technical Assessment Summary	10-3
	10.7	ISSUES	10-3
	10.8	RECOMMENDATIONS AND FOLLOW-UP ACTIONS	10-4
	10.9	PROTECTIVENESS STATEMENT	10-4

TABLE OF CONTENTS (Continued)

SECTION **PAGE NO.**

11.0 OPERABLE UNIT 9 11-1
11.1 INTRODUCTION 11-1
11.2 SITE BACKGROUND AND CHRONOLOGY 11-1
11.3 REMEDIAL ACTIONS 11-2
11.3.1 Remedy Selection 11-2
11.3.2 Remedy Implementation 11-4
11.3.3 Remedy Cost 11-5
11.3.4 System Operations/Operation and Maintenance 11-5
11.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW 11-7
11.5 FIVE-YEAR REVIEW PROCESS 11-7
11.5.1 Document and Analytical Data Review 11-7
11.5.2 Site Inspection 11-7
11.6 TECHNICAL ASSESSMENT 11-8
11.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents? 11-8
11.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid? 11-8
11.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy? 11-8
11.6.4 Technical Assessment Summary 11-8
11.7 ISSUES 11-9
11.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS 11-9
11.9 PROTECTIVENESS STATEMENT 11-9

12.0 OPERABLE UNIT 10 12-1
12.1 INTRODUCTION 12-1
12.2 SITE BACKGROUND AND CHRONOLOGY 12-1
12.3 REMEDIAL ACTIONS 12-2
12.3.1 Remedy Selection 12-2
12.3.2 Remedy Implementation 12-2
12.3.3 Remedy Cost 12-3
12.3.4 System Operations/Operation and Maintenance 12-3
12.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW 12-3
12.5 FIVE-YEAR REVIEW PROCESS 12-3
12.5.1 Document and Analytical Data Review 12-3
12.5.2 Site Inspection 12-4
12.6 TECHNICAL ASSESSMENT 12-4
12.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents? 12-4
12.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid? 12-4
12.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy? 12-4
12.6.4 Technical Assessment Summary 12-4
12.7 ISSUES 12-5
12.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS 12-5
12.9 PROTECTIVENESS STATEMENT 12-5

TABLE OF CONTENTS (Continued)

SECTION **PAGE NO.**

13.0 PROTECTIVENESS STATEMENTS AND OTHER COMMENTS 13-1
13.1 OPERABLE UNIT 1A 13-1
13.2 OPERABLE UNIT 3 13-2
13.3 OPERABLE UNIT 4 13-2
13.4 OPERABLE UNIT 7 13-3
13.5 OPERABLE UNIT 9 13-4
13.6 TIMETABLE FOR NEXT REVIEW 13-4

REFERENCES R-1

APPENDICES

A FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST

TABLES

SECTION **PAGE NO.**

3-1 Area A Soils, Sites 1, 2 & 3
11-1 Surface Soil Concentrations Protective of Sediment/Ecological Receptors

FIGURES

SECTION **PAGE NO.**

1-1 Site Location Map
1-2 On-Base Areas of Investigation
2-1 Area A Layout
2-2 Site 1 and Impoundment Areas EPIC Features
2-3 Site 2 EPIC Features
2-4 Site 3 EPIC Features
2-5 Well and Geologic Cross Section Locations
2-6 Area A Removal Action Layout
2-7 February 2000 Isoconcentration Contours and Monitoring Well Locations, Area A
2-8 Area B Layout

FIGURES (Continued)

SECTION		PAGE NO.
2-9	Conceptual Layout of Site 5 Trenches	
2-10	Area B Sites 5, 6, and 7 and Suspected Disposal Areas	
2-11	Appropriate Removal Areas, Remedial Investigation, Area B - Sites 6 and 7	
2-12	Well Locations, Area B	
2-13	South Base Boundary Well Locations	
2-14	Area C Layout	
2-15	Site 4 Location Map	
2-16	Area C and Site 8 Layout	
2-17	Off-Base Wells	
2-18	Site 8 Removal Action	
2-19	Subsurface Sample Locations Site 4	
2-20	Interior Features of Concern Buildings, 1, 2, and 3 - Area D	
2-21	Area D Key Features	
2-22	Well Location Map, Area D	
2-23	TCE Isoconcentrations for Hydrogeologic Unit B, Area D	
3-1	Technical Impracticability Waiver Zone	
3-2	Capture Zone & Potentiometric Surface Map, OU-1A Hydrogeologic Unit B	
3-3	TCE Concentration Map, OU-1A Hydrogeologic Unit B	
4-1	OU 2 Boundaries for Public Water Connections	
5-1	Capture Zone & Potentiometric Surface Map, OU-3 Shallow Hydrogeologic	
5-2	PCE Concentration Map, OU-3 Shallow Hydrogeologic Unit	
6-1	Capture Zone & Potentiometric Surface Map, OU-4 Hydrogeologic Unit B	
6-2	TCE Concentration Map, OU-4 Hydrogeologic Unit B	
9-1	Final Grading Plan for Sites 6 and 7, Area B	
10-1	Area A, Site 2 Area of Concern	

ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
AWQC	Ambient Water Quality Criterion
bgs	Below ground surface
BCT	BRAC Cleanup Team
BRAC	Base Realignment and Closure
CCl_4	Carbon tetrachloride
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	Contaminant of concern
COPC	Chemical of potential concern
CSF	Cancer slope factor
CTO	Contract Task Order
DCE	Dichloroethene
DoD	Department of Defense
DNAPL	Dense non-aqueous phase liquid
EBS	Environmental Baseline Survey
EDC	Economic development conveyance
EEQ	Ecological Effects Quotient
EE/CA	Engineering Evaluation/Cost Analysis
ESD	Explanation of Significant Differences
FFA	Federal Facility Agreement
FLRA	Federal Lands Reuse Authority
FOST	Finding of Suitability to Transfer
FS	Feasibility Study
Gpm	Gallons per minute
HHS	Health and Human Services
HI	Hazard Index
HQ	Hazard Quotient
HRS	Hazard Ranking System
JRB	Joint Reserve Base
MCL	Maximum Contaminant Level
NADC	Naval Air Development Center
NAWC	Naval Air Warfare Center
NAS	Naval Air Station

NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	No further action
NPL	National Priorities List
O&M	Operation and maintenance
OPS	Operating Properly and Successfully
OU	Operable Unit
PA	Preliminary Assessment
PADEP	Pennsylvania Department of Environmental Protection
PAH	Polynuclear aromatic hydrocarbon
PBC	Public benefit conveyance
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
PID	Photoionization detector
RAB	Restoration Advisory Board
RAGS	Risk Assessment Guidance for Superfund
RAO	Remedial Action Objective
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RfD	Reference dose
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SI	Site Investigation
SSL	Soil screening levels
TBC	To be considered
TCA	Trichloroethane
TCE	Trichloroethene
TI	Technical impracticability
TtNUS	Tetra Tech NUS, Inc.
USEPA	United States Environmental Protection Agency
UST	Underground storage tank
VOC	Volatile organic compound
WTMA	Warminster Township Municipal Authority
mg/L	Milligram(s) per liter
µg/L	Microgram(s) per liter
mg/kg	Milligram(s) per kilogram

µg/kg	Microgram(s) per kilogram
µg/dL	Micrograms(s) per deciliter

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name ***(from WasteLAN)*****: Naval Air Development Center Warminster**		
EPA ID ***(from WasteLAN)*****: PA6170024545**		
Region: 3	**State: PA**	**City/County: Warminster/Bucks**

SITE STATUS	
NPL status: ☒ Final ☐ Deleted ☐ Other (specify)	
Remediation status (choose all that apply): ☐ Under Construction ☒ Operating ☒ Complete	
Multiple OUs?* ☒ YES ☐ NO	**Construction completion date:** 9/28/2000
Has site been put into reuse? ☒ YES ☐ NO	

REVIEW STATUS	
Lead agency: ☐ EPA ☐ State ☐ Tribe ☒ Other Federal Agency -- United States Navy	
Author name: Orlando Monaco	
Author title: Remedial Project Manager	**Author affiliation: Engineering Field Activity Northeast**
Review period:** 3/1/2001 to 12/31/2005	
Date(s) of site inspection: 3/27/2006	
Type of review: ☒ Post-SARA ☐ Pre-SARA ☐NPL-Removal only ☐Non-NPL Remedial Action Site ☐NPL State/Tribe-lead ☐ Regional Discretion	
Review number: ☐ 1 (first) ☒ 2 (second) ☐ 3 (third) ☐ Other (specify) _____	
Triggering action: ☐ Actual RA Onsite Construction at OU #____ ☐ Construction Completion ☐ Other (specify)	☒ Actual RA Start at OU#_1__ ☐ Previous Five-Year Review Report
Triggering action date ***(from WasteLAN)*****:** 6 / 2 / 1994	
Due date* *(five years after triggering action date)*:** 5/ 31/ 2006	

* ["OU" refers to operable unit.]
** [Review period should correspond to the actual start and end dates of the Five-Year Review in WasteLAN.]
*** Five years after first five-year review period.

Five-Year Review Summary Form (cont.)

Issues:

No deficiencies were discovered during the five-year review for that would be sufficient to warrant a finding of not protective. The remedial actions for the sites reviewed have been implemented. However, several items were identified during the previous Five-Year Review Report and site inspection that should be addressed. These items and recommendations and follow-up actions were identified for OU-1, OU-1A, OU-3, OU-4, OU-7, OU-9, and OU-10.

Recommendations and Follow-up Actions:

Continuation of long-term monitoring and enforcement of land use controls/institutional controls are required at OU-1A, OU-3, OU-4, OU-7, and OU-9. Continued evaluation/operation of pump and treat system is required for OU-1A, OU-3, and OU-4 and continued site inspections and maintenance is required for OU-7 and OU-9.

No further action is required at OU-1B, OU-2, OU-5, OU-6, OU-8, and OU-10.

Protectiveness Statement(s):

The remedial actions at the OUs at the former NAWC Warminster are expected to be protective of human health and the environment. Remedial actions have been taken to address areas of contamination that posed unacceptable risks to human health and the environment, and remediation systems are operating consistently and effectively and they been determined to be operating properly and successfully (OPS). Remedial actions have been completed for OU-2, OU-5, OU-6, OU-8, and OU-10 with RODs that specify NFA. Remedial actions at OU-1A, OU-3, and OU-4 have been implemented that require long-term groundwater monitoring and operation and maintenance (O&M) programs to provide a degree of protection of human health and the environment. Remedial actions at OU-7 and OU-9 have also been completed and require long-term O&M programs to provide a degree of protection of human health and the environment.

Long-term operation, maintenance, and monitoring programs are in place, were appropriate, to make sure that the implemented remedies continue to operate as planned and achieve their remedial action objectives. However, the long-term O&M programs (post-closure monitoring activities) for OU-7 and OU-9 have not been conducted since September 2001. These monitoring activities have been discontinued.

Former NAWC Warminster has several OUs that are considered statutory sites that require ongoing five-year reviews.

This five-year review shows that the Navy is meeting or exceeding the requirements of the RODs for the OUs at former NAWC Warminster. The Navy is constantly re-evaluating to utilize permanent remedies and alternative treatment technologies to the maximum extent practical for each OU. The Navy is currently reviewing a groundwater remedy optimization report is being prepared by Batelle. The report will be finalized with recommendations to optimize the groundwater treatment system.

Other Comments:

The majority of former NAWC Warminster was transferred in accordance with the re-use plan. The Navy has retained ownership of some of the property. Land Use Controls/Institutional Controls have been implemented and are currently providing a significant degree of protectiveness of human health and the environment until completion of the remedy is achieved to provide full protectiveness.

Five-Year Review Summary Form (cont.)

Signature of U.S. Department of the Navy and Date	
_____ , USN Commanding Officer	_____ Date

EXECUTIVE SUMMARY

The second Five-Year Review Report for the former Naval Air Warfare Center (NAWC) in Warminster, Pennsylvania was prepared for the Northern Division, Naval Facilities Engineering Command as part of Contract Task Order (CTO) 041 under Contract N62472-03-D-0057. This review serves to meet the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERLCA) and its amendments and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The purpose of the Five-Year Review was to determine whether the various remedies at the base are protective of human health and the environment. The methods, findings, and conclusions of the Five-Year Review are documented in this report. In addition, the report identifies deficiencies found during the review and makes recommendations to address these.

On October 4, 1989, NAWC Warminster was placed on the final National Priorities List (NPL). That same year, EPA submitted a draft Interagency Agreement to the Navy for formalizing and scheduling remedial activities. The contents of this agreement were negotiated in 1990. In October 1989, the Navy began conducting various remedial investigation/feasibility (RI/FS) activities at the facility. The RI/FS work was divided into several phases, and all activities were completed in August 2000.

The actual and potential hazardous waste disposal locations at NAWC Warminster were grouped into four areas:

- Area A (Sites 1, 2, and 3 and the Impoundment Area)
- Area B (Sites 5, 6, and 7)
- Area C (Sites 4 and 8)
- Area D, which includes the main building complex at the base west of Jacksonville Road

Between 1993 and 1998, both focused and comprehensive removal actions were conducted at many of the sites, with the exception of Site 5, where removal work was not necessary. During the performance of the RI/FS, several operable units (OUs) were established to help expedite the completion of environmental clean-up activities at the base. In the case of NAWC Warminster, work was organized into 11 OUs:

- OU-1: Contaminated shallow groundwater attributable to Areas A and B
  - OU-1A: Contaminated groundwater attributable to Area A
  - OU-1B: Contaminated groundwater attributable to Area B
- OU-2: Contamination of domestic well water for residences near the base
- OU-3: Contaminated groundwater attributable to Area C

- OU-4: Contaminated groundwater attributable to Area D
- OU-5: Soils, sediment, and surface water associated with Site 8 at Area C
- OU-6: Soils, sediment, and surface water associated with Site 4 at Area C
- OU-7: Soils and wastes associated with Sites 6 and 7 at Area B
- OU-8: Soils associated with Area D
- OU-9: Soils, surface water, and sediment associated with Area A
- OU-10: Site 5 soils and surface water and sediment associated with Area B

The triggering action for the Five-Year Review was the initiation of the remedial action for OU-1, which began on January 15, 1995. This Five-Year Review addresses the disposal locations and the OUs. Although some OUs do not require a Five-Year Review, this report includes the OUs listed above to streamline future reporting requirements. Because hazardous substances remain at the base above levels that allow for unrestricted use and unlimited exposure, subsequent 5-year reviews will be required.

The results of the Five-Year Review did not reveal that contaminant characteristics have changed in such a manner that could affect the protectiveness of the remedies selected for the various OUs at the base. The remediation systems for OU-1A, OU-3, and OU-4 are operating consistently and effectively and they been determined to be operating properly and successfully (OPS) and require long-term groundwater monitoring and operation and maintenance (O&M) programs to provide a degree of protection of human health and the environment. Remedial actions have been completed for OU-2, OU-5, OU-6, OU-8, and OU-10.

Several minor deficiencies were discovered during the Five-Year Review; however, none were sufficient to warrant a finding of not protective as long as corrective actions are taken. Remedial actions at OU-7 and OU-9 have also been completed and require long-term O&M programs to provide a degree of protection of human health and the environment. The long-term O&M programs (post-closure monitoring activities) for OU-7 and OU-9 have not been conducted since September 2001. These monitoring activities have been discontinued.

This five-year review shows that the Navy is meeting or exceeding the requirements of the RODs for the OUs at former NAWC Warminster. The Navy is constantly re-evaluating to utilize permanent remedies and alternative treatment technologies to the maximum extent practical for each OU.

1.0 INTRODUCTION

1.1 INTRODUCTION

The purpose of five-year reviews is to determine whether remedies implemented at CERCLA Sites/Operable Units (OUs) are protective of human health and the environment. The methods, findings, and conclusions of the reviews are documented in Five-Year Review Reports. In addition, Five-Year Review Reports identify issues found during the review, if any, and identify recommendations to address them.

The United States Environmental Protection Agency (USEPA) is responsible for implementing statutory five-year reviews pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) §121 and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA §121 states:

> "If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than every five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgement of the President that action is appropriate at such site in accordance with section [104] or [106], the president shall take or require such action. The President shall report to Congress a list of facilities at which such review is required, the results of all such reviews, and any actions taken as a result of such reviews."

The USEPA interpreted this requirement further in the NCP; 40 Code of Federal Regulations (CFR) §300.430(f)(4)(ii) states:

> "If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action."

For federal facility sites under the jurisdiction, custody, or control of the Department of Defense (DoD), Executive Order 12580 relieves the USEPA of this responsibility and delegates the responsibility to the DoD. The Navy is the lead agency responsible for this Five-Year Review at the former Naval Air Development Center (NADC), working with the USEPA Region III and the Pennsylvania Department of Environmental Protection (PADEP) through the Federal Facility Agreement (FFA).

This Five-Year Review Report has been prepared under Contract Task Order (CTO) 041 as part of the Comprehensive Long-Term Environmental Action Navy (CLEAN) IV Contract No. N62467-03-D-0057 for the Engineering Field Activity Northeast Naval Facilities Engineering Command. Tetra Tech NUS, Inc. (TtNUS) conducted this five-year review of the pending, completed, and ongoing remedial actions implemented at 10 of the OUs at the former NADC located in Warminster Township and Ivyland Borough, Bucks County, Pennsylvania (Figure 1-1). The remedial actions include two interim remedial actions and 11 final remedial actions, five of which are no further action (NFA). The NADC was renamed the Naval Air Warfare Center (NAWC) Aircraft Division in January 1993 and was disestablished on September 30, 1996 in response to the requirements of the Base Realignment and Closure Act (BRAC). This Five-Year Review Report was prepared based on remedial actions conducted up to February 2006.

This is the second five-year review for the former NAWC Warminster OUs. The triggering action for the statutory review was the initiation of the remedial action for OU-1 that began on January 15, 1995. The first Five-Year Review was completed in February 2001. Because hazardous substances, pollutants, or contaminants remain at some of the OUs at NAWC Warminster above concentrations that allow for unlimited use and unrestricted exposure, a subsequent five-year review is required.

The actual and potential hazardous waste disposal locations at the base have been grouped into four areas: Area A (Sites 1, 2, 3, and the Impoundment Area), Area B (Sites 5, 6, and 7), Area C (Sites 4 and 8), and a fourth general area, Area D, that is located west of Jacksonville Road and primarily includes the main building complex at the base. Figure 1-2 shows the locations of these areas, and Section 2.0 provides detailed descriptions of these areas.

Section 300.430(a)(1)(ii)(A) of the NCP, 40 CFR Section 300.340(a)(1)(ii)(A) provides that CERCLA National Priorities List (NPL) sites “should generally be remediated in operable units when early actions are necessary or appropriate to achieve significant risk reduction quickly, when phase analysis or response is necessary or appropriate given the size or complexity of the site, or to expedite the completion of a total cleanup.” In the case of NAWC Warminster, the Navy organized work into 10 OUs:

- OU-1: Contaminated shallow groundwater attributable to Areas A and B (interim remedy only)
  - OU-1A: Contaminated groundwater attributable to Area A (final remedy)
  - OU-1B: Contaminated groundwater attributable to Area B (final remedy)
- OU-2: Contamination of domestic well water for residences near the base
- OU-3: Contaminated groundwater attributable to Area C
- OU-4: Contaminated groundwater attributable to Area D (interim and final remedy)
- OU-5: Soils, sediment, and surface water associated with Site 8 at Area C

- OU-6: Soils, sediment, and surface water associated with Site 4 at Area C
- OU-7: Soils and wastes associated with Sites 6 and 7 at Area B
- OU-8: Soils associated with Area D
- OU-9: Soils, surface water, and sediment associated with Area A
- OU-10: Soils and surface water and sediment associated with Site 5 at Area B

This report consists of 13 sections and one appendix, as follows:

- Section 1.0 discusses the purpose of the report, provides a summary of the history and site chronology of NAWC Warminster, and evaluates the changes that have occurred in Applicable or Relevant and Appropriate Requirements (ARARs).

- Section 2.0 provides descriptions of each of the four areas at NAWC Warminster (A, B, C, and D), including land and resource uses, investigation and initial response actions, nature and extent of contamination, assessment of risks, and current status.

- Sections 3.0 through 12.0 are the five-year reviews for OU-1 (including OU-1A and OU-1B), OU-2, OU-3, OU-4, OU-5, OU-6, OU-7, OU-8, OU-9, and OU-10, respectively, at NAWC Warminster. Each section includes the OU chronology, background, summary of the remedial actions performed, and the five-year review findings, assessment, deficiency list, recommendations, and protectiveness statement.

- Section 13.0 provides a general summary, conclusions, and protectiveness statement for the NAWC Warminster facility. This section also identifies when the next five-year review is required and the other tasks that should be performed as part of that five-year review.

- Appendix A contains the Five-Year Review Site Inspection Checklists for each OU.

Administrative Components and Community Involvement

This Five-Year Review consisted of a review of relevant documents, interviews, and a site inspection. In addition, an announcement about the release of the Five-Year Review Report was provided to the Restoration Advisory Board (RAB), which is open to concerned citizens and is supported by the BCT. The completed report will be available in the Information Repository located at a local library. The address for the repository is as follows:

Bucks County Library
150 South Pine Street
Doylestown, Pennsylvania

The next five-year-review for NAWC Warminster is required by 2011, 5 years from the date for the finalization of this review.

1.2 SITE CHRONOLOGY

The USEPA officially recognized the NAWC Warminster sites as possibly needing investigation in September 1979. In 1980, the Department of the Navy began its environmental investigative work at NAWC Warminster. The first study, known as the Clay/Law Report, inventoried disposal activities at each of eight sites. Since 1980, several environmental consultants under Navy contracts have studied these sites. The first of the resulting reports, prepared by JRB Associates in 1983, concluded that on-base contamination existed but probably was not affecting off-base water supply wells.

In June 1985, USEPA completed a CERCLA Preliminary Assessment/Site Inspection (PA/SI) report. In June 1986, NAWC Warminster was proposed for inclusion on the NPL based on a Hazard Ranking System (HRS) score greater than 28.50. USEPA used the HRS to assess the relative threats from releases of hazardous substances from the eight NAWC Warminster sites to surrounding groundwater and surface water. The facility score was based on the likelihood that a hazardous substance would be released from the sites, the toxicity and amount of hazardous substances at the sites, and the people and sensitive environments potentially affected by contamination at the sites.

On October 4, 1989, NAWC Warminster was placed on the final NPL. That same year, USEPA submitted a draft Interagency Agreement to the Navy for formalizing and scheduling remedial activities. The contents of this agreement were negotiated in 1990. In 1989, the Navy began conducting various CERCLA Remedial Investigation/Feasibility Study (RI/FS) activities at the facility for the four areas of concern (i.e., Area A, Area B, Area C, and Area D). These activities were completed in August 2000.

The RI/FS work was divided into three phases. The Phase I RI was performed between October 1989 and April 1991. The Phase II RI/FS was performed between May 1992 and April 1993. Both Phase I and Phase II primarily addressed groundwater, surface water, and sediment contamination attributable to the base. In October 1993, focused RI/FS work for groundwater contamination attributable to the base began; this work was completed in August 2000.

The Phase III RI/FS, which primarily focused on potential source areas and their impacts to soils, surface waters, and sediments, began in January 1995 and was completed in August 2000. During the

performance of the RI/FS, OUs were established to help expedite the completion of environmental clean-up activities at the base. Between 1993 and 1998, both focused and comprehensive removal actions were conducted at the sites, with the exception of Site 5, where removal work was not necessary.

A list of important NAWC Warminster historical events and relevant dates is shown below. The identified events are illustrative, not comprehensive.

DATE(S)	EVENT
1944	NADC Warminster commissioned for research, development, and testing of Naval Aircraft systems
1940 to 1973	Operated burn pits, unlined impoundments, lagoons, trench disposal site
September 1979	Initial discovery of contamination
1980	Navy initially reported potential locations of hazardous substances disposal
June 9, 1981	Notification of Hazardous Waste Site submitted
June 24, 1981	PA
June 7, 1985	SI
June 10, 1986	Proposed NPL listing
October 4, 1989	NPL listing
October 1989	Base wide Phase I RI activities began
September 20, 1990	FFA signed
April 1991	Base wide Phase I RI activities completed
May 1992	Base wide Phase II RI and FS activities began
January 1993	Renamed the NAWC Aircraft Division
April 1993	Base wide Phase II RI and FS activities completed
September 30, 1996	NAWC Warminster operations ceased pursuant to BRAC
September 28, 2000	Construction complete for entire base; Preliminary Close-Out Report signed
November 27, 2000	Transfer of the parcel that includes OU-7 to the U. S. National Park Service

1.3 FACILITY DESCRIPTION AND HISTORY

1.3.1 Facility Description

NAWC Warminster was an 824-acre facility located in Warminster Township, Ivyland Borough, Bucks County, Pennsylvania. The former NAWC Warminster lies in a populated suburban area surrounded by private homes, various commercial and industrial activities, and a golf course. The area encompassing

the former base includes various buildings and other structures connected by paved roads, mowed fields, and a small wooded area. The former facility is located on a ridge, generally oriented east-west, with elevations ranging from 297 feet at the northwestern property boundary to 377 feet at the eastern boundary. Slopes are gentle and average 3 to 5 percent. The northern portion of the former facility (about 65 percent) drains into small, unnamed tributaries of Little Neshaminy Creek. The remaining portions drain into unnamed tributaries of Pennypack Creek.

The main runway was generally located along the topographically highest area at the facility. Many of the primary facility buildings were located west of the airstrip, along Jacksonville Road. A housing development for military enlisted personnel associated with nearby NAS Willow Grove is within the southeastern portion of the former NAWC Warminster. A municipal wastewater treatment plant is now located in the northwestern corner of the facility.

A number of commercial businesses currently operate at the former base, and residents live in a retirement community (Ann's Choice Retirement Community) and at the enlisted personnel's housing area year round. These residents are the nearest population centers. The closest off-base home is about 200 feet away.

NAWC Warminster is underlain by the Stockton Formation, which provides water for more than 100,000 people within the area. Local surface water bodies are used for recreational and industrial purposes.

1.3.2 Facility History

The facility was originally the location of Brewster Aeronautical Corporation, a manufacturer of military aircraft. In 1944, the Navy assumed full control of the Brewster plant. The Naval Air Modification Unit was installed at the base to add design modifications to military aircraft produced at other locations. After World War II, activities at the base were altered; in 1949, the facility was designated the NADC, and its main mission, research, development, testing, and evaluation for Naval aircraft systems, was established. These activities varied over the years, but they included the development, research, and testing of aircraft components, coatings, electronics, and control devices. Concurrent with these activities, aircraft continued to be used and maintained at the facility. NADC also conducted studies in anti-submarine warfare systems and software development.

Historically, wastes were generated during aircraft maintenance and repair, pest control, firefighting training, machine and plating shop operations, spray painting, and various materials research and testing activities in laboratories. These wastes included paints, solvents, sludges from industrial wastewater treatment, and waste oils that were disposed in several pits, trenches, and landfills throughout the facility property. None of the sites are currently used for waste disposal.

NADC was placed on the NPL in October 1989 as Naval Air Development Center Warminster (Eight Waste Areas). This list includes sites where uncontrolled hazardous substance releases present the most significant potential threats to human health and the environment. Areas reported by the Navy to have been potentially used for disposal of hazardous substances include the following nine locations covering more than 15 acres:

- Three waste disposal locations (Sites 1, 3, and 6)
- Two sludge disposal pit locations (Sites 2 and 7)
- Two landfills (Sites 4 and 5)
- One fire training location (Site 8)
- A series of eight unlined impoundments (Impoundment Area)

None of the sites have been used for non-hazardous waste disposal. As mentioned above, these disposal locations have since been grouped within the following areas on NAWC property: Area A (Sites 1, 2, and 3 and the Impoundment Area), Area B (Sites 5, 6, and 7), and Area C (Sites 4 and 8). A fourth general area, Area D, is located west of Jacksonville Road and primarily includes the main building complex at the base. Figure 1-2 shows the locations of these areas.

The facility name was changed from NADC to NAWC Aircraft Division in January 1993. In 1996, NAWC Warminster was realigned under the BRAC Program managed by the DoD. This realignment, which was due to the downsizing of the entire DoD budget, was implemented in September 1997. The realignment resulted in the relocation of NAWC Warminster activities to Naval Air Station (NAS) Patuxent River, Maryland. The base is now closed and has been redeveloped for non-military use by the Bucks County Federal Lands Reuse Authority (FLRA).

1.4 ARAR AND SITE-SPECIFIC ACTION LEVEL CHANGES

The technical assessment of the five-year review provides a framework for organizing and evaluating data and makes sure that relevant issues are considered when determining the protectiveness of the selected remedies. This technical assessment of the remedies also reviews the risk parameters on which the original remedy decisions were based to determine whether the assumptions or anticipated conditions used to select remedies at the base are still valid or appropriate. The following items were evaluated as part of the technical assessment:

- Changes in ARARs and to be considered (TBCs) criteria
- Changes in exposure pathways

- Changes in toxicity and other contaminant characteristics
- Changes in risk assessment methodologies

The ARARs identified in each of the Record of Decisions (RODs) were reviewed, as were new federal and State regulations that have been promulgated. The only ARAR that has changed since the first five-year review is the groundwater Maximum Contaminant Level (MCL) for arsenic. The MCL was changed from 50 micrograms per liter (µg/L) to 10 µg/L effective February 22, 2002 and enforceable on January 23, 2006. New USEPA Region 3 Risk-Based Concentrations (RBCs) were published in April 2006, but these are generally used for screening purposes and not to establish cleanup goals. Other federal and State ARARs have not changed since the first five-year review.

No significant changes in the physical conditions at the sites of concern that affect exposure pathways were discovered as part of the five-year review. No current or planned changes in land use (as described in the various RODs) were identified, and no new contaminants, suspected sources of contamination, or routes of exposure have been identified.

Toxicity factors for most contaminants of concern (COCs) associated with RODs at the base have not been revised in a manner that could affect the protectiveness of the remedies. The reference doses (RfDs) and/or cancer slope factors (CSFs) for some of the chlorinated solvents have changed considerably since 2001. Most notable is the status of 1,1-dichloroethene (DCE) which was previously classified as a carcinogen (USEPA Region 3 Tap Water RBC = 0.044 µg/L). 1,1-DCE is now classified as a non-carcinogen by the USEPA, and the most recently published USEPA Region 3 Tap Water RBC for 1,1-DCE is 350 µg/L. The result of the changes in the CSFs for tetrachloroethane (PCE) and trichloroethane (TCE) is that the USEPA Region 3 Tap Water RBCs for these chemicals have decreased (i.e., are more conservative) by more than an order of magnitude. However, the changes in toxicity values for these chemicals have not affected the protectiveness of the remedies established for groundwater at the base because the cleanup goals for contaminants in groundwater are the federal MCLs, which have not changed.

The results of the five-year review did not reveal that contaminant characteristics have changed in a manner that could affect the protectiveness of the remedies selected for the various OUs at the base.

The risk assessments for the OUs were performed in accordance with current and standardized USEPA and Navy risk assessment methodologies. These methodologies have not changed significantly since the last five-year review was conducted. Among the more notable changes in risk assessment methodologies are the following:

- A new dermal Risk Assessment Guidance for Superfund (RAGS-Part E) has been published and finalized in the past 5 years.

- New approaches for the statistical treatment of environmental data were published by the USEPA in December 2002. In addition, the USEPA now provides software (ProUCL) and guidance for calculating exposure concentrations to evaluate risks.

- The USEPA and the Navy have published guidance documents for the statistical treatment of background data. The USEPA and Navy approaches for evaluating background are somewhat different. The Navy advocates eliminating chemicals determined to be naturally occurring from the quantitative risk assessment, whereas the USEPA states that chemicals that exceed screening concentrations should be carried through the quantitative risk assessment. The USEPA recommends only eliminating chemicals with concentrations within background levels after the quantitative risk evaluation. However, the end result of the two approaches should be the same and should not affect the list of COCs for a site.

The five-year review indicates that none of the changes related to these recently published guidance documents should affect the protectiveness of the remedies established for the base.

Recently, volatilization of chemicals from groundwater into indoor air has become an exposure pathway of concern in risk assessments. Volatilization of chemicals from groundwater into indoor air may occur if buildings were constructed on a site with contaminated groundwater, thereby exposing individuals inside buildings or dwellings. Therefore, potential risks associated with chemical concentrations in indoor air as a result of vapor migration from impacted groundwater for OU-1, OU-1A, OU-3, and OU-4 were evaluated for hypothetical future on-site residents and workers.

The Johnson and Ettinger Vapor Intrusion Model (USEPA, 2004) was used to determine the indoor air concentration of a chemical that is present in groundwater. The model assumes that vapors of volatile chemicals are emitted from groundwater, migrate through cracks in building foundations, and accumulate in air inside buildings. The Johnson and Ettinger Model assume that residential dwellings or commercial buildings have been constructed on the site and that the building dimensions and ventilation rates are typical of residential and commercial buildings in the United States. The risk assessment was performed in two steps:

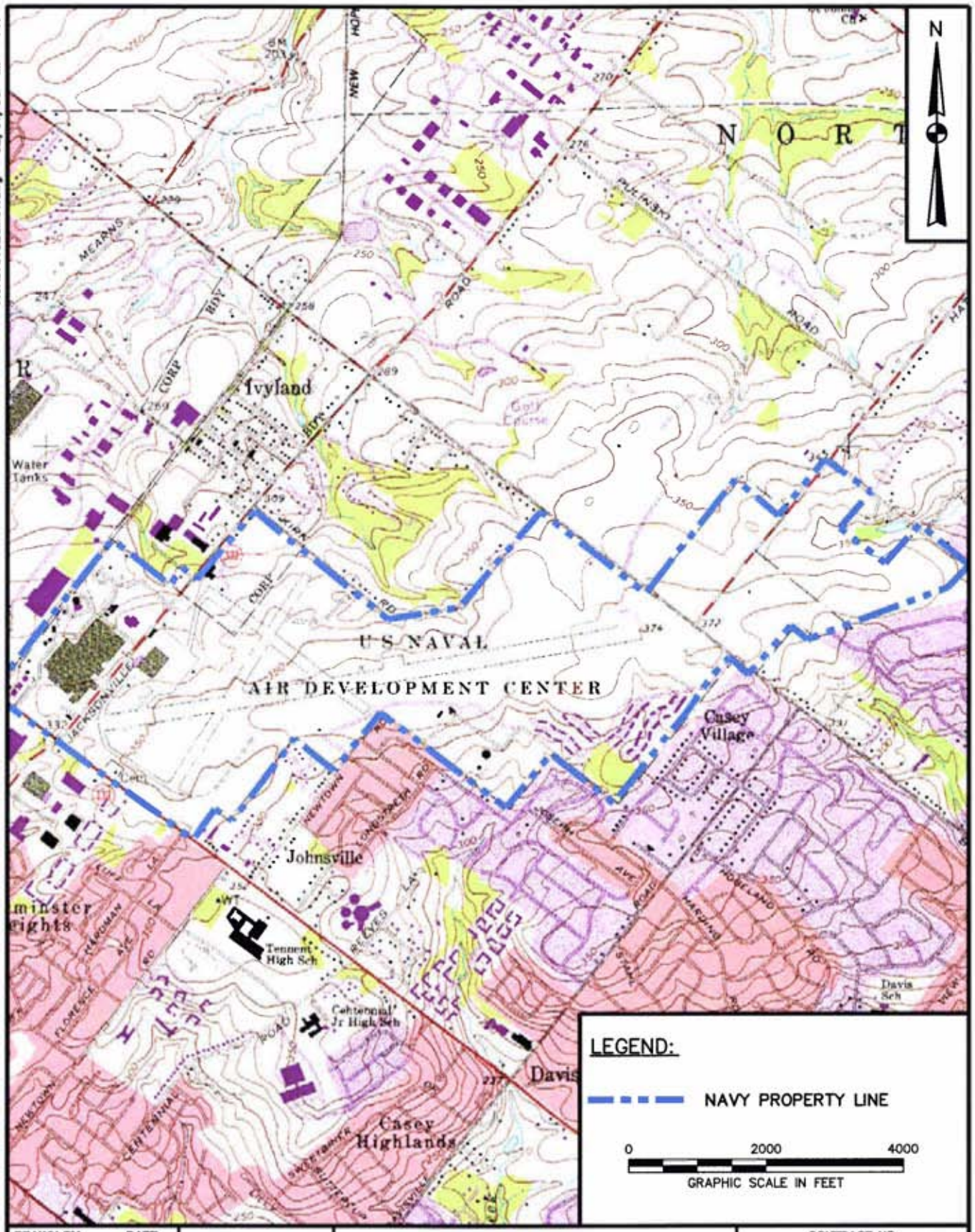
1. Concentrations in groundwater were compared to USEPA screening concentrations for vapor intrusion obtained from OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air

Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance), EPA530-D-02-004, November 2002.

2. If the maximum concentration of a chemical exceeded its screening concentration, risks for that chemical were evaluated using the Johnson and Ettinger Model. Typical USEPA exposure factors were used to quantify the potential risks. For example, residents and workers were assumed to inhale 20 cubic meters of air per day. Residents were assumed to be exposed 350 days per year for 30 years, and workers were assumed to be exposed 250 days per year for 25 years. The concentrations in indoor air were calculated by the Johnson and Ettinger Model.

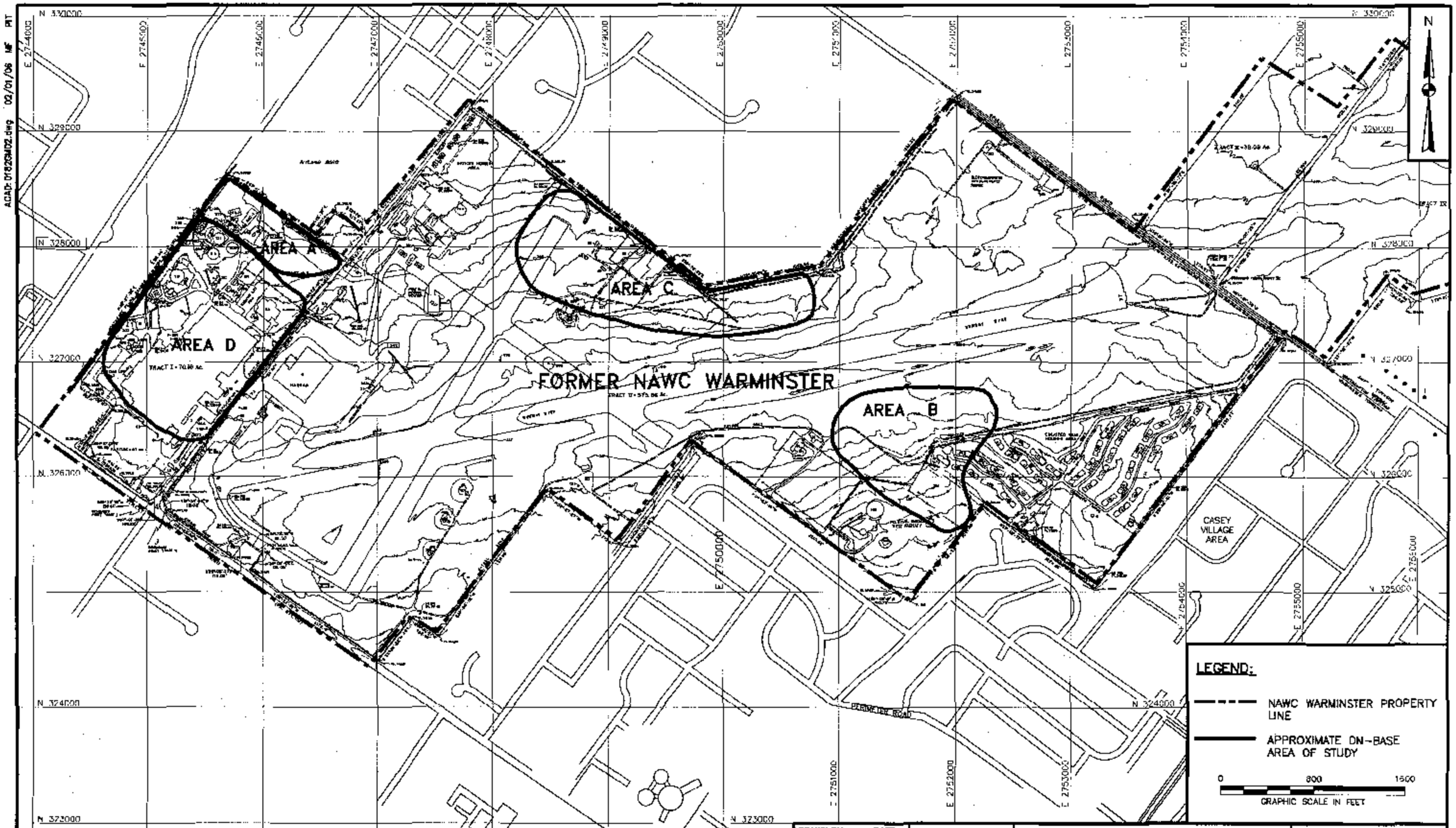
Results of the vapor intrusion risk analysis for OU-1, OU-1A, OU-3, and OU-4 are presented in Sections 3, 5, and 6 based on the 4th Quarter Fiscal Year 2005 long-term performance monitoring report.

ACAD: 0182GM01.dwg 02/01/06 MF PIT



DRAWN BY MF	DATE 2/1/06	Tetra Tech NUS, Inc.	SITE LOCATION MAP FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA	CONTRACT NO. 0182	
CHECKED BY	DATE			OWNER NO. 0000	
REVISED BY	DATE			APPROVED BY	DATE
SCALE AS NOTED				DRAWING NO. FIGURE 1-1	REV. 0

FORM CADD NO. TTNUS-AV.DWG - REV 1 -9/10/98



DRAWN BY MF	DATE 2/1/06	Tetra Tech NUS, Inc.	ON-BASE AREAS OF INVESTIGATION FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA
CHECKED BY	DATE		CONTRACT NO. 0182
REVISED BY	DATE		OWNER NO. 0000
SCALE AS NOTED			APPROVED BY / DATE
			DRAWING NO. FIGURE 1-2 / REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

2.0 AREA DESCRIPTIONS AND BACKGROUND

As mentioned in Section 1.0, initial investigations at NAWC Warminster were grouped into four areas based on actual and potential hazardous waste disposal locations. After these initial investigations, the Navy organized the work at these areas and sites into 10 OUs according to type, potential for a common remedy, proximity, contamination of a common resource, and funding priority. Descriptions of the four areas and disposal locations are presented below.

2.1 AREA A

Area A generally consists of Sites 1, 2 and 3 and adjacent areas in the northwestern corner of the former facility. In addition to Sites 1, 2, and 3, Area A includes the location of eight former impoundments utilized for the storage of industrial wastewater treatment sludge. Area A has been divided into two OUs. OU-1A consists of contaminated Area A groundwater, and OU-9 consists of Area A surface and subsurface soils and sediment and surface water associated with Area A. As an interim remedy, overburden and shallow contaminated Area A groundwater (along with overburden and shallow contaminated Area B groundwater) was formerly referred to as OU-1. The site locations in Area A are shown on Figure 2-1.

Area A is a flat-lying area, approximately 1,200 feet by 270 feet in size, that covers approximately 7.4 acres. An industrial area to the west and northwest and a wooded lot to the immediate north border Area A. An unnamed tributary of Little Neshaminy Creek is located along the northern edge of this area, and the former NAWC/current Warminster municipal wastewater treatment facility, former jet fuel storage area, and parking lots are immediately to the south.

The former NAWC is situated on an upland area divided between two local drainage basins, the Little Neshaminy Creek Basin on the north and the Pennypack Creek Basin on the south. The northern 65 percent of the former facility (including Area A) drains toward the north through several swales and storm sewers into small unnamed tributaries of Little Neshaminy Creek. An unnamed tributary of Little Neshaminy Creek flows in a northwestward direction immediately adjacent to Area A. This stream originates from a stormwater culvert under Jacksonville Road and flows to the northwest before turning north. The current stormwater outfall (OF1) within Area A and along the base boundary (in the area of Site 2) may represent the discharge point of a former stream on base property. Several additional outfalls between Jacksonville Road and outfall OF1 drain stormwater from the parking lot south of Sites 2 and 3. Between the base boundary and Bristol Road, this tributary flows through developed areas with numerous small manufacturing plants, apartment complexes, restaurants, and single-family residences to Little Neshaminy Creek, approximately 2.5 miles from NAWC Warminster.

A small forested wetland dominated by mature red maple and arrowwood was identified just north of outfall OF1 and beyond the base property boundary during a wetland assessment conducted as part of the Phase III RI. This assessment concluded that the stream and wetlands provide good ecological habitat within an urbanized landscape. There are no known critical habitats of endangered species located within 1 mile of Area A.

Soils observed within NAWC during RI field work ranged from 2 feet to more than 15 feet in thickness. Soil types observed included orange-red, brown, and maroon-red mixtures of silt, clay, and sand, with the finer-grained soils dominant.

A substantial portion of soils within Area A consists of fill materials. The topography of the area of Sites 2 and 3 has been significantly altered since the Navy first occupied the property. A former tributary of Little Neshaminy Creek, an associated ravine, and surface drainage pathways in the area of Site 2 were filled in and leveled in the 1950s. This area is now underlain by a storm sewer that drains the majority of NAWC property west of Jacksonville Road. A relatively steep slope descends from the leveled area of Site 2 to the subject tributary. Similarly, although the area of Site 3 formerly consisted of a more gradual slope to a tributary of Little Neshaminy Creek, this area was also regraded by placement of fill in the 1950s. As with the area of Site 2, a steep slope descends from the area of Site 3 to the remaining tributary. Although the topography of Site 1 does not appear to have been altered substantially since Navy ownership of the property, the area of Site 1 contains a substantial amount of fill material.

The eight former impoundments located in the northwestern portion of Site A have been filled in with fill materials consisting primarily of silt and clay, with minor amounts of sand and rock fragments. Typically, the soil grades into weathered bedrock at depths of about 8 to 10 feet below ground surface (bgs) and to competent bedrock at a depth of about 15 feet bgs. The transition from soils to weathered bedrock to competent bedrock occurs gradually and varies somewhat in depth across Area A.

The bedrock units of the Stockton Formation dip gently to the north-northwest. Lithologic units typically vary in thickness from less than 1 foot to about 50 feet. The fine-grained lithologic units are described as mudstones and typically consist primarily of red-brown siltstones and shales. The coarser-grained rock units typically consist of fine- to coarse-grained arkosic sandstones, ranging in color from red-brown to gray and green-gray.

The major source of groundwater in the vicinity of NAWC is the fractured bedrock of the Stockton Formation. The middle arkose member of the Stockton Formation is considered to be the most productive bedrock aquifer in Bucks County. These rocks form a multi-aquifer system of relatively discrete water-bearing zones separated by less permeable zones. Transmissivity and groundwater movement within water-bearing zones are greater parallel to bedding than across bedding. Groundwater in the Stockton

Formation occurs locally under both confined and unconfined conditions. Bedrock underlying the base consists of alternating coarse- and fine-grained sedimentary bedrock units of the Stockton Formation underlying a thin veneer of clayey residual soils.

Groundwater in the vicinity of Area A occurs primarily within the underlying bedrock units. Groundwater is encountered in discrete fractures within the rock mass. Interconnected networks of fractures within the bedrock serve as the primary groundwater migration pathways. Within the bedrock, the sandstone units function as the primary water-transmitting units, and the fine-grained mudstone units act as semi-confining layers to groundwater flow. Both sandstones and mudstones are fractured to varying degrees; however, fractures in the sandstones tend to have higher yields and, as a result, the sandstone units act as preferential zones of groundwater flow. Below a depth of about 80 to 100 feet, groundwater occurs under semi-confined conditions. The overall groundwater flow direction beneath Area A is generally to the north and northwest.

2.1.1 Area A Site Descriptions

2.1.1.1 Site 1

In 1980, the Navy initially reported Site 1 as a potential location of hazardous substance disposal. At the time, Site 1 was reported to include a burn pit operated from 1940 to 1955 and located at the embankment of a ravine formed by erosion (Figure 2-2). Waste materials were reportedly dumped over the bank and burned. The wastes reportedly disposed included inorganics, solvents, acids, bases, and firing range waste. The volume of material disposed was unknown. Site 1 was reportedly closed by covering the site with excess soil generated by grading an extension of an aircraft runway. Site 1 burn pit was reported to be located along the base property boundary, northwest of the base wastewater treatment plant.

Site 1 is located approximately 300 feet from an unnamed tributary of Little Neshaminy Creek and currently includes an extraction well network constructed as part of the remedy for Area A groundwater (see OU-1A), a gravel access road, and grass.

2.1.1.2 Site 2

In 1980, the Navy reported Site 2 to be the location of a 200-foot by 12-foot by 8-foot trench used for the disposal of approximately 1,400 cubic yards of industrial wastewater treatment sludge (Figure 2-3). The disposal area was reported to be about 150 feet southwest of Site 2, along the northeastern NAWC property boundary, was used from 1965 to 1970, when the site was closed with 2 feet of cover and revegetated.

The area of Site 2 currently includes paved and gravel roads, a paved parking lot, an extraction well network for Area A groundwater, erosion controls, and maintained lawn.

2.1.1.3 Site 3

Site 3 is immediately southeast of Site 2, (Figure 2-4) along the northeastern base property boundary. It was reportedly used from 1955 to 1965 as a burn pit for solvents, paints, acids, bases, mixed municipal waste, and other unspecified chemicals. The pit was reportedly approximately 20 feet wide by 30 feet long by 10 feet deep and was covered by a large metal screen enclosure. Residue from the pit was reportedly removed periodically and deposited at an unspecified, on-base "sanitary landfill." Upon closure in 1965, Site 3 was reportedly backfilled with on-base soil and regraded.

The stream bank of the unnamed tributary of Little Neshaminy Creek is adjacent to Site 3, and an asphalt access road lies within 10 to 20 feet of this site. Most of the area of Site 3 is a sparsely vegetated lot.

2.1.1.4 Impoundment Area

The Navy formerly operated eight unlined impoundments or lagoons immediately south of Site 1 (Figure 2-2). The lagoons were used for storage of wastewater treatment sludges generated by the industrial wastewater treatment plant just south of Area A. Each lagoon was approximately 60 feet wide by 75 feet long, with depths of approximately 8 to 10 feet. The first impoundments were installed as early as 1940 and reportedly closed in 1973. The area of the former impoundments currently includes level ground, two concrete-lined basins constructed prior to 1977, and a groundwater treatment plant constructed as part of the remedy for contaminated groundwater attributable to the base (OU-1).

The former unlined impoundments received sludge generated from treatment of industrial wastewaters generated by NAWC. The wastewaters included liquids from electroplating operations, photographic operations, aircraft maintenance and washing activities, and several laboratories. The industrial wastewater was treated through neutralization and metals precipitation. No treatment for organic compounds was performed. Apparently, the solid phase of the sludges stored in these impoundments was periodically removed and disposed at other locations at the base. The lagoons were clean-closed in 1973, backfilled, and replaced with two concrete-lined impoundments.

A fuel farm was located immediately south of the former location of the unlined lagoons. This area included a gas station with gasoline and diesel fuel underground storage tanks (USTs), four 15,000-gallon JP-5 USTs, and a storage building. The tanks were removed by the Navy. No releases are known to

have occurred in this area; however, localized PCE contamination has historically been detected in groundwater in the general vicinity of the fuel farm.

2.1.2 Land and Resource Uses

Area A groundwater underlies the northwestern portion of the NAWC, as well as an off-base area to the north and northwest of NAWC. Onbase, Area A groundwater underlies the groundwater treatment plant, extraction wells, parking lots, paved roads, two concrete-lined basins, and maintained lawn. The onbase portion of the transferred property that is underlain by Area A groundwater was targeted by an approved re-use plan prepared by the FLRA for industrial use. The re-use plan for the base identified industrial use as the planned use for Area A. A portion of this area was transferred to the Warminster Township Municipal Authority (WTMA) under an economic development conveyance (EDC) or public benefit conveyance (PBC), and the remainder of Area A has been retained by the Navy.

The off-base properties adjacent to Area A consist of land used for industrial purposes and a wooded lot. WTMA operates a supply well, located about 1,900 feet north of Area A, that intercepts groundwater migrating from Area A. Off-base groundwater is considered part of a Class IIA aquifer under USEPA's groundwater protection strategy. No other supply wells are known to be in use on property underlain by Area A groundwater.

2.1.3 Investigations and Initial Response Actions

In response to the identification of on-base groundwater contamination with volatile organic compounds (VOCs) in February 1980, two soil borings were installed in the vicinity of one of the two concrete basins in the Impoundment Area to identify potential sources of VOCs. Analysis of soil samples from these two borings had TCE concentrations of up to 78 micrograms per kilogram (µg/kg).

The following sections briefly summarize the RI activities and response actions for Area A at former NAWC Warminster.

2.1.3.1 Area A Investigations

Phase I (1989 - 1991): RI activities involved mapping VOCs in soil gas and detecting magnetic and conductive anomalies through electromagnetic surveys. Approximate site boundaries were identified and confirmation of site contamination was made through soil borings, installation of overburden and shallow bedrock monitoring wells, and groundwater sampling and analysis. Surface water and sediment samples were collected from the unnamed tributary draining Area A, and a biological characterization of the

tributary was performed. No soil or waste samples were collected for analysis. The draft Phase I RI report for the entire base (including Area A) was issued in April 1991.

Phase II (1992 - 1993): RI/FS work helped determine the nature and extent of groundwater contamination, evaluate shallow groundwater flow and add to the hydrogeologic database, and ascertain possible remedial alternatives. Activities included installing additional overburden and shallow bedrock monitoring wells; sampling and analyzing groundwater, surface water, sediment, and soils; and evaluating aquifer characteristics through water-level monitoring and a pumping test. Groundwater-related RI/FS reports for OU-1 were released in April 1993. At the end of Phase II, the Navy and USEPA selected an interim remedy for contaminated shallow groundwater attributable to Area A (as well as Area B) at the base, referred to as OU-1.

Focused RI/FS for Groundwater (1993 - 2000): From 1993 through 1995, the Navy expanded Area A groundwater studies to address deep aquifers and off-base, downgradient areas. Determination of both the lateral and vertical extent of groundwater contamination and hydrogeologic conditions within Area A were the focus of these investigations. Previous and new monitoring wells were sampled, and a water-level study was performed. The results of these investigations indicated that Area A groundwater contaminants at levels of concern had migrated to off-base areas. In addition, the detection of high concentrations of contaminants on base suggested the potential presence of dense non-aqueous phase liquid (DNAPL) contamination in the bedrock aquifer. In response to the findings of the ongoing RI work, the Navy upgraded an air stripper on a nearby municipal supply well (WTMA Well 26) to make sure that the water supply was protected. Well 26 is located approximately 1,900 feet north of the base property boundary (Figure 2-5). The Navy also connected an adjacent commercial facility to the public water system.

In 1996 and 1997, the Navy conducted additional investigations to better characterize groundwater flow and hydrogeologic conditions in and around Area A. An inactive, off-base commercial production well was tested in December 1996 to evaluate the hydrogeologic conditions within the well, to investigate the hydraulic connection between the well and Area A groundwater, and to evaluate groundwater quality conditions at different depths within the well.

In September 1997, the Navy performed a water-level study of Area A groundwater that addressed off-base/downgradient areas. The study was performed to determine the impacts of the operation of WTMA Well 26 on groundwater levels and flow direction in the area between the well and the base. In December 1997, the Navy conducted a comprehensive round of groundwater monitoring that included the available monitoring wells in and downgradient of Area A. The comprehensive round of groundwater

monitoring was performed to provide an updated “snapshot” of groundwater conditions and included the collection of comprehensive rounds of water-level measurements.

A final RI/FS report for Area A groundwater (designated as OU-1A) was submitted in June 2000. This report considered the information generated for Area A groundwater since the interim remedy was selected and the results from the operation of the interim remedy since July 1999.

Starting in 1994, the Navy has been conducting a groundwater monitoring program. This program consists of sampling selected wells on base and in the surrounding areas (including within and around Area A). It has been performed periodically by the Navy as a part of the monitoring required by RODs issued by the Navy and USEPA. Following each round of monitoring, a report is generated that provides the results along with historical data from previous rounds of monitoring. The most recent round of groundwater sampling was completed in April 2006.

Phase III (1995 - 2000): The primary RI objective during this phase was to characterize sources of contamination, primarily soils and wastes, at known and potential waste disposal sites. RI work for OU-9 (Area A soils, surface water, and sediment included a soil gas survey, multiple surface geophysical surveys, test pits and soil borings, and soil and waste sampling and analysis. A surface water and sediment sampling and analysis program was performed to evaluate the impacts of Area A on the nearby stream. An assessment of wetlands near Area A was also conducted. A final RI/FS report for OU-9 was released in April 2000.

2.1.3.2 Area A Response Actions

OU-1: The OU-1 Interim ROD, signed in September 1993, selected an interim remedial action to minimize the migration of contaminated groundwater while additional RI work was performed to determine the full nature and extent of Area A groundwater contamination. The interim remedy included pumping and treatment of Area A groundwater and periodic testing of groundwater in monitoring wells and other wells near the base.

Construction of the groundwater treatment system began in July 1996, but the drilling and installation of Area A extraction wells were deferred while additional RI work addressing Area A soils and groundwater was completed. The interim remedy for Area A groundwater was constructed by July 1999.

During the construction of the OU-1 remedy, the Navy excavated contaminated soils beneath the footprint of the treatment plant building and along the route of groundwater transfer piping near Area A. The soils were disposed in an off-base landfill. This work was performed in 1996.

Using Navy funds, one commercial property with a contaminated well was connected to the WTMA system in the summer of 1995. This property was located north of Site 2.

OU-9: During the construction of the groundwater treatment plant, elevated concentrations of metals were encountered adjacent to and within the former Impoundment Area. A removal action was conducted in 1996 to remove soils at two locations beneath the footprint of the treatment plant building and surrounding property. Approximately 430 cubic yards of soil were removed from within the excavation areas. Soils were removed until contaminant concentrations within the excavation areas were either within the range established for background soil concentrations or less than the risk-based soil screening concentrations for industrial use. The cleanup levels were as follows:

- Beryllium: 1.7 milligrams per kilogram (mg/kg)
- Chromium: 1,000 mg/kg
- Manganese: 400 mg/kg
- Aroclor 1260: 370 µg/kg

During the course of the Phase III RI, several removal actions were performed in response to the detection of hazardous substances that presented a risk to human health and the environment. Based on preliminary RI results, about 6,700 tons of non-hazardous Area A surface and subsurface soils were excavated, transported, and disposed in an off-base landfill between August 1998 and January 1999 (Figure 2-6). The soils were excavated from two separate locations within Site 1, three locations within Site 2, and one location near Site 3. An Action Memorandum for the Area A soil removal action was signed by the Navy in June 1998. A small amount (about 100 pounds) of flammable solids or corrosive liquids was also disposed. Post-removal soil sampling was performed to confirm that cleanup goals established for the protection of groundwater and human health were attained with the designated removal action areas.

Removal cleanup goals were established for each contaminant based on the potential risks identified through the RI work. Additional sampling and analysis were performed until the removal cleanup goals were met for the soils of concern. Samples were collected from the base and sidewalls of each excavation to verify the completeness of the response actions. The sample analysis results were compared to target cleanup concentrations protective of industrial land use, ecological receptors, and groundwater quality. Any exceedances of target cleanup concentrations in a confirmation sample were followed by additional excavation of the area where the sample was collected. Where soils remained after the additional excavation, supplemental verification samples were obtained and analyzed for the compounds that initially exceeded the target concentration to verify that sufficient excavation had been

performed. As a result, there were no exceedances of target cleanup concentration for the final samples from each excavation location sampled.

Approximately 3,600 cubic yards of material were removed from Excavations 1A and 1B at Site 1. The cleanup concentrations are presented in Table 2-1.

For Site 2, approximately 800 cubic yards of soils within Excavation 2A were removed from the surface to depths of 2 to 4 feet bgs. Soils were also removed from two other areas at Site 2, Excavation 2B and Excavation 2C. Soils in Excavation 2B were removed based on the observation and detection of petroleum products. Petroleum products were also observed and detected in subsurface soil adjacent to Excavation 2B under the paved access road. Soils within Excavation 2C were removed to a depth of 2 feet based on the detection of elevated concentrations of benzo(a)pyrene that was determined to present an unacceptable risk to receptor sediment quality. A total of 30 cubic yards of soil was removed from Excavation 2C. The cleanup concentrations are presented in Table 2-1.

For Site 3, soils within the excavation area (Excavation 3) were removed from the surface to depths of 2 to 3 feet bgs. Surface soils were removed until contaminant concentrations on the sidewalls of the excavation area were less than cleanup concentrations (Table 2-1). Approximately 380 cubic yards of soil were removed from Excavation 3.

The results of the RI work addressing soils, sediment, and surface water associated with Area A were described in the OU-9 RI/FS Report for Area A submitted in April 2000. This report characterized Area A prior to and after the removal actions and contained an assessment of risk posed by OU-9 to human health and the environment after the removal actions. Although the April 2000 RI/FS report assessed the potential impact of soils at Area A on groundwater quality, the report did not address underlying and downgradient groundwater, which was identified as Area A groundwater. The OU-9 ROD was signed in June 2000.

OU-1A: Based on the focused RI for Area A groundwater, including the results of several supplemental investigations and the interim remedy for Area A groundwater, a final remedy ROD for Area A groundwater was signed in September 2000. The final remedy consists of extracting the contaminated groundwater, treating the contaminated groundwater in an on-base treatment plant, and discharging the treated water to an unnamed tributary of Little Neshaminy Creek.

2.1.4 Nature and Extent of Contamination

Potential sources of hazardous substances within Area A include various pits, trenches, dumps, and miscellaneous disposal features associated with Sites 1, 2, and 3 and the former unlined impoundments.

Significant conclusions of the RI regarding conditions after the Area A soil removal actions were as follows:

- For surface soils, only benzo(a)pyrene frequently exceeded screening criteria for protection of human health.

- Concentrations of polynuclear aromatic hydrocarbons (PAHs) and metals such as copper, lead, and zinc were detected at concentrations greater than background in both surface and subsurface soils.

- Soil screening levels (SSLs) protective of groundwater were exceeded for certain metals. However, these metals are not present in Area A groundwater at significant concentrations.

- VOCs found in Area A groundwater were not found at significant concentrations in Area A soils.

- Low concentrations of VOCs were detected in Area A surface water, including TCE, PCE, carbon disulfide, and chloromethane. In addition, elevated concentrations of copper, zinc, and lead were detected in surface water.

- Numerous organic and inorganic substances were detected in sediment at concentrations greater than background and screening levels protective of ecological receptors.

2.1.4.1 Site 1 Soils

Test pits and soil borings conducted as part of subsurface investigations at Site 1 encountered non-native materials such as wood, fabric, blankets, cinders, charred material, and fill material. In addition, an area of multicolored silty clay material was observed in the subsurface. This material covered an area of about 0.25 acre and was observed to be present from approximately 2 to 8 feet bgs. Sampling of the multicolored clay material consistently identified elevated concentrations of cadmium and antimony. The detected concentrations of cadmium and antimony were determined to present an unacceptable risk to industrial receptors exposed via dermal contact.

In response to these findings, the Navy performed a removal action in 1998 to excavate the subject material. The RI/FS report for OU-9 provided data regarding the quality of soils left in place at Site 1 after the removal action. The RI risk assessment determined that none of the remaining substances in subsurface soils posed an unacceptable risk to human health under reasonably anticipated land uses, and the ecological risk assessment determined that these soils did not pose an unacceptable risk to environmental receptors. As a result, there are no COCs for Site 1 subsurface soils under reasonably

anticipated land uses. In addition, the surface soils were replaced by clean fill and soil as part of the removal action. As a result, there were no contaminants of concern for Site 1 surface soils.

2.1.4.2 Site 2 Soils

Test pits and soil borings installed as part of subsurface investigations at Site 2 encountered non-native materials such as cinders, glass fragments, ceramic pieces, brick fragments, metal fragments, charred debris, and fill material. In addition, a blue-green crystalline material was observed in surface and subsurface soils in several portions of Site 2. Sampling of soils containing this blue-green material identified elevated concentrations of lead, antimony, copper, and zinc. The detected concentrations of lead and antimony were determined to present an unacceptable risk to industrial receptors.

In response to these findings, the Navy performed a removal action to excavate the soils of concern. The RI report for OU-9 provided data regarding the quality of soils left in place at Site 2 after the removal action. The RI risk assessment determined that none of the remaining substances in surface or subsurface soils posed an unacceptable risk to human health under reasonably anticipated land uses. However, the ecological risk assessment determined that Site 2 surface and subsurface soils presented a potential threat to ecological receptors if allowed to migrate to the unnamed tributary of Little Neshaminy Creek. The COCs for Site 2 soils in this case included metals, PAHs, and pesticides.

2.1.4.3 Site 3 Soils

Site 3 subsurface investigations encountered non-native materials such as cinders, glass fragments, ceramic pieces, brick fragments, metal fragments, charred debris, and fill material. A layer of charred material was encountered several feet below ground surface. However, no evidence of the presence of the reported 2-foot-deep burn pit was encountered during RI work. Elevated concentrations of organic vapors were detected in the charred layer with a photoionization detector (PID), and petroleum odors were evident. Similar observations were noted for several soil borings advanced in the paved access road in the area of Site 3. Elevated concentrations of PAHs such as benzo(a)pyrene were detected in surface soil samples at Site 3

The detected concentrations of these compounds were determined to present an unacceptable risk to sediment quality. In response, the Navy performed a removal action to excavate the soils of concern. The RI report for OU-9 provided data regarding the quality of soils left in place in the area of Site 3 after the removal action. The RI risk assessment determined that none of the remaining substances in surface or subsurface soils posed an unacceptable risk to human health under reasonably anticipated land uses. However, the ecological risk assessment determined that Site 3 subsurface soils presented a potential

threat to ecological receptors if allowed to migrate to the unnamed tributary of Little Neshaminy Creek. The COCs for Site 3 subsurface soil included metals and PAHs.

2.1.4.4 Impoundment Area Subsurface Soil

The primary objective of RI sampling at the Impoundment Area was to characterize the quality of soil below the fill material reportedly placed in the former impoundments as part of the closure process. As a result, surface soil samples were not collected. Soil borings encountered non-native materials such as rock, cinders, roots, concrete, and brick at certain locations. Elevated concentrations of several metals (including beryllium, chromium, and manganese) and Aroclor-1260 [a polychlorinated biphenyl (PCB)] were detected in samples at concentrations greater than risk-based soil screening concentrations collected at the location of former impoundment IM8. The detected concentrations were determined to present an unacceptable risk to human health. In response, in 1995, the Navy performed a removal action to excavate the soils of concern.

The RI report for OU-9 provided data regarding the quality of subsurface soils in the impoundment area. A risk assessment determined that these soils did not pose an unacceptable risk to human health under reasonably anticipated land uses or to ecological receptors. Therefore, there were no COCs in the Impoundment Area soils.

2.1.4.5 Area A Surface Water and Sediment

OF3 is the location of an outfall that discharges surface runoff from both Jacksonville Road and NAWC property west of Jacksonville Road. OF1 discharges surface runoff from the majority of NAWC property west of Jacksonville Road, and OF2 discharges runoff from the parking lot south of Sites 2 and 3. Surface water sample results were compared to Ambient Water Quality Criteria (AWQCs) protective of aquatic life developed pursuant to the federal Clean Water Act. Exceedances of lead, copper, zinc, and iron, contaminants detected at elevated concentrations in Site 2 soils, occurred only in samples collected downstream of OF1 and Site 2.

The RI determined that many of the detected concentrations of organics and inorganics in sediment samples exceeded available screening criteria indicative of a potential risk of concern to ecological receptors. PAHs, a class of compounds that exceeded the screening criteria in most of the samples collected, were detected at the greatest concentrations next to OF3, which is upgradient of the majority of Area A and is the entrance point of surface drainage from Jacksonville Road. Lead was also detected at concentrations greater than screening levels at this location. PAHs and numerous metals were also elevated at sample locations immediately downstream of OF1 and Site 2.

2.1.4.6 Area A Groundwater

Significant conclusions of the RI for Area A groundwater were as follows:

- Groundwater investigations in Area A focused primarily on three hydrogeologic units, designated in order of decreasing depth: A, B, and C.

- Hydrogeologic unit B was of most importance to the investigation in terms of groundwater contaminant occurrence and migration from Area A. This hydrogeologic unit comprises the sandstone unit found at depths of 15 to 100 feet along the northern edge of Area A. Flow within this unit was to the north and northwest.

- Hydrogeologic unit B was the unit with the greatest levels of TCE, carbon tetrachloride (CCl_4), and other COCs (Figure 2-7).

- The performance data from the operation of the OU-1 interim remedy indicated that the existing extraction well system was containing the source area of contamination.

- The suspected source of persistently observed Area A groundwater contamination was residual DNAPL contamination present within the bedrock fracture network and, to a lesser degree, within the intergranular pores of the rock.

- A diffuse contaminant plume that extends downgradient of the capture zone area of the extraction well network appeared to be captured and treated by WTMA Well 26.

The RI work addressing Area A groundwater was summarized in a final RI Report for OU-1A issued in June 2000.

2.1.5 Assessment of Risks

As part of the RI work, risk assessments were conducted with available data to estimate the potential risks posed to human health and the environment by Area A soils, surface water, sediment, and groundwater. In the case of soils, the risk assessment addressed conditions after the performance of the removal actions.

2.1.5.1 Area A Surface and Subsurface Soils

No estimated carcinogenic and noncarcinogenic risks greater than USEPA's target risk levels of 1.0×10^{-4} and 1.0, respectively, were present for the industrial and commercial scenario evaluated for chemicals of potential concern (COPCs) in Area A surface or subsurface soils. These were the greatest carcinogenic risks identified under intended reuse and fall within the USEPA's target risk range (10^{-4} to 10^{-6})associated with the most likely future land use scenario (industrial/commercial).

Both noncarcinogenic and carcinogenic risks above USEPA's target risk levels of 1.0 and 1×10^{-4}, respectively, were estimated for the hypothetical future residential child scenario evaluated for COPCs in Area A surface and subsurface soil. Specifically, non-cancer risks were identified in Site 2 surface soils and in subsurface soils in the four Area A sites (Sites 1, 2, and 3 and Impoundment Area). Cancer risks were identified in subsurface soils in Site 3. The removal action at Site 3 was not intended to remove contaminants to a level protective of this scenario because the intended reuse is expected to be industrial/commercial.

The individual noncarcinogenic Hazard Quotients (HQs) were less than 1.0 for ingestion and dermal contact with COCs in Area A stream sediment by recreational child receptors. The combined estimated cancer risks were 1.5×10^{-6} for ingestion of and 3.1×10^{-7} for dermal contact with sediment for recreational child receptors.

2.1.5.2 Area A Surface Water and Sediment

Potential risks from metals in surface water in the tributary of Little Neshaminy Creek were generally indicative of low potential risk to the environment, as were potential risks from organics in surface water. In sediments, inorganic Ecological Effects Quotients (EEQs) were also mostly indicative of low potential risk, although some elevated EEQs were calculated for lead, manganese, and zinc, and concentrations of these metals were elevated downstream from Area A. EEQs for PCBs and some pesticides were indicative of moderate to high potential risk, but potential risks were heavily mitigated by several factors. Potential ecological risks for several PAHs in sediment were moderate to high, and frequencies of detection were generally high. Also, elevated concentrations of some PAHs were detected in samples taken several hundred feet from Area A and far downstream of Area A near Bristol Road. Heavily developed areas exist offbase near the tributary that contribute PAHs to the waterway, but the presence of highly elevated concentrations of PAHs adjacent to Area A suggested significant contaminant inputs from base-related activities.

2.1.5.3 Area A Groundwater

The human health risks associated with potential exposure to Area A groundwater were evaluated as part of the RI for OU-1A. Because Area A groundwater is hydraulically connected with groundwater captured by an operating municipal supply well, the risk assessment assumed that Area A groundwater may potentially be used by residents for domestic purposes.

The interim RI Report and interim remedy ROD for OU-1 presented the baseline risk assessment for Area A groundwater. The final RI for Area A groundwater presented a qualitative risk assessment that compared groundwater quality data generated since the interim RI to federal Safe Drinking Water Act MCLs.

The baseline risk assessment for Area A groundwater found that carcinogenic and noncarcinogenic risks were unacceptable. Carcinogenic risks were estimated to be as high as 9.9×10^{-4}. The primary contributors to the carcinogenic risk were identified as TCE, carbon tetrachloride, PCE, 1,1-DCE, chloroform, vinyl chloride, and arsenic. The noncarcinogenic risks were estimated to correspond to Hazard Indices (HIs) of up to 93. The primary contributors to the noncarcinogenic risk were TCE, carbon tetrachloride, PCE, cis-1,2-DCE, arsenic, barium, and thallium. In addition, TCE and PCE were found to exceed MCLs at multiple well locations, and carbon tetrachloride, vinyl chloride, 1,2-DCA, cadmium, manganese, nickel, arsenic, and barium each exceeded MCLs at one well location.

The final RI for OU-1A included a qualitative risk assessment that compared groundwater quality data generated since the interim RI to MCLs. This assessment found MCL exceedances of TCE, carbon tetrachloride, PCE, 1,1-DCE, cis-1,2-DCE, 1,1,1-trichloroethane (TCA), 1,1,2-TCA, vinyl chloride and benzene. These are the COCs in Area A groundwater according to the final RI, with the exception of 1,1,1-TCA, which is attributable to non-site related sources, and 1,2-DCA, which was detected in one well out of 12 rounds of sampling.

The final RI also further assessed risks presented by metals in Area A groundwater by evaluating sampling results generated since the Interim RI. Only thallium and iron were detected at concentrations exceeding MCLs. Thallium [MCL of 2 micrograms per liter (µg/L)] was detected in unfiltered samples in 2 of 20 wells at concentrations of 4.3 µg/L and 5.3 µg/L. However, in each case, no thallium was detected in filtered samples, which are more representative of groundwater pumped for domestic use. Therefore, thallium is not considered a groundwater COC. Iron was detected at concentrations greater than the MCL in wells constructed with steel casing. As a result, the detected iron does not appear attributable to the site and is not a COC.

An evaluation was also conducted to determine if Area A groundwater quality was threatened by Area A soils. Contaminant concentrations in Area A soils were compared to SSLs protective of groundwater quality, and none of the soil contaminants exceeding these criteria are COCs in Area A groundwater. As a result, Area A soils do not present a threat to groundwater quality.

2.1.6 Current Status

As part of the DoD closure of NAWC Warminster, the FLRA of Bucks County was given the opportunity to develop the property and bring new opportunities for employment at the base. The redevelopment plan for the base calls for industrial land use in the vicinity of Area A. Adjacent to Site 1 and the Impoundment Area, the WTMA has built a wastewater treatment plant. The Navy transferred land in the vicinity of Site 1 to WTMA as part of a PBC through the U.S. Department of Health and Human Services (HHS). Near Site 2, a morgue for the Bucks County Department of Health has been built. The Navy transferred land associated with the morgue to Bucks County as part of a second PBC, also through HHS. The remaining property in the vicinity of Area A, including Site 3, was transferred to the FLRA.

In September 1999, the Navy began a long-term stream monitoring program for the unnamed tributary to Little Neshaminy Creek north of Area A. A total of eight rounds of stream monitoring were completed by November 2001, at which time the monitoring program was discontinued.

2.2 AREA B

Area B comprises Sites 5, 6, and 7 and has been divided into four OUs (see Figure 2-8). OU-1B consists of contaminated Area B groundwater, OU-2 addresses contamination of domestic well water for residences near the base, OU-7 addresses soils and wastes associated with Sites 6 and 7, and OU-10 consists of Site 5 soils and sediment and surface water associated with Area B.

Area B is located in the southeastern section of the former base and encompasses part of the Shenandoah Woods Navy housing area. Area B groundwater is considered to be groundwater potentially impacted by Sites 5, 6, and 7. Groundwater in the off-base Casey Village Area is not considered to be part of Area B groundwater.

Soils at Site 5 extend to depths of 4 to 14 feet, where weathered bedrock is encountered. The soils at the site primarily consist of silt loam with slow to moderate permeability. Soils at Sites 6 and 7 primarily consist of silt and clay with minor amounts of sand and extend to an average depth of 10 feet bgs, where a transition to weathered bedrock begins. Competent bedrock begins at a depth of 10 to 20 feet.

Surface topography across parts of Sites 6 and 7 slopes toward Site 5. The slope across Site 5 is about 3 percent. Stormwater collecting in the vicinity of Site 5 is designed to be discharged through two stormwater drains. The stormwater is then piped underground to Outfall No. 11 (OF11) at the south-central base property boundary. OF11 also collects surface runoff in the form of sheet flow from Area B.

From OF11, stormwater flows to the south in a subsurface channel for 500 feet, where the stormwater is discharged to a surface concrete channel. The surface concrete channel flows through a residential subdivision for about 1,000 feet and through a road culvert before flowing into a streambed. This stream flows through a shaded 250-foot reach before entering a small and shallow off-base pond that overflows into a second small pond that flows into Southampton Creek. Minimal flow and virtually no biotic component were observed during the RI within the approximately 1,000-foot length of the surface concrete channel.

Several wetlands occur downstream along Southampton Creek south of Area B. These wetlands are primarily palustrine, forested, broad-leaved deciduous, and temporary. There are no known critical habitats of endangered species located within 1 mile of Area B.

The geology of Area B consists of a thin veneer of residual soils overlying sedimentary bedrock of the Stockton Formation. The soils consist primarily of silt and clay, with some sand, and extend to an average depth of about 10 feet bgs. The transition from soils to competent bedrock typically occurs gradually over a depth of about 5 to 10 feet, due to the effects of weathering on the bedrock surface. The bedrock surface within Area B slopes gently to the south and southeast, mimicking ground topography.

The bedrock of the Stockton Formation consists of alternating sequences of fine- and coarse-grained, gently dipping rock units. Lithologic units vary in thickness from less than 1 foot to a maximum observed thickness of about 60 feet within Area B.

The overall direction of groundwater flow across Area B is to the south. Shallow groundwater flow (less than 60 feet deep) across Area B is generally to the south. Intermediate-depth (60 to 110 feet) groundwater flow across Area B is to the south and is similar to the shallow groundwater flow pattern. As with the shallow and intermediate-depth groundwater, deep (greater than 110 feet deep) groundwater flow across Area B is generally to the south.

2.2.1 Area B Site Descriptions

2.2.1.1 Site 5

Site 5, which is located within the enlisted personnel housing area, was initially reported in the Navy Shore Facility Fact Form (see Figure 2-9). Site 5 reportedly consisted of up to eight trenches used for the disposal of demolition wastes, paint, solvents, scrap metal, aircraft paints, cans, and asphalt. The trenches were reportedly operated from 1955 to 1970 and were approximately 12 feet by 70 feet by 8 feet in dimension and were covered with 2 feet of fill, graded, and seeded. Site 5 is contained within a parcel of land that will be retained by a nearby Navy base [NAS Joint Reserve Base (JRB) Willow Grove]. A housing unit designated as Building 401, paved roadways and walkways, and lawns currently occupy the area of Site 5. Buildings 402 and 403 are immediately adjacent to Site 5. Historical aerial photographs indicate these housing units were constructed within the apparent disposal area after disposal occurred.

2.2.1.2 Sites 6 and 7

Sites 6 and 7 are contained within a parcel of land that has been transferred to the FLRA and local municipalities under a PBC (Figure 2-10). The re-use plan for Sites 6 and 7, prepared by the FLRA and approved by the local municipalities, identifies recreational use as the designated use for this land.

Sites 6 and 7 are located within the same area north of Site 5. Site 6 was reportedly used for disposal activities from 1960 to 1980. The site reportedly received unknown quantities of waste paints, solvents, oil, flammable wastes, grease trap waste, and demolition debris. These materials were reportedly disposed in pits excavated by backhoe through general dumping and backfilling throughout the area.

Site 7 reportedly consisted of two disposal trenches used from 1950 to 1955 to receive sludge from the wastewater treatment plant. The trenches were reportedly 100 feet long by 12 feet wide and 8 feet deep. The estimated potential capacity of each trench is 356 cubic yards. The trenches were reportedly backfilled with fill after each dumping episode. Upon site closure in 1955, the trenches were covered with 2 feet of soil, graded, and seeded.

The area of Sites 6 and 7 was also used for the deposition of demolition and construction debris from the mid-1950s to the 1970s. Large quantities of concrete and asphalt from demolished runways and parking aprons were deposited over part of the area of Sites 6 and 7. The area of debris deposition is now partly covered by a woodlot.

The RI for OU-7 confirmed that waste was disposed in trenches and pits in the area of Sites 6 and 7. Many of the trenches and pits were initially identified by the interpretation of available aerial photographs

and visual observations of depressions in the ground surface. Geophysical surveys, soil borings, and test pits further determined the locations of the trenches and pits.

During the RI much of the debris was found to be covered with at least 2 feet of soil and vegetation. While the majority of identified buried waste within the area of debris deposition was greater than 6 feet bgs, buried waste on the outer edges of the debris layer was noted in several locations as close as 2 feet from the ground surface.

Outside the area of the deposited debris, the waste in trenches and pits was generally covered with several feet of soil and located between 2 and 8 feet bgs. In certain cases, the cover material over the trenches had subsided, creating depressions that could be observed at the surface.

Waste observed in the trenches and pits included construction debris, large concrete slabs, charred debris, asphalt, metal, and general refuse. A sludge-like waste material was observed in several trenches. Crushed and deteriorated drums, portions of drums, and/or metal containers were encountered in different test pits. The total number of drums did not appear to exceed 10. With the exception of two drums, the subject drums and containers did not contain substantial quantities of waste material. The drums of concern contained solid material. The drums encountered during the test pitting were removed from the site and disposed in accordance with federal and State requirements.

2.2.2 Land and Resource Uses

Site 5 is located in the southeastern portion of the former NAWC and is within the enlisted personnel housing area that has been retained by the Navy as part of the Willow Grove base. However the 2005 round of the Base Realignment and Closure Commission has targeted Willow Grove for closure. This housing are will be transferred to non-Department of Defense ownership at some time in the future but there is no set timetable for this transfer.

Area B surface water and sediment are located off base within a residential area that also includes wooded areas and wetlands. The area of Sites 6 and 7 is currently undeveloped and consists of open space covered with grass, shrubs, and trees. The property is located within Warminster Township. There are no structures in the area of Sites 6 and 7 at this time. The re-use plan developed by the FLRA and approved by Warminster Township and other municipalities identifies the future use of the area of Sites 6 and 7 as recreational. Available information suggests that residential use of the property is not reasonably anticipated. However, it has been suggested that limited industrial and commercial use of Sites 6 and 7 may be possible.

The enlisted housing area is serviced by public water. The Navy retains this portion of the property, however it is anticipated that the Navy will eventually transfer the property. The closest groundwater supply users are located about one-half mile from Area B and are not immediately downgradient.

2.2.3 Investigations and Initial Response Actions

Initial investigations of Area B, consisting of the installation and sampling of shallow overburden wells, were performed in 1982. RI work addressing Area B was conducted in several phases. Field work included soil gas sampling, geophysical surveys, surface soil sampling and analysis, subsurface soil sampling and analysis, and a wetlands assessment. The subsurface studies included drilling soil borings to determine subsurface conditions. In addition, surface water and sediment sampling and analysis were conducted to evaluate the potential impacts of Area B on surface water and sediment within the unnamed tributary of Southampton Creek.

The following sections briefly summarize the investigations and response actions for Area B at the former NAWC Warminster.

2.2.3.1 Area B Investigations

Phase I (1989 - 1991): Phase I activities were similar in scope to those in Area A. The Phase I RI included a cursory soil gas study and electromagnetic survey to better define the locations of disposal site boundaries and potential source areas. Limited test pitting was also conducted to delineate the disposal areas. Shallow and overburden wells were installed and sampled to characterize groundwater quality and to determine groundwater flow direction. An air sampling program was also performed to evaluate the potential for atmospheric contamination in nearby residences.

Phase II (1992 - 1993): Phase II RI/FS work was similar to that in Area A. Phase II RI activities included installing additional overburden and shallow bedrock monitoring wells; sampling and analyzing groundwater, surface water, sediment, and soils; and evaluating aquifer characteristics through water-level monitoring and a pumping test. Several off-base well samples were also collected for analysis. Groundwater-related RI and FS reports for OU-1, which was defined as contaminated overburden and shallow bedrock groundwater attributable to Area A and Area B at the base, were released in April 1993. Based on TCE concentrations in three monitoring wells slightly in excess of the MCL for public drinking water supplies, the Phase II RI and FS reports projected the presence of a TCE contamination plume attributable to Area B.

Focused RI for Groundwater (1993 - 2000): This work investigated groundwater conditions within and downgradient of Sites 5, 6, and 7. The focused groundwater scope of work was similar to Area A. Activities

included installing and sampling monitoring wells at multiple depths in and around Area B. Groundwater-quality trends and hydrogeologic characteristics within the study area were evaluated to further define the nature and extent of the contamination and potential migration patterns. Water-level studies and pumping tests were performed to better define the nature of the hydrogeologic setting. Based on this work, a final RI Report for Area B groundwater (designated as OU-1B) was released in July 2000.

Phase III (1995 - 1999): The Phase III RI objective was to characterize sources of contamination, primarily soils and wastes at known and potential waste disposal sites. Phase III RI work within Area B was similar to that conducted for Area A, and consisted of soil gas and electromagnetic studies to define potential source and/or disposal areas, surface and subsurface soil sampling, and sampling of area streams and sediments. The Phase III RI did not address groundwater. The draft Phase III RI Report was issued in November 1996.

Based on the findings of the draft Phase III RI report, a supplemental RI was performed at Sites 6 and 7 in 1997. These investigations supported limited removal actions for these sites. In November 1999, a final RI report was issued for soils/waste at Sites 6 and 7 (designated as OU-7). This report considered the previous RI work and characterized conditions at Sites 6 and 7 after the removal. Following the removal actions, RI and FS reports for Sites 6 and 7 were prepared in 1998.

A supplemental soil investigation was conducted for Site 5 in December 1999, and the RI Report for Site 5 soils and Area B surface water and sediment (designated as OU-10) was submitted in July 2000.

2.2.3.2 Area B Response Actions

OU-1: At the end of Phase II, an interim remedy ROD was signed for OU-1 in September 1993. The ROD selected an interim remedy to minimize the migration of contaminated groundwater while additional studies were performed to determine the full nature and extent of groundwater contamination. The interim remedy ROD included pumping and treating Area B groundwater (as well as Area A groundwater), with continued periodic testing of groundwater in monitoring wells and other wells near the base over a 30-year period.

In December 1994 and January 1995, the Navy installed two planned extraction wells and six observation wells downgradient of Sites 5, 6, and 7 and within the projected TCE plume. The two planned extraction wells were sampled while pumping tests of various durations were performed. No TCE or other contaminants were detected at concentrations greater than MCLs in the pumped water. After completion of the extraction well yield tests and the hydrogeologic investigation report of 1995, contaminant trends were evaluated, and it was concluded that TCE concentrations in the well with the maximum concentrations of TCE (up to 13 µg/L) appeared to be stable and that TCE concentrations were either not detected or were

present at concentrations consistently below the MCL in downgradient monitoring wells. Considering this contaminant trend, along with the extraction well results, a decision was reached to discontinue the plan to pump Area B groundwater but to continue monitoring and conduct additional investigations during Area B source investigation and removal activities, in accordance with the interim remedy ROD.

As called for by the interim remedy ROD, Area B groundwater was regularly monitored between 1994 and 2000. This monitoring was part of a basewide groundwater monitoring program and included 14 rounds of groundwater monitoring in and downgradient of Area B.

OU-2: Following Phase II, the Navy performed sampling of off-base drinking water wells in the vicinity of NAWC Warminster. Results from well water samples collected during the testing indicated that, at several residences, groundwater had concentrations of VOCs greater than MCLs. Beginning in April 1993, the Navy provided bottled water and installed water treatment systems at these residences despite the lack of clear evidence that the Navy was responsible for the elevated contaminant concentrations of concern. In the summer of 1994, USEPA and the Navy connected homes in the Casey Village Area (located south of Area B) to the WTMA and Upper Southampton Water and Sewer Authority public water supply systems. This remedial action was designated as OU-2. Due to the time-critical nature of the remedial action, a ROD was not issued for OU-2.

OU-7: Based on the Phase III RI findings, including the results of several supplemental investigations, the Navy conducted a response action within Sites 6 and 7. These actions were initiated in May 1997 and were completed in September 1997. Actions included the excavation and off-site disposal of about 3,700 tons of soil and debris from three discrete excavations and the removal of construction debris and concrete from the surface area (Figure 2-10). Contaminated soils and wastes excavated during this action included potential source areas for groundwater contamination. The removed soils included those containing elevated concentrations of TCE and PCE. The excavations extended in depth to the bedrock surface and laterally to the point where sample analysis confirmed the lack of contamination greater than action levels protective of groundwater quality.

Final RI and FS reports were issued for OU-7 in November 1998 and December 1998, respectively. The ROD for OU-7 was signed in June 2000.

OU-1B: A final ROD for OU-1B was issued on September 6, 2000 and indicated that no action was necessary to address Area B groundwater.

OU-10: Based on the Phase III RI findings, including a supplemental soil investigation, a no-action ROD for OU-10 was released in September 2000. No response actions were taken at Site 5 or to directly address the stream associated with Area B surface water and sediment.

2.2.4 Nature and Extent of Contamination

2.2.4.1 Site 5 Soils

The potential sources of contamination at Site 5 include several disposal trenches. Based on observations during the RI, the general area of Site 5 was used for subsurface disposal of waste and placement of fill material. Based on soil borings, buried waste materials occur from 2 to 10 feet bgs. Fill material placed at Site 5 occurred at 3.5 to 8 feet bgs. Wastes were found north, east, and south of Building 401 and west of Building 403. The wastes included ash, wood, glass, cardboard, paper, tree limbs, roots, brick fragments, wire, charcoal, and scrap metal pieces in a matrix of fill material. Waste observations suggest that subsurface disposal did occur as reported. However, the pattern of subsurface wastes observed during the RI was that the wastes appeared to be scattered within the subsurface area of disposal, suggesting that the wastes were either not disposed in linear trenches or that the contents of the trenches had been moved since placement.

Significant conclusions of the RI Report for Site 5 soils and OU-10 were as follows:

- Wastes and fill were identified in the subsurface within the area reportedly used for disposal; however, the pattern of disposal was not indicative of trenches.

- Buried waste materials included ash, wood, glass, cardboard, paper, scrap metal pieces, tree limbs and roots, brick fragments, wire, and charred material. The wastes were located adjacent to several enlisted housing units and under roadways and paving.

- Lead, copper, and vanadium were the inorganics detected at concentrations greater than preliminary SSLs protective of residential use in more than one soil/waste sample.

- The organics detected in more than one soil/waste sample at concentrations greater than the residential SSLs were Aroclor-1254 and benzo(a)pyrene.

- Numerous sediment screening criteria protective of aquatic life were exceeded in sediment potentially impacted by Area B.

2.2.4.2 Sites 6 and 7 Soils

The primary findings of the RI with regard to site conditions after completion of removal actions are as follows.

- Disposal activities occurred over an area of approximately 5 acres. Although discrete disposal locations such as pits or trenches were found within the site, materials related to disposal activities, including waste, residuals associated with waste, and/or fill materials, were found throughout the 5-acre site.

- Although not highly elevated, site-wide surface soils contained certain metals at concentrations greater than background concentrations. Elevated metals in surface soils include chromium and thallium. Organic compounds were not detected at significant concentrations or frequencies in surface soils.

- Site-wide surface soils also contained elevated concentrations of metals apparently related to disposal activities, including chromium, thallium, cadmium, iron, and lead. No organic compounds were detected at significant concentrations or frequencies. Elevated concentrations of TCE, PCE, and PCBs detected prior to removal actions were excavated and disposed by these response actions.

- Concentrations of metals in subsurface soils were greater within three zones, identified as Zones 1, 2, and 3, which apparently included the discrete pits or trenches used for the disposal of waste.

- VOCs were not detected in groundwater in the area at concentrations that exceeded groundwater protection criteria. These data suggested that response actions had met the objective of removing soils known to present threats to groundwater quality.

2.2.4.3 Area B Stream

The Area B surface water sample results were compared to AWQCs protective of aquatic life developed pursuant to the Federal Clean Water Act. The manganese concentration in one surface water sample exceeded AWQC.

Many of the Area B sediment sample results exceeded available screening criteria indicative of a potential risk of concern to ecological receptors. Exceedances at multiple sample locations were found for a group of PAHs. Other organics detected at high concentrations were DDT and n-nitrosodiphenylamine. Aroclor-1260, a PCB, was detected at 1,900 µg/kg in a sample from the drainage swale collecting flow from

the area of Building 108; however, further sampling in this swale detected Aroclor-1260 at concentrations of 270 to 580 µg/kg in three samples.

2.2.4.4 Area B Groundwater

The results of RI work for Area B groundwater, including work performed since the interim RI, were included in a final RI Report dated May 2000. Significant conclusions of the final RI were as follows:

- Two monitoring wells continued to exhibit TCE concentrations greater than the MCL of 5 µg/L. In particular, TCE was detected in wells HN-36S and HN-03S at 5 µg/L to 12 µg/L (Figure 2-11). No other organics were detected at concentrations greater than MCLs.

- TCE was not detect in excess of the MCL in wells HN-36S and HN-03S, which are 300 feet apart.

- Groundwater samples collected during a pumping test in extraction well EW-B14, located next to monitoring well HN-03S, did not detect TCE in excess of the MCL.

- There were low concentrations of TCE in Area B groundwater; however, there was no discernible plume that exceeded the MCL of 5 µg/L.

- Inorganic analysis of unfiltered (total metals) and filtered (dissolved metals) samples detected a variety of metals. However, the detections were not considered indicative of a pattern that would suggest a release from Area B.

- A review of RI data also found no information suggesting that Area B groundwater would adversely impact surface water quality.

In 1995, the Navy installed extraction wells in response to the interim remedy OU-1 ROD. Two potential extraction wells were installed in the downgradient portion of the projected TCE plume identified during the Phase II RI. During extraction well installation, several yield and pumping tests were performed. Samples were collected from the extraction wells during both a 12-hour yield test and a 72-hour pumping test. TCE was identified in only one sample from one extraction well during the 12-hour yield test, at an estimated concentration of 1.5 µg/L. No other VOC was reported above detection limits. During the 72-hour pumping test, the only compound identified was 1,2-dichloropropane, which was found at concentrations ranging from 0.7 to 2 µg/L. The maximum detection was less than the MCL of 5 µg/L for this compound. For these reasons, TCE in Area B groundwater was not considered to affect the beneficial use of the aquifer.

The Navy conducted a groundwater monitoring program for Area B between 1994 and 2005. As part of this monitoring program, Area B well clusters located near the base perimeter (HN-10, HN-38, HN-39, and HN-40) were sampled and analyzed on a periodic basis (Figure 2-12). During the sampling, no VOCs were detected in excess of the MCLs in these well samples.

The perimeter monitoring program also included the periodic sampling of wells within Area B, and monitoring program sampling results were initially presented in perimeter monitoring summary reports issued by the Navy. An evaluation of these data indicated that two monitoring wells (HN-36S and HN-03S) did not contain any contaminant in excess of its MCL more than once. TCE was detected in each of these wells at concentrations greater than the MCL during sampling events performed in 1990, 1992, 1994, 1998, and 1999. In these sampling events, the detected concentrations were between 6 and 13 µg/L. In 1999, the detected concentrations of TCE in wells HN-03S and HN-36S were 8.4 and 6.2 µg/L, respectively. Downgradient and adjacent monitoring well clusters were found to contain TCE in excess of the MCL on one occasion during this time period. Extraction well EW-14 was installed next to and within the same hydrogeologic zone as well HN-03S. TCE was not detected in excess of the MCL in well EW-14 during or after a pumping test. Collectively, these data indicated that there was no discernible plume of TCE that exceeded the MCL of 5 µg/L.

2.2.5 Assessment of Risks

2.2.5.1 Site 5 Soils

The risk assessment estimated the risks posed to human health by Site 5 soils and Area B surface water and sediment (OU-10) if no action was taken. For Site 5 soils, the assessment was conducted assuming residential use of the property. In addition, although industrial use of the property was not reasonably anticipated, potential risks under industrial use were also assessed. The area of Site 5 is expected to continue to be used for residential purposes.

The highest carcinogenic risk estimated by the risk assessment was 1.2×10^{-5} for a lifetime resident exposed to subsurface soils. This carcinogenic risk is within the acceptable risk range. Therefore, carcinogenic risks associated with both surface and subsurface soils were acceptable.

The highest noncarcinogenic risks for surface soil were to a residential child and were estimated to correspond to a HI of 1.4. The principal substance contributing to this HI was manganese. In this case, the manganese contribution to the HI was 0.38 and the target organ was the central nervous system. No other substances contributed more than 0.2 to the HI. To further evaluate whether the noncarcinogenic risks posed by surface soils to a residential child were unacceptable, noncarcinogenic risks were identified by target organ. This evaluation found that in no case did the HI for any target organ exceed

1.0. As a result, noncarcinogenic risks posed by surface soils to residential children were considered acceptable. Noncarcinogenic risks posed by surface soils to residential adults corresponded to an HI of less than 1.0 and were also acceptable.

Noncarcinogenic risks posed by subsurface soils at Site 5 were also found to be acceptable. An evaluation was also performed to determine if groundwater quality was threatened by Site 5 soils. Contaminant concentrations in Site 5 soils were compared to USEPA SSLs protective of groundwater quality. Only thallium, silver, and methylene chloride exceeded these criteria. However, the final ROD for Area B groundwater determined that no substances in Area B groundwater presented an unacceptable risk; therefore, Site 5 (OU-10) soils do not present a threat to groundwater quality.

2.2.5.2 Sites 6 and 7 Soils

As part of the RI for OU-7, a risk assessment was conducted with available data to estimate the potential risks to human heath posed by soils associated with Sites 6 and 7 after the removal action. To assess these risks, hypothetical exposure scenarios under residential and recreational use were evaluated.

Analytical results for surface and subsurface soils were evaluated to estimate risks associated with the recreational use planned for the property. Although not reasonably anticipated, risks were also estimated for potential residential land use. Under recreational land use, site-wide surface soils were estimated to present a carcinogenic risk of 2.0×10^{-6}, and HIs for noncarcinogenic risks were less than 1. In each case, no unacceptable risk was identified.

Although exposure to subsurface soils is not currently occurring, an evaluation was conducted to estimate the risk presented by subsurface soils in the event that these soils are displaced to the surface during recreational use of the property. In this case, the total carcinogenic risk presented by site-wide subsurface soils for recreational use was 1.0×10^{-5}, which was within the acceptable range. For noncarcinogenic risk, the HI for chromium in site-wide subsurface soils was estimated to range from 1.0 to 4.2. As a result, noncarcinogenic risks associated with site-wide subsurface soils were considered to be unacceptable. Risks associated with subsurface soils within three separate locations in the vicinity of Sites 6 and 7 (Zones 1, 2, and 3) were also estimated. The total carcinogenic risk for each zone was acceptable. With regard to noncarcinogenic risks, the three zones had HIs in exceedance of 1.0, with the highest risk in Zone 3. As a result, noncarcinogenic risks for each zone were estimated to be unacceptable.

Assuming residential land use, the risks were generally similar to those associated with recreational land use, with two primary exceptions. Both carcinogenic and noncarcinogenic risks associated with surface soils were estimated to be unacceptable. In this case, the HI for chromium was estimated at 6.47, and

the HI for thallium was estimated at 1.22. In addition, with regard to subsurface soils, thallium and iron were also found to present an unacceptable noncarcinogenic risk.

In summary, site-wide subsurface soils presented an unacceptable risk under the planned recreational use if these soils were excavated or brought to the surface by other means. In addition, although residential use is not reasonably anticipated, site-wide surface soils present an unacceptable risk under this use scenario.

2.2.5.3 Area B Surface Water and Sediment

An evaluation of potential risks posed to children by surface water and sediment impacted by Area B found that carcinogenic and noncarcinogenic risks were within the acceptable range. An ecological risk assessment was also performed to identify whether Area B surface water and sediment presented a potential for adverse impact to aquatic and semi-aquatic receptors. The focus of the ecological risk assessment was a portion of Southampton Creek and its headwaters that receive runoff, channelized stormwater, and discharges from Area B. The discharges from the stormwater collection systems within Area B comprise a substantial portion of the flow at the headwaters of the creek. Surface water downstream of Area B was estimated to present a very low potential risk. Sediment downstream was estimated to present a low to moderate potential risk to both aquatic and semi-aquatic receptors.

2.2.5.4 Area B Groundwater

The interim remedy ROD for OU-1 estimated that Area B groundwater presented an incremental carcinogenic risk of up to 8.4×10^{-5}, and the noncarcinogenic risk was estimated to correspond to a HI of up to 28. The primary contributors to the carcinogenic risk were identified as TCE, PCE, carbon tetrachloride, and arsenic, and the contributors to the noncarcinogenic risk were identified as arsenic, barium, cadmium, and manganese. The calculation of these risks incorporated the results of the unfiltered groundwater analyses. However, the interim RI suggested that the metals detected in unfiltered samples may be within background levels and not attributable to releases from Area B. During the interim RI, TCE concentrations exceeded the MCL of 5 µg/L in three shallow bedrock monitoring wells.

The final RI for OU-1B re-evaluated risks based on data generated since the interim RI. Although Area B groundwater is not known to be currently used, the risk assessment assumed that this groundwater may potentially be used by residents for domestic purposes. The revised assessment estimated a carcinogenic risk of 1.8×10^{-6} for the potential future residential groundwater user. This risk is within the acceptable range. Since the interim RI, TCE was detected at concentrations of 5 to 12 µg/L in two monitoring wells, exceeding the MCL of 5 µg/L. However, the RI concluded that there was no continuous,

discernible plume of TCE that exceeds the MCL. Based on this conclusion, TCE in Area B groundwater did not present an unacceptable risk.

The noncarcinogenic risk was found to correspond to an HI of 4.1, exceeding the acceptable HI of 1.0. Manganese was the primary contributor to the noncarcinogenic risk, accounting for 3.52 of the HI. A review of RI data found that manganese concentrations of concern were present in one well cluster and were within background concentrations identified in the Phase II RI. Based on this review, the manganese concentrations did not appear to be attributable to Sites 5, 6, and 7, and Area B groundwater did not present an unacceptable noncarcinogenic risk.

2.2.6 Current Status

Surface water and sediment sampled as part of the RI primarily receive drainage from residential areas south of NAWC Warminster. Based on available data, the relative contribution of Area B to those concentrations detected in surface water and sediment could not be distinguished from concentrations attributable to potential sources within these residential areas.

Although the RI found that Area B sediment presented potential risks of concern to ecological receptors, the estimated potential risks may not be representative of potential risks posed by sediment to receptors in the streambed. These sediments have not been characterized since the completion of the response actions at Sites 6 and 7. Although these actions were projected to mitigate potential unacceptable risks presented by sediment potentially impacted by Area B, additional stream monitoring will be performed by the Navy to confirm that future impacts on sediment by Area B have been mitigated. A work plan describing the confirmation sampling and analysis program will be developed and implemented to achieve the confirmation monitoring goals. This work plan will require the collection and analysis of sediment samples.

The Navy currently retains the former base property in the vicinity of Site 5 as an enlisted family housing area for NAS Willow Grove. The property associated with Sites 6 and 7 was transferred to the Warminster Township Parks and Recreation Department in 2001.

2.3 AREA C

Area C includes Sites 4 and 8 and nearby locations where hazardous substance releases may have resulted in groundwater contamination, which was identified both on and off base in this area. Area C has been divided into four OUs. OU-2 addresses contamination of domestic well water for residences near the base, OU-3 consists of contaminated Area C groundwater, OU-5 addresses soils, surface water,

and sediment associated with Site 8, and OU-6 addresses soil, sediment, and surface water associated with Site 4. The site locations in Area C are shown on Figure 2-13.

Area C is in a gently to moderate rolling area, located adjacent to Kirk Road and Newtown Roads in the north-central portion of the former base. The sites of concern cover approximately 10 acres. Ann's Choice Retirement Community was built over much of Area C following closure of the base. Scattered single-family houses and two local parks are just north of Area C. Two unnamed tributaries of Little Neshaminy Creek, just north of the base boundary, collect drainage from Area C. These tributaries run through a residential area and a local park. An unnamed creek is located north of Site 4, in Munro Park. This stream originates at the base of the stormwater drain located east of Site 4 and runs east to west through Munro Park before turning north, away from NAWC Warminster. During base flow conditions, this stream appears heavily silted and has an estimated maximum flow rate of 7 to 10 gallons per minute (gpm). The uppermost part of this stream is small and intermittent and, during dry periods, water in the stream tends to be limited to pool areas. The stream channel is well developed despite the low or intermittent flow rates. Channel width is 3 to 5 feet, and channel depth is 1 to 2 feet. Sediments in the stream are sands and cobbles in run areas and sands and silts in pools.

Soils observed within Area C during RI activities ranged from 2 to 15 feet in thickness. Soil types included orange-red, brown, and maroon-red mixtures of silt, clay, and sand, with finer-grained soils dominant. Site 4 soils are classified as Duncannon silt loam and Chalfont silt loam, and Site 8 soils are mapped as Urban Land-Lansdale Complex, indicating that these soils were reworked from their natural state.

A relatively large wooded area borders the stream to the north and northwest of Area C. The wooded area extends along the stream from Kirk Road downstream toward Werner Park. This area offers a secluded and physically diverse habitat. Snails, earthworms, and amphipods are common in sediments and leaf packs from downstream portions of the study area, as are small numbers of mayfly larvae. In addition, various songbirds, rabbits, raccoons, and white-tailed deer were found in this area.

A wetlands assessment of the area north of Area C classified a wetland along the unnamed tributary of Little Neshaminy Creek as primarily palustrine, forested, broad-leaved, deciduous, and temporary. Green ash, silver maple, box elder, black cherry, and spicebush as the canopy and sub-canopy characterized this wetland. Blackberry, Japanese honeysuckle, jewelweed, poison ivy, and skunk cabbage were the dominant herbaceous species. A small scrub-shrub wetland, located immediately southwest of a residence, was also associated with this area.

The wetlands assessment concluded that the stream and wetlands appear to be fairly healthy. No evidence of pollution, fish kills, or stressed vegetation was observed. Urban trash and litter (tires, boards, bottles, cans, paper, plastic) were common.

The Area C soils lie over highly weathered bedrock that starts at approximately 5 to 15 feet bgs. The weathered bedrock gradually transitions into competent bedrock that belongs to the Stockton Formation, which consists of alternating lithologic units of predominantly fine-grained arkosic sandstone and siltstone/mudstone. Within Area C, the Stockton Formation comprises a multi-aquifer system of relatively discrete water-bearing zones separated by thicker, less permeable zones. Groundwater occurrence and movement through the Stockton Formation is primarily through secondary porosity (fractures) that exist within the rock mass. These fractures include both bedding plane partings and fractures that extend through individual rock units. Some minor primary porosity, especially in the sandstone units, also contributes to groundwater occurrence and movement. The overall groundwater flow direction beneath Area C is generally to the north and northwest.

2.3.1 Area C Site Descriptions

2.3.1.1 Site 4

Site 4 is a 7-acre grassy area just north of the former main runway and just south of Kirk Road (Figure 2-14). Site 4 is the largest of the NAWC Warminster waste disposal locations and it is less than 100 feet from the facility boundary. Some surface water drainage from this area enters the unnamed tributary of the Little Neshaminy Creek, off base to the north of Kirk Road, near Munro Park. Several off-base residences are located within 200 feet of Site 4.

The Navy initially reported Site 4 as a disposal site in a Navy Shore Activity Disposal Fact Form in 1980. The site reportedly was operated from 1966 to 1970. A review of historical aerial photographs initially verified the presence of at least two trenches at Site 4 and indicated that Site 4 was active through 1973. Several trenches on the site reportedly were used to dispose of non-industrial solid waste, paints, waste oils, waste metals, construction debris, solvents, and sewage sludge from the sewage treatment plant.

2.3.1.2 Site 8

As reported by the Navy, Site 8 was used as a 2-acre fire-training area from 1961 to 1988 (Figure 2-15). The fire training activities were conducted at the northeastern end of the old runway located in Area C and involved pouring contaminated jet fuels onto a runway area that was contained by berms. The fuel was then ignited and extinguished to simulate fire-fighting procedures. In addition, an area of the runway immediately south of the fire-training area was used to test the resistance of aviation suits to fire. This

area consisted of a corrugated metal building (Structure S1) where flight suits were passed through flames to test the durability of the suits. Although it was not initially reported as a disposal site, the former location of this test area is considered to be part of Site 8.

The maintenance area east of Site 8 (Figure 2-15) was also the focus of soil and groundwater investigations because it resides with the area of PCE groundwater plume. These historical soil and groundwater investigations did not provide evidence of significant levels of contamination or identify potential sources of contamination. However, recent monitoring well installations and groundwater sampling activities have detected elevated concentrations of PCE in the general area and further investigations are being planned by the Navy.

2.3.2 Land and Resource Uses

Ann's Choice Retirement Community was built over much of Area C primarily in the vicinity of Site 8. Residential development for Ivyland Borough has occurred west of Site 8, and other adjacent property in the vicinity of Site 4 is used for open-space recreational land use (i.e., park land) on the part of Warminster Township. WTMA operates a supply well (Well 13) located about 1,700 feet north of Area C (Figure 2-16). A few private drinking water wells are also located northwest and northeast of Area C; the nearest active private well is about 500 feet northeast of Site 4 and the base boundary.

2.3.3 Investigations and Initial Response Actions

Initial investigations of Area C were performed in 1982. These studies consisted of installing and sampling shallow overburden wells. RI activities addressing Area C was conducted in several phases. Field work included soil gas sampling, geophysical surveys, surface soil sampling and analysis, subsurface soil sampling and analysis, and a wetlands assessment. The subsurface studies included drilling soil borings and excavating test pits to determine subsurface conditions. In addition, surface water and sediment sampling and analysis were conducted to evaluate the potential impacts of Area C on nearby surface water and sediment. A series of groundwater investigations was also performed as part of Phase I and Phase II RI work and as part of the focused RI for Area C groundwater.

The following sections briefly summarize the investigations and response actions for Area C at NAWC Warminster.

2.3.3.1 Area C Investigations

Phase I (1989 - 1991): Activities were similar in scope to Areas A and B.

Phase II (1992 - 1993): RI/FS work was similar to Areas A and B. For Area C groundwater, the Phase II RI included the installation of additional monitoring wells, sampling of groundwater, and the performance of hydraulic tests to assess aquifer characteristics. One off-base well was samples and tested.

Focused RI for Groundwater (1993 - 1994): Groundwater conditions were investigated within and downgradient of Sites 4 and 8. The focused groundwater scope of work was similar to Areas A and B. Based on this work, separate RI and FS reports were submitted for Area C groundwater in August 1994. A schematic design for shallow groundwater remediation was completed in July 1994.

Phase III (1995 - 1999): The Phase III RI objectives and field work were similar to those for Areas A and B. Phase III included further investigation of the nature and extent of potentially contaminated soils, buried wastes, surface water, and sediment associated with this area. An Engineering Evaluation/Cost Analysis (EE/CA) was prepared to help support a removal action for Site 4 (designated as OU-6) in July 1995. A supplemental study for Site 8 was conducted between July 1998 and March 1999 to complete RI work for this site. The RI report for Site 8 soils, surface water, and sediment (designated as OU-5) was issued in August 1999. The nature and results of all RI work performed at Site 8 were described in the RI Report for OU-5 issued in August 1999.

2.3.3.2 Area C Response Actions

OU-2: Following Phase II, the Navy performed sampling of off-base drinking water wells in the vicinity of Area C. In 1994, USEPA and the Navy connected homes along Kirk Road to the Warminster Municipal Authority water supply system.

OU-3: In response to the findings of the focused RI for Area C groundwater, a ROD for OU-3 was issued in March 1995. The ROD selected pumping and treatment of Area C groundwater as the remedy to address groundwater contaminated with PCE. The interim OU-1 remedy for Areas A and B was modified to incorporate the additional volume of contaminated groundwater associated with OU-3. Construction of the groundwater treatment plant was completed in May 1996, and the pumping and treatment of Area C groundwater were initiated in July 1996. Six extraction wells were installed in Area C, and piping and electrical wiring were run between these wells and the treatment plant.

OU-5: Based on the Phase III RI findings, including the results of several supplemental investigations, the Navy determined that lead concentrations in certain surface soil at Site 8 presented an unacceptable risk to human health. The soils of concern were located adjacent to the western side of the runway Structure S1, the former flight suit test area. In response, the Navy completed a removal action at Site 8 in February 1999, eliminating the unsafe risk associated with lead-contaminated soils (Figure 2-17). The removal action was a time-critical nature response and an Action Memorandum was prepared and signed

in February 1999. This action included the excavation and removal of soils containing elevated lead levels and disposal in an off-base landfill. Sampling was conducted after the action to ensure removal of the soils of concern. Based on the results of this sampling a NFA ROD for OU-5 was signed in September 1999.

OU-6: Based on the results of the investigations summarized in the EE/CA, the Navy determined that soils at Site 4 presented an unacceptable risk to human health and the environment. In response, the Action Memorandum for the Site 4 removal action was signed in June 1996. The Navy began excavating trenches at Site 4 in August 1996. More than 22,000 tons of soil and debris were excavated and transported to an off-base landfill (Figure 2-18). Waste/soil characterization sampling and analysis were performed before, during, and after excavation work. Excavation continued until bedrock was encountered or until the contaminated soil was removed. The excavated areas at Site 4 were backfilled with clean fill material, covered with 4 inches of topsoil, graded, and seeded. A vegetative cover was established over the disturbed areas. The excavation work was completed in December 1996, and remaining site restoration work was finished in July 1997. A NFA ROD for OU-6 was signed in June 2000.

2.3.4 Nature and Extent of Contamination

2.3.4.1 Site 4

Although the RI for OU-6 also characterized the conditions at Site 4 prior to the removal action, the primary objective of the RI was to characterize conditions after the removal action. The findings of the RI were as follows:

- No visible wastes remain on site.
- The remaining contaminant concentrations in soils were less than soil cleanup levels established prior to the action.
- Site 4 did not appear to be a past or current source of Area C groundwater contamination.
- Contaminant releases from Site 4 to downstream surface water and sediment have not produced observable impacts on the subject stream.

2.3.4.2 Site 8

The RI Report for OU-5 characterized the nature of the site prior to and after the removal action. The primary findings of the RI after the removal action were as follows:

- The removal action significantly reduced lead concentrations in Site 8 soils.
- Soil sampling results suggested that Site 8 is not a past or present source of Area C groundwater contamination.
- PAHs were the organic compounds detected in Site 8 soils at significant frequencies and concentrations. PAHs are commonly associated with burning activities.
- With the exception of the lead concentrations addressed by the soil removal action, metals were not detected at concentrations greater than background at a significant frequency.
- Concentrations of organics and metals in surface water and sediment associated with Site 8 were found to be only slightly greater than background levels.
- Low levels of compounds commonly associated with fuels were detected in both surface and subsurface soils at Site 8.

2.3.4.3 Area C Groundwater

The findings of the RI with respect to contaminated groundwater in overburden and shallow bedrock aquifers attributable to Area C were detailed in the OU-3 RI Report. The primary findings were as follows:

- PCE was detected in 10 of 34 monitoring wells sampled at concentrations ranging from 1 to 29 µg/L. In addition, acetone was detected in 9 of 24 monitoring wells at concentrations ranging from 8 to 74 µg/L. These were the only organics detected at significant concentrations or frequencies.
- Groundwater samples from wells in Area C contained manganese, arsenic, antimony, beryllium, and thallium at concentrations that resulted in elevated calculated risks. With the exception of thallium, these compounds appeared to be within natural background levels.
- Groundwater flow from Area C within overburden and shallow bedrock is to the north.

- PCE attributable to Area C has migrated north to residential wells along Kirk Road. In addition, 2 µg/L of PCE was detected in a monitoring well located 800 feet north of Area C. The affected residences were provided with water treatment systems and were connected to a public water supply under remedial actions conducted by the Navy and USEPA.

- The specific locations of the releases of organic groundwater contaminants and elevated concentrations of inorganics were unknown.

2.3.5 Assessment of Risks

As part of the RIs for OU-5 and OU-6, risk assessments were conducted with available data to estimate the potential risks to human heath and the environment posed by soils, sediment, and surface water associated with both Site 4 and Site 8 after the respective removal actions. To assess these risks, hypothetical exposure scenarios under residential and recreational use were evaluated. A human health risk assessment was also performed for Area C groundwater.

2.3.5.1 Site 4

Following the removal action, the RI risk assessment found the HI for exposure to Site 4 soils to be significantly less than 1.0 for child and adult receptors under both residential and recreational land use, indicating no adverse non-cancer effects were expected from exposure to soil at Site 4. The incremental carcinogenic risk for the residential child was 1.05×10^{-5}. The incremental cancer risk for a recreational user was 5.3×10^{-7}. These carcinogenic risks were within or less than the acceptable risk range.

2.3.5.2 Site 8

The RI risk assessment for Site 8 found that maximum carcinogenic risk would occur if one assumed a lifetime of exposure to surface soils as a resident. In this case, the total incremental carcinogenic risk was determined to be 2.94×10^{-5}, which is within the acceptable range. In assessing noncarcinogenic risks posed by Site 8 soils, the highest HI was 0.6. In this case, exposure of a residential child to surface soil was assumed. This value is less than the acceptable level of 1.0. The assessment of risk posed by lead in Site 8 soils found that the estimated percentage of children with a blood level greater than 10 micrograms per deciliter (µg/dl) was 0.35 percent, which is less than the protective level of 5 percent.

Estimated cancer and non-cancer risks for human receptors under a recreational scenario were found to be acceptable for downstream surface water and sediments. These findings indicated that sediment and surface water associated with Sites 4 and 8 do not present a threat to human health. The ecological risk assessment did not indicate that the stream downstream of Sites 4 and 8 was threatened by

contamination related to these sites or Area C. No apparent stress on aquatic species was observed during the RI.

Finally, an evaluation of Site 4 and Site 8 soil data indicated that these sites did not present a threat to groundwater quality.

2.3.5.3 Area C Groundwater

The risk assessment for contaminated Area C groundwater found that the carcinogenic risk for hypothetical exposure to this groundwater was 1.2×10^{-4}. The carcinogenic risk associated with PCE, the only organic contaminant contributing to this risk, was 3.1×10^{-6}. The carcinogenic risks for arsenic and beryllium were calculated at 8.7×10^{-5} and 3.3×10^{-5}, respectively. However, the detected concentrations of arsenic and beryllium may be attributable to natural geologic conditions. Although the overall carcinogenic risk attributable to groundwater contaminated by Area C could potentially be considered acceptable, PCE was detected in residential wells formerly used for drinking water and bathing purposes at concentrations ranging up to 31 µ/L, in exceedance of the MCL of 5 µg/L for PCE.

The total HI and HIs for each substance were calculated using unfiltered monitoring well sample results. Using these data, the total HI was determined to be significantly greater than 1.0, primarily due to elevated concentrations of manganese downgradient of Site 5, and to a lesser extent, antimony and thallium in wells elsewhere in Area C. However, manganese and antimony are naturally occurring, and detected concentrations may be within background concentrations.

2.3.6 <u>Current Status</u>

The area of Site 4 has been reconstructed into a sedimentation basin for the construction of an assisted living residential development.

The Navy has transferred the property west of Site 8 for use as a residential neighborhood by Ivyland Borough, as well as property associated with Ann's Choice Retirement Community and a multi-purpose business park near Site 8, and for the park land property in the vicinity of Site 4.

Recently (2005), significantly higher PCE concentrations (up to approximately 300 µg/L) have been found in a new shallow bedrock monitoring well in Area C (HN-23A). Extraction well concentrations have not increased, however, and the new monitoring well is within the capture zone of the extraction system. Therefore the remedy is still protective. The Navy is currently in the planning stages of further source investigation activities related to this new well with high PCE detections.

2.4 AREA D

Area D includes former NAWC property west of Jacksonville Road, outside Area A, and a smaller area east of Jacksonville Road (Figure 2-19). Area D was divided into two OUs, OU-4 consists of contaminated Area D groundwater, and OU-8 includes Area D soils.

2.4.1 Area D Site Description

Area D was not reported as a disposal area but was identified as an area where contaminant releases to groundwater may have occurred. The largest buildings used by the Navy in Area D were Buildings 1 and 2 east of Jacksonville Road and Building 4 west of Jacksonville Road (Figure 2-20). Brewster Aeronautical Corporation, the owner of the property before the Navy, constructed the three buildings as aircraft hangers in 1942. The laboratories necessary to support associated research and development operations were constructed within Buildings 1 and 2, and Building 4 was continually used as an aircraft hangar. Numerous other support facilities were also constructed throughout Area D. The Navy operated the research and development laboratories and support facilities until 1994, when the base was selected for closure. The research and development operations ceased in 1996.

During the period that aircraft were assembled at the facility, the main assembly line, including parts fabrication and finishing, was located within Building 1. Parts storage and sub-assembly lines occupied much of Building 2. The fabrication, finishing, and assembly of parts and aircraft involved several metal shops where parts were formed, treated, plated, and painted.

During the initial years of operation, liquid wastes generated within Area D were conveyed via sewer lines to an on-base wastewater treatment plant built by Brewster and the Navy. The wastewater treatment plant which was operated by the Navy until base closure, is located north of Area D within Area A, and accepted both sanitary and industrial wastes from facility operations. Industrial wastewater was pretreated before it entered the sanitary wastewater treatment plant. Waste collection and transfer lines serving the main building complex and the associated support buildings are located throughout Area D.

There is no surface water body in Area D. The majority of the area is covered with pavement and/or buildings. Surface water runoff and water from roof drains enter a series of on-base stormwater collection and management structures. The majority of stormwater from Area D drains to the north toward Area A and discharges to an unnamed tributary to Little Neshaminy Creek. Surface water runoff from the southwestern part of Area D drains to the south and discharges to the Warminster Township stormwater system.

Groundwater contamination attributable to releases within Area D is addressed under OU-4. The primary COC in Area D groundwater is TCE. An interim remedial action was implemented to address OU-4.

Although TCE was detected in Area D soils, no soil sample contained TCE at concentrations greater than the USEPA SSL for protection of groundwater quality. These data indicated that Area D soils were not a significant source of TCE in Area D groundwater. In addition, no other contaminants were determined to present a threat to groundwater quality.

2.4.2 Land and Resource Uses

OU-8 is located in the western portion of the former NAWC, west of Jacksonville Road and north of Street Road. The area consists of industrial and office-type buildings, parking lots, and paved roadways. The property was transferred to the FLRA and local municipalities under an EDC in August 2000. The re-use plan for this area, prepared by the FLRA and approved by the local municipalities, identified light industrial use as the designated use for this land, and is currently being used for an industrial office park complex.

2.4.3 Investigations and Initial Response Actions

Groundwater investigations in Area D began in the late 1970s when TCE was identified in two on-base supply wells located within Area D. The Navy initiated CERCLA RI work addressing Area D in 1994. A series of groundwater investigations in several phases was also performed as part of focused RI for Area D groundwater.

The following sections briefly summarize the investigations and response actions for Area D at NAWC Warminster.

2.4.3.1 Area D Investigations

Focused RI for Groundwater (1993 - 2000): Groundwater conditions were investigated within and downgradient of Area D. The focused RI groundwater scope of work was similar to the investigations for Areas A, B, and C. In October 1996, the Navy issued an interim RI Report that described the nature and extent of Area D groundwater contamination based on information available at the time. The interim RI found that groundwater in wells located within Area D contained TCE and other substances at concentrations that presented an unacceptable risk to groundwater users. The interim RI indicated that additional investigations were necessary to confirm the nature and extent of the subject contamination. An interim FS was also completed in October 1996 to evaluate remedial alternatives for minimizing migration of the contaminated groundwater while these investigations were completed.

Final RI and FS reports for OU-4 were issued in April 2000.

Area D RI (1996 - 1998): The Area D RI objective was to characterize sources of contamination, primarily soils and wastes, at potential waste disposal sites within the main building complex at the base, including the hangar area east of Jacksonville Road. Other potential locations of contaminant releases within Area D were investigated by the Navy as part of an Environmental Baseline Survey (EBS), conducted in response to the requirements of BRAC and CERCLA Section 120(h).

Surface soils were sampled at Buildings 15/130, where hazardous waste storage was permitted under the Resource Conservation and Recovery Act (RCRA). Field investigations beneath buildings consisted of a more limited number of soil borings and soil samples under Building 1 and 2. The locations of these interior borings and samples considered information regarding hazardous waste.

RI field work consisted of soil gas surveys to detect chlorinated VOCs (including TCE), soil borings, and soil sampling. Soil gas surveys addressed areas outside the buildings. The results of these surveys were used to select exterior soil boring and sample locations. Exterior soil gas sampling stations were located and subsurface soil samples were collected along sewer lines, loading docks, railroad spurs, and drainage ways.

The RI Report for Area D soils was released in September 1998. Based on the Area D RI results for soils, an FS Report was not warranted.

2.4.3.2 Area D Response Actions

OU-4: At the end of the focused groundwater RI for Area D groundwater, an interim ROD for OU-4 was released in September 1997. The interim remedy documented in the ROD included installing extraction wells and connecting these wells to the existing groundwater treatment system; the interim remedy was completed by July 1999. A final remedy ROD for OU-4 was issued in June 2000. The final remedy included the existing extraction, modified treatment, and discharge system, monitored natural attenuation, institutional controls, abandonment of two base supply wells, and groundwater monitoring.

In April 2000, the Navy issued a final RI/FS for Area D groundwater that considered information generated since the issuance of the interim RI/FS and performance monitoring information for the operating interim pump and treat remedy.

OU-8: No CERCLA response actions for specific Area D sources were conducted. However, the Navy removed several petroleum-related aboveground storage tanks and USTs within Area D. Based on RI findings, a no-action ROD for OU-8 was released in June 2000.

2.4.4 Nature and Extent of Contamination

2.4.4.1 Area D Soils

Significant conclusions of the RI for Area D soils were as follows:

- Chlorinated VOCs were detected in soil gas samples collected at sampling stations throughout Area D. The greatest concentrations and frequencies of elevated detections were along part of a sewer line that conveyed industrial wastewater from Building 1 and, to a lesser extent, in the vicinity of Buildings 15 and 130. The subject sewer line had reportedly been damaged and subsequently repaired.

- Soil samples collected in and around the Former Metal Plating Shop, Building 1, loading docks at Buildings 15 and 130 and along the sewer line were analyzed for VOCs. The concentrations present were found to be less than groundwater and human health protection criteria.

- Low concentrations of chlorinated VOCs, including TCE, were detected in soil samples collected throughout the study area, including locations under Buildings 1 and 2. However, only one isolated sample result for PCE exceeded the groundwater protection criterion, and no result exceeded human health protection criteria. Samples collected at depths below the surrounding surface soils did not contain PCE at concentrations greater than screening criteria.

- Observations during performance of soil borings and other RI data did not suggest the presence of disposal areas or substantial releases of hazardous substances.

2.4.4.2 Area D Groundwater

Significant conclusions of the final RI/FS for Area D groundwater were as follows:

- Groundwater flow directions under non-pumping, ambient conditions varied within the units. A groundwater divide was present, resulting in groundwater flow to the northwest, north, and northeast.

- Groundwater in the units A and B were contaminated with VOCs. The detected TCE concentrations exceeded the MCL and presented an unacceptable risk to human health and the environment.

- Contamination was primarily in the area west of the main building complex, extending to the base boundary. TCE concentrations ranged from 480 µg/L in well HN-32S adjacent to the building, to approximately 20 µg/L at well HN-33I (Figure 2-21).

- Groundwater in unit C did not contain concentrations of contaminants that present a risk to human health or the environment.

- Contamination patterns and groundwater flow data for hydrogeologic unit A indicated the presence of an additional source of contamination not related to NAWC Warminster.

- The current extraction network, implemented as the interim remedy, contained the on-base portion of the Area D-related TCE plume, and continued operation would control potential migration of contamination and eventually restore the aquifer to its beneficial use.

- Based on site data, TCE concentrations greater than MCLs were projected to extend approximately 200 feet and downgradient of the base boundary.

- Natural attenuation processes were projected to reduce off-base Area D-related TCE concentrations to MCLs within 2 to 3 years following successful operation of the extraction well system.

- Supply wells SW-1 and SW-2 should be abandoned as part of the final remedy. As deep, open borehole wells, they provide a potential vertical conduit for groundwater contaminant migration among groundwater flow zones. Also, due to their close proximity to the Area D extraction wells, their operation would have an adverse impact on the effectiveness of the remedy.

Historical and performance monitoring data indicated that Area D groundwater was contaminated with VOCs. TCE is the major COC for Area D groundwater. Although other VOCs are present, their concentrations are neither consistent nor greater than MCLs, with the exception of 1,1-DCE. These data suggested an off-base source of the 1,1-DCE contamination.

Extraction system performance monitoring sampling is being performed periodically and has confirmed the presence of TCE concentrations that exceed the MCL (Figure 2-22). These data indicate that the continued operation of the extraction system appears to be decreasing the size of and the concentrations within the plume. This decrease in plume area is an indication that the current extraction well network is capturing the on-base portion of the Area D TCE plume.

2.4.5 Assessment of Risks

2.4.5.1 Area D Soils

As part of the RI for OU-8, a risk assessment was conducted to estimate the potential risks to human health posed by Area D soils. The primary objective was to determine whether Area D soil might impact groundwater quality to an extent where the affected groundwater may present an unacceptable risk to human health. The RI also assessed potential risks posed by the incidental ingestion of and dermal contact with soils sampled during the RI. Finally, the RI assessed whether the intrusion of contaminant vapors from groundwater and soils into Building 1 and 2 may present an unacceptable risk to human health.

To assess the risk presented by Area D soils to groundwater, contaminant concentrations were initially compared to screening criteria protective of groundwater quality. The screening criteria were contaminant concentrations in soil that, if exceeded, may result in groundwater quality that presents an unacceptable noncarcinogenic or carcinogenic risk. One of 129 soil samples collected during the RI exceeded these screening criteria. An evaluation of RI data for the area where this sample was collected found the detected concentration was isolated and not representative of a significant quantity of soil. As a result, soils characterized during the RI should not impact groundwater quality to an extent that the groundwater presents an unacceptable health risk.

The human health risk assessment assessed risks from potential exposure via incidental ingestion and dermal contact to Area D soils characterized during the RI. Risks from exposure to subsurface soils throughout Area D and both surface and subsurface soils in the area of Buildings 15 and 130 were assessed. Risks were calculated for potential residential and industrial use and for construction workers. The calculated HIs were less than 1.0 for subsurface soils in Area D and for surface and subsurface soils in the vicinity of Buildings 15 and 130. In addition, incremental carcinogenic risks were calculated to be within or less than the acceptable range. Based on these risk assessment results, incidental ingestion of and dermal contact with Area D and Buildings 15 and 130 soils were not found to present an unacceptable risk to human health. The assessment of the incremental carcinogenic risk posed by the potential intrusion of VOC vapors into Buildings 1 and 2 estimated this risk to be less than the acceptable range.

2.4.5.2 Area D Groundwater

The risk assessment for Area D groundwater was initially performed as part of the interim RI and found that Area D groundwater presented unacceptable carcinogenic and noncarcinogenic risks. Primary contributors to the unacceptable carcinogenic risk were TCE, 1,1-DCE, arsenic, and beryllium, and

primary contributors to the unacceptable noncarcinogenic risk were TCE, manganese, iron, and aluminum. In addition, TCE, aluminum, barium, beryllium, cadmium, iron, lead, and manganese were found to be present in at least one well at concentrations greater than MCLs for public water supplies.

The final RI for OU-4 re-evaluated risks based on data generated since the interim OU-4 RI. Additional sampling for metals was performed to determine whether metals concentrations were at background concentrations or was due to releases from Area D. The results indicated that metals concentrations in Area D groundwater were within the background range for the base.

In September 2000, an Operating Properly and Successfully (OPS) determination was made for the OU-4 groundwater remedy.

2.4.6 Current Status

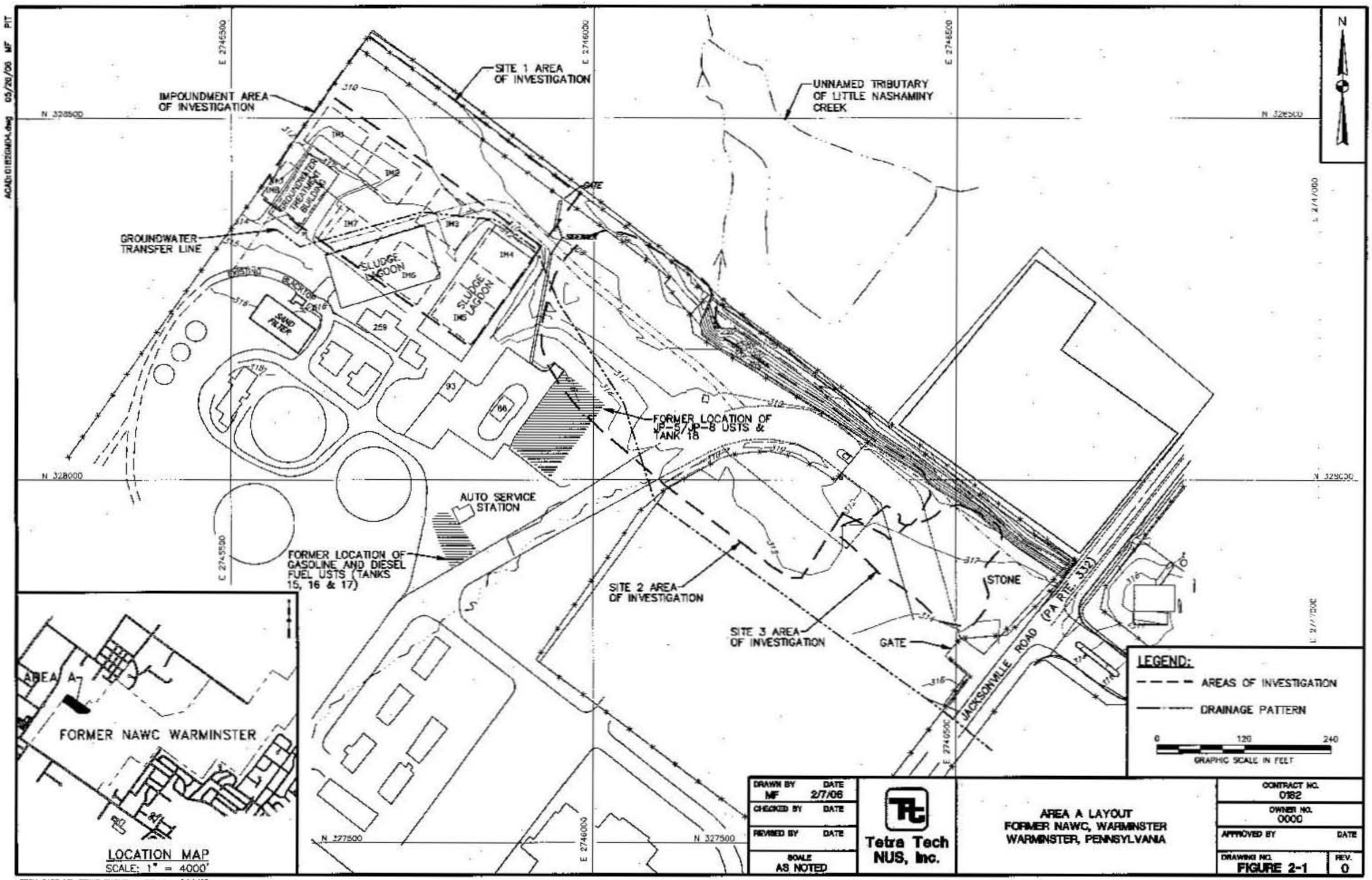
The Area D property was transferred to the FLRA in September 2000. The area is being used by light industrial/commercial businesses.

TABLE 2-1

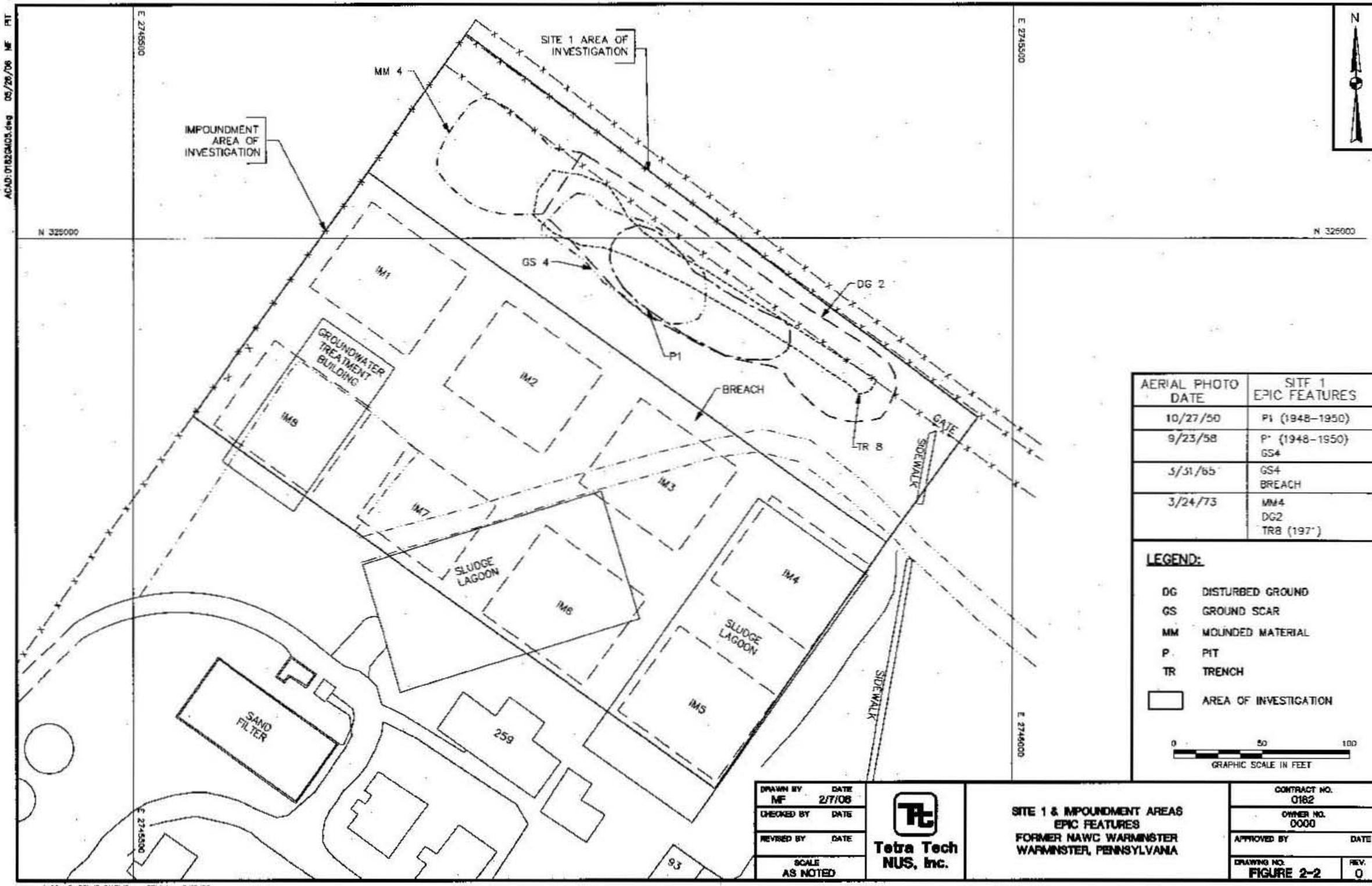
AREA A SOILS
REMOVAL ACTION CLEAN-UP GOALS
NAWC WARMINSTER, PENNSYLVANIA

Site	Parameter	Clean-up goal
Site 1 Excavation 1a	Trichloroethylene (TCE)	60 µg/kg
	Antimony	113 mg/kg
	Cadmium	76 mg/kg
	Chromium	16,161 mg/kg
Site 1 Excavation 1b	Tce	60 µg/kg
	Antimony	113 mg/kg
	Cadmium	76 mg/kg
	Chromium	16,161 mg/kg
	Thallium[(1)]	14 mg/kg
Site 2 Excavation 2a	Antimony surface soils	50 mg/kg
	Lead surface soils	1,000 mg/kg
	Antimony subsurface soils	113 mg/kg
	Lead subsurface soils	1,750 mg/kg
Site 2 Excavation 2b	Benz(a)anthracene	2,300 µg/kg
	Indeno(1,2,3-cd)pyrene	1,100 µg/kg
Site 2 excavation 2c	Benzo(a)pyrene	78,000 µg/kg
Site 3	Anthracene	540 µg/kg
	Benz(a)anthracene	2,300 µg/kg
	Benzo(a)pyrene	2,500 µg/kg
	Fluoranthene	5,000 µg/kg

1. Thallium was added as a clean-up goal for the eastern end of Excavation 1B after evaluation of characterization samples from drum excavation.


SITE 1 AREA OF INVESTIGATION
IMPOUNDMENT AREA OF INVESTIGATION
UNNAMED TRIBUTARY OF LITTLE NASHAMINY CREEK
GROUNDWATER TRANSFER LINE
GROUNDWATER TREATMENT BUILDING
SLUDGE LAGOON
SAND FILTER
BLOWDOWN
GATE
FORMER LOCATION OF JP-5/JP-8 USTS & TANK 18
AUTO SERVICE STATION
FORMER LOCATION OF GASOLINE AND DIESEL FUEL USTS (TANKS 15, 16 & 17)
SITE 2 AREA OF INVESTIGATION
SITE 3 AREA OF INVESTIGATION
STONE
JACKSONVILLE ROAD (PA RTE. 332)
N 328500
N 328000
N 327500
E 2745500
E 2746000
E 2746500
N
LEGEND:
AREAS OF INVESTIGATION
DRAINAGE PATTERN
0 120 240
GRAPHIC SCALE IN FEET
AREA A
FORMER NAWC WARMINSTER
LOCATION MAP
SCALE: 1" = 4000'
DRAWN BY MF DATE 2/7/06
CHECKED BY DATE
REVISED BY DATE
SCALE AS NOTED
Tetra Tech NUS, Inc.
AREA A LAYOUT
FORMER NAWC, WARMINSTER
WARMINSTER, PENNSYLVANIA
CONTRACT NO. 0162
OWNER NO. 0000
APPROVED BY DATE
DRAWING NO. FIGURE 2-1
REV. 0
FORM CADD NO. TTNUS-2H.DWG - REV 1 - 9/10/98

ACAD:0182GM05.dwg 05/26/06 MF PIT



AERIAL PHOTO DATE	SITE 1 EPIC FEATURES
10/27/50	P1 (1948–1950)
9/23/58	P' (1948–1950) GS4
5/31/65	GS4 BREACH
3/24/73	MM4 DG2 TR8 (197')

LEGEND:

DG	DISTURBED GROUND
GS	GROUND SCAR
MM	MOUNDED MATERIAL
P	PIT
TR	TRENCH
	AREA OF INVESTIGATION

0 50 100
GRAPHIC SCALE IN FEET

DRAWN BY	DATE
MF	2/7/06
CHECKED BY	DATE
REVISED BY	DATE
SCALE AS NOTED	

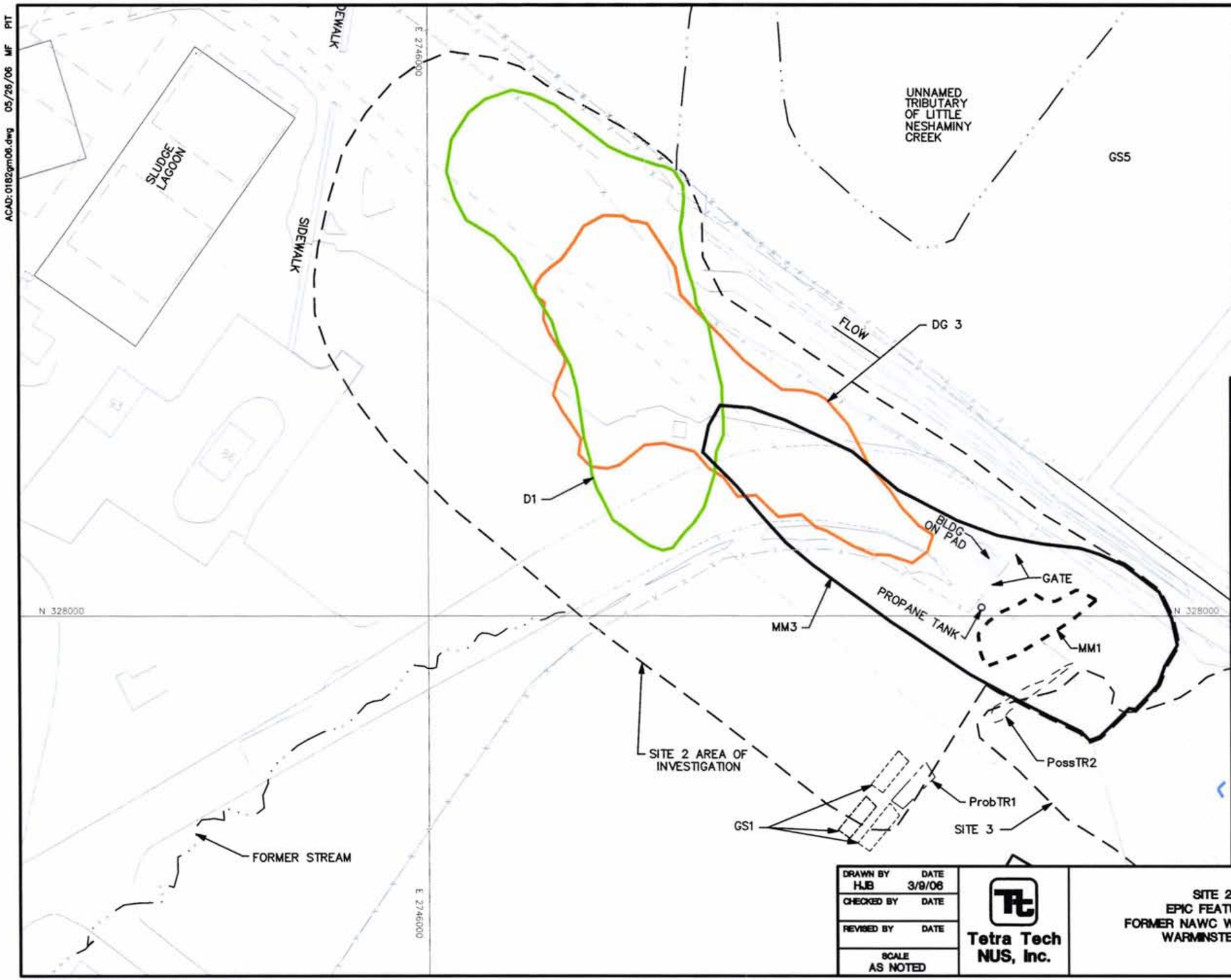
Tetra Tech NUS, Inc.

SITE 1 & IMPOUNDMENT AREAS
EPIC FEATURES
FORMER NAWC WARMINSTER
WARMINSTER, PENNSYLVANIA

CONTRACT NO. 0182	
OWNER NO. 0000	
APPROVED BY	DATE
DRAWING NO. FIGURE 2-2	REV. 0

FORM CADD NO. TTNUS-3H.DWG - REV 1 - 9/10/98

ACAD: 0182gm06.dwg 05/26/06 MF PIT



AERIAL PHOTO DATE	SITE 2 EPIC FEATURES
10/27/50	D1 (1942–1950) GS1 ProbTR1
9/23/58	D1 (1942–1950) GS1 ProbTR1 MM1 PossTR2
3/31/65	MM3 PossTR2/MM1 (1958)
3/24/73	DG3

LEGEND:

D	–	DUMP
DG	–	DISTURBED GROUND
GS	–	GROUND SCAR
MM	–	MOUNDED MATERIAL
TR	–	TRENCH
⊏⊐	–	AREA OF INVESTIGATION

0 60 120
GRAPHIC SCALE IN FEET

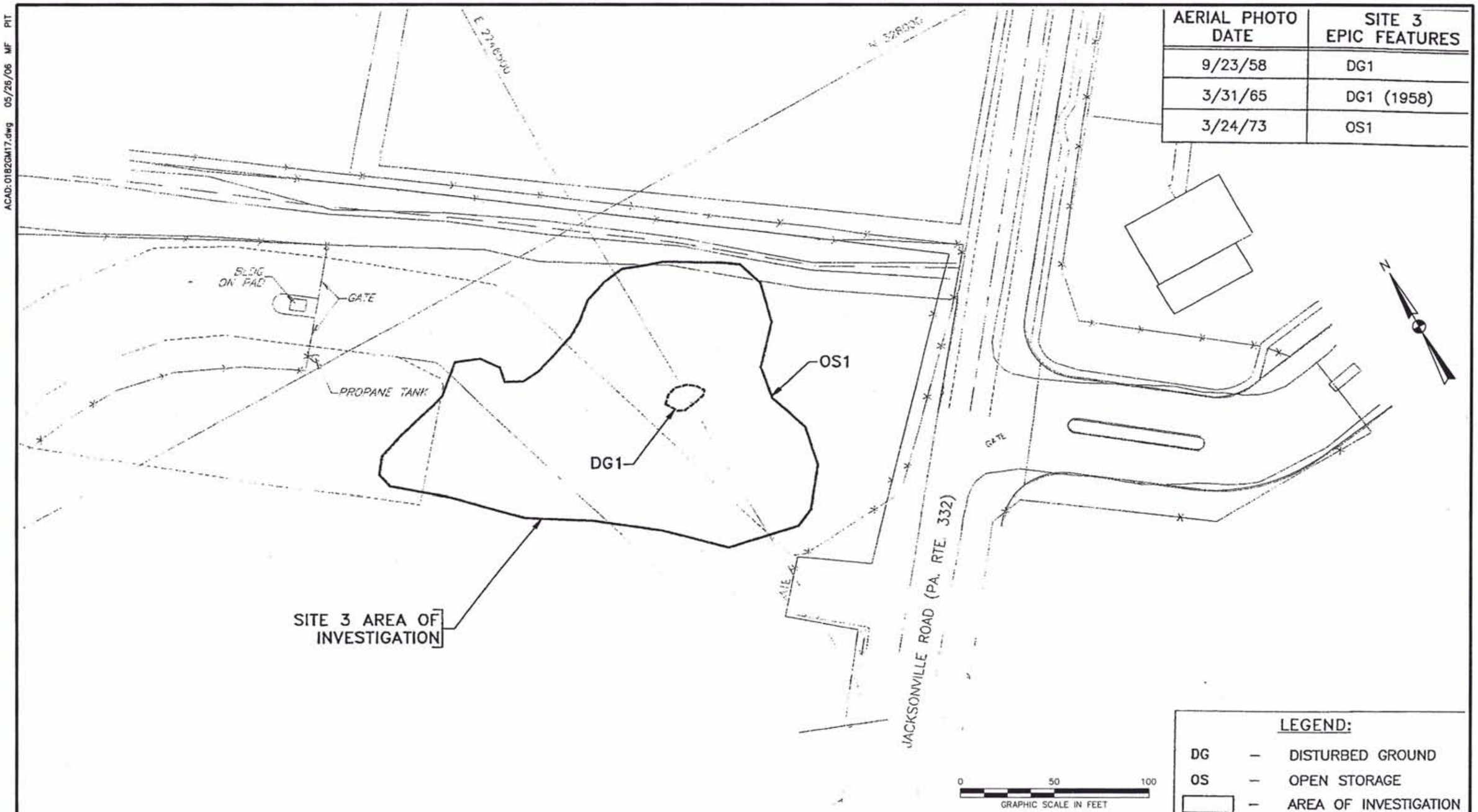
DRAWN BY HJB	DATE 3/9/06	Tetra Tech NUS, Inc.	SITE 2 EPIC FEATURES FORMER NAWC WARMINSTER WARMINSTER, PA
CHECKED BY	DATE		
REVISED BY	DATE		
SCALE AS NOTED			

CONTRACT NO. 0182
OWNER NO. 0000
APPROVED BY DATE
DRAWING NO. FIGURE 2-3
REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

ACAD:0182GM17.dwg 05/26/06 MF PIT

AERIAL PHOTO DATE	SITE 3 EPIC FEATURES
9/23/58	DG1
3/31/65	DG1 (1958)
3/24/73	OS1



LEGEND:

DG – DISTURBED GROUND

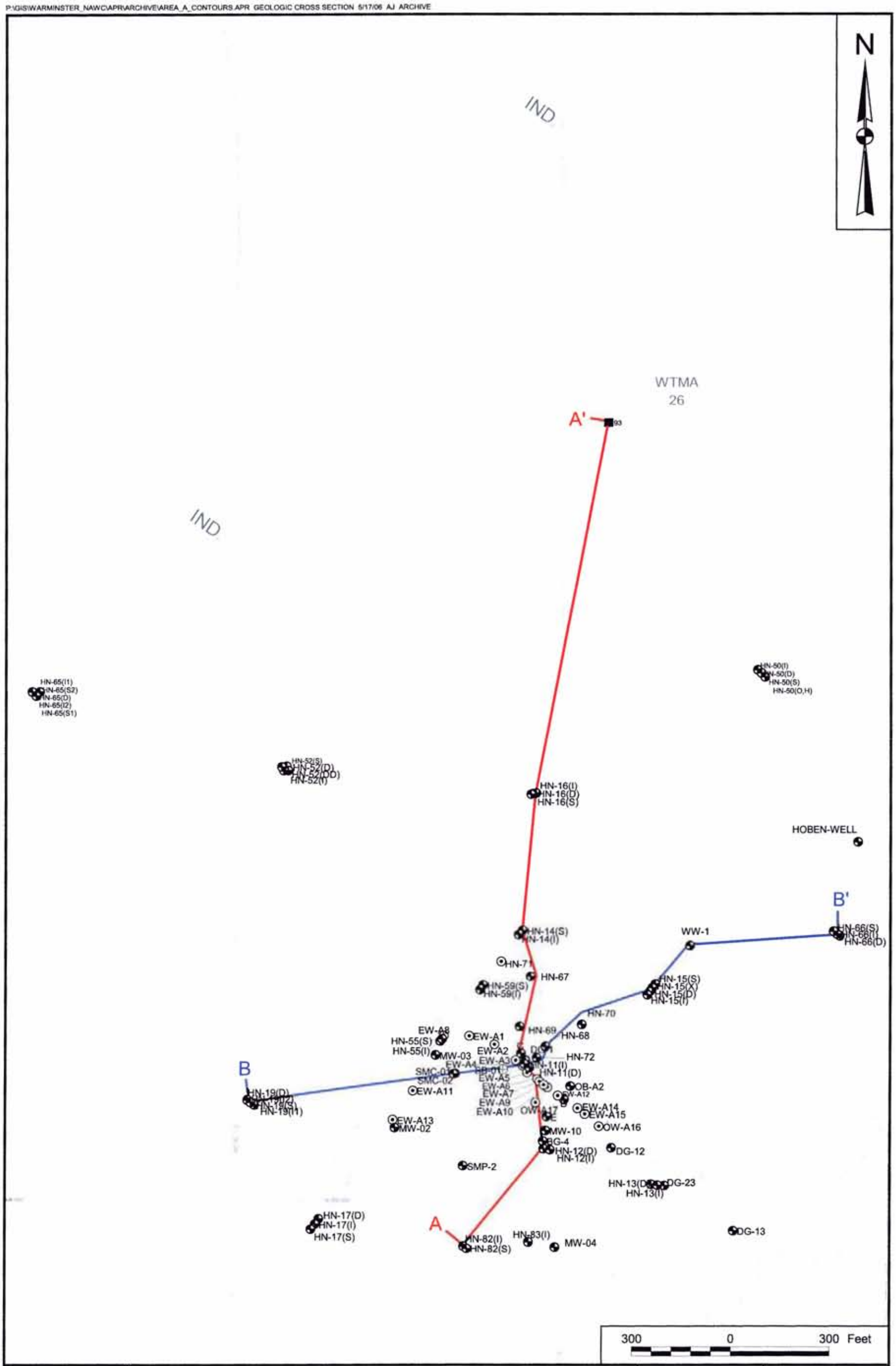
OS – OPEN STORAGE

☐ – AREA OF INVESTIGATION

DRAWN BY MF DATE 5/26/06	Tetra Tech NUS, Inc.	SITE 3 EPIC FEATRUES FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA	CONTRACT NO. 0182
CHECKED BY DATE			OWNER NO.
REVISED BY DATE			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2-4 REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

P:\GIS\WARMINSTER_NAWC\APR\ARCHIVE\AREA_A_CONTOURS.APR GEOLOGIC CROSS SECTION 5/17/06 AJ ARCHIVE



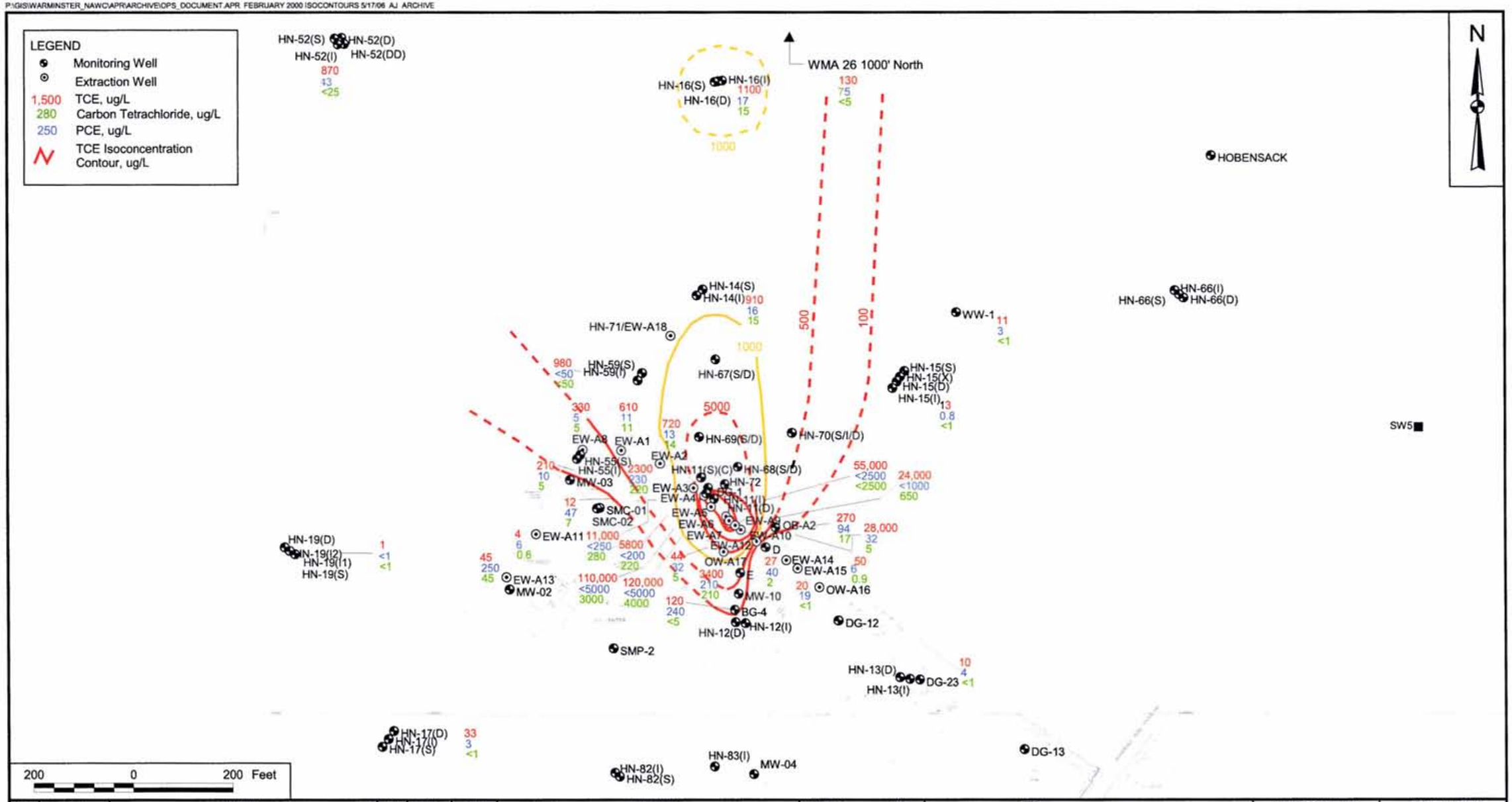
DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER	OWNER NUMBER
J. BELLONE	7/24/00		00182	—
CHECKED BY	DATE	WELL AND GEOLOGIC CROSS SECTION LOCATIONS	APPROVED BY	DATE
B. DAVIS	5/18/06	AREA A	—	—
COST/SCHEDULE-AREA		NAWC WARMINSTER, PENNSYLVANIA	APPROVED BY	DATE
			—	—
SCALE			DRAWING NO.	REV
AS NOTED			FIGURE 2 - 5	0

ACAD: 0182GM16.dwg 05/26/06 MF PIT

DRAWN BY MF	DATE 5/15/06	Tetra Tech NUS, Inc.	AREA A REMOVAL ACTION LAYOUT FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA	CONTRACT NO. 0182
CHECKED BY	DATE			OWNER NO.
REVISED BY	DATE			APPROVED BY / DATE
SCALE AS NOTED				DRAWING NO. FIGURE 2-6 / REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

P:\GIS\WARMINSTER_NAWC\APR\ARCHIVE\OPS_DOCUMENT.APR FEBRUARY 2000 ISOCONTOURS 5/17/06 AJ ARCHIVE



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

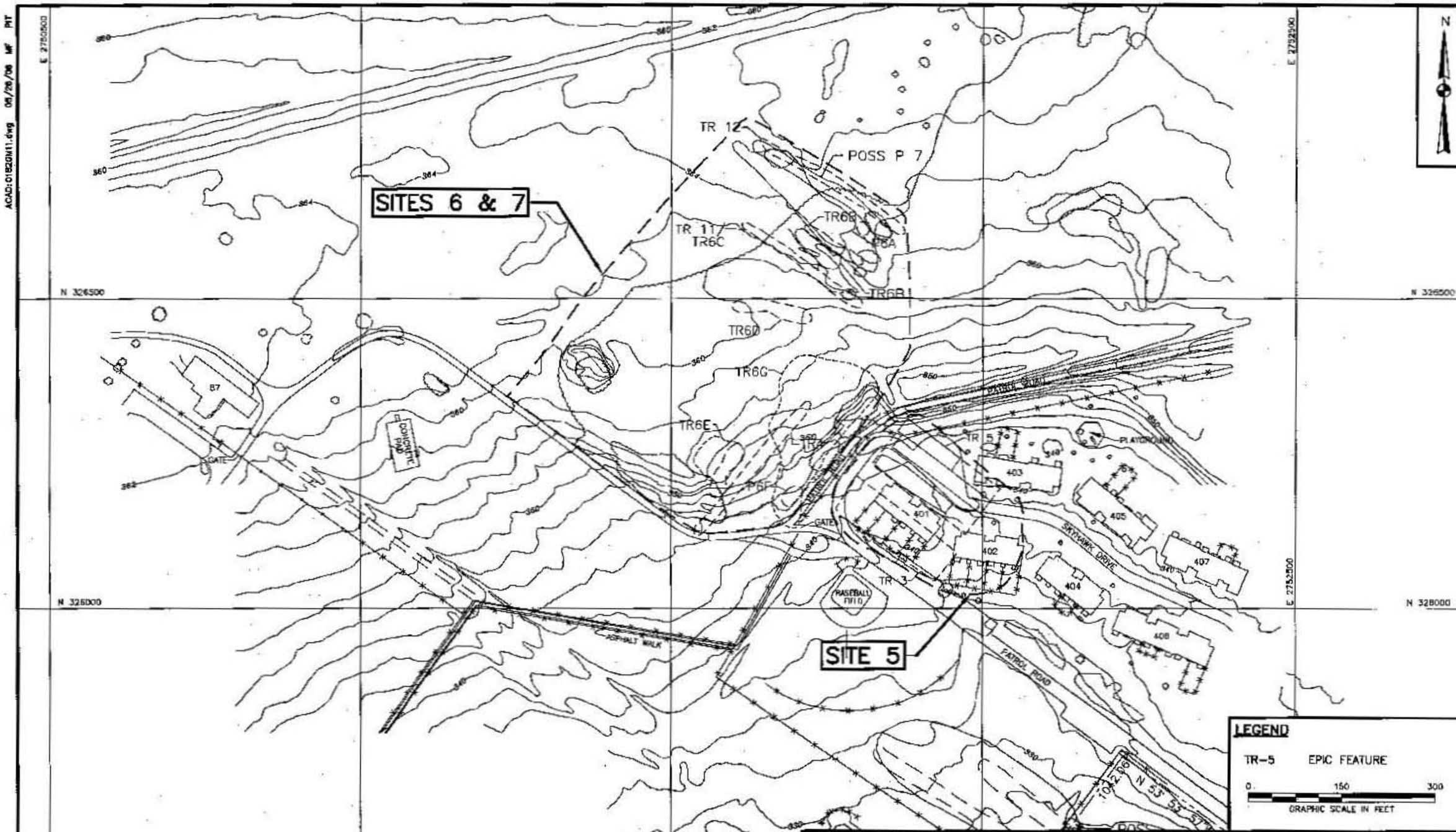
DRAWN BY J. BELLONE	DATE 7/21/00
CHECKED BY B. DAVIS	DATE 5/18/06
COST/SCHEDULE-AREA	
SCALE AS NOTED	

Tetra Tech NUS, Inc.

FEBRUARY 2000 ISOCONCENTRATION CONTOURS, ug/L
MONITORING WELL LOCATIONS
AREA A
NAWC WARMINSTER
WARMINSTER, PENNSYLVANIA

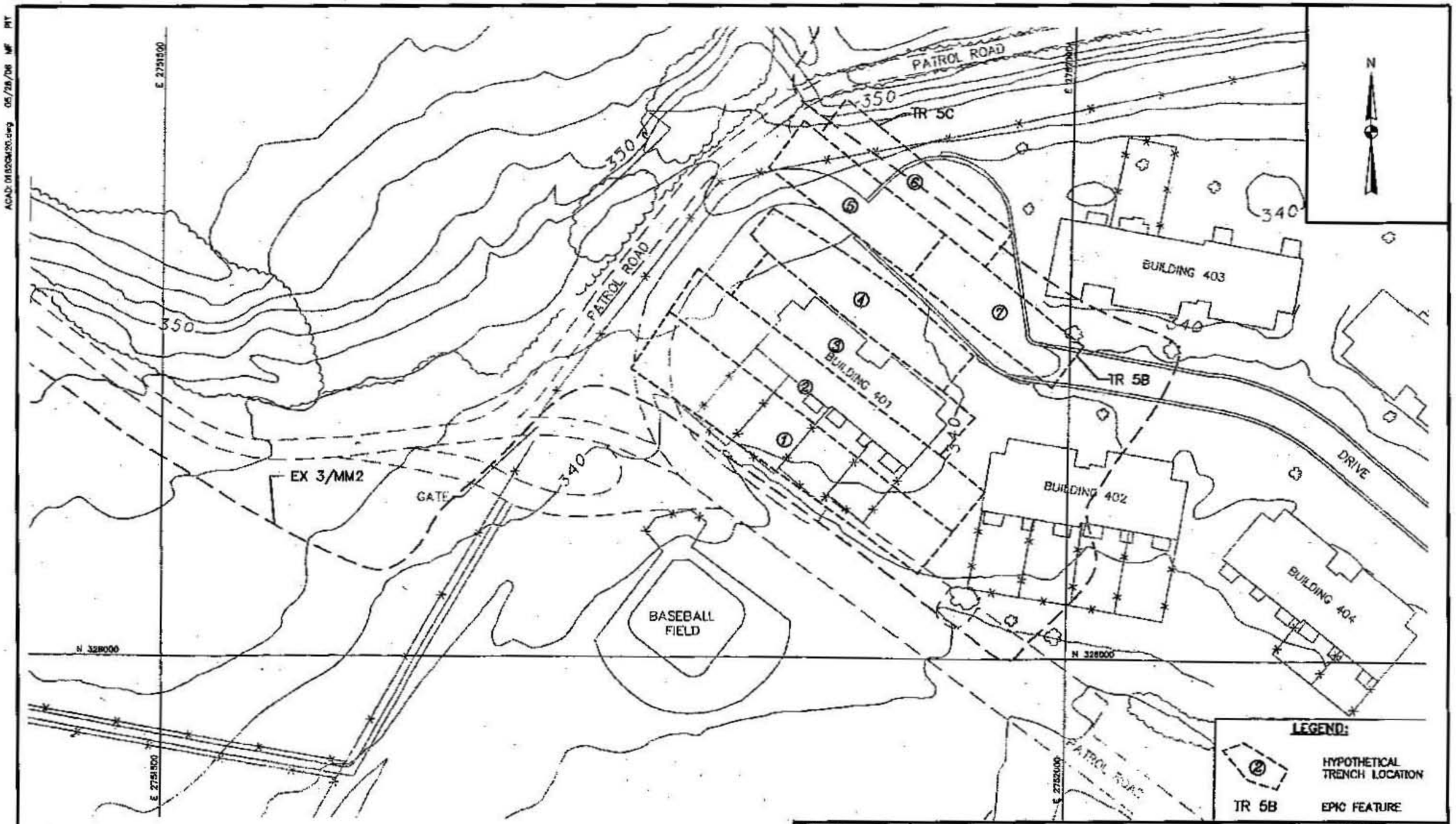
CONTRACT NUMBER 00182	OWNER NUMBER —
APPROVED BY —	DATE —
APPROVED BY —	DATE —
DRAWING NO. FIGURE 2 - 7	REV 0

ACAD:0182GM11.dwg 05/26/08 MF PIT



DRAWN BY MF DATE 5/15/08	Tetra Tech NUS, Inc.	AREA B LAYOUT FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA	CONTRACT NO. 0182
CHECKED BY DATE			OWNER NO.
REVISED BY DATE			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2-8 REV. D

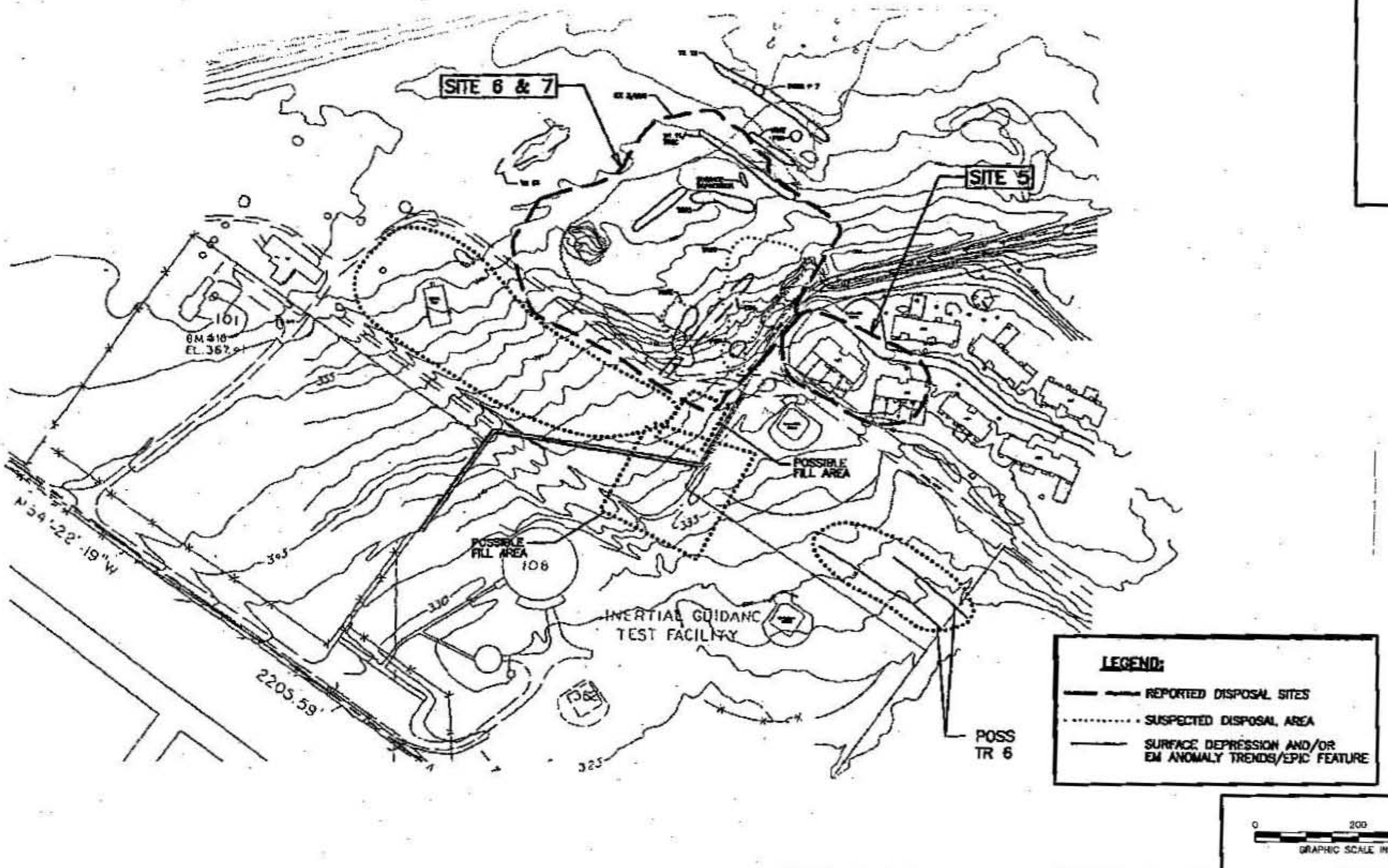
FORM CADD NO. TTNUS-BA.DWG - REV 1 - 9/10/98



DRAWN BY MF	DATE 5/26/06	Tetra Tech NUS, Inc.	CONCEPTUAL LAYOUT OF SITE 5 TRENCHES AREA B - SITE 5 FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA
CHECKED BY	DATE		
REVISED BY	DATE		
SCALE AS NOTED			

CONTRACT NO. 0182	
OWNER NO.	
APPROVED BY	DATE
DRAWING NO. FIGURE 2-9	REV. 0

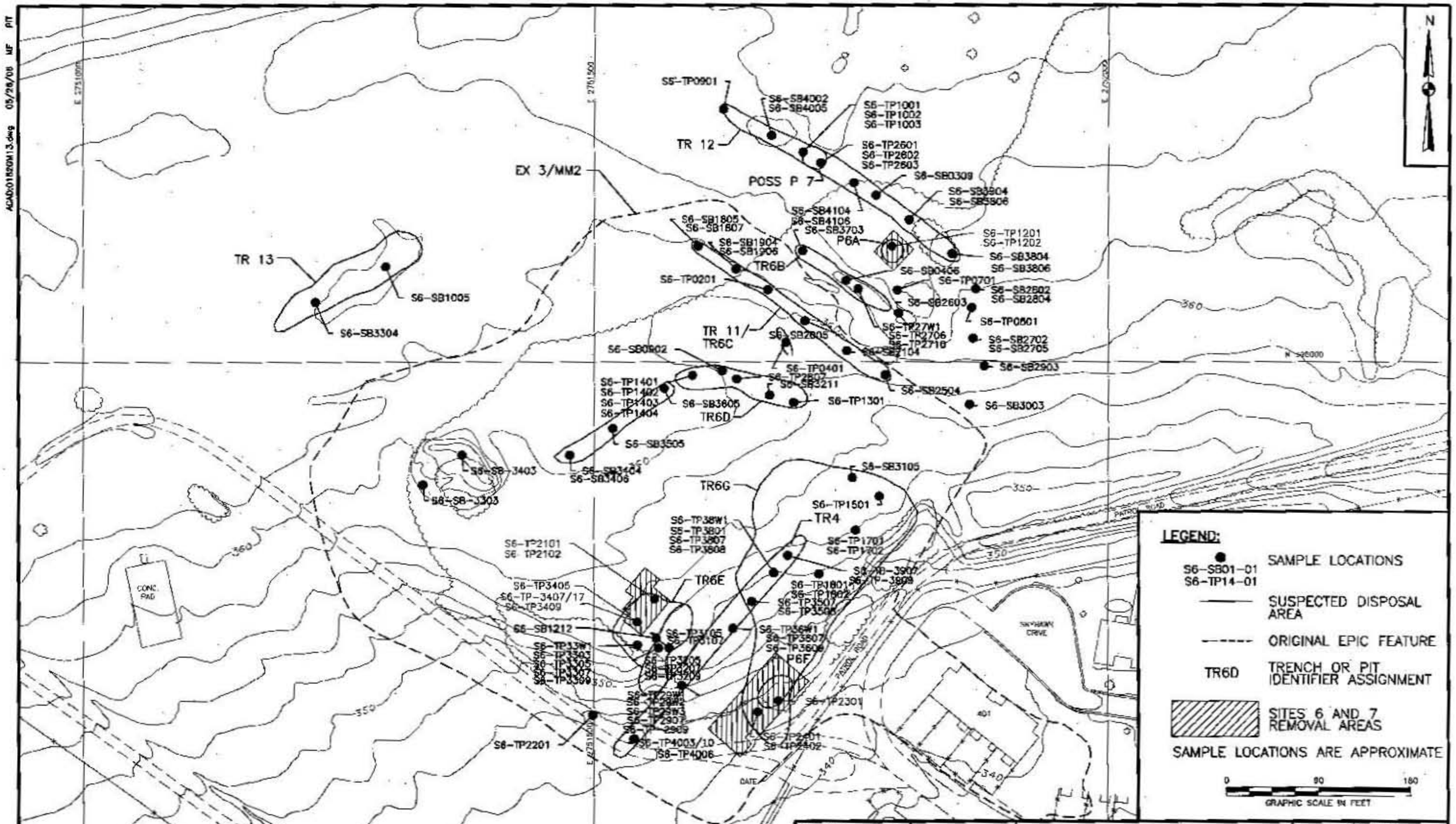
FERN CADD NO. TTNUS-BASE.DWG – REV 1 – 9/10/99



DRAWN BY MF DATE 5/26/06	Tetra Tech NUS, Inc.	AREA B - SITES 5, 6 AND 7, AND SUSPECTED DISPOSAL AREAS FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA	CONTRACT NO. 0182
CHECKED BY DATE			OWNER NO.
REVISED BY DATE			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2-10 REV. 0

ACAD: 0182GMIS.dwg 05/26/06 MF PIT

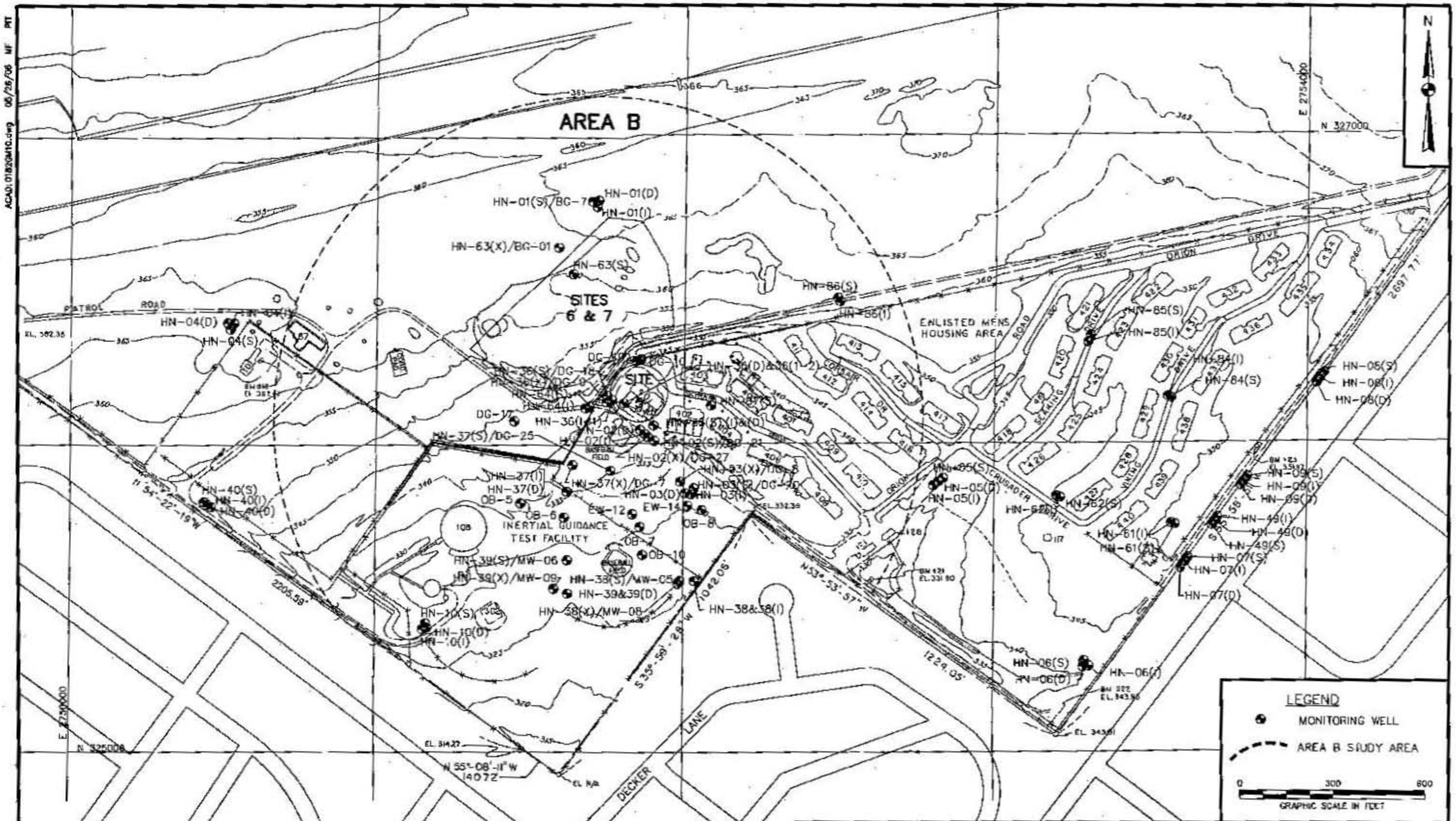
FORM CADD NO. FTNUS-IN.DWG - REV 1 - 9/10/98



DRAWN BY MF	DATE 5/15/06	Tetra Tech NUS, Inc.	APPROXIMATE REMOVAL AREAS REMEDIAL INVESTIGATION AREA B - SITES 6 AND 7 FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA
CHECKED BY	DATE		
REVISED BY	DATE		
SCALE AS NOTED			

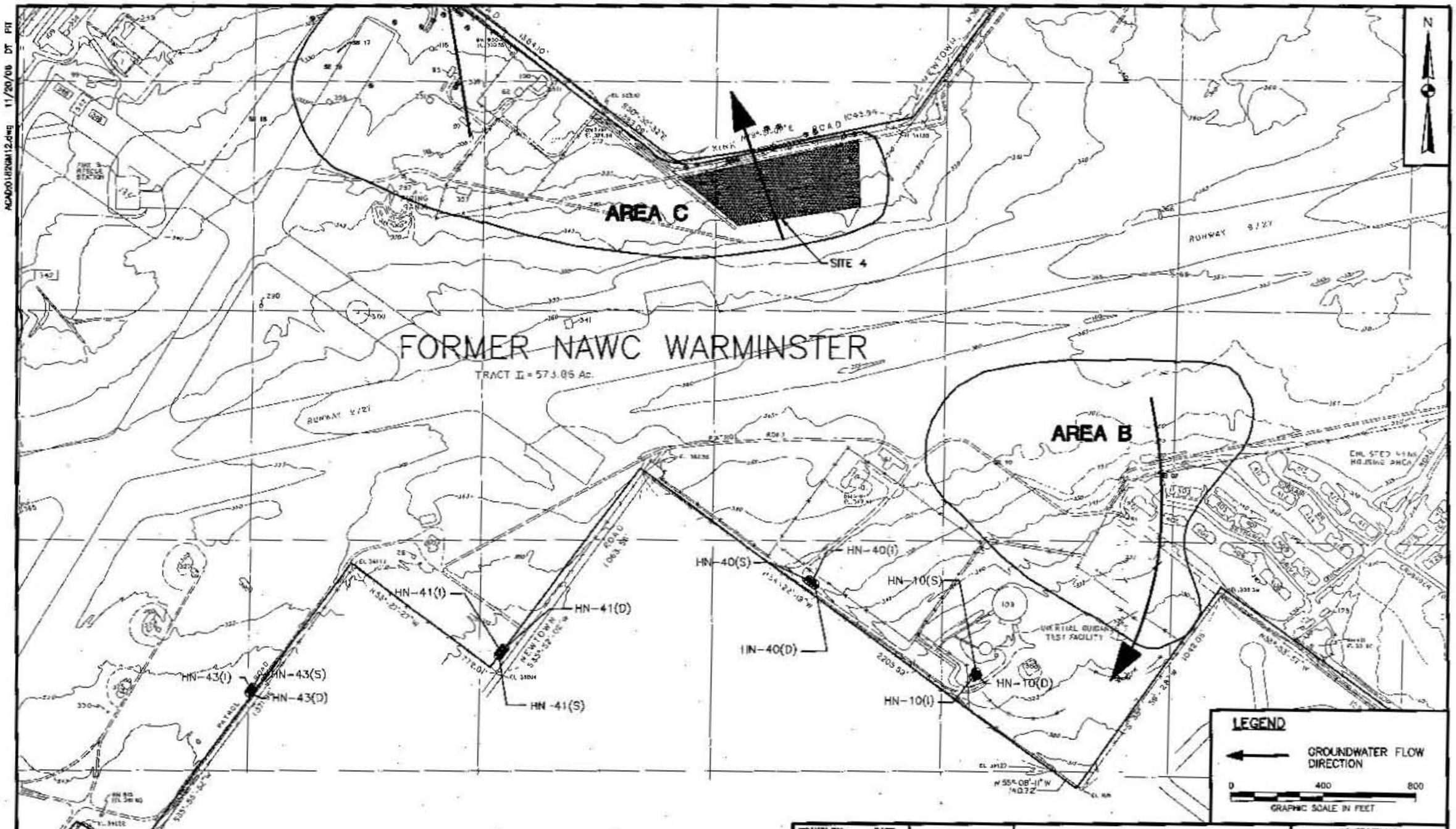
CONTRACT NO. 0182	
OWNER NO.	
APPROVED BY	DATE
DRAWING NO. FIGURE 2-11	REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/96



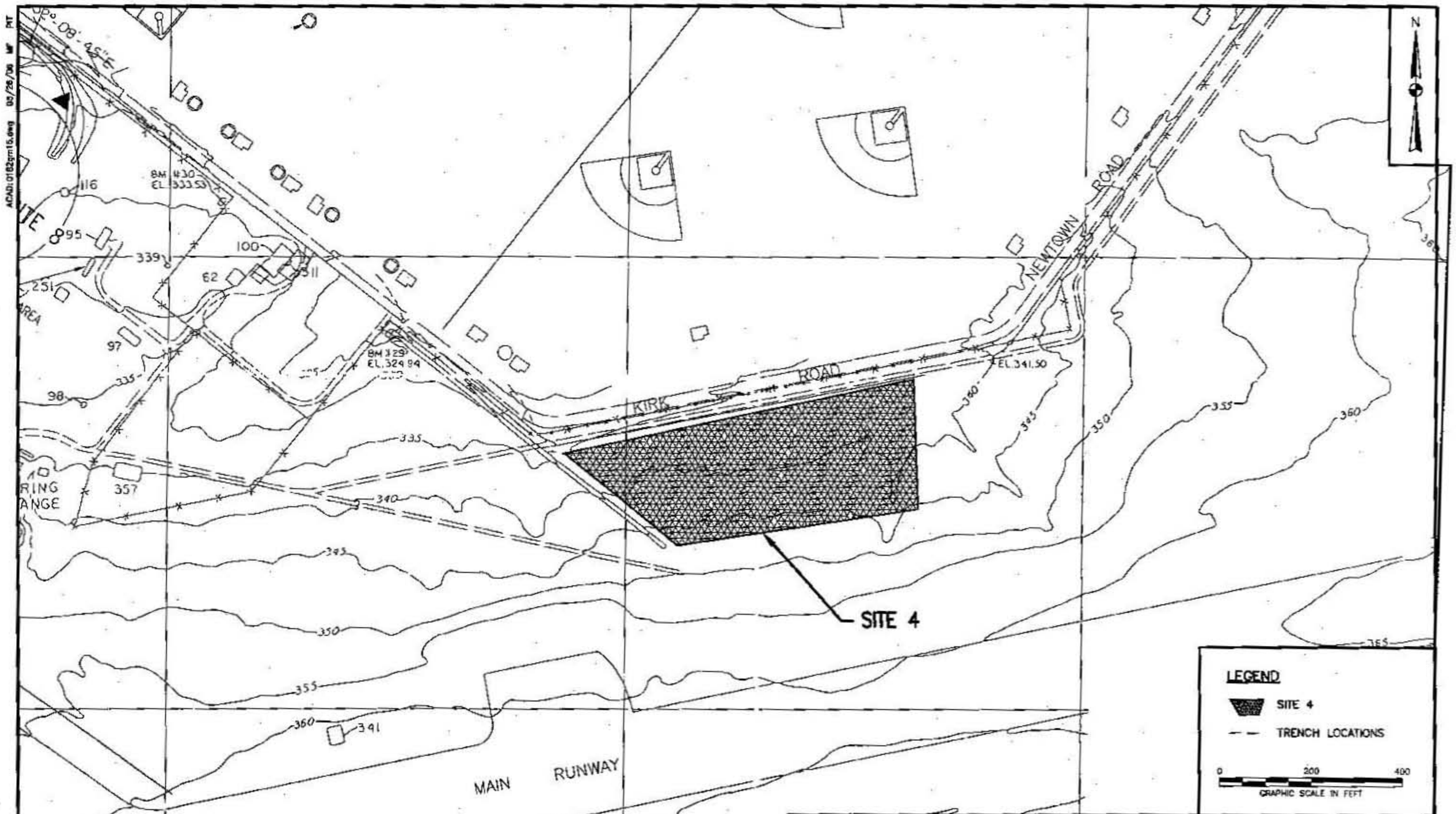
DRAWN BY MF	DATE 5/15/06	Tetra Tech NUS, Inc.	WELL LOCATIONS AREA B FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA
CHECKED BY	DATE		CONTRACT NO. 0182
REVISED BY	DATE		OWNER NO.
SCALE AS NOTED			APPROVED BY / DATE
			DRAWING NO. FIGURE 2-12 / REV. 0

FORM CADD NO. TTNUS-BM.DWG - REV 1 - 9/10/98



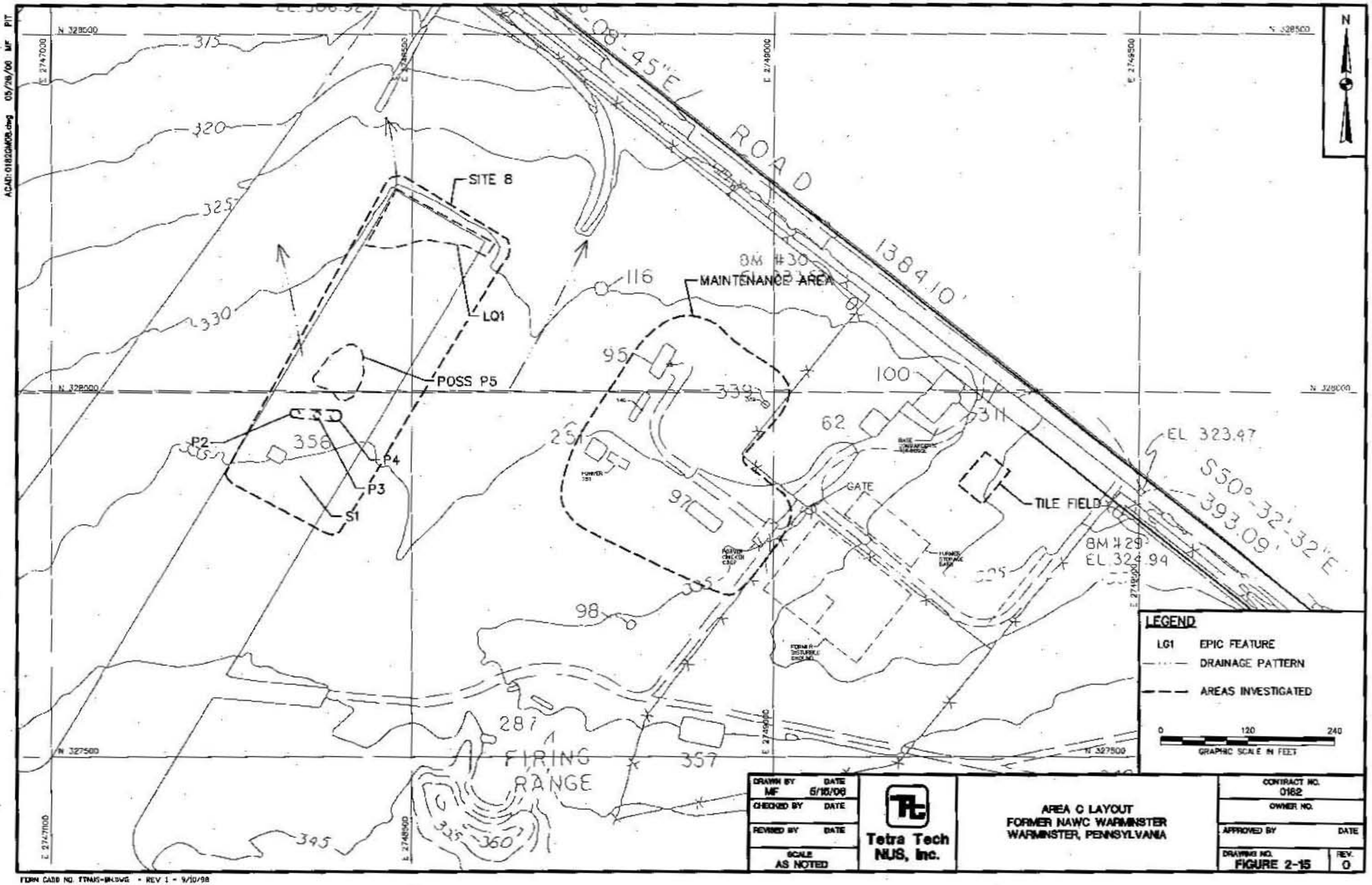
DRAWN BY MF	DATE 6/15/06	Tetra Tech NUS, Inc.	SOUTH BASE BOUNDARY WELL LOCATIONS FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA
CHECKED BY	DATE		CONTRACT NO. 0182
REVISED BY	DATE		OWNER NO.
SCALE AS NOTED			APPROVED BY / DATE
			DRAWING NO. FIGURE 2-13 / REV. 0

FORM CADD NO. TTNUS-WHDWG - REV 1 - 9/10/98

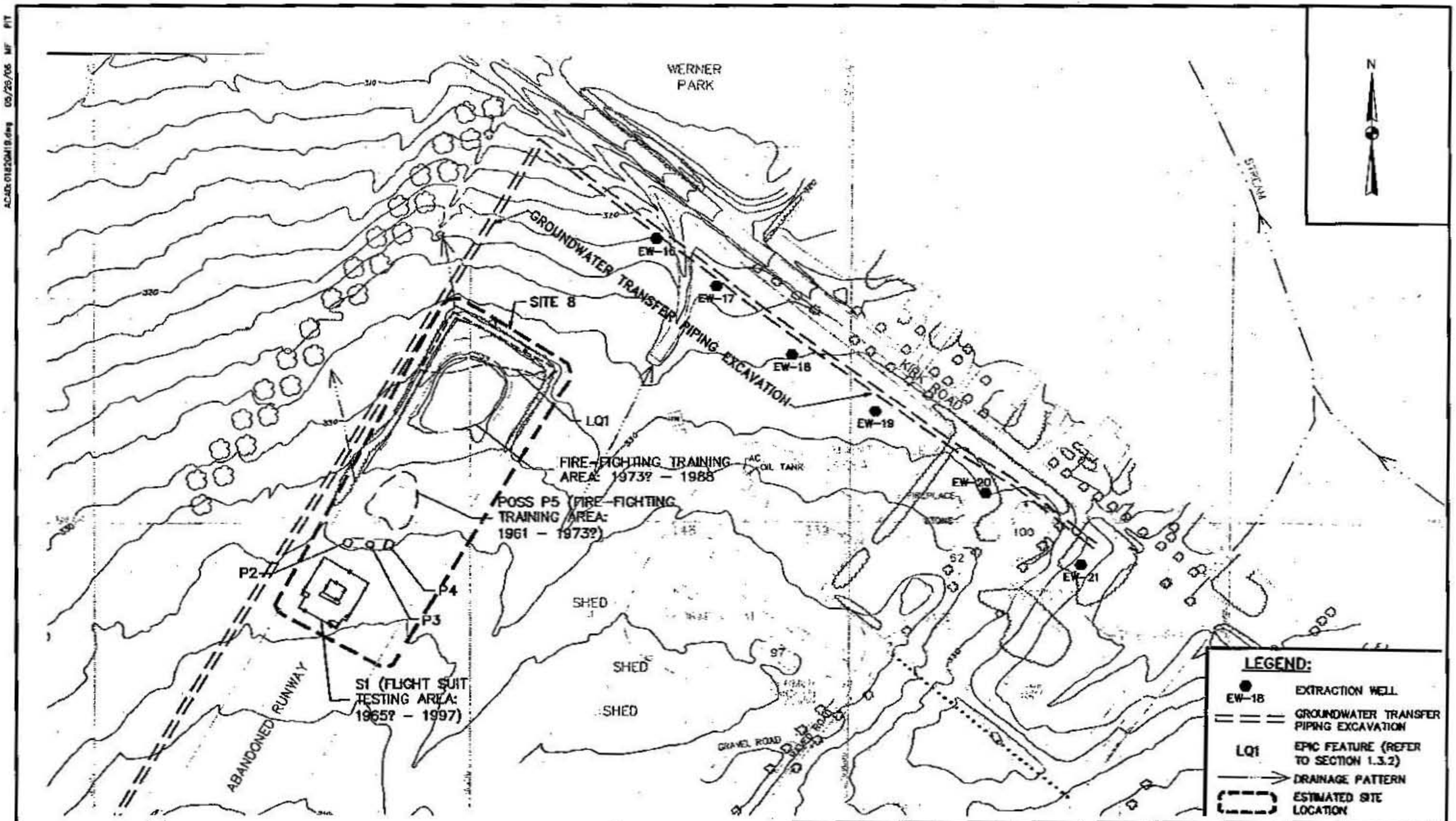


DRAWN BY MF	DATE 5/15/06	Tetra Tech NUS, Inc.	SITE 4 LOCATION MAP FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA
CHECKED BY	DATE		CONTRACT NO. 0182
REVISED BY	DATE		OWNER NO.
SCALE AS NOTED			APPROVED BY / DATE
			DRAWING NO. FIGURE 2-14 / REV. 0

FORM CADD NO. TTNUS-3A.DWG - REV 1 - 9/10/98

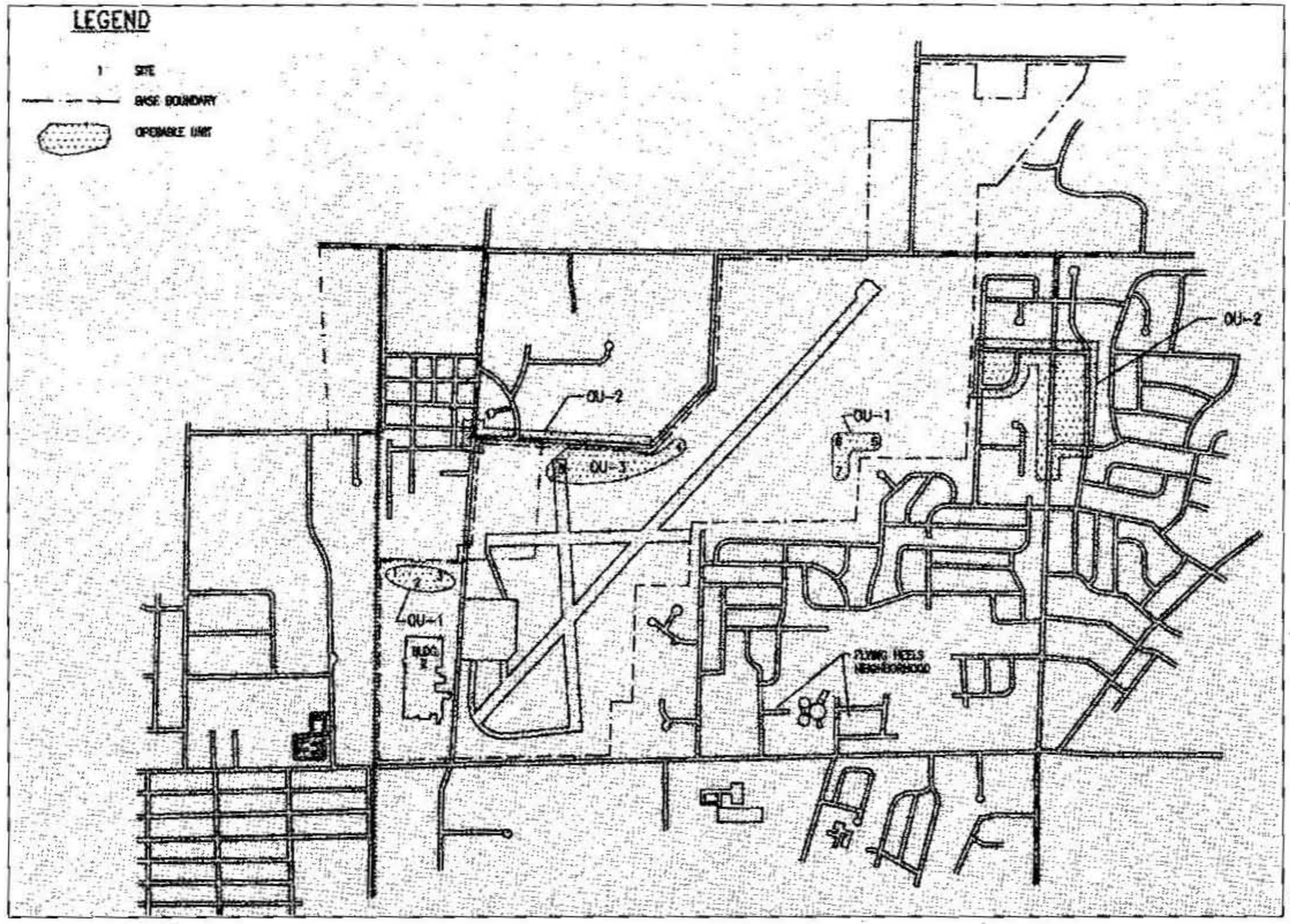


FORM CADD NO. TTNUS-BK.DWG - REV 1 - 9/10/98



DRAWN BY MF	DATE 5/26/06	Tetra Tech NUS, Inc.	AREA C AND SITE 8 LAYOUT FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA
CHECKED BY	DATE		CONTRACT NO. 0182
REVISED BY	DATE		OWNER NO.
SCALE AS NOTED			APPROVED BY / DATE
			DRAWING NO. FIGURE 2-16 / REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98



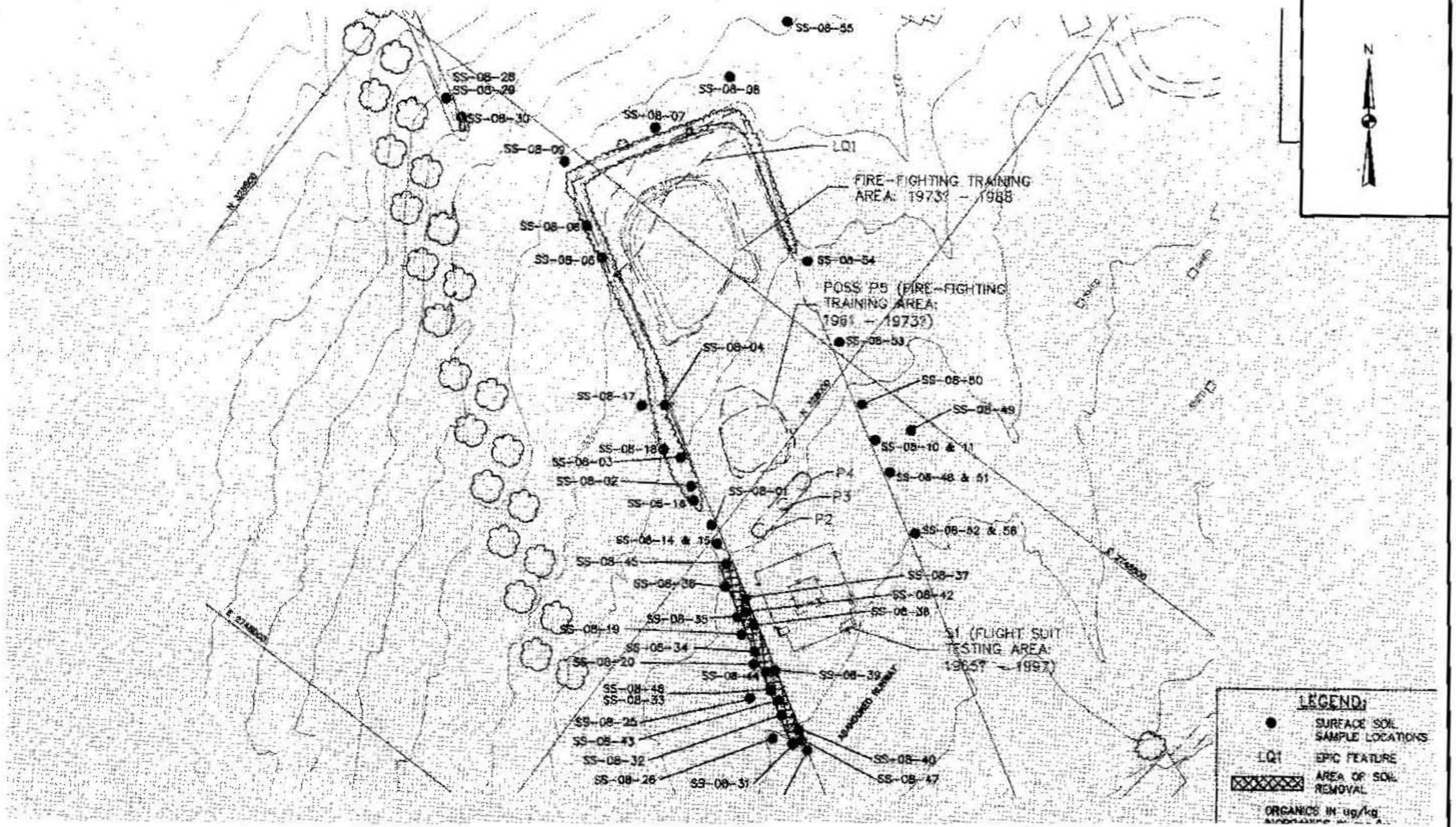
0 1200 2400
GRAPHIC SCALE IN FEET

DRAWN BY MF	DATE 5/26/06	Tetra Tech NUS, Inc.	OFF-BASE WELLS FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA	CONTRACT NO. 0182
CHECKED BY	DATE			OWNER NO.
REVISED BY	DATE			APPROVED BY / DATE
SCALE AS NOTED				DRAWING NO. FIGURE 2-17 / REV. 0

ACAD: 0182GM21.dwg 05/26/06 MF PIT

FORM CADD NO. TTNUS-B42W0 - REV 1 - 9/10/98

ACAD: 01B20DM22.dwg 05/26/06 MF PIT

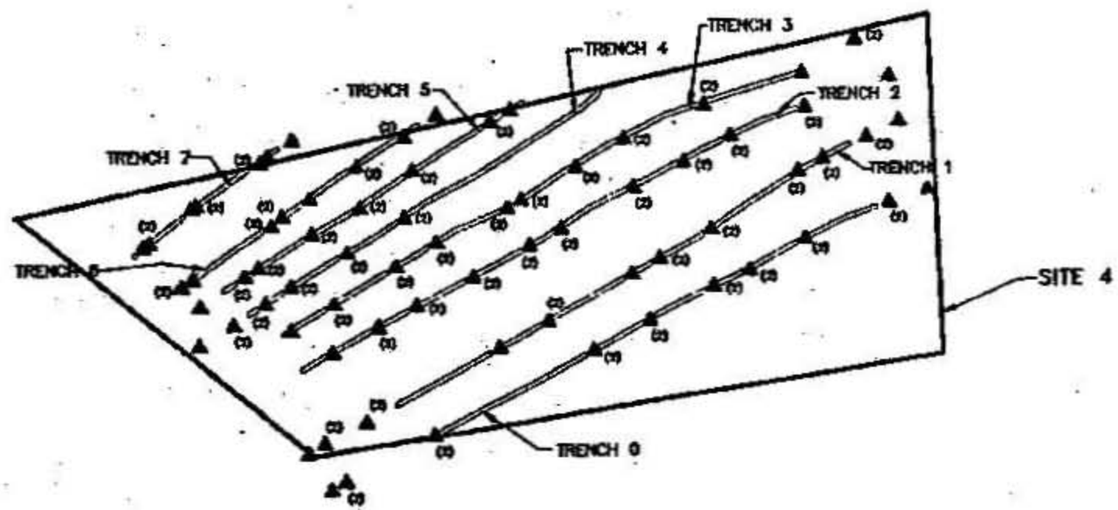


0 80 160
GRAPHIC SCALE IN FEET

DRAWN BY MF	DATE 5/26/06	Tetra Tech NUS, Inc.	SITE B REMOVAL ACTION FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA	CONTRACT NO. D182
CHECKED BY	DATE			OWNER NO.
REVISED BY	DATE			APPROVED BY / DATE
SCALE AS NOTED				DRAWING NO. FIGURE 2-18 / REV. 0

FORM CADD NO. TTNUS-3H.DWG - REV 1 - 9/10/98

ACAD: D182GM24.dwg 05/26/06 MF PIT



N

LEGEND

▲ SAMPLE LOCATION

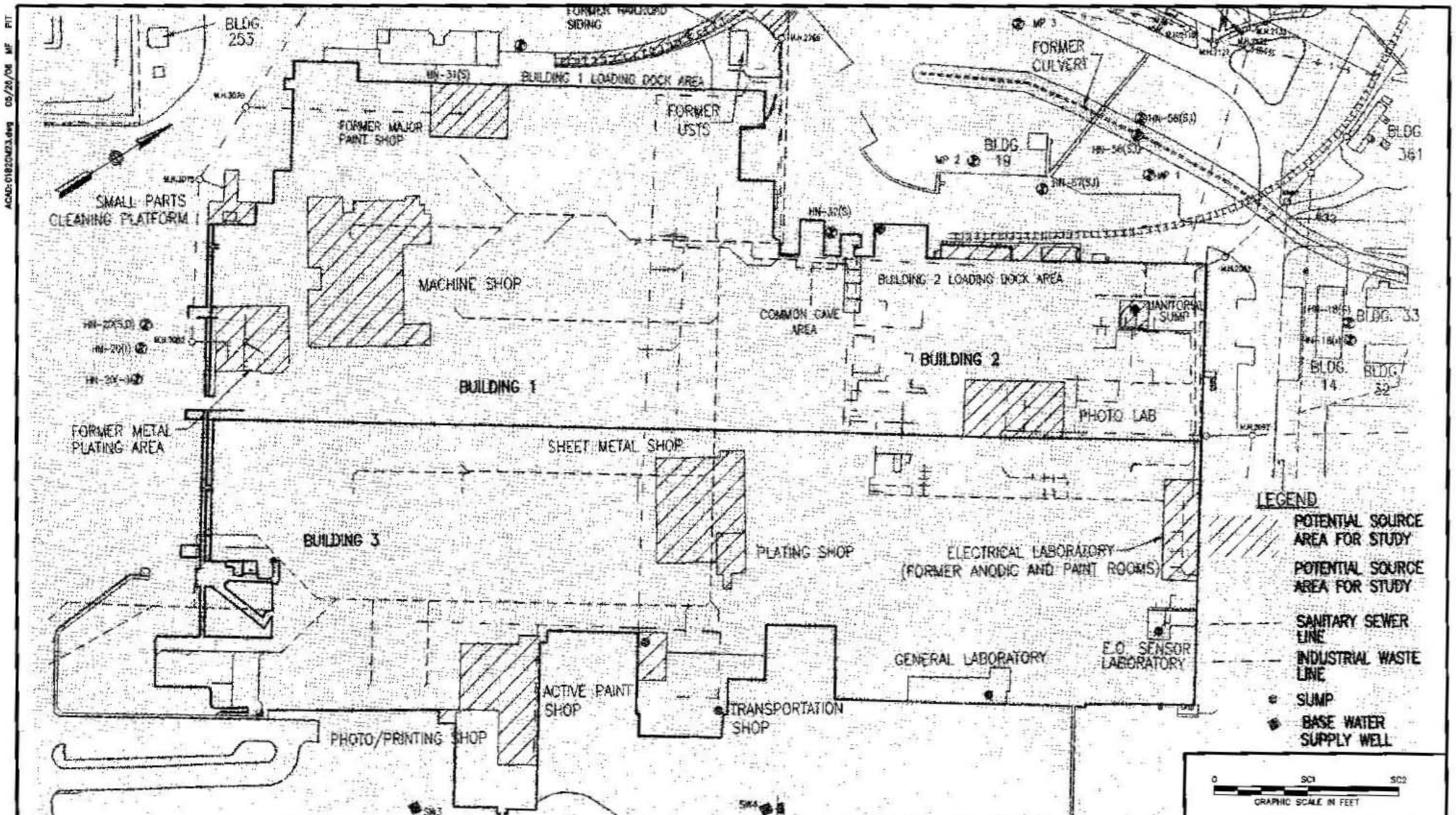
(3) NUMBER OF SAMPLES AT SAME LOCATION

EXCAVATED TRENCH LOCATION

0 SC1 SC2
GRAPHIC SCALE IN FEET

DRAWN BY MF DATE 5/26/06	Tetra Tech NUS, Inc.	SUBSURFACE SAMPLE LOCATIONS SITE 4 FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA	CONTRACT NO. 0182
CHECKED BY DATE			OWNER NO.
REVISED BY DATE			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2-19 REV. 0

FORM CADD NO. TTNUS-BM.DWG - REV 1 - 9/10/98



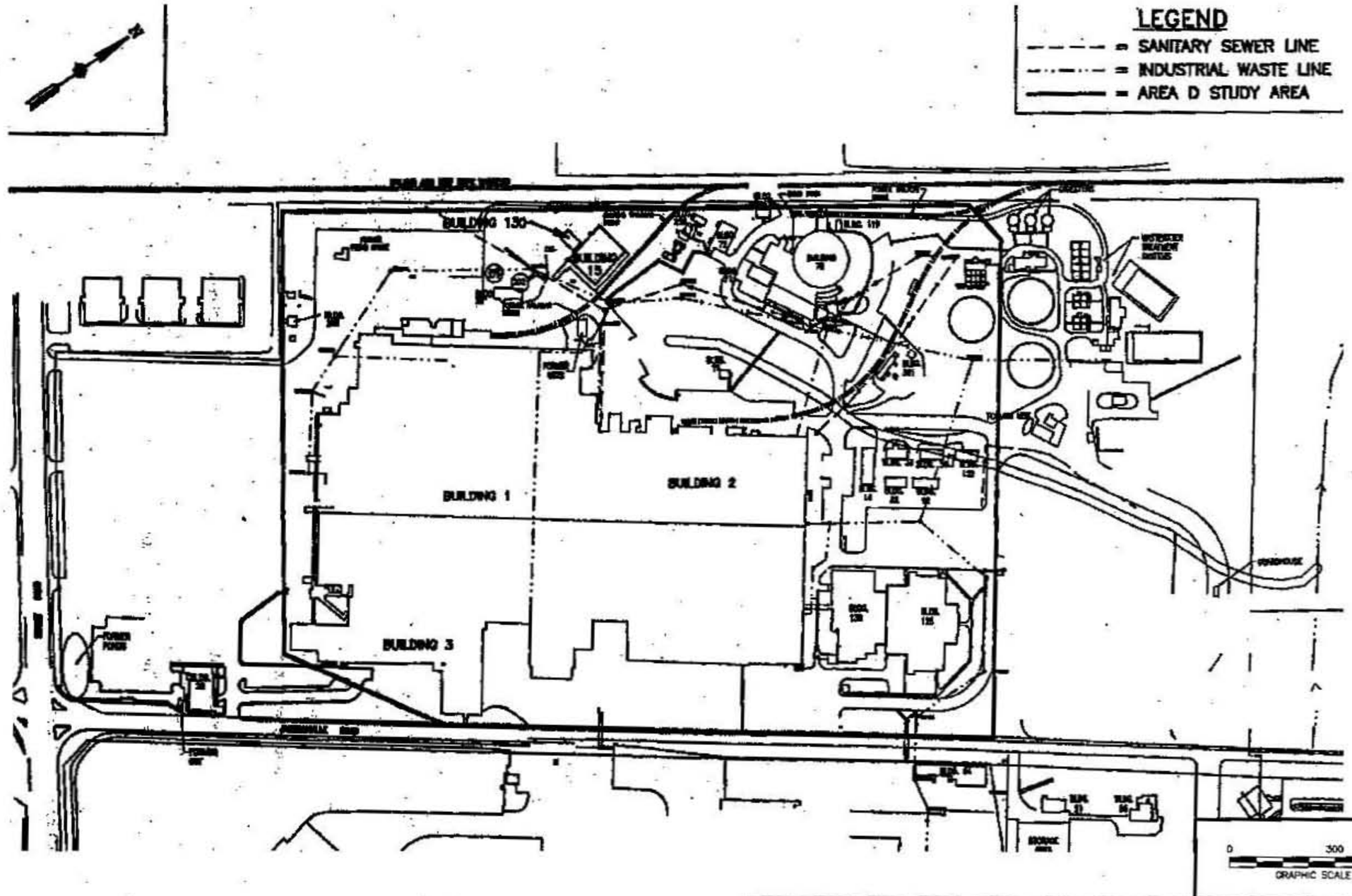
DRAWN BY MF	DATE 5/28/08	Tetra Tech NUS, Inc.	INTERIOR FEATURES OF CONCERN BUILDINGS 1, 2, AND 3 AREA D FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA
CHECKED BY	DATE		
REVISED BY	DATE		
SCALE AS NOTED			

CONTRACT NO. 0182	
OWNER NO.	
APPROVED BY	DATE
DRAWING NO. FIGURE 2-20	REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

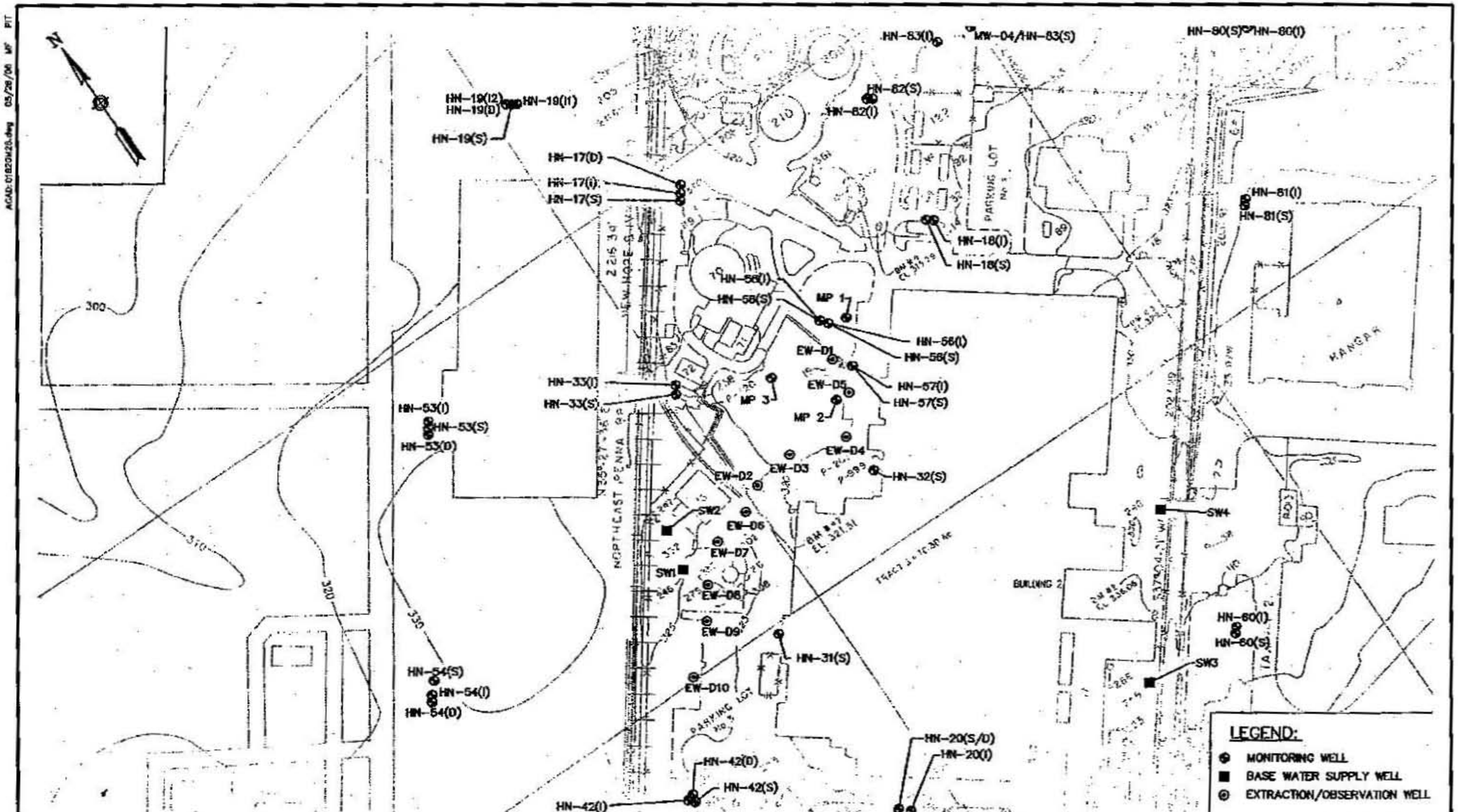
AC4D:0182DM23.dwg 05/28/08 MF FIT

ACAD: 0182DM25.dwg 05/26/06 MF PIT



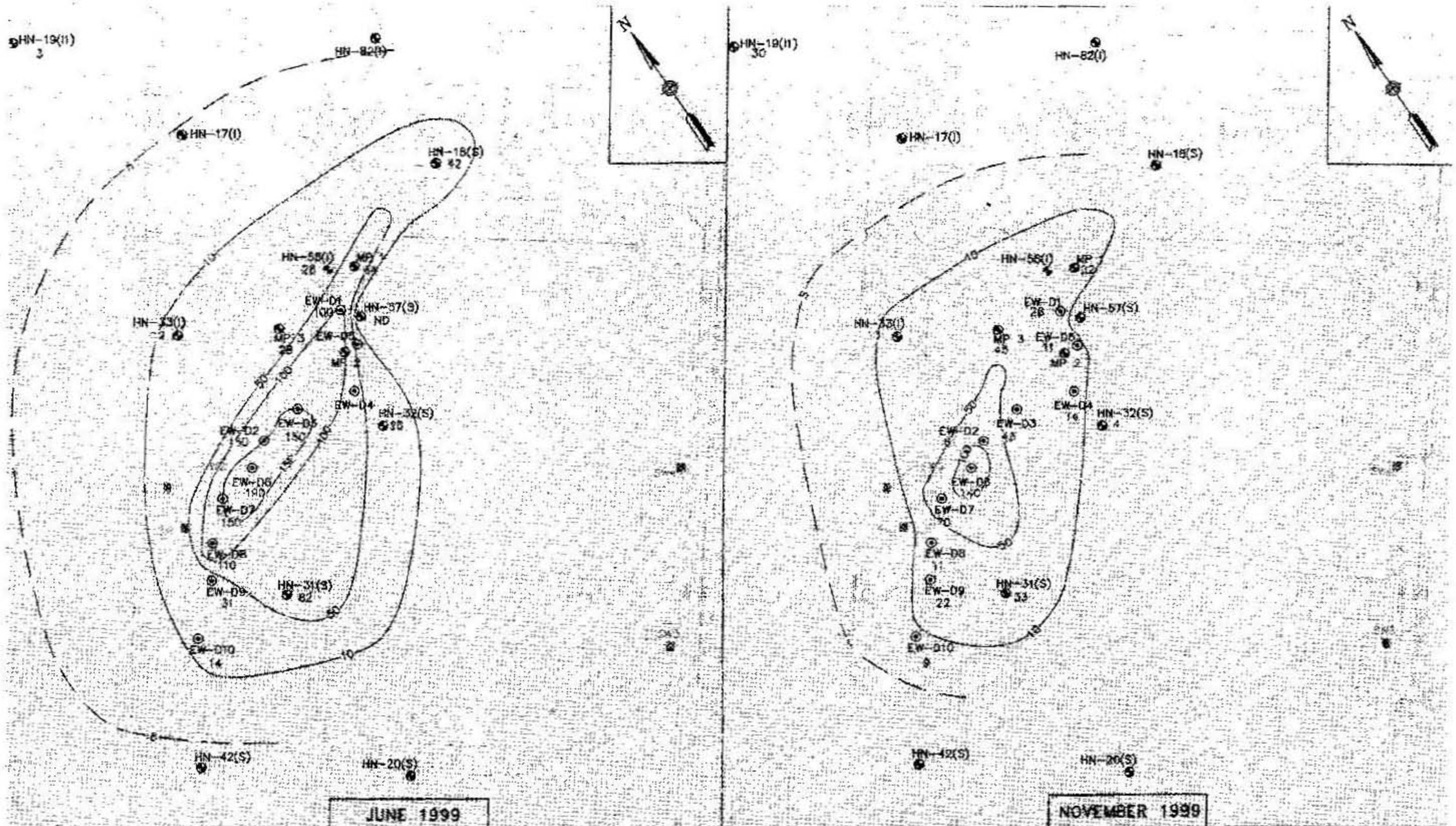
DRAWN BY MF	DATE 5/26/06	Tetra Tech NUS, Inc.	AREA D - KEY FEATURES FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA	CONTRACT NO. D182
CHECKED BY	DATE			OWNER NO.
REVISED BY	DATE			APPROVED BY / DATE
SCALE AS NOTED				DRAWING NO. FIGURE 2-21 / REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/99



DRAWN BY MF	DATE 5/26/06	Tetra Tech NUS, Inc.	WELL LOCATION MAP AREA D FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA
CHECKED BY	DATE		CONTRACT NO. 01R2
REVISED BY	DATE		OWNER NO.
SCALE AS NOTED			APPROVED BY / DATE
			DRAWING NO. FIGURE 2-22 / REV. 0

FORM CARD NO. TTNUS-WMJWG - REV 1 - 9/10/98



DRAWN BY MF DATE 6/28/06	Tetra Tech NUS, Inc.	TCE ISOCONCENTRATIONS HYDROGEOLOGIC UNIT 'B' AREA D FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA	CONTRACT NO. 0182
CHECKED BY DATE			OWNER NO.
REVISED BY DATE			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2-23 REV. 0

FORM CADD NO. FTNUS-1H.DWG - REV 1 - 9/10/98

ACAD:0182GM27.dwg 06/28/06 MF PIT

3.0 OPERABLE UNITS 1, 1A, AND 1B

3.1 INTRODUCTION

Implementation of the interim remedial actions at OU-1 began in approximately 1993, and implementation of the final remedial actions at OU-1A and OU-1B began in approximately 2000. This five-year review includes an evaluation of approximately 13 years of data and provides a current status update for OU-1, OU-1A, and OU-1B. This review is required because contaminated groundwater is still present on site that does not allow for unlimited use and unrestricted exposure. OU-1 addresses an interim remedial action for the contaminated shallow groundwater attributable to Areas A and B. Final remedies are incorporated into OU-1A and OU-1B for Areas A and B, respectively.

3.2 SITE BACKGROUND AND CHRONOLOGY

OU-1 was identified as the contaminated groundwater located in Areas A and B. The remedial action for OU-1 was an interim action to minimize the migration of groundwater while additional RI activities were performed to determine the full nature and extent of groundwater contamination. Based on the additional RI work for Area A groundwater, the final remedial action for Area A groundwater was developed. The final remedy continued the operation of the interim remedial action, which included extracting contaminated groundwater, treating the groundwater in an on-base treatment plant, and discharging the treated water to an unnamed tributary of Little Neshaminy Creek.

Based on the additional RI work for Area B groundwater, it was determined that no additional action was necessary to address Area B groundwater (OU-1B).

A list of important OU-1, OU-1A, and OU-1B historical events and relevant dates in the site chronology is shown below. The identified events are illustrative, not comprehensive.

DATE(S)	EVENT
September 1979	Initial discovery of contamination at NAWC Warminster
June 9, 1981	Notification of Hazardous Waste Site submitted
June 24, 1981	PA
June 7, 1985	SI
October 4, 1989	NPL listing of NAWC Warminster
October 1989	Base wide Phase I RI activities began
April 1991	Base wide Phase I RI activities Completed
May 1992	Base wide Phase II RI and FS activities began

DATE(S)	EVENT
April 1993	Base wide Phase II RI and FS activities completed
September 29, 1993	Interim RI/FS complete for OU-1
September 30, 1993	Interim OU-1 ROD signed
October 1, 1993	Final (Focused) RI/FS for OU-1A and OU-1B began
November 4, 1993	OU-1 remedial design began
June 6, 1994	OU-1 remedial design completed
January 15, 1995	Interim OU-1 actual remedial action started
February 22, 1995	Interim OU-1 construction started
September 30, 1996	NADC Warminster operations ceased pursuant to BRAC
July 6, 1999	Interim OU-1 construction completed and operation (pump and treat) start up
January 21, 2000	Final OU-1A actual remedial action started
April 27, 2000	Final OU-1A remedial action construction finished
May 26, 2000	Final RI/FS for OU-1B completed
June 29, 2000	Final RI/FS for OU-1A completed
September 6, 2000	OU-1B ROD signature – NFA; RI/FS for OU-1B completed
September 27, 2000	OU-1A ROD signature; RI/FS for OU-1A completed
September 28, 2000	OPS for OU-1A signed
September 28, 2000	Construction complete for entire base; Preliminary Close-Out Report signed
July 11, 2002	OU-1 interim remedial action completed

3.3 REMEDIAL ACTIONS

3.3.1 Remedy Selection for OU-1

An interim remedy ROD for OU-1 (groundwater contamination attributable to Areas A and B in overburden and shallow bedrock aquifers) was issued in September 1993. This was the first ROD issued for the site. The Remedial Action Objectives (RAOs) for OU-1 were to minimize the migration of contaminated shallow groundwater and to initiate aquifer restoration while further studies were performed to determine the full nature and extent of contamination in these aquifers. The interim remedy included the following major components:

- Installation, operation, and maintenance of groundwater extraction wells.

- Installation, operation, and maintenance of an on-base groundwater treatment system that includes precipitation, filtration, air stripping, carbon adsorption, and/or other necessary means of treatment.

- Periodic sampling of treated water to ensure the effectiveness of the treatment system.

- Discharge of treated water to an unnamed tributary of Little Neshaminy Creek or an unnamed tributary of Southampton Creek.

- Installation, operation, and maintenance of vapor-phase carbon adsorption as necessary.

- Off-base treatment and/or disposal of solid residuals generated during water treatment.

- Monitoring of groundwater in monitoring wells and residential wells.

- Installation and periodic sampling of observation wells to ensure the effectiveness of the groundwater extraction wells.

- Periodic evaluation of hydrogeologic data and the effectiveness of the groundwater extraction wells.

- Modification of the groundwater extraction well system and/or groundwater treatment system as necessary based on periodic evaluations.

The OU-1 ROD did not specify groundwater cleanup concentrations for the interim remedy. The interim remedy for Area A groundwater (subsequently designated as OU-1A) was constructed and became operational in July 1999. Additional information regarding the final remedy for Area A groundwater (subsequently designated as OU-1A) is discussed below.

3.3.2 Remedy Selection for OU-1A

A final remedy for OU-1A was selected in September 2000. OU-1A comprises groundwater contamination underlying Area A. The RAOs for the final remedy were as follows:

- Prevent further migration of Area A groundwater that presented an unacceptable risk.
- Prevent use of Area A groundwater that presented an unacceptable risk.
- Restore Area A groundwater, where technically practicable, to usable standards and cleanup goals established in the ROD.

Where practicable, the unacceptable risk to human health posed by Area A groundwater would be eliminated by reducing COCs in Area A groundwater to specific remedial action concentrations. The

remedial action concentrations were the federal MCLs for each COC: TCE - 5 µg/L; PCE - µg/L; CCl_4 - 5 µg/L; 1,1-DCE - 7 µg/L; cis-1,2-DCE - 70 µg/L; 1,1,2-TCA - 5 µg/L; vinyl chloride - 2 µg/L; chloroform - 80 µg/L; and benzene - 5 µg/L.

Groundwater data collected during the installation and operation of monitoring and extraction wells identified the presence of DNAPL contaminants in bedrock within Area A. This DNAPL contains TCE and potentially CCl_4 and PCE at saturation levels within the bedrock fracture network and, to a lesser degree, within the intergranular pores of the rock. This DNAPL zone contains groundwater that is technically impracticable to restore to beneficial use. Because of the high concentrations of TCE and potentially of CCl_4 and PCE, a technical impracticability (TI) waiver was approved for this area. The area where remedial action cleanup goals were determined to be impracticable to attain was referred to as the TI zone (Figure 3-1). Federal and State ARARs associated with the restoration of groundwater to drinking water standards for these three specific contaminants were waived within this TI zone. The waiver does not apply to the dissolved-phase contaminant plume (i.e., Area A groundwater downgradient of the TI zone) or to other compounds within the TI zone. The TI waiver and the OU-1A ROD required that contamination associated with the TI zone and the DNAPL present within the TI zone be contained.

The major components of the final remedy for OU-1A were as follows:

- The existing groundwater extraction system constructed as part of the interim OU-1 remedy would contain the source area (DNAPL zone), contain and remediate the source area groundwater dissolved contaminant plume, and remediate a portion of the downgradient groundwater contaminant plume. The existing pumping of WTMA Well 26 would capture and remediate the balance of the downgradient groundwater contaminant plume.

- The existing groundwater treatment system would be used to treat extracted Area A groundwater. This component would include operation and maintenance (O&M) of the existing system and monitoring of its performance.

- The existing interim remedy discharge of treated Area A groundwater would continue from the existing treatment system to the chlorine contact chamber and to OF 001 through the existing pipeline to Little Neshaminy Creek. This component would include regular monitoring and reporting of the quality of discharged water.

- Institutional controls would be implemented to prevent the use of Area A groundwater as long as this groundwater presents an unacceptable risk and to protect the integrity and effectiveness of the extraction well network. The institutional controls addressing current NAWC property would consist of

restrictions to be included in deeds entered into for transfer of the property. The controls for current off-base property in Warminster Township would consist of the continued enforcement of a municipal ordinance that regulates well drilling. The controls for current off-base property in Ivyland Borough would consist of enforcement of a well drilling regulation ordinance to be promulgated by Ivyland Borough.

- Groundwater monitoring would consist of regularly collecting water-level measurements and analyzing groundwater samples both from within and outside the contaminant plume to assess the progress of remediation and to evaluate contaminant migration.

The groundwater extraction and treatment system was anticipated to operate for at least 10 years before achieving cleanup levels outside the designated TI zone. The time required for cleanup will be determined by actual sampling results over time.

3.3.3 Remedy Selection for OU-1B

The interim remedy ROD for OU-1 (overburden and shallow groundwater contamination attributable to Areas A and B) issued in September 1993 selected pumping and treatment of both Area A and Area B groundwater to limit groundwater contaminant migration and to initiate aquifer restoration. However, the interim remedy for Area B groundwater was never completed.

In December 1994 and January 1995, the Navy installed two planned extraction wells and six observation wells in response to the interim OU-1 ROD. The two planned extraction wells were sampled while pumping tests of various durations were performed. No TCE or other contaminants were detected at concentrations greater than MCLs in the pumped water. After completion of the extraction well yield tests and other Area B groundwater studies, VOC contaminant trends were evaluated. The evaluation concluded that TCE concentrations in the well with maximum concentrations of TCE (up to 13 μg/L) appeared to be stable and that TCE concentrations were either not detected or were present at concentrations consistently less than the MCL in downgradient monitoring wells. Considering this contaminant trend, along with the extraction well results, a decision was reached to discontinue the plan to pump Area B groundwater but to continue monitoring and conduct additional investigations during Area B source investigation and removal activities, in accordance with the interim ROD.

Based on further investigations since the interim ROD, a no-action final remedy was selected for OU-1B in September 2000. Groundwater monitoring in the vicinity of Area B, which had been prescribed in the interim OU-1 ROD, was discontinued in September 2000 based on the ROD.

3.3.4 Remedy Implementation for OU-1 and OU-1A

The remedial design for OU-1 began in October 1993 and was completed by the Navy in April 1994. The Navy contracted with OHM Corporation to construct the OU-1 remedy, construction began in June 1994. During the installation and testing of extraction wells for Area B groundwater, the Navy suspended construction of the OU-1 remedy.

Although the groundwater treatment system was constructed by July 1996, the drilling and installation of Area A extraction wells were deferred while Area A soil removal actions and necessary groundwater investigations were completed. Following removal activities performed within Area A in 1998, a total of 18 potential extraction and/or performance monitoring wells were drilled onbase within Area A from January through March 1999. Of the 18 wells, 14 were subsequently completed as groundwater extraction wells, and four were completed as monitoring wells. The extraction wells became operational on a full-time basis in July 1999.

A second phase of Area A extraction and observation well drilling was performed from December 1999 through January 2000. Six wells were drilled on the property immediately north of Area A, using procedures similar to those used for the on-base Area A extraction wells. One of the six wells was completed as a potential extraction well. The remaining five wells were completed as monitoring wells.

As part of the interim remedy, the Navy implemented a performance monitoring program to monitor the effectiveness and operation of the interim remedy extraction system. Performance monitoring activities for the Area A extraction system began in June 1999, immediately prior to the start-up of the on-base extraction system. The performance monitoring has included the collection and analysis of groundwater samples from the extraction wells and selected nearby monitoring wells, the collection and mapping of periodic rounds of water levels, and the evaluation of the resultant data. Many performance monitoring reports have been generated to date, including the Pre-Startup and Startup Performance Monitoring Report (EA Engineering, 1999), and quarterly Performance Monitoring Reports. The most recent quarterly report reviewed for this Five-Year Review was prepared by ECOR dated February 2006.

The OU-1 interim remedy groundwater extraction system has been in operation since mid-1999, with 12 wells (EW-A1, EW-A2, EW-A3, EW-A4, EW-A6, EW-A7, EW-A8, EW-A10, EW-A11, EW-A12, EW-A13, and EW-A15) pumping at an average cumulative discharge rate of approximately 40 gpm. The extraction wells are completed in and draw water from hydrogeologic unit B. Two other extraction wells (EW-A5 and EW-A9) are currently inactive but are configured for pumping at a later date if needed.

Within the area of greatest TCE concentrations, the presence of DNAPL has been inferred based on detections of TCE in groundwater at concentrations of greater than 100 milligrams per liter (mg/L) (the

solubility of TCE is approximately 1,100 mg/L) and has been confirmed through dye testing. Selective pumping of the extraction wells containing DNAPL and the maximum dissolved TCE concentrations (EW-A6 and EW-A7) is performed. Adjacent extraction wells EW-A5 and EW-A9 are not being pumped to avoid pulling DNAPL from the immediate vicinities of these two wells. After the TCE concentrations in EW-A6 and EW-A7 decrease to concentrations similar to those in the surrounding wells, it is anticipated that extraction wells EW-A5 and EW-A9 may be activated. In addition, a nearby off-base extraction well (EW-A18) has been constructed that could be added to the extraction system in the future.

The final groundwater remedy for OU-1A includes a source area groundwater extraction system comprising extraction wells EW-A1 through A13, EW-A15, and EW-A18 that has been in operation since 2000. Wells EW-A14, A16, and A17 were also drilled for use as potential extraction wells; however, based on yield testing and/or water-quality sampling results, the wells were completed as open borehole observation and monitoring wells. The average cumulative pumping rate of the system is approximately 40 gpm. The discharges from the source area extraction wells are routed to the groundwater treatment plant, located along the western edge of Area A, for treatment via air stripping and carbon adsorption. The source area groundwater extraction system is designed to capture the highly contaminated portion of the Area A-related contaminant plume and to hydraulically isolate the source area from downgradient areas.

Further downgradient from the source area extraction system, WTMA Well 26 is pumped continuously at an average rate of approximately 250 gpm. Water from this well is routed through an air stripping unit for treatment before entering the municipal water system. The portion of the Area A-related groundwater plume not captured by the source area groundwater extraction system is captured by this well and treated.

The hydraulic effects of the groundwater extraction system were evaluated based on water-level data gathered during pre-startup through Month 3 performance monitoring activities. Pre-start-up groundwater flow patterns in the vicinity of the extraction system were established using "Day 7" (June 21, 1999) water-level data. The hydrogeologic unit B groundwater flow direction across the on-base and near-off-base portion of the study area is to the north-northwest. In the vicinity of the extraction wells, the groundwater flow gradient averages approximately 0.02 and steepens in the area west of the railroad tracks.

Groundwater flow patterns in the same area under extraction system operating conditions were evaluated using Month 3 (November 15, 1999) data. Based on these data, drawdowns due to pumping are evident within hydrogeologic unit B in the general area and in the immediate vicinity of the on-base extraction

wells. The extraction system aggregate pumping rate for the month prior to the Month 3 round of water levels averaged 39 gpm, and the potentiometric surface generally reflects this total flow rate.

The water-level contours and flow arrows drawn for the Month 3 set of water-level data suggest that the capture zone of the extraction system extends within hydrogeologic unit B across the area of the extraction well network and onto a portion of the adjacent property formerly owned by John C. Wagner and Sons (now owned by the Navy). Groundwater west of the rail line that runs along the NAWC property does not appear to be captured by the extraction system constructed as part of the interim remedy (except in the immediate vicinity of the extraction system), and this groundwater is migrating in a north-northwest direction, similar to the flow direction under non-pumping conditions. More recent water level data from ongoing performance monitoring activities is consistent with older data.

The OU-1A extraction system was designed to contain groundwater within the source area for contaminants that have been identified within Area A and to stop the migration of contaminants from the source area. The performance data gathered to date indicate that the system is containing the source area contamination.

3.3.5 Remedy Cost

The Navy estimated the capital cost for implementation of the selected interim remedial alternative in the ROD at $3,515,000 for OU-1. This estimate included costs associated with site preparation, groundwater extraction, on-site treatment, and discharge to surface water. The Navy estimated the capital cost for implementation of the selected final remedial alternative in the ROD at $ 7,688 for OU-1A. This estimate included costs associated with maintaining and operating the existing interim groundwater remedy, implementing institutional controls (including a TI Zone) to prevent the use of Area A groundwater and to protect the integrity and the effectiveness of the extraction well network, and implementing a monitoring system to evaluate the progress of the remediation and make sure that migration of contamination is not occurring. The results of the OU-1B risk assessment and the RI indicate that Area B groundwater did not present an unacceptable risk. The selected final remedy for OU-1B is No Action. There are no costs associated with this remedy.

The actual cost for the implementation of the remedy has not yet been tabulated.

3.3.6 System Operations/Operation and Maintenance

3.3.6.1 Long-Term Monitoring Program for OU-1 and OU-1A

An O&M plan and a performance monitoring plan are in place for the OU-1 and OU-1A remedies and are being implemented. The plans provides operating information relative to the extraction well pumps and pump controllers, the transfer sump and pump, and the treatment system. The O&M plan (Foster Wheeler, 1999) will be updated as necessary to reflect operating conditions and needs. Included in the updates will be revisions to the O&M plan incorporating guidance regarding O&M of extraction and injection wells at hazardous waste sites (U.S. Army Corps of Engineers, January 2000).

The first-year performance monitoring plan called for monthly monitoring and review of the system performance through the collection of groundwater levels, sampling of select wells, and collection of pumping rate information. The performance monitoring plan was updated in December 2000 to include descriptions of the procedures to be followed to evaluate the long-term performance of the groundwater extraction systems. The plan described the procedures and activities associated with evaluating extraction well operations, groundwater quality, and water-level changes due to operation of the extraction systems.

On September 27, 2000, the Navy submitted a technical demonstration document to support the determination that the OU-1A remedy was OPS. USEPA approved the OPS Demonstration on September 28, 2000. The OU-1A remedy performance was evaluated through the analysis of technical data collected in accordance with sampling and monitoring plans approved by USEPA and PADEP. The basis for the OPS demonstration was the evaluation of remedy performance using groundwater monitoring well and extraction well data as they relate to the applicable RAOs and medium-specific cleanup goals specified in the ROD.

The Navy demonstrated in the OPS that a well-developed cone of depression has formed within the hydrologic unit with maximum observed concentrations of TCE and other VOCs around the Area A extraction wells, which indicated that inward gradients have been achieved in the plume area. The capture zone analysis showed that the capture of the plume exists to a point offbase and that the source area or DNAPL zone has been hydraulically controlled. Analysis of these data showed that the groundwater plume was contained in the vicinity of the base boundary and that overall groundwater contaminant concentrations were remaining at steady-state or decreasing outside the DNAPL zone.

Long-term performance monitoring program is currently being conducted by ECOR, a Navy contractor. ECOR's long-term performance monitoring plan, prepared in November 2005 (ECOR, 2005), is being used as guidance for performance monitoring, review of the system performance through the collection of

groundwater levels, sampling of select wells, and collection of pumping rate information (an earlier version of the plan was prepared by Battelle in 2003). This long-term performance monitoring plan describes the procedures to be followed to evaluate the long-term performance of the groundwater extraction systems. The plan also describes the procedures and activities associated with evaluating extraction well operations, groundwater quality, and water-level changes due to the operation of the extraction systems. The Navy is continuing to monitor and evaluate trends in groundwater quality, as required by the ROD.

The results of the Third Quarter Fiscal Year 2006 long-term performance monitoring indicated that hydraulic containment of the groundwater contamination was partially achieved (see Figure 3-2). The total overall average pumping rate from the extraction wells was approximately 49 gpm in the capture zone. The Fourth Quarter Fiscal Year 2005 monitoring also indicated that progress is being made to restore the groundwater quality to levels protective of human health and the environment (see Figure 3-3). Contaminant mass is being removed at a fairly significant rate by the extraction well network (ECOR, 2006).

In September 2000, the Navy transferred remaining property in the vicinity of Area A to the FLRA as part of an EDC. The associated FOST was signed by the Navy on October 3, 2000. Land use controls and restrictions specified in the OU-1 and OU-1A ROD were included in the conveyance documents for this property. As specified in these documents, the land use controls prohibit extraction and use of Area A groundwater by current and future landowner. Although the OU-1A OPS demonstration does not imply that cleanup actions have been completed for Area A groundwater in compliance with the ROD, it does allow for the deeded transfer of Area A property from the Navy to the FLRA and other parties.

3.3.6.2 Cost

The Navy's original annual O&M cost estimate for OU-1 long-term performance monitoring was approximately $628,000. The Navy's updated annual O&M cost estimate for long-term performance monitoring based on the OU-1A ROD was approximately $402,500. The Navy estimates that the groundwater O&M costs for OU-1, OU-1A, OU-3, and OU-4 average about $500,000 per year; however, the actual cost for implementation of the remedial design has not yet been tabulated because the remedial actions are ongoing.

3.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

The following recommendations and required actions were developed based on the previous five-year review for OU-1, OU-1A, and OU-1B.

Previous Recommendation/ Required Action	Current Status
Grading around some Area A extraction wells requires improvement due to settlement of the ground surface	Completed
Monitoring and observation wells missing locks	Completed
Some monitoring wells with cracked or badly damaged well covers	Completed
Extraction well vaults missing locks	Completed
O&M manual requires revisions and updating to reflect intended operating procedures	Pending
Strategy to determine the merits of terminating the pumping and treating of contaminated groundwater	Pending
Institutional controls for the use and withdrawal of Area A groundwater within Ivyland Borough have not been promulgated	Completed

3.5 FIVE-YEAR REVIEW PROCESS

3.5.1 Document and Analytical Data Review

This second five-year review consisted of a review of relevant documents for OU-1, OU-1A, and OU-1B including the ROD, O&M plan, and O&M reports. The remedial action (extraction well and groundwater treatment system installation) has been completed. O&M of the treatment system is being conducted by a Navy contractor, and long-term performance monitoring is being conducted.

3.5.2 Site Inspection

A site inspection was conducted in March 2006. No unusual observations were documented during the visit. Selected extraction wells, plumbing, and pipelines were inspected and found to be in good working order. Some wells were not operating at the time of the site visit because they were either intentionally shut down as part of system optimization activities, awaiting repair parts, or being repaired. Fencing around the groundwater treatment plant was secure. The Navy also reported that a groundwater remedy optimization report is being prepared by Batelle at the Navy's request. This report is not yet final. The Five-Year Review Site Inspection Checklist from the March 2006 inspection is included in Appendix A.

3.6 TECHNICAL ASSESSMENT

3.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents?

The remedy selected for OU-1 and OU-1A was groundwater extraction, on-site treatment, and discharge to surface water and implementing institutional controls (including a TI Zone) and a long-term performance monitoring plan. The review of documents, ARARs, and risk assumptions and the results of

the site inspection indicate that the remedy is functioning as intended by the ROD. Opportunities for optimization of the treatment system exist and a report is being finalized, as reported during the site inspection.

Based on the completed activities, the intent and goals of ROD have been met, and there are no deficiencies or early indicators of potential remedy failure.

3.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid?

There have been no significant changes in the physical conditions for OU-1, OU1A, and OU-1B, changes in the ARARs, or changes in exposure pathways that would affect the protectiveness of the remedy. There have been no changes in the risk assessment methodologies or exposure assumptions. Therefore, there have been no significant changes in cleanup goals established for OU-1, OU1A, and OU-1B.

Results of the vapor intrusion risk analysis for OU-1A are presented below based on the Fourth Quarter Fiscal Year 2005 long-term performance monitoring report. Ten VOCs were detected in groundwater at OU-1A. The maximum concentrations of four of these chemicals (CCl_4, methylene chloride, PCE, and TCE) exceeded vapor intrusion screening concentrations. The risks were calculated using a range of groundwater concentrations (i.e., minimum, maximum, and average). Risk estimates for hypothetical future residents and are presented in the following tables.

Groundwater Concentrations (µg/L)

Chemical	CCl_4	Methylene Chloride	PCE	TCE
Minimum	2.6	5	1.5	3.2
Maximum	540	470	240	12,000
Average	93	238	61	1857

Noncarcinogenic Hazard Quotients for Future Residents (USEPA Goal is 1)

Chemical	CCl_4	Methylene Chloride	PCE	TCE	Total HI
Minimum	0.0006	0.00009	0.00007	0.0001	0.0008
Maximum	0.11	0.009	0.01	0.44	0.6
Average	0.02	0.004	0.003	0.07	0.1

Cancer Risks for Future Residents (USEPA Target Risk Range is 1E-6 to 1E-4)

Chemical	CCl_4	Methylene Chloride	PCE	TCE	Total Cancer Risk
Minimum	2.7E-7	8.3E-9	3.8E-8	2.6E-8	3.4E-7
Maximum	5.6E-5	7.8E-7	6.1E-6	9.6E-6	1.6E-4
Average	9.6E-6	3.9E-7	1.5E-6	1.5E-5	2.6E-5

The data in the above tables indicate that the noncarcinogenic HQs for the four chemicals evaluated and the total HIs for hypothetical future residents were less than the USEPA goal of 1, indicating that no adverse noncarcinogenic health effects are expected from exposure to indoor air under the assumed Reasonable Maximum Exposure conditions.

For cancer risks, residential risks from exposure to minimum and average concentrations were less than and within the USEPA's target risk range, respectively. However, the total inhalation cancer risk based on the maximum groundwater concentrations (1.6E-4) exceeded the upper limit of the target risk range. However, there would be no residential exposure risk from inhalation because institutional controls have been implemented at the site. As shown in the table, TCE was the major contributor to the total risk, accounting for approximately 60 percent of the total.

Total noncarcinogenic HIs and cancer risks for occupational workers were less than USEPA goals.

3.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No human health or ecological risks have been identified, and no weather-related events have affected the protectiveness of the remedy. No other information has come to light that could call into question the protectiveness of the remedy.

3.6.4 Technical Assessment Summary

The remedy as specified in the ROD is groundwater extraction, on-site treatment, and discharge to surface water and implementing institutional controls (including a TI Zone) and a long-term performance monitoring plan. According to the information reviewed and the site inspection, the remedy is functioning as intended by the ROD.

There have been no significant changes in the physical condition of the OU, to toxicity factors, or to the standardized risk assessment methodology that would affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

3.7 ISSUES

There were no issues discovered during the five-year review that would be sufficient to warrant a finding of not protective for OU-1, OU-1A, and OU-1B.

3.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

The recommendations and required actions based on the inspection and second five-year review are as follows.

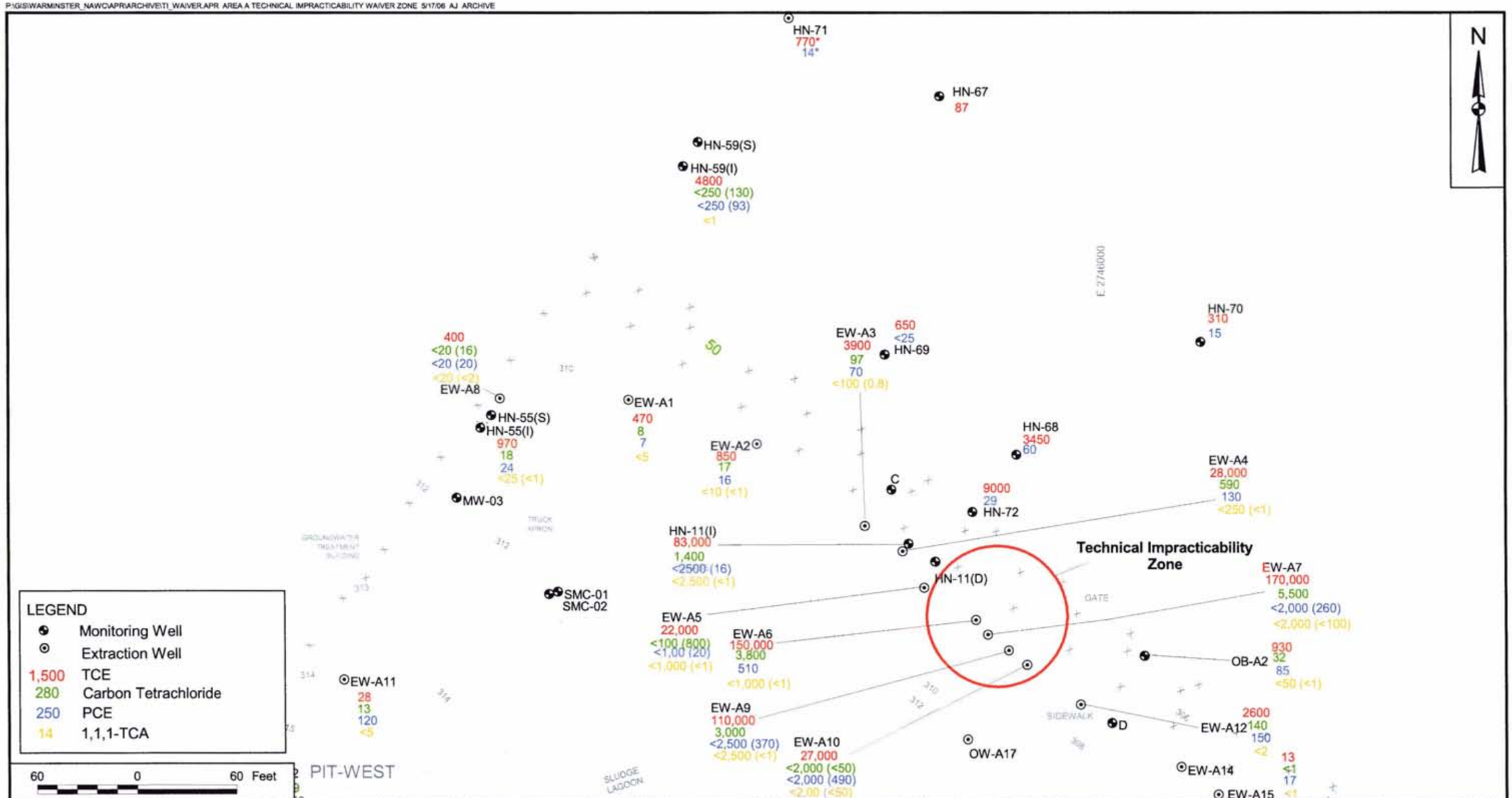
Recommendations/ Required Actions	Responsible Party	Oversight Agency	Milestone Date
O&M manual revisions and updating (as needed) to reflect intended operating procedures	Navy	USEPA and PADEP	On-going
Develop a strategy to terminate the pumping and treating of contaminated groundwater	Navy	USEPA and PADEP	On-going
Implement Institutional controls	Navy	USEPA and PADEP	On-going
Finalize the remediation optimization report and make it available to O&M and inspection contractors. Address any residual PCE source (near HN-23A and BG-05A) and recommend source treatment measures.	Navy (Batelle)	USEPA and PADEP	ASAP

3.9 PROTECTIVENESS STATEMENT

The contaminated groundwater treatment remedy for OU-1 and OU-1A is OPS. Contaminant migration is being adequately contained, and removal of contamination is progressing towards attainment of cleanup goals. The institutional controls are in place and are protective in the interim. The remedies implemented at OU-1, OU-1A, and OU-1B are expected to be protective of human health and the environment upon completion.

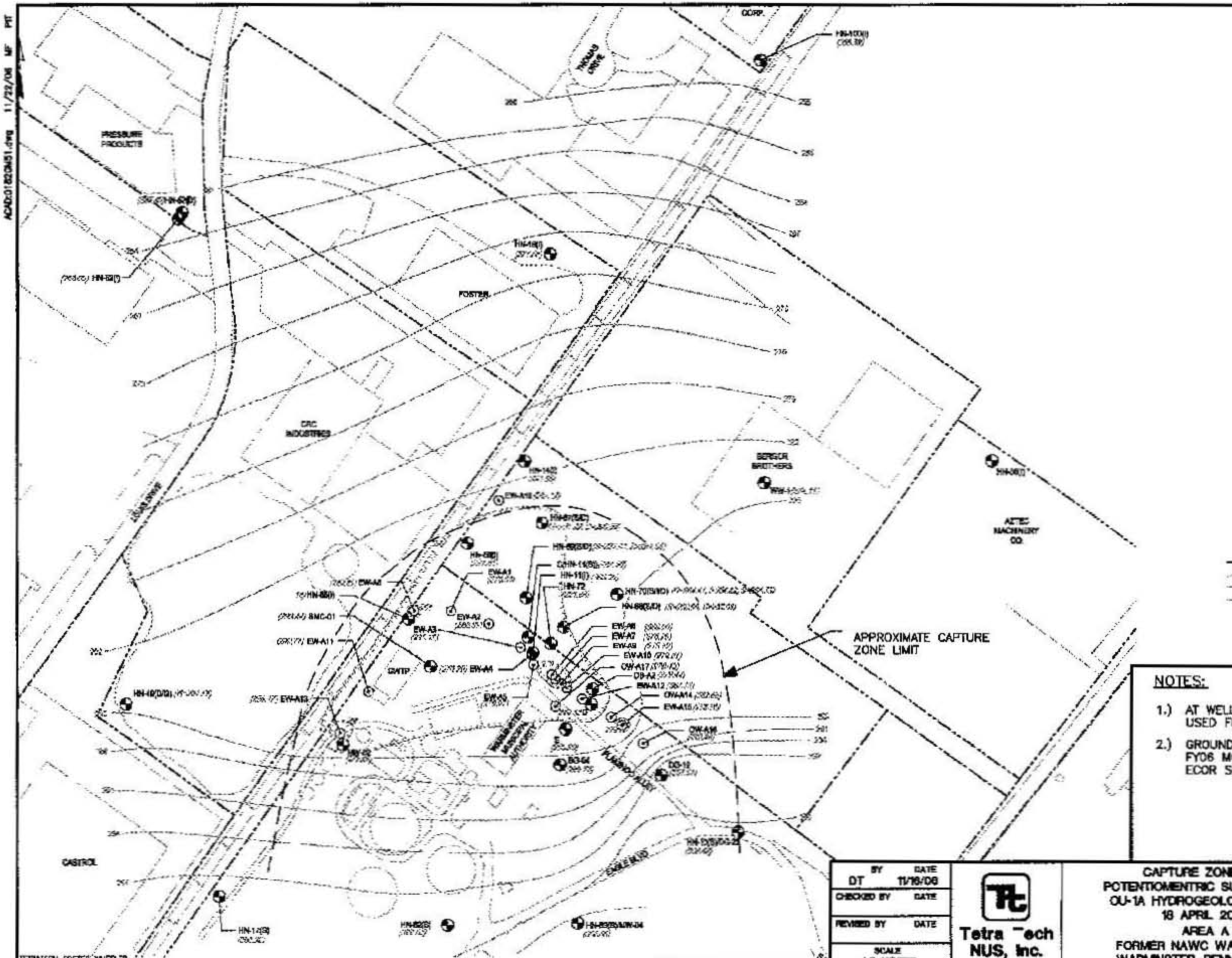
Because contamination remains in the groundwater at concentrations above the MCL and the time required to capture and remove those contaminants to acceptable levels is undefined, additional five-year reviews will be required.

P:\GIS\WARMINSTER_NAWC\APR\ARCHIVE\TI_WAIVER.APR AREA A TECHNICAL IMPRACTICABILITY WAIVER ZONE 5/17/06 AJ ARCHIVE



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY J. BELLONE	DATE 3/27/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER 00182 / OWNER NUMBER —
CHECKED BY B. DAVIS	DATE 5/18/06	TECHNICAL IMPRACTICABILITY WAIVER ZONE AREA A GROUNDWATER NAWC WARMINSTER, PENNSYLVANIA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 3 - 1 / REV 0



WELL ID.	Q (gpm) INSTANTANEOUS	Q (gpm) 3 MONTH AVERAGE
EW-A1	5.7	4.6
EW-A2	6.7	4.4
EW-A3	3.5	7.2
EW-A4	5.7	4.9
EW-A5	0	0
EW-A6	2.7	2.7
EW-A7	1.7	0.3
EW-A8	5.0	5.4
EW-A9	0	0
EW-A10	~3	3.4
EW-A11	6.7	6.6
EW-A12	6.7	5.7
EW-A13	3.7	2.1
EW-A15	3.0	1.9
EW-A18	0	0
TOTAL SYSTEM 3 MONTH AVERAGE Q – 49.2 gpm		

EXTRACTION WELL PUMPING RATES

LEGEND

- MONITORING WELL
- EXTRACTION WELL
- PROPERTY LINE
- TREELINE
- GROUNDWATER CONTOUR (ft amsl)
- INFERRED GROUNDWATER CONTOUR
- (234.11) GROUNDWATER ELEVATION (ft amsl)
- AREA OF GROUNDWATER DEPRESSION

NOTES:

1.) AT WELL CLUSTER HN-52, HN-52(D) WAS NOT USED FOR CONTOURING.

2.) GROUNDWATER FLOW MAP SOURCE: FINAL 3RD QTR FY06 MONITORING REPORT, NAWC WARMINSTER ECOR SOLUTIONS, INC.

0 200 400
GRAPHIC SCALE IN FEET

BY	DATE
DT	11/16/06
CHECKED BY	DATE
REVISED BY	DATE
SCALE AS NOTED	

Tetra Tech NUS, Inc.

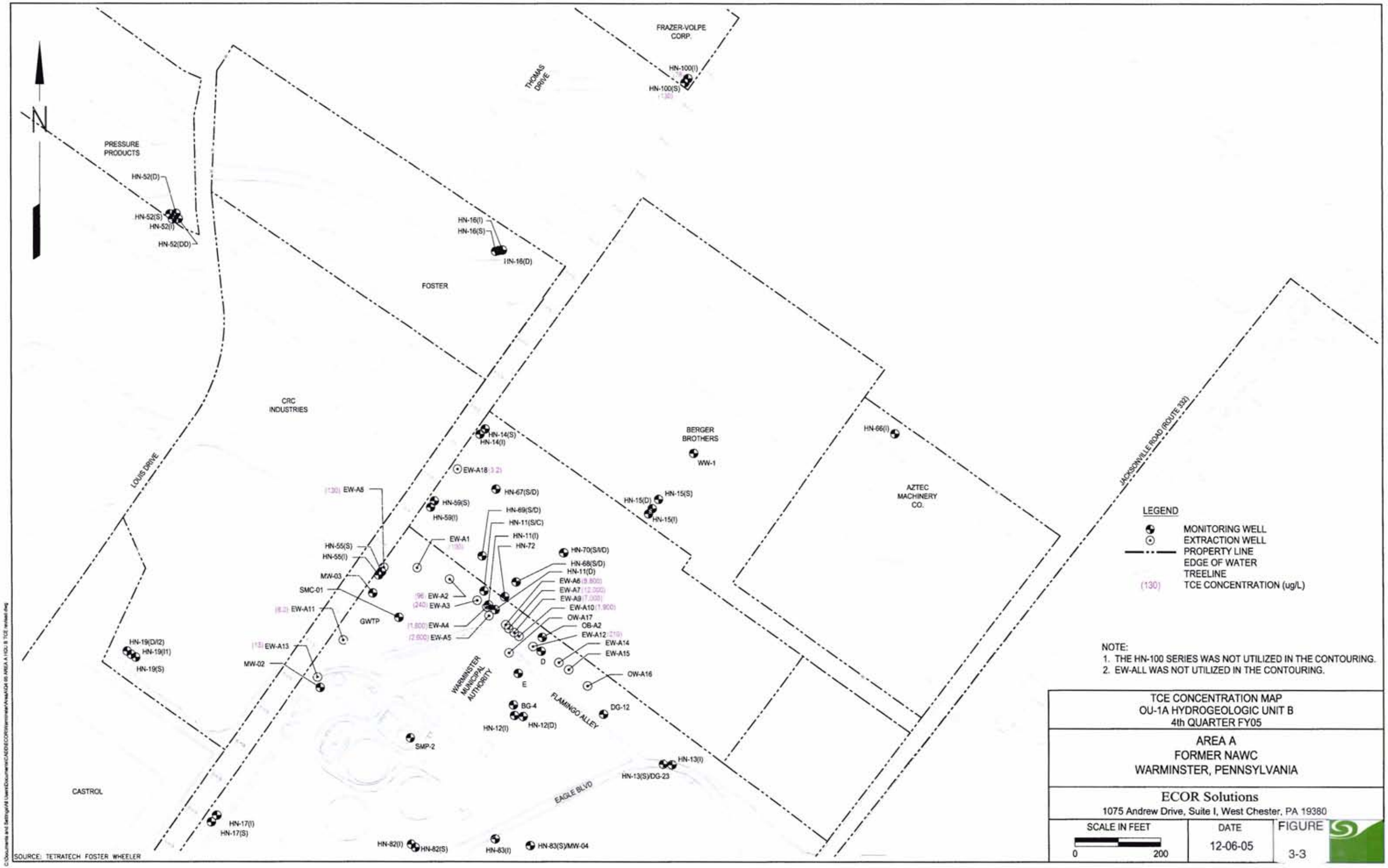
CAPTURE ZONE AND POTENTIOMENTRIC SURFACE MAP
OU-1A HYDROGEOLOGIC UNIT B
18 APRIL 2006
AREA A
FORMER NAWC WARMINSTER
WARMINSTER, PENNSYLVANIA

CONTRACT NO. 0182
OWNER NO.
APPROVED BY DATE
DRAWING NO. FIGURE 3-2 REV. 0

ACAD:01820N51.dwg 11/22/06 MF PIT

TETRATECH FOSTER WHEELER

FORM CADD NO. TTNUS-BH.DWG – REV 1 – 9/10/98



TCE CONCENTRATION MAP
OU-1A HYDROGEOLOGIC UNIT B
4th QUARTER FY05

AREA A
FORMER NAWC
WARMINSTER, PENNSYLVANIA

ECOR Solutions
1075 Andrew Drive, Suite I, West Chester, PA 19380

SCALE IN FEET	DATE	FIGURE
0 — 200	12-06-05	3-3

4.0 OPERABLE UNIT 2

4.1 INTRODUCTION

Implementation of the remedial actions at OU-2 began in approximately 1993 and was completed in 1996. This five-year review provides a current status update for OU-2. This review is required because contaminated groundwater is still present that does not allow for unlimited use and unrestricted exposure. Remedial efforts for OU-2 were conducted because contaminated groundwater impacted domestic well water for residences and a business near the base.

4.2 SITE BACKGROUND AND CHRONOLOGY

The Navy performed sampling of off-base drinking water wells in the vicinity of NAWC Warminster and results indicated that groundwater from several domestic water wells had concentrations of VOCs greater than MCLs. There was no clear evidence that the Navy was responsible for the elevated contaminant concentrations of concern, and offbase (non-Navy sources have been identified for at least some of the contamination. The remedial actions for the contamination in the domestic water wells were designated as OU-2. Due to the time-critical nature of the remedial actions, a ROD was not issued for OU-2. In July 1993, USEPA signed an Action Memorandum for OU-2 to address the off-base well water contamination.

A list of important OU-2 historical events and relevant dates in the site chronology is shown below. The identified events are illustrative, not comprehensive.

DATE(S)	EVENT
September 1979	Initial discovery of contamination at NAWC Warminster
October 4, 1989	NPL listing of NAWC Warminster
October 1989	Base wide Phase I RI activities began
September 20, 1990	FFA signed
September 20, 1990	OU-2 RI/FS start
April 1993 - July 1995	OU-2 remedial action
July 14, 1993	OU-2 Action Memo signed
September 2, 1993	OU-2 remedial design start
May 4, 1994	OU-2 remedial design completed
June 14, 1994	OU-2 remedial action start
September 19, 1996	OU-2 construction finished
September 28, 2000	Construction complete for entire base; Preliminary Close-Out Report signed

4.3 REMEDIAL ACTIONS

4.3.1 Remedy Selection

OU-2 consisted of several off base removal actions to provide drinking water to affected residences and businesses in the vicinity of Area A, Area B, and Area C. USEPA signed an Action Memorandum for OU-2 on July 14, 1993 based on the results of the Phase II RI and off-base well testing conducted from April to July 1993. The primary removal action objective was to eliminate the imminent and substantial threats posed by contaminated drinking water in the vicinity of the base. The groundwater sample data indicated that drinking water was contaminated with PCE and TCE in excess of USEPA removal action levels in residential well water. The proposed removal action was to extend existing WTMA municipal water supply lines to affected residences in areas near Davisville, Orchid, Azalea, Rosebud, Kirk, Hogeland, and Rambler Roads. The Navy also proposed connecting homes in the Casey Village Area (located south of Area B) to the WTMA and Upper Southampton Water and Sewer Authority public water supply systems.

4.3.2 Remedy Implementation

Beginning in April 1993, the Navy provided bottled water and installed water treatment systems at approximately 40 residences and businesses, despite the lack of clear evidence that the Navy was responsible for the elevated contaminant concentrations of concern. To mitigate the hazards to public health posed by groundwater contamination, the remedial design for OU-2 was initiated in September 1993 by the U.S. Army Corps of Engineers (on behalf of USEPA) and was completed in May 1994. USEPA contracted with the U.S. Army Corps of Engineers to provide municipal water connections to the WTMA system. The Navy also provided emergency water supplies to affected residences and provided lateral connections to the Upper Southampton Municipal Authority public water supply system.

Between June and September 1994, USEPA and the Navy connected homes along Davisville, Orchid, Azalea, Rosebud, Kirk, Rambler, and Jacksonville Roads were provided with municipal water from the WTMA system (Figure 4-1). The U.S. Army Corps of Engineers assisted USEPA with a portion of these connections. Properties in the Casey Village Area (located south of Area B) were also provided with municipal water from the WTMA and Upper Southampton Water and Sewer Authority systems.

Most of the affected residential wells were abandoned in accordance with PADEP guidance or were converted for use as monitoring wells. For those residences that were not connected to municipal water supplies but were provided with water treatment systems, the Navy subsequently transferred the

responsibility for maintaining the water treatment systems to the property owners. In July 1995, the Navy connected a commercial business to the WTMA water supply system.

The OU-2 remedial actions were completed in July 1995.

4.3.3 Remedy Cost

The estimated cost for the water treatment system was $1,557,000 according the USEPA in the signed Action Memorandum. The actual costs for the remedial action for OU-2 have not been tabulated.

4.3.4 System Operations/Operation and Maintenance

4.3.4.1 Long-Term Monitoring Program

No long-term monitoring program was required with this remedial action; however, the WTMA and Upper Southampton Water and Sewer Authority have established monitoring systems for their water treatment facilities and distribution systems.

4.3.4.2 Cost

There are no costs associated with a long-term monitoring program.

4.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

No deficiencies, recommendations, or follow-up actions were identified in the first five-year review for OU 2. No activities or additional remedial actions have been performed since that time, and no additional activities or remedial actions are required.

4.5 FIVE-YEAR REVIEW PROCESS

4.5.1 Document and Analytical Data Review

No new documents were available for review.

4.5.2 Site Inspection

A site inspection was conducted in March 2006. No unusual observations were documented during the visit. The Five-Year Review Site Inspection Checklist from the March 2006 inspection is included in Appendix A.

4.6 TECHNICAL ASSESSMENT

4.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents?

No ARARs or TBCs were established for OU-2. The primary removal action objective was to eliminate the imminent and substantial threats posed by contaminated drinking water in the vicinity of the base. The review of documents, ARARs, and risk assumptions and the results of the site inspection indicate that the remedy is functioning as intended by the Action Memorandum. The connections to the local water systems have mitigated the hazards to public health posed by the groundwater contamination. NFA is required at OU-2. Based on the completed activities, the intent and goals of the Action Memorandum have been met.

4.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid?

There have been no changes in the physical conditions of OU-2, changes in the ARARs, or changes in the exposure pathways that would affect the protectiveness of the remedy.

4.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No human health or ecological risks have been identified, and no weather-related events have affected the protectiveness of the remedy. No other information has been identified that calls into question of protectiveness of the remedy.

4.6.4 Technical Assessment Summary

According to the information reviewed and the site inspection, the remedy is functioning as intended by the Action Memorandum. There have been no changes in the physical conditions of the sites, to toxicity factors for the COCs, or to the standardized risk assessment methodology that would affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

4.7 ISSUES

No issues were discovered during the five-year review.

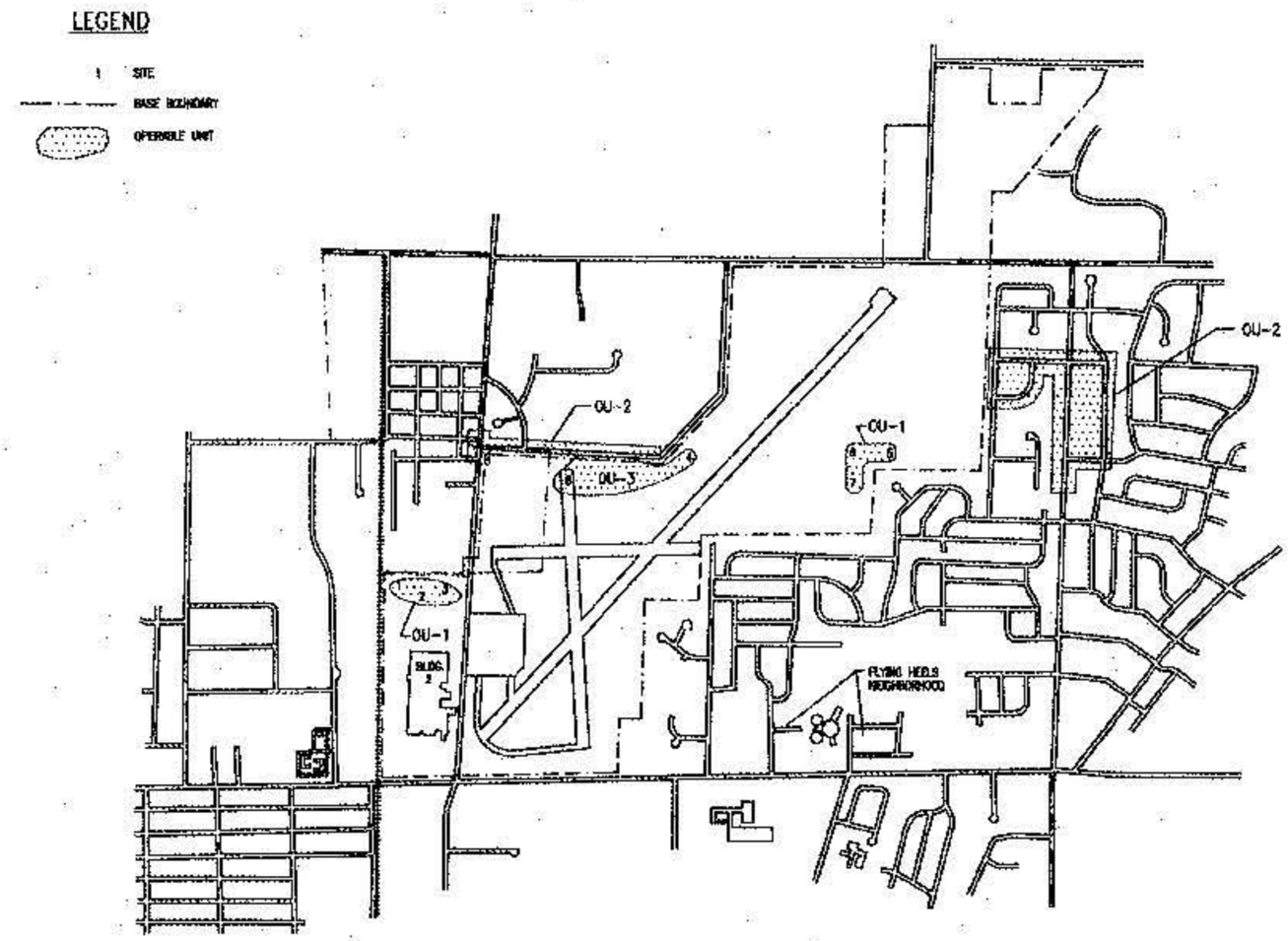
4.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Based on the results of the five-year review, no follow-up actions are required for OU-2.

4.9 PROTECTIVENESS STATEMENT

The remedies selected for OU-2 in the Action Memorandum are protective of human health and the environment. Based on the activities completed, the intent of the goals of the Action Memorandum have been met.

ACAD: 0182GM30.dwg 05/28/06 MF PIT



DRAWN BY MF DATE 5/26/06	Tetra Tech NUS, Inc.	OU-2 BOUNDARIES FOR PUBLIC WATER CONNECTIONS FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA	CONTRACT NO. 0182
CHECKED BY DATE			OWNER NO.
REVISED BY DATE			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 4-1 REV. 0

FORM CADD NO. TTNUS-DRAWING - REV 1 - 9/10/98

5.0 OPERABLE UNIT 3

5.1 INTRODUCTION

Implementation of the remedial actions at OU-3 began in approximately 1993. This five-year review includes an evaluation of approximately 13 years of data and provides a current status update for OU-3. This review is required because contaminated groundwater is still present on site that does not allow for unlimited use and unrestricted exposure. OU-3 consists of contaminated groundwater in overburden and shallow bedrock in Area C.

5.2 SITE BACKGROUND AND CHRONOLOGY

OU-3 was identified as the contaminated groundwater in Area C. A list of important OU-3 historical events and relevant dates in the site chronology is shown below. The identified events are illustrative, not comprehensive.

DATE(S)	EVENT
September 1979	Initial discovery of contamination at NAWC Warminster
June 9, 1981	Notification of Hazardous Waste Site submitted
June 24, 1981	PA
June 7, 1985	SI
October 4, 1989	NPL listing of NAWC Warminster
October 1989	Base wide Phase I RI activities began
April 1991	Base wide Phase I RI activities completed
May 1992	Base wide Phase II RI and FS activities began
April 1993	Base wide Phase II RI and FS activities completed
December 28, 1993	OU-3 RI/FS began
August 1994	OU-3 RI/FS completed
January 15, 1995	OU-3 treatment system construction began
March 10, 1995	OU-3 ROD signed
March 10, 1995	OU-3 remedial design began
May 1996	OU-3 treatment system construction completed
July 1996	OU-3 remedial action (pump-and-treat) began
September 30, 1996	NADC Warminster operations ceased pursuant to BRAC
September 29, 1999	OU-3 Explanation of Significant Differences signed
September 7, 2000	OPS for OU3 signed
July 11, 2002	Construction complete for entire base; Preliminary Close-Out Report signed

5.3 REMEDIAL ACTIONS

5.3.1 Remedy Selection

The OU-3 ROD for contaminated groundwater in overburden and shallow bedrock attributable to Area C was signed on March 10, 1995. The RAO for OU-3 was as follows:

- Restore contaminated groundwater attributable to Area C to a level protective of human health and the environment.

The objective of the OU-3 remedy was to eliminate the unacceptable risk associated with exposure or potential exposure to this groundwater. The ROD selected a remedy of groundwater extraction, treatment at Area A or Area C, and discharge to surface water at the Area A system. The remedy included the following major components:

- Installation, operation, and maintenance of groundwater extraction wells.
- Installation, operation, and maintenance of an on-base groundwater treatment system that includes precipitation, filtration, air stripping, carbon adsorption, and/or other necessary means of treatment.
- Periodic sampling of treated water to ensure the effectiveness of the treatment system.
- Discharge of treated water to the outfall of the groundwater treatment system constructed pursuant to the OU-1 ROD. The outfall is located along an unnamed tributary of Little Neshaminy Creek.
- Installation, operation, and maintenance of vapor-phase carbon adsorption (if such a unit was necessary to control air emissions).
- Off-base treatment and/or disposal of solid residuals generated during water treatment and control of air emissions (if necessary).
- Monitoring of groundwater in monitoring wells and residential wells.
- Installation and periodic sampling of observation wells to ensure the effectiveness of the groundwater extraction wells.
- Periodic evaluation of hydrogeologic data and the effectiveness of the groundwater extraction wells.

- Modification of the groundwater extraction well system and/or groundwater treatment system as necessary based on periodic evaluations.

The OU-3 extraction well system is to be shut down when groundwater sample results confirm that cleanup levels have been attained throughout the plume for 12 consecutive quarters. The cleanup levels for Area C groundwater were based on background concentrations in accordance with Pennsylvania regulations. No estimate was made regarding the length of time to achieve cleanup levels. The time required for cleanup will be dictated by actual sampling results over time.

An Explanation of Significant Differences for OU-3 was signed on September 29, 1999. The ESD added, as an additional component of the remedy, institutional controls to prevent the use of groundwater that presented an unacceptable risk to human health and to protect the integrity and effectiveness of the Area C extraction well network that was constructed pursuant to the OU-3 ROD. These controls were divided into two categories:

- Those that address portions of Area C on current Navy property.
- Those on current private property.

The institutional controls addressing Navy property consist of restrictions on the use of water from existing wells and restrictions on the future installation of wells and/or the use of water from wells installed in the future. Existing supply wells will not be used, additional supply wells will not be installed, and groundwater will not be withdrawn from the site without the approval or the Navy and/or USEPA. The controls for private property consist of the continued enforcement of Ordinance No. 32 by Warminster Township that regulates well drilling in the Township to promote the health of residents.

The institutional controls will remain in place so long as a threat to human health and the environment is posed by contaminated groundwater attributable to Area C and as long as the Area C extraction well network remains in operation.

5.3.2 Remedy Implementation

Construction of the OU-3 remedy began in January 1995, commencing with the construction of the treatment plant building for the interim remedy for OU-1. Extraction wells for Area C were installed between January and May 1995. The Navy completed construction of the groundwater treatment plant in May 1996, and the groundwater extraction system for OU-3 became operational in July 1996.

Navy contractors are conducting a regular schedule of O&M for the groundwater treatment system. In July 1999, the Area C extraction wells were washed with an acidic solution to remove deposits and suspended materials in the wells.

The groundwater remediation system for OU-3 currently includes a groundwater extraction system comprising six extraction wells (EW-C16 through EW-C21) designed to contain and capture the PCE-contaminated groundwater associated with OU-3. The total pumping rate is about 50 gpm. Two of the extraction wells, EW-C16 and EW-C17, are currently inactive because the contaminant concentrations in these two extraction wells have decreased to less than the MCL for PCE and have remained consistently low. They are, however, operational and could be used in the future if performance monitoring data indicate that their operation would increase the effectiveness of the groundwater remedy.

In July 1999, modifications inside the treatment plant were made to treat only Area C groundwater using liquid carbon adsorption vessels. The discharges from the extraction wells are routed to the groundwater treatment plant located along the western edge of Area A for treatment via air stripping and/or carbon adsorption. The transfer line for OU-3 groundwater is configured such that the water can be routed through the entire treatment system or can bypass all but the final, carbon adsorption portion of the treatment process. Due to the low concentrations of PCE in the groundwater, the current operation includes bypass of the pretreatment and air stripping components of the treatment plant, with contaminant removal achieved through carbon adsorption only.

5.3.3 Remedy Cost

The capital cost for construction of the treatment plant was estimated in the ROD in the range of $1,186,852 and $1,839,690. The costs include installation of the groundwater extraction and treatment system including liquid or air discharge controls that may be necessary depending on the need to meet emission standards. The actual cost for the implementation of the remedy has not yet been tabulated.

5.3.4 System Operations/Operation and Maintenance

5.3.4.1 Long-Term Monitoring Program

Similar to the OU-1A remedy, an O&M plan and a performance monitoring plan are in place for the OU-3 remedy and are being implemented. The plan provides operating information relative to the extraction well pumps and pump controllers, the transfer sump and pump, and the treatment system. The O&M plan will be updated as necessary to reflect operating conditions and needs. Included in the updates will be revisions to the O&M plan that incorporate guidance regarding O&M of extraction and injection wells at hazardous waste sites.

The first-year performance monitoring plan called for monthly monitoring and review of the system performance through the collection of groundwater levels, sampling of select wells, and collection of pumping rate information. The performance monitoring plan was updated in November 2000 to include a description of the procedures to be followed to evaluate the long-term performance of the groundwater extraction system. The plan described the procedures and activities associated with evaluating extraction well operations, groundwater quality, and water-level changes due to the operation of the extraction system.

On June 12, 2000, the Navy submitted a technical demonstration document to support the determination that the OU-3 remedy was OPS. The OU-3 remedy performance was evaluated through the analysis of technical data collected in accordance with sampling and monitoring plans approved by USEPA and PADEP. The basis for the OPS demonstration was the evaluation of remedy performance using groundwater monitoring well and extraction well data as they relate to the applicable RAOs and medium-specific cleanup goals specified in the ROD. Specific findings of the OPS demonstration are discussed below.

The Navy demonstrated that a well-developed cone of depression has formed within the hydrologic unit with maximum concentrations of VOCs around the Area C extraction wells, which indicated that inward gradients have been achieved in the plume area along the base boundary. The capture zone analysis showed that capture of the plume exists to a point off-base and that the source area has been hydraulically controlled. During the first 6 months after start-up, TCE concentrations in performance monitoring wells were generally stable to slightly decreasing over time in the downgradient and fringe portions of the plume. This was demonstrated through the presentation and analysis of groundwater quality data collected during six sampling events since 1997 as part of RI/FS studies, interim environmental monitoring efforts, and treatment system performance monitoring. Analysis of these data showed that the groundwater plume was contained in the vicinity of the base boundary and that overall groundwater contaminant concentrations were remaining at steady state or decreasing. More recent water level data from ongoing performance monitoring activities is consistent with older data.

The data further indicated that natural attenuation processes (primarily dilution and dispersion) are active and are limiting the migration of contaminants from the source area within Area C. The Navy is continuing to monitor and evaluate these trends in groundwater quality as required by the ROD.

Long-term performance monitoring program is currently being conducted by ECOR, a Navy contractor. ECOR's long-term performance monitoring plan prepared in November 2005 (ECOR, 2005) is being used as guidance for performance monitoring, review of the system performance through the collection of

groundwater levels, sampling of select wells, and collection of pumping rate information (an earlier revision to the plan was prepared by Battelle in 2003). This long-term performance monitoring plan describes the procedures to be followed to evaluate the long-term performances of the groundwater extraction system. The plan describes the procedures and activities associated with evaluating extraction well operations, groundwater quality, and water-level changes due to the operation of the extraction system. The Navy is continuing to monitor and evaluate trends in groundwater quality, as required by the ROD.

The results of the Third Quarter Fiscal Year 2006 long-term performance monitoring indicated that hydraulic containment of the groundwater contamination is being achieved (see Figure 5-1). The total overall average pumping rate from the extraction wells was approximately 24 gpm in the capture zone. The Fourth Quarter Fiscal Year 2005 monitoring also indicated that progress is being made to restore the groundwater quality to levels protective of human health and the environment (see Figure 5-2) (ECOR, 2006). However, recent groundwater monitoring found significantly higher PCE concentrations (up to approximately 300 µg/L) in a new shallow bedrock monitoring well in Area C (HN-23A). Extraction well concentrations have not increased, however, and the new monitoring well is within the capture zone of the extraction system.

In September 2000, the Navy began the process of transferring the remaining property in the vicinity of Area C to the FLRA as part of an EDC. The associated FOST was signed by the Navy on October 2, 2000. Land use controls and restrictions specified in the OU-3 ROD and ESD were included in the conveyance documents for this property. As described in these documents, the land use controls prohibit extraction and use of Area C groundwater by current and future landowners. Although the OU-3 OPS demonstration does not imply that cleanup actions have been completed for Area C groundwater in compliance with the ROD, it does allow for the deeded transfer of Area C from the Navy to the FLRA.

5.3.4.2 O&M Cost

An annual O&M cost ranging from $ 214,729 to $ 244,444 was estimated in the ROD. The costs included O&M of the groundwater extraction and treatment system (including water and air emission treatment wastes as necessary to meet standards) and groundwater/effluent monitoring. The Navy's O&M cost records were not available for review; however, their estimate is an average of $500,000 per year. This estimated cost includes the O&M addressing OU-1, OU-3, and OU-4. The actual cost for the implementation of the remedial design has not yet been tabulated because the remedial actions are ongoing.

5.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

The following recommendations and required actions were developed based on the previous five-year review for OU-3.

Previous Recommendation/ Required Action	Current Status
Monitoring and observation wells missing locks	Completed
Some monitoring wells with cracked or badly damaged well covers	Completed
Extraction well vaults missing locks	Completed
O&M manual requires revisions and updating to reflect intended operating procedures	Pending
Strategy to determine the merits of terminating the pumping and treating of contaminated groundwater	Pending
Thallium should be eliminated as a COC for Area C groundwater	Unknown
Groundwater cleanup levels for Area C groundwater require modification	Unknown

5.5 FIVE-YEAR REVIEW PROCESS

5.5.1 Document and Analytical Data Review

This second five-year review consisted of a review of relevant documents for OU-1, OU-1A, and OU-1B including the ROD, O&M plan, and O&M reports [Quarterly Monitoring Report for the July 2005 Performance Monitoring Event (Fourth Quarter Fiscal Year 2005) by ECOR (2006)]. The remedial action (extraction well and groundwater treatment system installation) has been completed. O&M of the treatment system is being conducted by a Navy contractor, and long-term performance monitoring is being conducted.

5.5.2 Site Inspection

A site inspection was conducted on March 27, 2006. The Five-Year Review Site Inspection Checklist from the March 2006 inspection is included in Appendix A.

The following components were inspected and found to be in good condition:

- Electrical enclosures and panels
- Tanks, vaults, and storage vessels
- Filters, air strippers, carbon adsorbers, and ion exchange unit

O&M checks are reported to be conducted twice per week on average by the Navy on-site contractor, and monthly pump-and-treat system operating reports are prepared. The treatment system building and monitoring wells were in good condition. A few monitoring wells along Kirk Road near Area C still need to be properly abandoned.

Selected extraction wells and wellhead plumbing and pipelines were inspected and found to be in good condition. Some wells were not operating at the time of the site visit, and the Navy O&M contractor reported being aware of the situation and was taking measures to correct the problems. Extraction system pipelines, valves, valve boxes, and other appurtenances were in good condition and not exposed to the weather. Spare parts were available and organized; however, a complete inventory of the significant spare parts was not available for review.

Other issues related to Area C that were revealed during an interview with the Navy O&M contractor were as follows:

- Installation of an air stripper on well WMA 13 under consideration by the Warminster Municipal Authority (a follow-up visit indicated that the well does not have an air stripper).

- Formal access agreements for long-term groundwater monitoring apparently have not been arranged for several monitoring wells, particularly wells that are located outside of former Navy property.

- The extraction system effluent and air emissions are sampled and analyzed for contaminants to ensure that the treatment system is functioning adequately. No permits are required for NPDES (effluent discharge) or air discharge.

The Navy also reported that a groundwater remedy optimization report is being prepared by Batelle at the Navy's request. This report is not yet final.

5.6 TECHNICAL ASSESSMENT

5.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents?

The OU-3 ROD required the restoration of groundwater in Area C. A subsequent Explanation of Significant Differences added requirement for institutional controls prohibiting the use of groundwater

within the area of contamination, including the prohibition of installation of new wells within this area. The institutional controls addressing former Navy property consist of restrictions on the use of water from existing wells and restrictions on the future installation of wells and/or the use of water from wells installed in the future. These controls were included in the FOSTs for various parcels of property in the vicinity of Area C and will be (or have been) incorporated into the deeds transferring the parcels. The controls for off-base property are enforced through Warminster Township Ordinance No. 32, which regulates well drilling north of Area C. The site inspection did not reveal any unacceptable issues with land use controls (LUCs) regarding groundwater prohibitions.

The quarterly monitoring report indicated that contaminants are being contained within the intended zone and not resulting in adverse effects to groundwater quality in downgradient areas. Opportunities for optimization of the treatment system exist, and a report describing these opportunities is being finalized.

The review of documents, ARARs, and risk assumptions and the results of the site inspection indicate that the remedy is functioning as intended by the ROD. Based on the completed activities, the intent and goals of ROD have been met, and there are no deficiencies or early indicators of potential remedy failure.

5.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid?

The groundwater cleanup standard for PCE is the MCL (5 µg/L), which has not become more stringent since the first five-year review. No changes in exposure pathways, toxicity, contaminant characteristics, or risk assessment methods have changed since the previous five-year review that would affect progress towards meeting RAOs. No changes to site conditions have been identified. No new receptors or potential receptors that could be affected by the contaminated groundwater have been identified.

Results of the vapor intrusion risk analysis OU-3 are presented below based on the Fourth Quarter Fiscal Year 2005 long-term performance monitoring report. Five VOCs were detected in groundwater at OU-3. Of these five, only the maximum detected concentration of PCE exceeded its vapor intrusion screening concentration.

The vapor intrusion risk analysis indicated that the noncarcinogenic HIs for future residents and workers based on the maximum groundwater concentration of PCE (210 µg/L) were less than the USEPA goal of unity.

The total cancer risk for future residents based on exposure to vapors from the maximum groundwater concentration of PCE was 5.3E-6 which is within the USEPA target risk range. Risks from exposure vapors based on the average concentration of PCE were less than the target risk range.

Total noncarcinogenic HIs and cancer risks for occupational workers were less than USEPA goals.

Based on this analysis, no adverse carcinogenic or noncarcinogenic health effects are expected from exposure to vapors from groundwater at OU-3.

5.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No human health or ecological risks have been identified, and no weather-related events have affected the protectiveness of the remedy. No other information has come into light that could call into question the protectiveness of the remedy.

Recently, significantly higher PCE concentrations (up to approximately 300 µg/L) have been found in a new monitoring well in Area C. Extraction well concentrations have not increased, however, and the new monitoring well is within the capture zone of the extraction system. Therefore the remedy is still protective.

5.6.4 Technical Assessment Summary

The remedy is functioning in providing the required protection to human health as required by the ROD as modified by the Explanation of Significant Differences. Since the last 5-year review, no changes to contaminant characteristics, site conditions, or standards that could adversely affect the protectiveness of the remedy have occurred.

5.7 ISSUES

There were no issues discovered during the five-year review that are sufficient to warrant a finding of not protective for OU-3. However, several items were identified during the previous Five-Year Review report and site inspection that should be addressed. These items are summarized as follows:

- Groundwater cleanup goals for Area C need to be re-evaluated. MCL of 5 µg/L should be used for PCE, and thallium should be eliminated as a COC. Although the focus of monitoring has been PCE, it appears that metals treatment components (specifically ion exchange) continues to be used in the treatment system, as recorded during the site inspection. The continued use of ion exchange can result in unnecessarily high O&M costs.

- A strategy for attainment of cleanup goals has not been developed. Currently, it appears that the treatment plant will require continued operation over an indefinite period of time.

- Other minor deficiencies regarding revisions/updates to O&M Manual exist (see table below).

- Monitoring wells along Kirk Road near Area C have not been properly abandoned.

- An air stripper was supposed to have been installed on municipal well WMA 13 by the Warminster Municipal Authority (a follow-up visit indicates that the well does not have an air stripper). If contaminants migrate to this water supply well, it may pose a potential human health exposure pathway (ongoing monitoring of this well has not identified problems to date).

- The draft groundwater remedy optimization report prepared by Battelle at the Navy's request has not been finalized. Therefore, potential methods for reduction in O&M costs are not available for implementation.

- Formal access agreements for long-term groundwater monitoring apparently have not been arranged for several monitoring wells, particularly wells that are located outside of former Navy property. This could hamper future off-site groundwater monitoring efforts.

- Additional investigation should be considered by the Navy to identify the source of higher PCE concentrations recently observed.

5.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

The recommendations and required actions based on the inspection and five-year review are as follows:

Recommendations/ Required Actions	Responsible Party	Oversight Agency	Milestone Date
Finalize the remediation optimization report and make it available to O&M and inspection contractors	Navy (Batelle)	USEPA and PADEP	ASAP
O&M manual revisions and updating (as needed) to reflect intended operating procedures	Navy	USEPA and PADEP	On-going
Document revised cleanup goals for groundwater remediation and issue direction to O&M contractor to bypass the ion exchange unit, and consider returning or recycling the equipment	Navy	USEPA and PADEP	Summer 2006

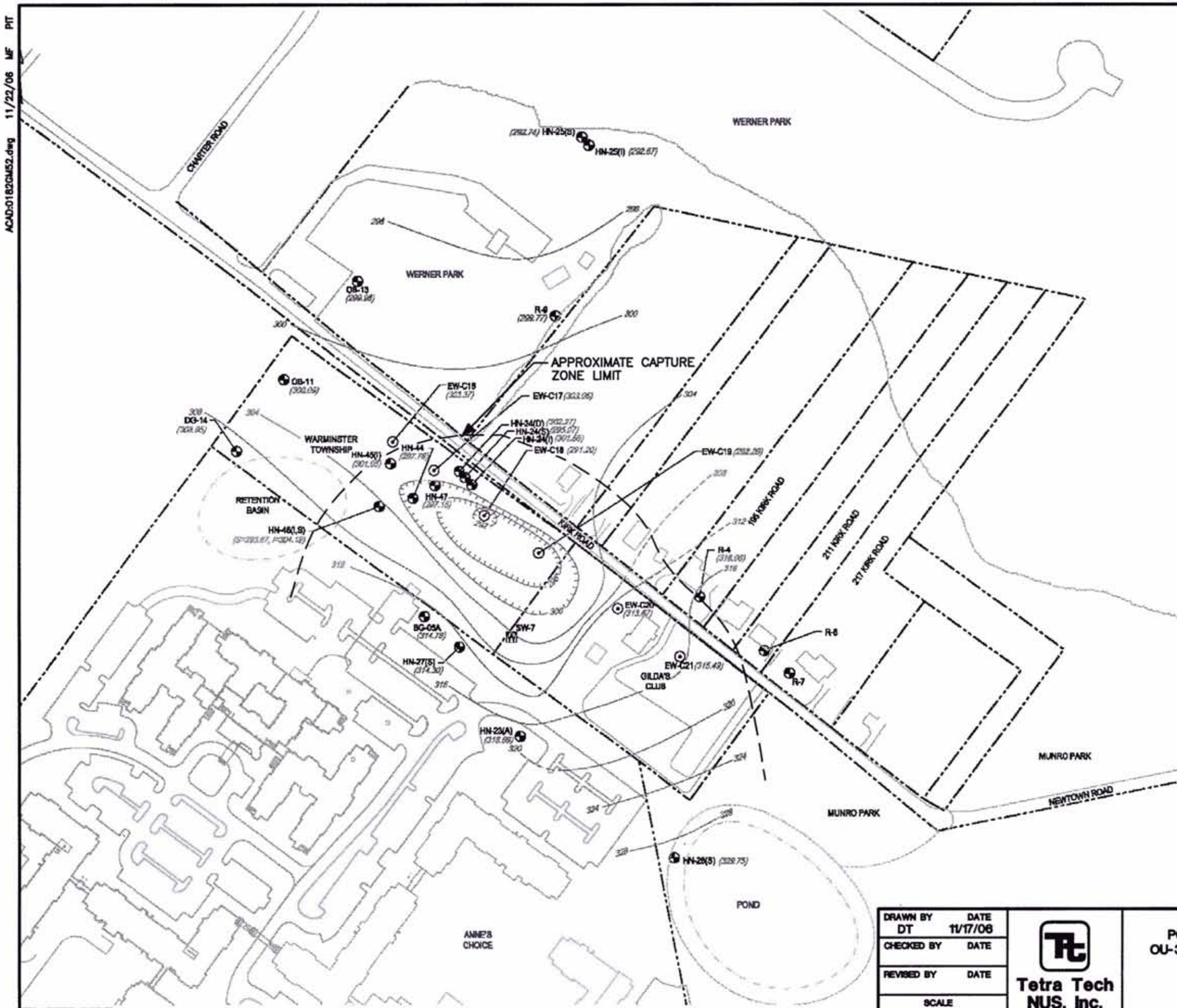
Recommendations/ Required Actions	Responsible Party	Oversight Agency	Milestone Date
Abandon the identified monitoring wells along Kirk road	Navy	USEPA and PADEP	Summer 2006
Prepare a strategy for attainment of cleanup goals and evaluate the predicted cleanup durations. Propose alternatives for decreasing cleanup durations, if appropriate	Navy	USEPA and PADEP	Winter 2006
Additional investigation to identify the source of higher PCE concentrations	Navy	USEPA and PADEP	Winter 2006
Install air stripper on WMA 13 (optional at WTMAs discretion)	WTMA	Navy	To be determined
Obtain formal access agreements for off-site monitoring wells	Navy	WTMA	2006/2007

5.9 PROTECTIVENESS STATEMENT

The remedy at OU-3 is protective of human health and the environment, and the remedy is OPS. Contaminant migration is being adequately contained, and removal of contamination is progressing toward attainment of cleanup goals. The institutional controls for the OU-3 remedy have been fully implemented and continue to be protective in the interim.

Because contamination remains in groundwater at concentrations greater than the PCE MCL and the time required to capture and remove those contaminants to acceptable levels is undefined, additional five-year reviews will be required.

ACAD:0182GM52.dwg 11/22/06 MF PIT



EXTRACTION WELL PUMPING RATES		
WELL ID.	Q (gpm)	
	INSTANTANEOUS	3 MONTH AVERAGE
EW-C16	0	0
EW-C17	0	0
EW-C18	11.7	11.6
EW-C19	13	11.8
EW-C20	~3	~2
EW-C21	0	0
TOTAL SYSTEM 3 MONTH AVERAGE Q – 23.5 gpm		

LEGEND

- MONITORING WELL
- EXTRACTION WELL
- WATER SUPPLY WELL
- PROPERTY LINE
- EDGE OF WATER
- TREELINE
- GROUNDWATER CONTOUR (ft amsl)
- INFERRED CONTOUR
- (303.06) GROUNDWATER ELEVATION (ft amsl)
- AREA OF GROUNDWATER DEPRESSION

NOTES:

1.) AT WELL CLUSTER HN–46, HN–46(I) WAS NOT USED FOR CONTOURING.

2.) GROUNDWATER FLOW MAP SOURCE: FINAL 3RD QTR FY06 MONITORING REPORT, NAWC WARMINSTER ECOR SOLUTIONS, INC.

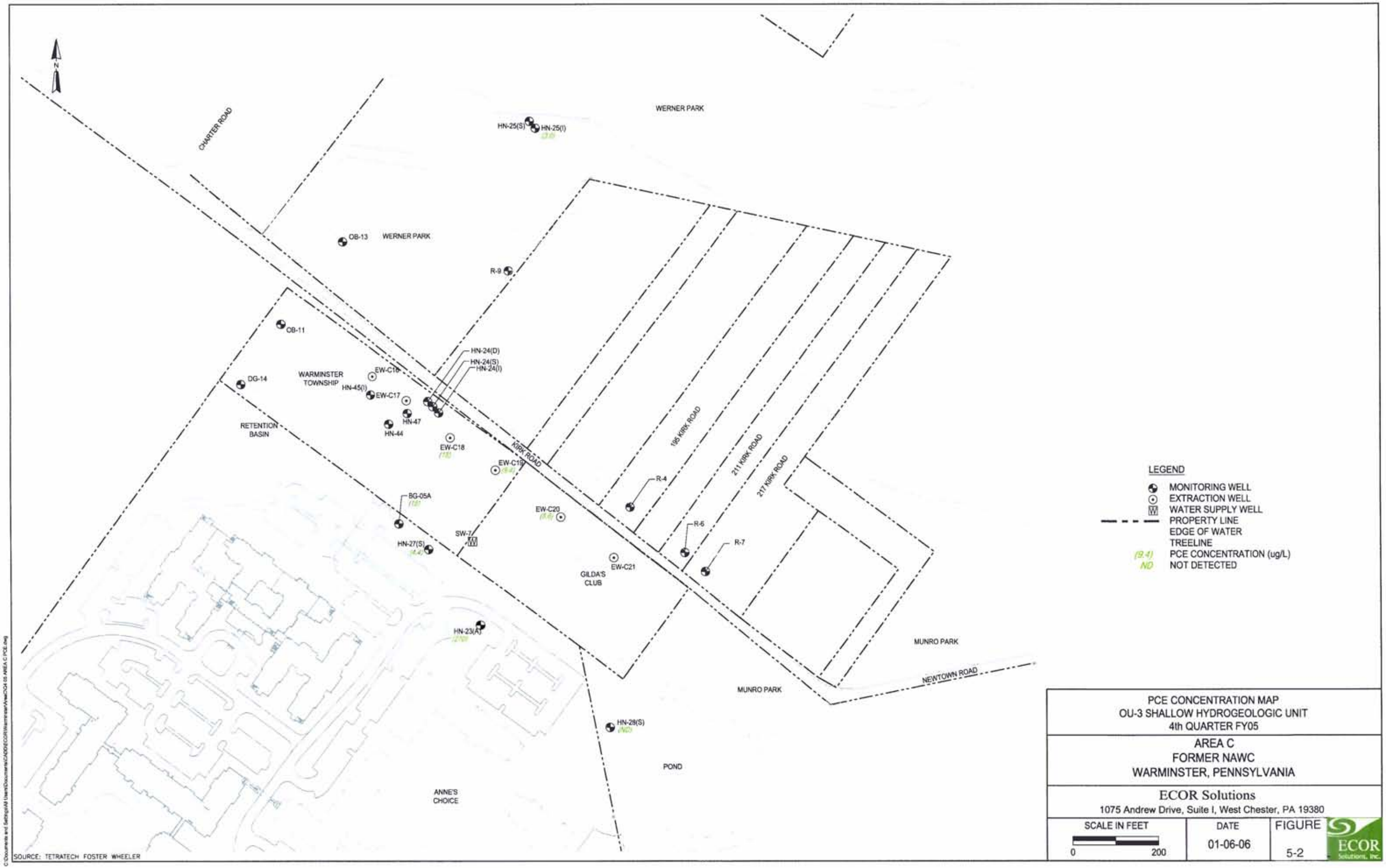
0 200 400
GRAPHIC SCALE IN FEET

DRAWN BY DT	DATE 11/17/06	Tetra Tech NUS, Inc.	CAPTURE ZONE AND POTENTIOMENTRIC SURFACE MAP OU-3 SHALLOW HYDROGEOLOGIC UNIT 18 APRIL 2006 AREA C FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA
CHECKED BY	DATE		
REVISED BY	DATE		
SCALE AS NOTED			

CONTRACT NO. 0182	
OWNER NO.	
APPROVED BY	DATE
DRAWING NO. FIGURE 5-1	REV. 0

TECH FOSTER WHEELER

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98



PCE CONCENTRATION MAP
OU-3 SHALLOW HYDROGEOLOGIC UNIT
4th QUARTER FY05

AREA C
FORMER NAWC
WARMINSTER, PENNSYLVANIA

ECOR Solutions
1075 Andrew Drive, Suite I, West Chester, PA 19380

SCALE IN FEET	DATE	FIGURE
0 — 200	01-06-06	5-2

6.0 OPERABLE UNIT 4

6.1 INTRODUCTION

Implementation of the remedial actions at OU-4 began in approximately 1994. This five-year review includes an evaluation of approximately 13 years of data and provides a current status update for OU-4. This review is required because contaminated groundwater is still present on site that does not allow for unlimited use and unrestricted exposure. OU-4 consists of contaminated groundwater in Area D.

6.2 SITE BACKGROUND AND CHRONOLOGY

OU-4 was identified as the contaminated groundwater in Area D. A list of important OU-4 historical events and relevant dates in the site chronology is shown below. The identified events are illustrative, not comprehensive.

DATE(S)	EVENT
September 1979	Initial discovery of contamination at NAWC Warminster
June 9, 1981	Notification of Hazardous Waste Site submitted
June 24, 1981	PA
June 7, 1985	SI
October 4, 1989	NPL listing of NAWC Warminster
October 1989	Base wide Phase I RI activities began
April 1991	Base wide Phase I RI activities completed
May 1992	Base wide Phase II RI and FS activities began
April 1993	Base wide Phase II RI and FS activities completed
October 1, 1993	Final Focused RI/FS start for OU-1A, OU-1B, and OU-4
August 27, 1994	Interim OU-4 RI/FS began
October 1996	Interim OU-4 RI/FS completed
September 30, 1997	Interim OU-4 ROD signed
October 1, 1997	Final RI/FS for OU-4 began
August 7, 1998	Interim OU-4 remedial design began
October 9, 1998	Interim OU-4 remedial design completed
October 10, 1998	Interim OU-4 remedial action began
July 6, 1999	Interim OU-4 construction complete and pump-and-treat system began
April 2000	OU-4 Final RI/FS completed
June 22, 2000	OPS for OU-4 signed

DATE(S)	EVENT
June 26, 2000	Final OU-4 ROD signed
June 26, 2000	Final OU-4 actual remedial action began
July 28, 2000	Final OU-4 remedial action construction completed
August 20, 2000	Final RI/FS for OU-4 completed
September 28, 2000	Construction complete for entire base; Preliminary Close-Out Report signed

6.3 REMEDIAL ACTIONS

6.3.1 Remedy Selection

Groundwater attributable to Area D at NAWC Warminster is contaminated with TCE at concentrations that present an unacceptable risk to human health and the environment. This groundwater was defined as OU-4. An interim ROD for OU-4 was issued on September 30, 1997. The primary RAOs for the interim remedy were as follows:

- Minimize the migration of contaminated groundwater
- Initiate aquifer restoration
- Obtain information about the response of the aquifer to remediation measures

In addition, a secondary RAO was to limit or eliminate unacceptable exposure to the contaminated Area D groundwater while the interim remedy was being implemented.

The interim remedy included the following major components:

- Determination of the contribution of on -ase, open water-supply wells (i.e., SW-1, SW-2, SW-3, and SW-4) on the vertical distribution of contamination in groundwater.

- Reconstruction or abandonment of the open water supply wells, as necessary, to limit further contaminant migration.

- Installation, operation, and maintenance of groundwater extraction wells.

- Pumping of contaminated groundwater and conveyance through piping to an existing on-base groundwater treatment system.

- If necessary, installation and monitoring of observation wells to ensure the effectiveness of groundwater extraction wells.

- Periodic evaluation of hydrogeologic data and the effectiveness of the groundwater extraction system.

- Modification of the groundwater extraction well system as necessary based on periodic evaluations.

- O&M of the existing on-base groundwater treatment system and expansion of this system if necessary to treat extracted groundwater from Area D.

- Periodic sampling of treated water to ensure the effectiveness of the treatment system.

- Monitoring of treated water to ensure the effectiveness of the treatment system.

- Discharge of treated water to an unnamed tributary of Little Neshaminy Creek.

- Installation and O&M of vapor-phase carbon adsorption units as necessary to control air emissions from the treatment system.

- Off-base treatment and/or disposal of solid residuals generated during water treatment.

- Monitoring of groundwater in off-base monitoring wells.

- Institutional controls to prevent the use of groundwater that presents an unacceptable health risk.

- A review of the remedy on a 5-year basis.

The OU-4 ROD did not specify groundwater cleanup concentrations for the interim remedy. No estimate was made regarding the length of time to achieve cleanup.

Treatment of groundwater extracted under the interim remedy for OU-4 was via a groundwater treatment plant that was initially constructed as part of the interim remedy for Area A and Area B groundwater (OU-1) and the final remedy for the Area C groundwater (OU-3).

After the nature and extent of contaminated groundwater underlying Area D was determined, and considering the information generated during implementation of the interim remedial action, the final remedy ROD for OU-4 was issued on June 26, 2000. The RAOs of the final remedy were as follows:

- Prevent the use of contaminated Area D groundwater that presents an unacceptable risk.
- Restore Area D groundwater to remedial action levels protective of human health. The remedial action level in this case was the federal MCL for TCE, which is 5 µg/L.

The major components of the final OU-4 remedy included:

- Area D groundwater would continue to be pumped by the existing groundwater extraction system and conveyed to the existing treatment plant via existing transfer lines.

- Extracted groundwater would continue to be treated in the existing plant. Treatment of Area D groundwater may potentially be modified to include only treatment by granular activated carbon.

- Treated groundwater would continue to be discharged to an unnamed tributary of Little Neshaminy Creek. Monitoring of treated water would continue to ensure the effectiveness of the treatment system.

- Natural attenuation processes (e.g., dilution and dispersion) would reduce Area D groundwater contaminant concentrations of concern not captured by the extraction system.

- Groundwater monitoring would be performed as necessary to monitor the effectiveness of the groundwater extraction system and natural attenuation processes in restoring the beneficial use of the aquifer.

- Institutional controls would be implemented to prevent the use of Area D groundwater as long as this groundwater presented an unacceptable risk and to protect the integrity and effectiveness of the extraction well system and natural attenuation processes. The institutional controls addressing current off-base property would consist of the continued enforcement of a municipal ordinance that requires well drilling to protect the health of residents, and the controls for current Navy property would consist of deed restrictions entered into for transfer of the property and enforcement of the municipal ordinance.

- To prevent potential vertical contaminant migration, supply wells SW-1 and SW-2 would be abandoned in accordance with State guidelines or reconstructed as necessary to prevent vertical migration.

The groundwater extraction and treatment system was estimated to operate for at least 30 years before achieving cleanup concentrations within the capture zone of the extraction well network. The time required for cleanup will be determined by actual sampling results over time. The final remedy ROD for OU-4 indicated that a combination of the extraction well system and natural attenuation processes would

reduce Area D-related TCE concentrations outside the capture zone of the extraction well system to the MCL of 5 µg/L in 2 to 3 years.

6.3.2 Remedy Implementation

Construction of the interim remedy began in January 1995, commencing with the construction of the treatment plant building for the interim remedy for OU-1. The Navy completed construction of the groundwater treatment plant in June 1996. Drilling and installation of the extraction wells for OU-4 were performed between October 1998 and February 1999. Operation of the groundwater extraction system for OU-4 began in July 1999.

The groundwater remediation system for OU-4 includes a source area groundwater extraction system comprising extraction wells EW-D1 through EW-D8. Wells EW-D9 and EW-D10 were also drilled for use as potential extraction wells; however, based on yield testing and/or water-quality sampling results, the wells were completed as open borehole observation and monitoring wells. The discharges from the extraction wells are routed to the groundwater treatment plant located along the western edge of Area A for treatment via air stripping and carbon adsorption. The OU-4 groundwater extraction system is designed to capture the highly contaminated portion of the volatile organics plume (primarily TCE) before it migrates beyond the former facility boundary. The low-concentration portion of the plume that may extend beyond the capture zone of the extraction system will be remediated through natural attenuation processes, primarily dispersion and dilution.

Further downgradient from the source area extraction system, WTMA Well No. 26 is pumped continuously at an average rate of approximately 250 gpm. Water from this well is routed through an air stripping unit for treatment before entering the municipal water system. It is expected that natural attenuation processes will reduce Area D-related groundwater contamination that exists outside the capture zone of the extraction system to non-detect concentrations before it reaches this well.

6.3.3 Remedy Cost

The capital cost for construction of the treatment plant was estimated in the ROD in the range of $675,000 and $800,000. The costs included the installation of the groundwater extraction and treatment system, including any liquid or air discharge controls required depending on the need to meet emission standards. The actual cost for the implementation of the remedy has not yet been tabulated.

6.3.4 System Operations/Operation and Maintenance

6.3.4.1 Long-Term Monitoring Program

Similar to the OU-1A remedy, an O&M plan and a performance monitoring plan are in place for the OU-4 remedy and are being implemented. The plans provide operating information relative to the extraction well pumps and pump controllers, the transfer sump and pump, and the treatment system. The O&M plan will be updated as necessary to reflect operating conditions and needs. Included in the updates will be revisions to the O&M plan incorporating guidance regarding O&M of extraction and injection wells at hazardous waste sites.

On June 22, 2000, the Navy submitted a technical demonstration document to support the determination that the OU-4 remedy was OPS. The OU-4 remedy performance was evaluated through the analysis of technical data collected in accordance with sampling and monitoring plans approved by USEPA and PADEP. The basis for the OPS demonstration was the evaluation of remedy performance using groundwater monitoring well and extraction well data as they relate to the applicable RAOs and medium-specific cleanup goals specified in the ROD. Specific findings of the OPS demonstration are discussed below.

The Navy demonstrated that a well-developed cone of depression has formed within the hydrologic unit with the maximum concentrations of VOCs around the Area D extraction wells, which indicated that inward gradients have been achieved in the plume area along the base boundary. The capture zone analysis showed that the capture of the plume exists to a point off-base and that the source area has been hydraulically controlled. During the first 6 months after start-up, TCE concentrations in performance monitoring wells were generally stable to slightly decreasing over time in the downgradient and fringe portions of the plume. This was demonstrated through the presentation and analysis of groundwater quality data collected during six sampling events since 1997 as part of RI/FS studies, interim environmental monitoring efforts, and treatment system performance monitoring. Analysis of these data showed that the groundwater plume was contained in the vicinity of the base boundary and that overall groundwater contaminant concentrations were remaining at steady state or decreasing. More recent water level data from ongoing performance monitoring activities is consistent with older data.

The data further indicated that natural attenuation processes (primarily dilution and dispersion) are active and are limiting the migration of contaminants from the source area within Area D. The Navy is continuing to monitor and evaluate these trends in groundwater quality as required by the ROD.

Long-term performance monitoring program is currently being conducted by ECOR, a Navy contractor. ECOR's long-term performance monitoring plan prepared in November 2005 (ECOR, 2005) is being used

as guidance for performance monitoring, review of the system performance through the collection of groundwater levels, sampling of select wells, and collection of pumping rate information (an earlier version to the plan was prepared by Battelle in 2003). This long-term performance monitoring plan describes the procedures to be followed to evaluate the long-term performance of the groundwater extraction system. The plan describes the procedures and activities associated with evaluating extraction well operations, groundwater quality, and water-level changes due to the operation of the extraction system. The Navy is continuing to monitor and evaluate trends in groundwater quality as required by the ROD.

The results of the Third Quarter Fiscal Year 2006 long-term performance monitoring indicated that hydraulic containment of the groundwater contamination is being achieved (see Figure 6-1). The total overall average pumping rate from the extraction wells was approximately 33 gpm in the capture zone. The Fourth Quarter Fiscal Year 2005 monitoring also indicated that progress is being made to restore the groundwater quality to levels protective of human health and the environment (see Figure 6-2). The extraction rate data coupled with contaminant concentration trends indicated that contaminant mass is being removed (although not at a significant rate) by the extraction well network (ECOR, 2006).

In September 2000, the Navy transferred property in the vicinity of Area D to the FLRA as part of an EDC. The associated FOST was signed by the Navy on July 5, 2000. Land use controls and restrictions specified in the OU-4 ROD were included in the conveyance documents for this property. As described in these documents, the land use controls prohibit extraction and use of Area D groundwater by current and future landowners.

6.3.4.2 O&M Cost

The annual O&M cost estimated in the ROD was between $ 82,000 and $ 100,000. The costs included O&M of the groundwater extraction and treatment system (including water and air emission treatment wastes as necessary to meet standards) and groundwater/effluent monitoring. The Navy's O&M cost records were not available for review; however, their estimate is an average of $500,000 per year. This estimated cost includes the O&M addressing OU-1, OU-3, and OU-4 areas of groundwater. The actual cost for the implementation of the remedial design has not yet been tabulated because the remedial actions are ongoing.

6.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

The following recommendations and required actions were developed based on the previous five-year review for OU-4.

Previous Recommendation/ Required Action	Current Status
Monitoring and observation wells missing locks	Completed
Some monitoring wells with cracked or badly damaged well covers	Completed
Extraction well vaults missing locks	Completed
O&M manual requires revisions and updating to reflect intended operating procedures	Pending
Strategy to determine the merits of terminating the pumping and treating of contaminated groundwater	Pending

6.5 FIVE-YEAR REVIEW PROCESS

6.5.1 Document and Analytical Data Review

This second five-year review consisted of a review of relevant documents for OU-4 including the ROD, O&M plan, and O&M reports [Quarterly Monitoring Report for the July 2005 Performance Monitoring Event (Fourth Quarter FY 2005) by ECOR (2006)]. The remedial action (extraction well and groundwater treatment system installation) has been completed. O&M of the treatment system is being conducted by a Navy contractor, and long-term performance monitoring is being conducted.

6.5.2 Site Inspection

A site inspection was conducted on March 27, 2006. The Five-Year Review Site Inspection Checklist from the March 2006 inspection is included in Appendix A.

The following components were inspected and found to be in good condition:

- Electrical enclosures and panels
- Tanks, vaults, and storage vessels
- Filters, air strippers, carbon adsorbers, and ion exchange units

O&M checks are reported to be conducted twice per week on average, by the Navy on-site contractor, and monthly pump-and-treat system operating reports are prepared. The treatment system building and monitoring wells were in good condition.

Selected extraction wells and wellhead plumbing and pipelines were inspected and found to be in good condition. Some wells were not operating at the time of the site visit, and the Navy O&M contractor reported being aware of the situation and taking measures to correct the problems. Extraction system

pipelines, valves, valve boxes, and other appurtenances were in good condition and not exposed to the weather. Spare parts were available and organized; however, a complete inventory of the significant spare parts was not available for review.

Other issues related to the groundwater treatment system that were revealed during an interview with the Navy O&M site manager were as follows:

- Formal access agreements for long-term groundwater monitoring apparently have not been arranged for several monitoring wells, particularly wells that are located outside of former Navy property.

- The extraction system effluent and air emissions are sampled and analyzed for contaminants to ensure that the treatment system is functioning adequately. No permits are required for NPDES (effluent discharge) or air discharge.

The Navy also reported that a groundwater remedy optimization report is being prepared by Batelle at the Navy's request. This report is not yet final.

6.6 TECHNICAL ASSESSMENT

6.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents?

The final OU-4 ROD required the restoration of groundwater and the use of institutional controls to prohibit groundwater use in Area D. The institutional controls addressing former Navy property consist of restrictions on the use of water from existing wells and restrictions on the future installation of wells and/or the use of water from wells installed in the future. These controls prevent the use of groundwater that presents unacceptable human health risks and protect the integrity and effectiveness of the Area D extraction well network. These controls were included in the FOST for property in the vicinity of Area D and have been incorporated into the deed transferring the parcel (i.e., Parcel 3). The controls are enforced through Warminster Township Ordinance No. 32 for both former and off-base Navy property. The site inspection did not reveal any unacceptable issues with LUCs regarding groundwater use prohibitions.

The quarterly monitoring report indicated that contaminants are being contained within the intended zone and not resulting in adverse effects to groundwater quality in downgradient areas. The remedial action for the area downgradient of the capture zone is natural attenuation (dispersion and dilution). Based on Figures 6-1 and 6-2, the capture zone created by operation of the extraction system appears to contain the contaminant concentrations that are above the MCLs and the concentration of the contaminants

downgradient of the capture zone are less than the MCLs. Opportunities for optimization of the treatment system exist, and a report describing these opportunities is being finalized.

The review of documents, ARARs, and risk assumptions and the results of the site inspection indicate that the remedy is functioning as intended by the ROD. Based on the completed activities, the intent and goals of ROD have been met, and there are no deficiencies or early indicators of potential remedy failure.

6.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid?

The groundwater cleanup standard for TCE is the MCL (5 µg/L), which has not become more stringent since the first five-year review. No changes in exposure pathways, toxicity, contaminant characteristics, or risk assessment methods have changed since the previous five-year review that would affect progress toward meeting RAOs. No changes to site conditions have been identified. No new receptors or potential receptors that could be affected by contaminated groundwater have been identified.

Results of the vapor intrusion risk analysis OU-4 are presented below based on the Fourth Quarter Fiscal Year 2005 long-term performance monitoring report. Eight VOCs were detected in groundwater at OU-4. Of these eight compounds, only the maximum detected concentration of TCE exceeded its vapor intrusion screening concentration.

The vapor intrusion risk analysis indicated that total noncarcinogenic HIs and cancer risks for future residents and occupational workers based on exposure to vapors from the maximum detected groundwater concentration of TCE were less than USEPA goals. Therefore, no adverse carcinogenic or noncarcinogenic health effects are expected from exposure to vapors from groundwater at OU-4.

6.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No human health or ecological risks have been identified, and no weather-related events have affected the protectiveness of the remedy. No other information has come into light that could call into question the protectiveness of the remedy.

6.6.4 Technical Assessment Summary

The remedy is functioning in providing the required protection to human health as required by the ROD. Since the last five-year review, no changes to contaminant characteristics, site conditions, or standards that could adversely affect the protectiveness of the remedy have occurred.

6.7 ISSUES

There were no issues discovered during the five-year review that are sufficient to warrant a finding of not protective for OU-4. However, several items were identified during the previous Five-Year Review Report and site inspection that should be addressed. These items are as follows:

- Although the focus of monitoring has been TCE, it appears that metals treatment components (specifically ion exchange) continue to be used in the treatment system, as recorded during the site inspection. This ion exchange unit was added to the treatment system in 2004 when elevated concentrations of hexavalent chromium were detected in the treatment plant influent and effluent. The ion exchange unit successfully reduced the hexavalent chromium concentrations to non-detect. The continued use of ion exchange can result in unnecessarily high O&M costs.

- A strategy for attainment of cleanup goals has not been developed. Currently, it appears that the treatment plant will require continued operation over an indefinite period of time.

- Other minor deficiencies regarding revisions/updates to O&M Manual exist (see table below).

- The draft groundwater remedy optimization report prepared by Battelle at the Navy's request has not been finalized. Therefore, potential methods for reduction in O&M costs are not available for implementation.

- Formal access agreements for long-term groundwater monitoring apparently have not been arranged for several monitoring wells, particularly wells located outside of former Navy property. This could hamper future off-site groundwater monitoring efforts.

6.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

The recommendations and required actions based on the inspection and five-year review are as follows:

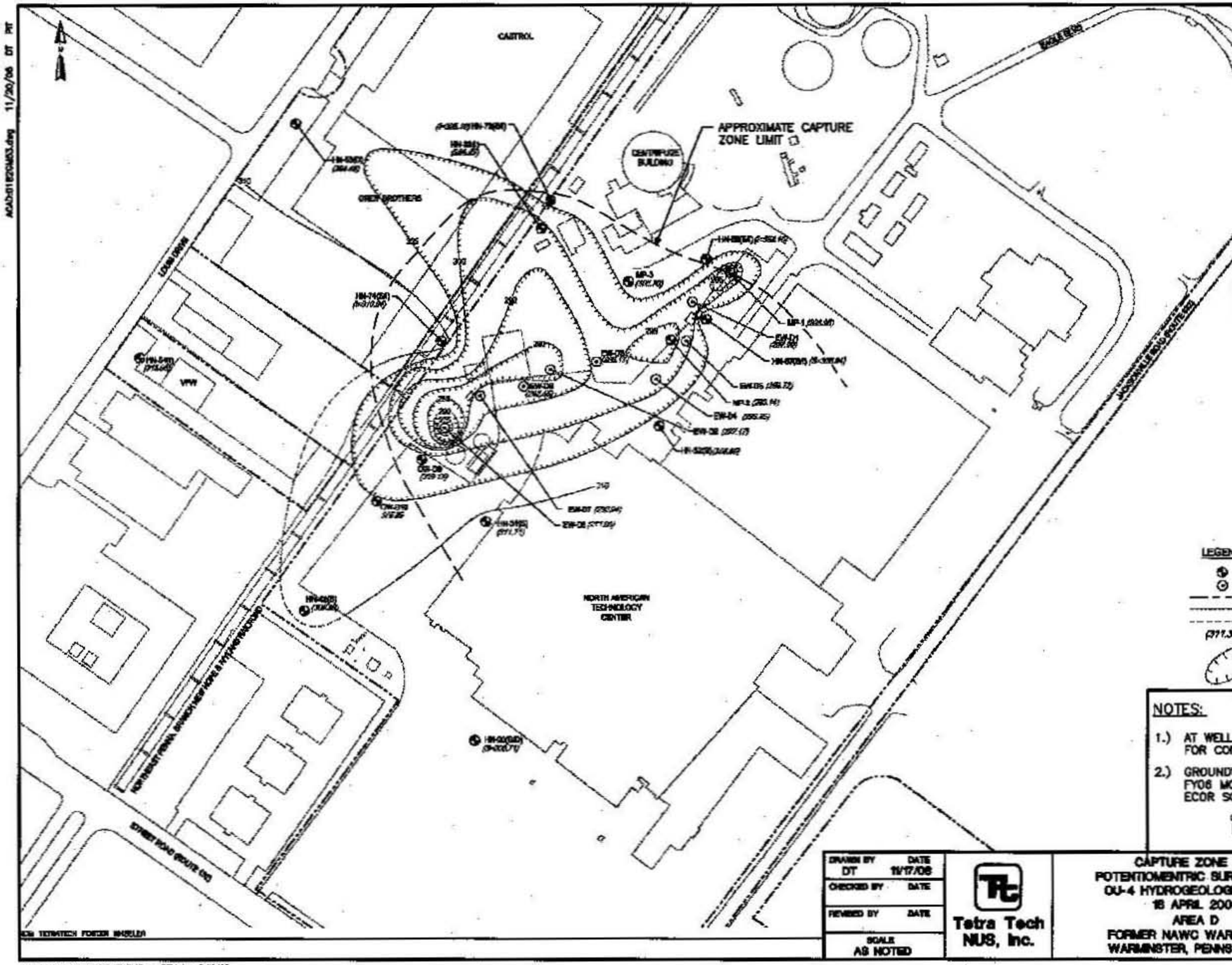
Recommendations/ Required Actions	Responsible Party	Oversight Agency	Milestone Date
Finalize the remediation optimization report and make it available to O&M and inspection contractors	Navy (Batelle)	USEPA and PADEP	ASAP
O&M manual revisions and updating (as needed) to reflect intended operating procedures	Navy	USEPA and PADEP	On-going

Recommendations/ Required Actions	Responsible Party	Oversight Agency	Milestone Date
Issue direction to O&M contractor to bypass the ion exchange unit, and consider returning or recycling the equipment	Navy	USEPA and PADEP	Summer 2006
Prepare a strategy for attainment of cleanup goals and evaluate predicted cleanup durations. Propose alternatives for reducing cleanup durations, if appropriate	Navy	USEPA and PADEP	On-going
Obtain formal access agreements for off-site monitoring wells	Navy	WTMA	2006/2007

6.9 PROTECTIVENESS STATEMENT

The remedy at OU-4 is protective of human health and the environment, and the remedy is OPS. Contaminant migration is being adequately contained, and removal of contamination is progressing toward attainment of cleanup goals. The institutional controls for the OU-4 remedy have been fully implemented and continue to be protective in the interim.

Because contamination remains in the groundwater at concentrations greater than the MCL and the time required to capture and remove those contaminants to acceptable levels is undefined, additional five-year reviews will be required.



EXTRACTION WELL PUMPING RATES		
WELL ID.	Q (gpm) INSTANTANEOUS	Q (gpm) 3 MONTH AVERAGE
EW-D1	6.0	3.5
EW-D2	6.3	6.2
EW-D3	4.7	3.4
EW-D4	8.0	4.7
EW-D5	3.7	0
EW-D6	13.7	5.3
EW-D7	5.0	5.1
EW-D8	5.0	5.1
TOTAL SYSTEM 3 MONTH AVERAGE Q = 33.3 gpm		

NOTES:

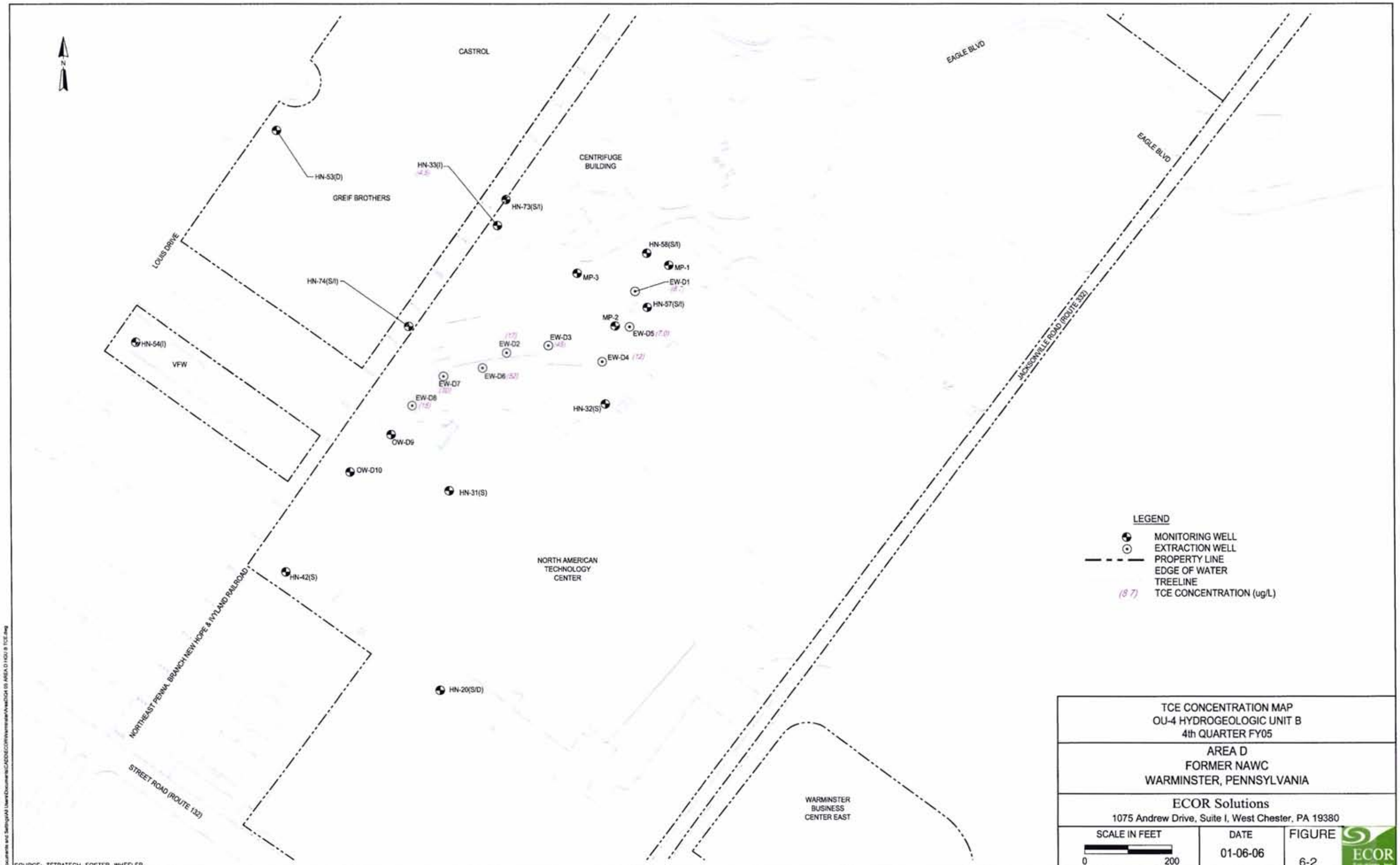
1.) AT WELL CLUSTER HN-20 (S) WAS NOT USED FOR CONTOURING.

2.) GROUNDWATER FLOW MAP SOURCE: FINAL 3RD QTR FY06 MONITORING REPORT, NAWC WARMINSTER ECOR SOLUTIONS, INC.

DRAWN BY DT	DATE 11/17/06	Tetra Tech NUS, Inc.	CAPTURE ZONE AND POTENTIOMENTRIC SURFACE MAP OU-4 HYDROGEOLOGIC UNIT B 18 APRIL 2006 AREA D FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA
CHECKED BY	DATE		
REVIEWED BY	DATE		
SCALE AS NOTED			

CONTRACT NO. 0182
OWNER NO.
APPROVED BY DATE
DRAWING NO. FIGURE 6-1
REV. 0

FORM CADD NO. TTNUS-SHLNVG - REV 1 - 9/18/98



TCE CONCENTRATION MAP
OU-4 HYDROGEOLOGIC UNIT B
4th QUARTER FY05

AREA D
FORMER NAWC
WARMINSTER, PENNSYLVANIA

ECOR Solutions
1075 Andrew Drive, Suite I, West Chester, PA 19380

SCALE IN FEET	DATE	FIGURE
0 — 200	01-06-06	6-2

7.0 OPERABLE UNIT 5

7.1 INTRODUCTION

Implementation of the remedial actions at OU-5 occurred in 1999. This five-year review provides a current status update for OU-5. OU-5 consists of contaminated soil, sediment, and surface water associated with Site 8 at Area C.

7.2 SITE BACKGROUND AND CHRONOLOGY

OU-5 (Site 8) was used as a 2-acre fire training area from 1961 to 1988 (see Figure 2-16). The training activities were conducted at the northeastern end of the old runway located in Area C. These activities involved pouring contaminated jet fuels onto a runway area that was contained by berms. The fuel was then ignited and extinguished to simulate fire-fighting procedures. In addition, an area of the runway immediately south of the training area was used to test the resistance of aviation suits to fire. This area consisted of a corrugated metal building (Structure S1) where flight suits were passed through flames to test the durability of the suits. Although it was not initially reported as a disposal site, the former location of this test area is considered to be part of Site 8.

A list of important OU-5 historical events and relevant dates in the site chronology is shown below. The identified events are illustrative, not comprehensive.

DATE(S)	EVENT
1961 to 1988	Site 8 operated as a fire training area that used aviation fuel, lubricants, and coolants.
September 1979	Initial discovery of contamination at NAWC Warminster
October 4, 1989	NPL listing of NAWC Warminster
October 1989	Base Wide Phase I RI activities began
September 20, 1990	FFA signed
April 1991	Base wide Phase I RI activities completed
May 1992	Base wide Phase II RI and FS activities began
April 1993	Base wide Phase II RI and FS activities completed
July 1998	OU-5, Site 8 RI began
February 2, 1999	OU-5, Site 8 Soils remedial action completed and Action Memorandum signed
August 1999	OU-5, Site 8 RI completed
September 29, 1999	OU-5 NFA ROD signed

7.3 REMEDIAL ACTIONS

7.3.1 Remedy Selection

OU-5 includes soil, sediment, and surface water associated with Site 8 within Area C. A removal action was selected to eliminate the human health risk associated with lead-contaminated surface soils at Site 8 (see Figure 2-18). Following the removal action, a NFA ROD was signed for OU-5 on September 29, 1999. The NFA remedy selection was based upon post-removal verification sampling and the risk assessment results from the RI Report for OU-5 that indicated that NFA was necessary to protect human health and the environment.

7.3.2 Remedy Implementation

The removal action was completed in 1999 before the ROD was signed. No additional remedial actions were selected in the OU-5 ROD for Site 8 soils, surface water, and sediment.

7.3.3 Remedy Cost

The Action Memorandum for Site 8 soils estimated the cost of the soil removal action to be $30,000. The actual costs for the remedial action for OU-5 have not been tabulated.

7.3.4 System Operations/Operation and Maintenance

7.3.4.1 Long-Term Monitoring Program

No long-term monitoring program was required for the remedial action for OU-5.

7.3.4.2 Cost

There are no costs associated with a long-term monitoring program.

7.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

No deficiencies, recommendations, or follow-up actions were identified in the first five-year review for OU-5. No additional activities or remedial actions are required.

7.5 FIVE-YEAR REVIEW PROCESS

7.5.1 Document and Analytical Data Review

No new documents were available for review.

7.5.2 Site Inspection

A site inspection was conducted in March 2006. No unusual observations were documented during the visit. The area of OU-5 (Site 8) has been reconstructed into a sedimentation basin for stormwater drainage near an Ivyland residential development. The Five-Year Review Site Inspection Checklist for OU-2 from the March 2006 inspections is included in Appendix A.

7.6 TECHNICAL ASSESSMENT

7.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents?

The remedy selected for OU-5 was NFA. The review of documents, ARARs, and risk assumptions and the results of the site inspection indicate that the remedy is functioning as intended by the ROD. No actions are required at OU-5 based on the results of the removal action of February 1999. The removal action mitigated the hazards to public health posed by soils, surface water, and sediment. Based on the completed activities, the intent and goals of ROD have been met.

7.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid?

There have been no changes in the ARARs or changes in the exposure pathways that would affect the protectiveness of the remedy. Physical changes have occurred at OU-5 based on the site inspection; however, these changes do not affect the remedy. The remedy is complete for OU-5.

7.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No human health or ecological risks have been identified, and no weather-related events have affected the protectiveness of the remedy. No other information has come into light that could call into question the protectiveness of the remedy.

7.6.4 Technical Assessment Summary

The remedy as specified in the ROD is NFA. According to the information reviewed and the site inspection, the remedy is functioning as intended by the ROD. There have been no changes in the physical condition of the OU, to toxicity factors for the COCs, or to the standardized risk assessment methodology that would affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

7.7 ISSUES

No issues were discovered during the five-year review.

7.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Based on the results of the five-year review, no follow-up actions are required for OU-5.

7.9 PROTECTIVENESS STATEMENT

The remedy implemented at OU-5 is protective of human health and the environment. Based on the activities completed, the intent and goals of the ROD have been met.

8.0 OPERABLE UNIT 6

8.1 INTRODUCTION

Implementation of the remedial actions at OU-6 occurred in 1996. This five-year review provides a current status update for OU-6. OU-6 consists of soils, sediment, and surface water associated with Site 4 at Area C.

8.2 SITE BACKGROUND AND CHRONOLOGY

OU-6 (Site 4) is a 7-acre grassy area just north of the main runway and just south of Kirk Road (see Figure 2-15). The site was operated from 1966 to 1970 and consisted of several trenches used to dispose of non-industrial solid waste, paints, waste oils, waste metals, construction debris, solvents, and sewage sludge from the sewage treatment plant. A review of historical aerial photographs verified the presence of trenches at Site 4 and indicated that Site 4 was active through 1973.

A list of important OU-6 historical events and relevant dates in the site chronology is shown below. The identified events are illustrative, not comprehensive.

DATE(S)	EVENT
1966 to 1970	Site 4 operated seven trenches for disposal of non-industrial solid waste, paints, waste oils, waste metals, construction debris, solvents, and sewage sludge.
September 1979	Initial discovery of contamination at NAWC Warminster
1980	Navy reported Site 4 as a disposal site in a Navy Shore Activity Disposal Fact Form
October 4, 1989	NPL listing of NAWC Warminster
October 1989	Base wide Phase I RI activities began
September 20, 1990	FFA signed
September 20, 1990	OU-6 RI/FS start
April 1991	Base wide Phase I RI activities completed
May 1992	Base wide Phase II RI and FS activities began
April 1993	Base wide Phase II RI and FS activities completed
July 1995	OU-6, Site 4 Engineering Evaluation/Cost Analysis report prepared for removal action
June 18, 1996	OU-6, Site 4 Action Memo signed
June 21, 1996	OU-6, Site 4 Removal Action work plan approved
August 2, 1996	OU-6, Site 4 removal action began
September 30, 1996	NADC Warminster operations ceased pursuant to BRAC
December 23, 1996	OU-6, Site 4 removal action completed

DATE(S)	EVENT
January 30, 1997	OU-6, Site 4 Close-Out Report for Removal Action
June 20, 2000	OU-6 NFA ROD signed; RI completed
September 28, 2000	Construction complete for entire base; Preliminary Close-Out Report signed

8.3 REMEDIAL ACTIONS

8.3.1 Remedy Selection

A removal action was selected and conducted to eliminate the unacceptable risk associated with contaminated soils at Site 4 (see Figure 2-19). Following the removal action, a NFA ROD was issued for OU-6 on June 20, 2000. The NFA remedy selection was based on post-removal verification sampling and the risk assessment results from the OU-6 RI report that indicated that NFA was necessary to protect human health and the environment.

8.3.2 Remedy Implementation

The removal action was completed in 1996 before the ROD was signed. No additional remedial actions were selected in the OU-6 ROD for Site 4 soils, surface water, and sediment.

8.3.3 Remedy Cost

The Action Memorandum for Site 4 soils estimated the cost of the removal action to be $1,218,832. The actual costs for the remedial action at OU-6 have not been tabulated.

8.3.4 System Operations/Operation and Maintenance

8.3.4.1 Long-Term Monitoring Program

No long-term monitoring program was required with the remedial action for OU-6.

8.3.4.2 Cost

There are no costs associated with a long-term monitoring program.

8.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

No deficiencies, recommendations, or follow-up actions were identified in the first five-year review for OU-6. No additional activities or remedial actions are required.

8.5 FIVE-YEAR REVIEW PROCESS

8.5.1 Document and Analytical Data Review

No new documents were available for OU-6 to review.

8.5.2 Site Inspection

A site inspection was conducted in March 2006. No unusual observations were documented during the visit. The area of OU-6 (Site 4) has been reconstructed into a sedimentation basin for the construction of an assisted living residential development. The Five-Year Review Site Inspection Checklist for OU-6 from the March 2006 inspections is included in Appendix A.

8.6 TECHNICAL ASSESSMENT

8.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents?

The remedy selected for OU-6 was NFA. The review of documents, ARARs, and risk assumptions and the results of the site inspection indicate that the remedy is functioning as intended by the ROD. No actions are required at OU-6 based on the results of the removal action in 1996. The removal action mitigated the hazards to public health posed by the soils, surface water, and sediment. Based on the completed activities, the intent and goals of ROD have been met.

8.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid?

There have been no changes in the ARARs or changes in the exposure pathways that would affect the protectiveness of the remedy. Physical changes have occurred at OU-6 based on the site inspection; however, these changes do not affect the remedy. The remedy is complete for OU-6.

8.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No human health or ecological risks have been identified, and no weather-related events have affected the protectiveness of the remedy. No other information has come into light that could call into question the protectiveness of the remedy.

8.6.4 Technical Assessment Summary

The remedy as specified in the ROD is NFA. According to the information reviewed and the site inspection, the remedy is functioning as intended by the ROD. There have been no changes in the physical condition of the OU, to toxicity factors for the COCs, or to the standardized risk assessment methodology that would affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

8.7 ISSUES

No issues were discovered during the five-year review.

8.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Based on the results of the five-year review, no follow-up actions are required for OU-6.

8.9 PROTECTIVENESS STATEMENT

The remedy implemented at OU-6 is protective of human health and the environment. The intent and goals of the ROD have been met.

9.0 OPERABLE UNIT 7

9.1 INTRODUCTION

Implementation of the remedial actions at OU-7 began in 1997. This five-year review provides a current status update for OU-7. This review is required because wastes remain on site that are not amenable to treatment and that do not allow for unlimited use and unrestricted exposure. OU-7 consists of contaminated soil and waste associated with Sites 6 and 7 at Area B. These sites are grouped as OU 7 because of their close proximity in Area B and the similarity of disposal practices.

9.2 SITE BACKGROUND AND CHRONOLOGY

OU-7 (Sites 6 and 7) are contained within a parcel of land that has been designated for transfer to the FLRA and local municipalities (see Figure 2-10). The re-use plan for Sites 6 and 7 identifies recreational use as the designated use for this land. Site 6 was reportedly used for disposal activities and reportedly received unknown quantities of waste paints, solvents, oil, flammable wastes, grease trap waste, and demolition debris. These materials were reportedly disposed in pits excavated by backhoe through general dumping and backfilling throughout the area.

Site 7 reportedly received sludge from the wastewater treatment plant. The trenches were reportedly 100 feet long by 12 feet wide and 8 feet deep. The estimated potential capacity of each trench was 356 cubic yards. The trenches were reportedly backfilled after each dumping episode. Upon site closure in 1955, the trenches were covered with 2 feet of soil, graded, and seeded. The area of Sites 6 and 7 was also used for the deposition of demolition and construction debris. Large quantities of concrete and asphalt from demolished runways and parking aprons were deposited. The area of debris deposition is now partly covered by a woodlot.

A list of important OU-7 historical events and relevant dates in the site chronology is shown below. The identified events are illustrative, not comprehensive.

DATE(S)	EVENT
1950 to 1955	Site 7 operated two trenches for disposal.
1960 to 1980	Site 6 operated an unknown number of trenches and pits for disposal.
September 1979	Initial discovery of contamination at NAWC Warminster
October 4, 1989	NPL listing of NAWC Warminster
October 1989	Base wide Phase I RI activities began
September 20, 1990	FFA signed

DATE(S)	EVENT
April 1991	Base wide Phase I RI activities completed
May 1992	Base wide Phase II RI and FS activities began
April 1993	Base wide Phase II RI and FS activities completed
September 30, 1996	NADC Warminster operations ceased pursuant to BRAC
May 1, 1997	OU-7, Sites 6 and 7 Action Memo signed
May 31, 1997	OU-7, Sites 6 and 7 removal action began
July 19, 1997	OU-7, Sites 6 and 7 removal action completed
June 20, 1998	OU-7 RI/FS began
November 1999	OU-7 RI completed
December 1999	OU-7 FS completed
June 20, 2000	OU-7 ROD signed
June 20, 2000	OU-7, Sites 6 and 7 removal action completed
June 20, 2000	OU-7 remedial design began
July 19, 2000	OU-7 remedial design completed
August 30, 2000	OU-7 actual remedial action began
September 28, 2000	Construction complete for entire base; Preliminary Close-Out Report signed
November 27, 2000	Transfer of the parcel that includes OU-7 to the U. S. National Park Service
August 1, 2002	OU-7 remedial action construction completed; Close-Out Report
August 1, 2002	OU-7 remedial action completed

9.3 REMEDIAL ACTIONS

9.3.1 Remedy Selection

OU-7 includes the soils and wastes associated with the Site 6 and Site 7 property within Area B. Prior to selecting the final remedy and preparing the ROD, an Action Memorandum was prepared for a removal action based on the OU-7 RI. The Action Memorandum also included removal of debris and construction rubble from the surface of Sites 6 and 7 and post-removal soil sampling.

The ROD for OU-7 was signed on June 20, 2000. The primary RAOs for the OU-7 final remedy were as follows:

- Prevent human exposure (via incidental ingestion and dermal contact) to subsurface soils containing hazardous substances at levels that present an unacceptable risk under the planned recreational use of the property.

- Eliminate unacceptable risk from exposure to soils by implementing institutional controls (e.g., land use restrictions) to ensure the property is not used for residential purposes.

- Prevent industrial/commercial use of the property by implementing institutional controls that require Navy and/or USEPA approval of a risk assessment for such use and additional environmental response work (if necessary).

The major components of the remedy for OU- 7 were as follows:

- Placement of a permanent 2-foot vegetated soil cover over site-wide subsurface soils and implementation of any engineering controls necessary to establish and maintain a stable cover.

- Deed restrictions that provide that the 2-foot vegetated soil cover remain in place and that Navy and/or USEPA must approve any plans for excavation below 2 feet within the area of site-wide subsurface soils.

- A deed restriction to prohibit residential use of the parcel.

- A deed restriction to prevent industrial and commercial use, especially daycare facilities, of the area of site-wide surface soils without Navy and/or USEPA approval of a risk assessment for industrial and commercial use and additional environmental response work, if necessary.

- Periodic monitoring to identify measures necessary to maintain the 2-foot vegetated soil cover and to identify whether deed restrictions are being adhered to as required.

- Maintenance of the 2-foot vegetated soil cover based on periodic monitoring. Maintenance may include revegetation, placement of additional soil cover, engineering controls, and/or other measures.

- Enforcement of deed restrictions based on periodic monitoring.

The deed restrictions would be included in the deed entered into for transfer of property from the Navy to the next property owner.

The FLRA re-use plan identified the planned use of property occupied by Sites 6 and 7 as recreational. To be protective of recreational use, the OU-7 remedy was targeted as preventing human ingestion of and dermal contact with hazardous substances in subsurface soils that exceed the concentrations indicated in the table below. Soil cleanup goals were developed for each substance determined to be a significant contributor to an unacceptable noncarcinogenic risk (corresponded to an HQ of 0.1) to ensure

protectiveness. The cleanup goals (in mg/kg) were as follows for site-wide subsurface soils and for the three zones (locations) of concern at OU-7.

Hazardous Substance	Site-Wide	Zone 1	Zone 2	Zone 3
Chromium	54.1	54.1	54.1	54.1
Thallium	7.43	7.43	7.43	7.43
Arsenic	-	-	27.9	27.9
Cadmium	-	-	40.2	40.2
Aroclor-1254	-	-	-	1,540

9.3.2 Remedy Implementation

The removal action for OU-7 was conducted between May and July 1997. The action included the excavation and removal of approximately 3,698 tons of soil and debris from three discrete locations at Sites 6 and 7 and the removal of debris and construction rubble from the surface of Sites 6 and 7. Post-removal soil sampling was performed to confirm that cleanup goals established for the removal action for protection of groundwater and human health were attained within the designated removal action areas.

The remedial design for OU-7 vegetated soil cover was completed in July 2000. The remedial action for OU-7 began in August 2000 and was completed on August 1, 2002. As part of construction, a 2-foot vegetated soil cover was placed over site-wide subsurface soils to make sure that subsurface soils exceeding remediation goals were not available for human exposure. Site- wide subsurface soils were defined as soils in areas where subsurface disposal had occurred. Engineering controls were also implemented to establish and maintain the soil cover.

Two separate areas were delineated that required additional cover and grading. An 18-inch clean fill layer and a 6-inch topsoil layer were placed over these two areas, as depicted in the final construction grading plan. A total of 10,760 tons for clean fill and 9,595 tons of topsoil were used during soil cover construction. Drainage swales were installed along the perimeter of Sites 6 and 7 to control stormwater flows. The soil cover was then vegetated to provide permanent erosion control, to establish surface stabilization, and to promote wildlife habitat. A seed mix was applied to the covered areas through hydroseeding, and a wildflower mix was applied to enhance the covered areas. In addition, hardwood trees were planted along the northern perimeter of one of the graded areas to control and maintain the soil cover. A topographic survey was conducted to document the as-built conditions of the soil cover (Figure 9-1).

Immediately following the completion of the soil cover, a significant rainfall event resulted in some erosion of the covered areas. A portion of the topsoil layer was washed downgradient of Sites 6 and 7. In

response, additional erosion and sediment control measures were taken. About 140 tons of topsoil was added to the soil cover, and the disturbed areas were again reseeded. A final topographic survey was also performed.

The draft remedial action close-out report for OU-7 was submitted on August 30, 2002 and is currently under review.

9.3.3 Remedy Cost

In the Action Memorandum, the Navy estimated the cost of the removal action for Site 6 at $500,000. The capital cost for implementation of the cap alternative was estimated in the ROD at $1,220,000 for Sites 6 and 7. This estimate included costs associated with site preparation, excavation, removal, and off-site disposal of subsurface soil, backfill of the excavation, site grading, soil cover placement (2 feet), construction of erosion control and stormwater drainage system, and revegetation. The actual cost for the implementation of the remedy has not yet been tabulated.

9.3.4 System Operations/Operation and Maintenance

9.3.4.1 Long-Term Monitoring Program

The O&M User Manual for OU-7 released in October 2001 indicates that post-closure care will be performed for 30 years. Monitoring and inspection of the vegetated soil cover and stormwater control measures will be conducted quarterly for the first 2 years of the post-closure care period and semi-annually thereafter for the remaining 28 years. The soil cover will be inspected for erosion, differential settling, coverage of vegetation, and any evidence of burrowing animals. Erosion of soil-covered areas will be repaired using appropriate clean fill or topsoil materials. The stormwater controls will be evaluated for sediment accumulation, subsidence, ponding, flow obstructions, erosion, and vegetative growth that could prevent the free flow of stormwater in the vicinity of Sites 6 and 7. Accumulated sediment and vegetation that are found to obstruct stormwater flow will be removed from the drainage swales and spread over the surrounding upland areas. If necessary, regrading will be conducted to promote positive drainage.

Settlement at Sites 6 and 7 will be monitored once per year through a periodic visual survey. If settlement greater than 6 inches is observed, the soil cover will be repaired and a topographic survey will be completed to determine the extent of the settlement.

The Navy's Remedial Action Contractor implemented the first year of quarterly monitoring according to the O&M User Manual for Sites 6 and 7. The first year report of the quarterly monitoring was prepared

and submitted to the Navy in November 2001. Observations/comments and action items conducted were reported in the first year report. No significant problems were identified (Foster Wheeler, 2001e). Monitoring has not been conducted since September 2001.

In addition, the ROD for OU-10 indicated the Navy would prepare a sediment confirmation sampling and analysis work plan and conduct additional stream monitoring to confirm that the OU-7 response actions would mitigate potential unacceptable risks presented by sediment impacted by Sites 6 and 7 in Area B. As part of post-ROD activities, a sampling and analysis plan for OU-7 was submitted on September 27, 2000 for the Area B stream. The plan was not approved by USEPA and no sediment sampling has been conducted to date.

On October 11, 2000, the Navy signed the FOST for Sites 6 and 7. The property was transferred to Warminster Township through a deed as part of an EDC. To date, the institutional controls for OU-7 have not yet been implemented. The deed included the land use controls and restrictions specified in the OU-7 ROD that require permanent maintenance of the soil cover and establishment of excavation controls.

The deed indicated that the vegetated soil cover present at the time of transfer will remain in place and that any plans for excavation below 2 feet within the area of site-wide subsurface soils must be approved by the Navy and/or USEPA. The deed also indicates that the property will not be used for residential purposes. The deed also prohibits industrial and commercial use, especially daycare facilities, without Navy and/or USEPA approval of a risk assessment for such use and any necessary additional environmental response work. This approval will consider the available information and will be contingent on the submission and approval of a plan that ensures that necessary measures are undertaken to protect human health and the environment. The information to be considered will include RI data regarding the nature and extent of COC in accordance with this ROD.

Every 5 years, a review will be conducted to evaluate the site status and to determine whether further action is necessary. Periodic review will be required because the selected remedy allows contaminants to remain at concentrations that are not protective of unrestricted land use.

9.3.4.2 Cost

The average annual O&M costs (includes long-term monitoring, mowing, cover repairs, etc.) are estimated at $8,000 per year for 30 years, and five-year reviews costs are estimated at $20,000 per event in the ROD. The actual costs for the implementation of maintenance and periodic monitoring have not yet been tabulated. The actual costs for the sediment sampling and analysis program for OU-10 have not been tabulated also.

9.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

The following recommendations and required actions were developed based on the previous five-year review for OU-7.

Previous Recommendation/ Required Action	Current Status
O&M Manual requires finalization; O&M activities need to be assigned to a Navy subcontractor	Completed O&M Manual, Conducted 1 year of quarterly monitoring until September 2001. Monitoring has not been conducted since September 2001
Sparse vegetation in selected areas requires reseeding	Completed
Newly planted hardwood trees along the northern perimeter of the soil cover may need replacement due to wildlife damage	Completed
O&M Manual needs to reflect the areas at Sites 6 and 7 that will be permanently maintained	Completed
Eroded areas require additional topsoil and reseeding	Completed

9.5 FIVE-YEAR REVIEW PROCESS

9.5.1 Document and Analytical Data Review

This second five-year review consisted of a review of relevant documents for OU-7 including the ROD, O&M User Manual, O&M report, and related OU-10 documents. The remedial action (2-foot vegetative cover) has been completed at OU-7. Quarterly O&M was conducted for 1 year but has not been continued since September 2001.

9.5.2 Site Inspection

A site inspection was conducted in March 2006. No unusual observations were documented during the visit. The cap appeared to be in good shape, and Warminster Township has posted signs indicating the area is a nature preserve. The area around Sites 6 and 7 has been revegetated and returned to its natural state. Some minor eroded areas and evidence of the soil cover being maintained and mowed were observed. Some trees show evidence of deer damage; however, the trees have been recently mulched, fitted with a special watering bag device, and appear to be healthy, based on branch buds. The Five-Year Review Site Inspection Checklist from the March 2006 inspection is included in Appendix A.

9.6 TECHNICAL ASSESSMENT

9.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents?

The remedy selected for OU-7 was focused excavation and off-site disposal, vegetated soil cover, erosion control and stormwater drainage systems, institutional controls, and monitoring. The review of documents, ARARs, and risk assumptions and the results of the site inspection indicate that the remedy is functioning as intended by the ROD. However, the post-closure monitoring activities have not been conducted since September 2001.

It was assumed that the OU-7 response actions mitigated potential unacceptable risks presented by sediment impacted by Area B and that no action is necessary to directly address the sediments (OU-10 ROD requirements). However, this has not been confirmed with sediment sampling and analysis.

Based on the completed activities (RI and risk assessment), the intent and goals of ROD have been met, and there are no deficiencies or early indicators of potential remedy failure.

9.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid?

There have been no significant changes in the physical conditions for OU-7, changes in the ARARs, or changes in exposure pathways that would affect the protectiveness of the remedy. There have been no changes in the risk assessment methodologies or exposure assumptions. There has been only one change in the toxicological values (i.e., the RfD for chromium changed from 0.005 to 0.003 mg/kg/day) used to calculate the recreational cleanup goals, but this change is not considered significant. Therefore, there have been no significant changes in cleanup goals established for OU-7.

9.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No human health or ecological risks have been identified, and no weather-related events have affected the protectiveness of the remedy. No other information has come into light that could call into question the protectiveness of the remedy.

9.6.4 Technical Assessment Summary

The remedy as specified in the ROD included focused excavation and off-site disposal, vegetated soil cover, erosion control and stormwater drainage systems, institutional controls, and monitoring. According

to the information reviewed and the site inspection, the remedy is functioning as intended by the ROD. However, the post-closure monitoring activities have not been conducted since September 2001.

In addition, the ROD for OU-10 indicated the Navy would prepare a sediment confirmation sampling and analysis work plan and conduct additional stream monitoring to confirm that potential impacts to stream sediment by Area B sites were mitigated by response actions for Area B, including response actions for OU-7. As part of post-ROD activities, a sampling and analysis plan for OU-7 was submitted on September 27, 2000 for the Area B stream. This plan described the scope of additional stream monitoring; however, the plan was not approved by USEPA and no sediment sampling has been conducted to date.

There have been no significant changes in the physical condition of the OU, to toxicity factors, or to the standardized risk assessment methodology that would affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

9.7 ISSUES

Three issues were identified during the five-year review that are related to the monitoring and close out aspects of the remedial action. One year of quarterly post-closure monitoring was conducted; however, post-closure monitoring activities have not been conducted since September 2001. In addition a sampling and analysis work plan was prepared and submitted in September 2000 for OU-10, but the sediment sampling and analysis program has not been implemented to confirm that the OU-7 response actions mitigated potential unacceptable risks. Finally, the draft remedial action close-out report for OU-7 was submitted on August 30, 2002 and is currently under review

These issues are not sufficient enough to warrant a finding of not protective for OU-7.

9.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

The recommendations and required actions based on the inspection and five-year review are as follows.

Recommendations/ Required Actions	Responsible Party	Oversight Agency	Milestone Date
Complete and implement the sediment sampling and analysis work plan for OU-10 to confirm that the OU-7 response action mitigated potential unacceptable risks.	USEPA, PADEP, and Navy	Navy	December 2006
Conduct/continue post-closure monitoring activities	Navy	USEPA and PADEP	Summer 2006

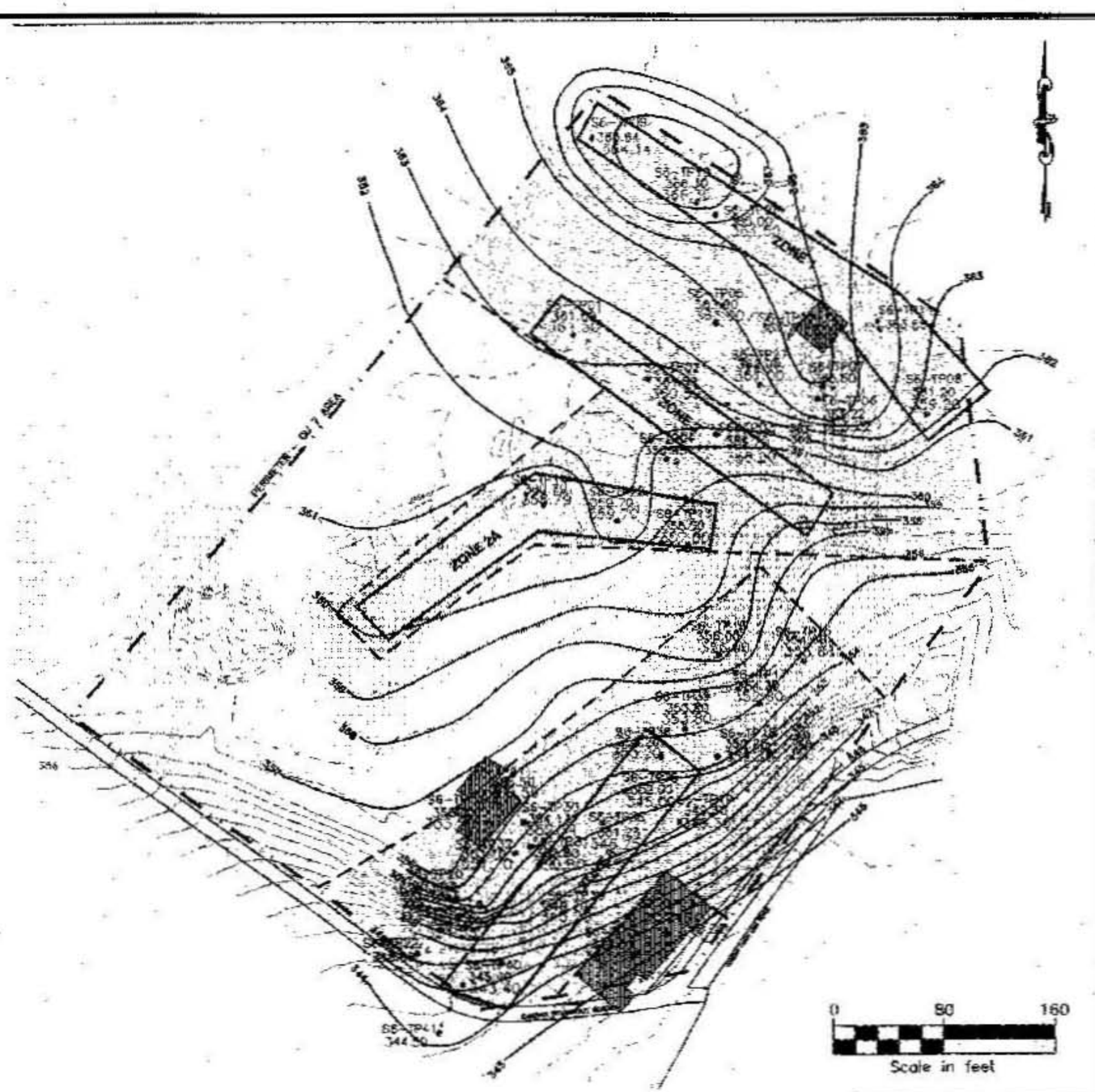
Recommendations/ Required Actions	Responsible Party	Oversight Agency	Milestone Date
Review the draft remedial action close-out report for OU-7	USEPA and PADEP	Navy	Summer 2006
Evaluate post-ROD information and prepare a memo for an insignificant change or an Explanation of Significant Differences	Navy	USEPA and PADEP	Winter 2007

9.9 PROTECTIVENESS STATEMENT

The remedy implemented at OU-7 is protective of human health and the environment. The source of contamination is contained, and the exposure pathways that could result in unacceptable risks are being controlled. The cover system minimizes infiltration and subsequent contaminant migration and prevents direct contact with soil and contaminated materials. Proper implementation of the long-term monitoring program, institutional controls, and O&M will maintain the effectiveness of the remedy into the future.

The Navy, USEPA, and PADEP have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner at OU-7. Based on the completed activities, the intent and goals of the ROD are being met.

Because wastes remain on the site and are not amenable to treatment, additional five-year reviews will be required.



Legend

- Final Grade Contour
- Areas Assumed to Require Fill/Soil Cover Material
- Area of Contaminated Surface Soil
- Area of Contaminated Subsurface Media
- Sites 6 & 7 Removal Areas
- Area of Contaminated Subsurface Media
- Test Pit Location
- 350.00 Test Pit Elevation
- 349.00 Top of Debris
- No Debris Present

General Notes

1) TOPOGRAPHIC DATA SHOWN HEREON BASED UPON A FIELD SURVEY CONDUCTED BY BOUCHER & JAMES, INC. ON 3/7/00 & 5/25/00.

2) VERTICAL DATUM FOR THIS SURVEY BASED UPON NGVD29 AS TAKEN FROM BENCH MARK DISK #47 LOCATED ON A CONCRETE WALL AT THE NW CORNER OF BUILDING NO. 1 (ELEV=321.61)

3) COORDINATE GRID SHOWN HEREON BASED UPON PA STATE PLANE COORDINATE SYSTEM.

Source:
The test pit elevations, i.e. debris & existing grade, were determined using information from the "Feasibility Study Report for OU-7 Soils/Waste at Sites 6/7" (Tetra Tech NUS, Inc., December, 1998) and topographic survey performed March, 2000 by Boucher & James, Inc.

DRAWN BY MF	DATE 5/26/08	Tetra Tech NUS, Inc.	FINAL GRADING PLAN FOR AREA B SITE 6, 7 & OU-7 FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA
CHECKED BY	DATE		
REVIEWED BY	DATE		
SCALE AS NOTED			

CONTRACT NO. 0182	
OWNER NO.	
APPROVED BY	DATE
DRAWING NO. FIGURE 9-1	REV. 0

AC/AD: 0182CM28.dwg 05/28/08 MF PIT

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

10.0 OPERABLE UNIT 8

10.1 INTRODUCTION

Implementation of the remedial actions at OU-8 began in 1998. This five-year review provides a current status update for OU-8. OU-8 consists of contaminated soils associated with Area D.

10.2 SITE BACKGROUND AND CHRONOLOGY

OU-8 (Area D) was not reported as a disposal area but was identified as an area where contaminant releases to groundwater may have occurred. The largest buildings in Area D are Buildings 1 and 2 east of Jacksonville Road and Building 4 west of Jacksonville Road (see Figure 2-21). Brewster Aeronautical Corporation, the owner of the property before the Navy, constructed all three buildings as aircraft hangers in 1942. The laboratories necessary to support the research and development operations were constructed within Buildings 1 and 2, and Building 4 was continually used as an aircraft hangar. Numerous other support facilities were also constructed throughout Area D. The Navy operated the research and development laboratories and support facilities until 1994, when the base was selected for closure. Research and development operations ceased in 1996.

A list of important OU-8 historical events and relevant dates in the site chronology is shown below. The identified events are illustrative, not comprehensive.

DATE(S)	EVENT
September 1979	Initial discovery of contamination at NAWC Warminster
October 4, 1989	NPL listing of NAWC Warminster
October 1989	Base wide Began Phase I RI activities Base wide
September 20, 1990	FFA signed
April 1991	Base wide Phase I RI activities completed
May 1992	Base wide Phase II RI and FS activities began
April 1993	Base wide Phase II RI and FS activities completed
September 30, 1996	NADC Warminster operations ceased pursuant to BRAC
June 20, 1998	OU-8 RI began
September 1998	OU-8 RI completed
June 20, 2000	OU-8 NFA ROD signed
September 2000	Area D (OU-4 and -8) property transferred to FLRA
September 28, 2000	Construction complete for entire base; Preliminary Close-Out Report signed

10.3 REMEDIAL ACTIONS

10.3.1 Remedy Selection

OU-8 includes Area D soils. The results of the risk assessment and the RI indicated that, based on available information, soils in Area D did not present an unacceptable risk to human health and the environment. A NFA ROD for OU-8 was signed on June 20, 2000.

10.3.2 Remedy Implementation

No remedial action was required in the OU-8 ROD for soils associated with Area D.

10.3.3 Remedy Cost

No remedial action costs were required for OU-8.

10.3.4 System Operations/Operation and Maintenance

10.3.4.1 Long-Term Monitoring Program

No long-term monitoring program was required for OU-8.

10.3.4.2 Cost

Because no long-term monitoring was required for OU-8, there are no costs associated with long-term monitoring.

10.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

No deficiencies, recommendations, or follow-up actions were identified in the first five-year review for OU-8. No additional activities or remedial actions are required.

10.5 FIVE-YEAR REVIEW PROCESS

10.5.1 Document and Analytical Data Review

No new documents were available for review.

10.5.2 Site Inspection

A site inspection was conducted in March 2006. No unusual observations were documented during the visit. The Five-Year Review Site Inspection Checklist from the March 2006 inspection is included in Appendix A.

10.6 TECHNICAL ASSESSMENT

10.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents?

The remedy selected for OU-8 was NFA. The review of documents, ARARs, and risk assumptions and the results of the site inspection indicate that the remedy is functioning as intended by the ROD. Based on the completed activities (RI and risk assessment), the intent and goals of ROD have been met.

10.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid?

There have been no changes in the physical conditions for OU-8, changes in the ARARs, or changes in the exposure pathway that would affect the protectiveness of the remedy. The remedy is complete for OU-8.

10.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No human health or ecological risks have been identified, and no weather-related events have affected the protectiveness of the remedy. No other information has come into light that could call into question the protectiveness of the remedy.

10.6.4 Technical Assessment Summary

The remedy as specified in the ROD is NFA. According to the information reviewed and the site inspection, the remedy is functioning as intended by the ROD. There have been no changes in the physical condition of the OU, to toxicity factors, or to the standardized risk assessment methodology that would affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

10.7 ISSUES

No issues were discovered during the five-year review.

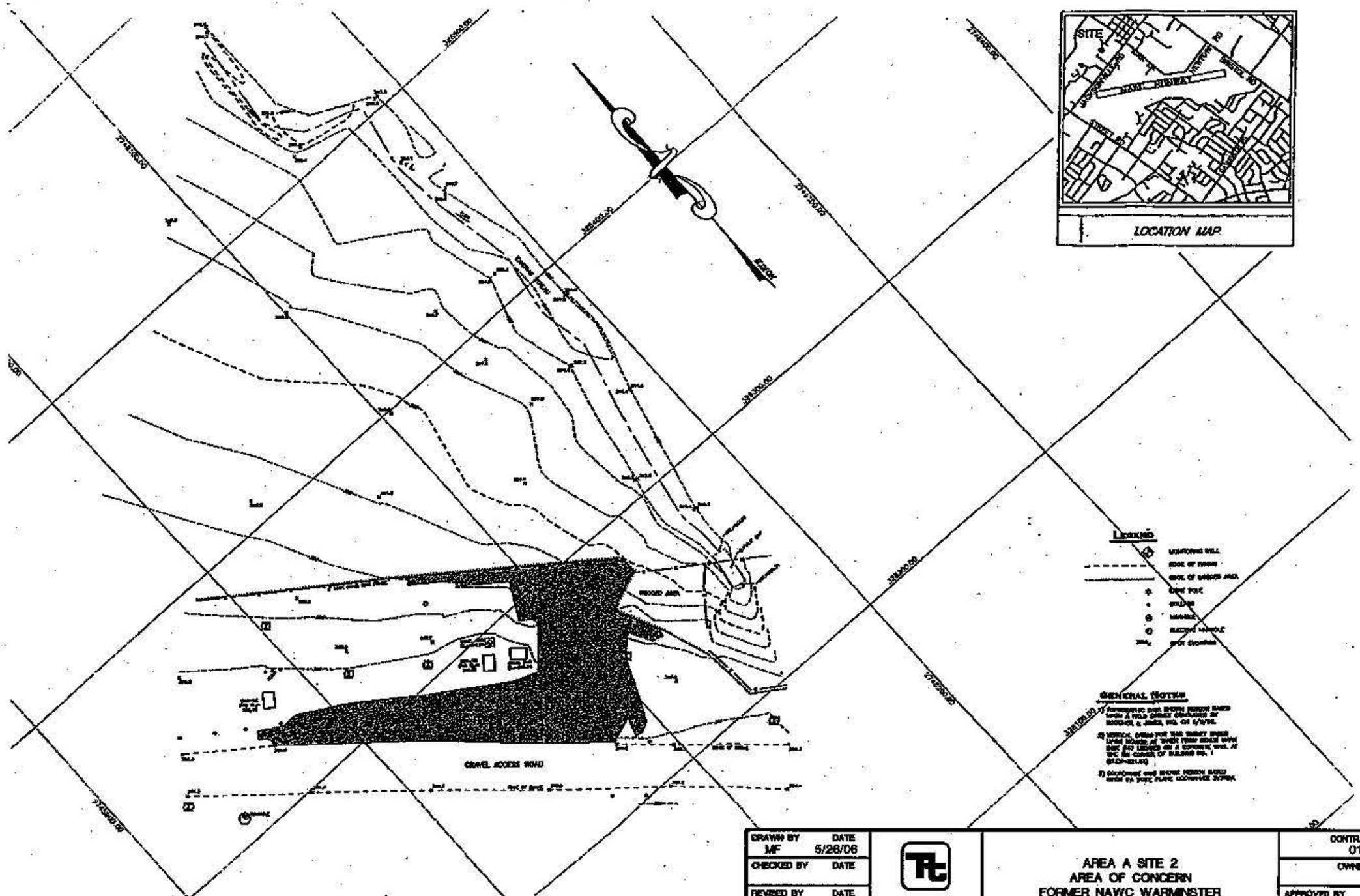
10.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Based on the results of the five-year review, no follow-up actions are required for OU-8.

10.9 PROTECTIVENESS STATEMENT

The remedy implemented at OU-8 is protective of human health and the environment. Based on the activities completed, the intent and goals of the ROD have been met.

ACAD: 0182GM29.dwg 05/26/06 MF PIT



DRAWN BY MF	DATE 5/26/06	Tetra Tech NUS, Inc.	AREA A SITE 2 AREA OF CONCERN FORMER NAWC WARMINSTER WARMINSTER, PENNSYLVANIA
CHECKED BY	DATE		CONTRACT NO. 0182
REVISED BY	DATE		OWNER NO.
SCALE AS NOTED			APPROVED BY / DATE
			DRAWING NO. FIGURE 10-1 / REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

11.0 OPERABLE UNIT 9

11.1 INTRODUCTION

Implementation of the remedial actions at OU-9 began in 1998. This five-year review provides a current status update for OU-9. This review is required because contaminated media are still present on site that does not allow for unlimited use and unrestricted exposure. The soils associated with Area A (OU-9) do not include any source materials constituting a principal threat and the remaining contaminated media are impracticable to treat. OU-9 consists of contaminated soils and sediment associated with Area A. Groundwater underlying and downgradient of Area A is being addressed by OU-1.

11.2 SITE BACKGROUND AND CHRONOLOGY

OU-9 (Area A) generally consists of Sites 1, 2, and 3 and adjacent areas in the northwestern corner of the facility. In addition to Sites 1, 2, and 3, Area A includes the location of eight former impoundments utilized for the storage of industrial wastewater treatment sludge.

Site 1 was reported to be a burn pit that was operated from 1940 to 1955 and was located at the embankment of a ravine formed by erosion action (see Figure 2-2). Waste materials were reportedly dumped over the bank and burned. The waste was reportedly disposed included inorganics, solvents, acids, bases, and firing range waste. Site 2 was a 200-foot by 12-foot by 8-foot trench used for the disposal of approximately 1,400 cubic yards of industrial wastewater treatment sludge (see Figure 2-3) from 1965 to 1970.

Site 3 is immediately southeast of Site 2, (see Figure 2-4) and was reportedly used from 1955 to 1965 as a burn pit for solvents, paints, acids, bases, mixed municipal waste, and other unspecified chemicals. The pit was reportedly approximately 20 feet wide by 30 feet long by 10 feet deep and was covered by a large metal screen enclosure. Residue from the pit was reportedly removed periodically and deposited at an unspecified, on-base “sanitary landfill.”

A list of important OU-9 historical events and relevant dates in the site chronology is shown below. The identified events are illustrative, not comprehensive.

DATE(S)	EVENT
1940 to 1955	Site 1 operated as a burn pit for paints, oils, asphalt, unspecified chemicals, firing range waste, etc. and closed by covering the site with excess soils generated by grading an extension of an aircraft runway.
1940 to 1973	Area A unlined impoundments or lagoons used for storage of wastewater treatment sludge generated by the industrial wastewater treatment plant that have been filled in.
1955 to 1965	Site 3 operated as a burn pit for solvents, paints, and unspecified chemicals and for closure the pit was backfilled with on-base soil and regraded.
1965 to 1970	Site 2 operated two trenches for disposal of industrial wastewater sludge and was closed with a cover and vegetation
September 1979	Initial discovery of contamination at NAWC Warminster
1980	Navy initially reported Site 1 as a potential location of hazardous substances disposal, Site 2 reported to be the location of a trench used for the disposal
October 4, 1989	NPL listing of NAWC Warminster
October 1989	Base wide Phase I RI activities began
September 20, 1990	FFA signed
April 1991	Base wide Phase I RI activities completed
May 1992	Base wide Phase II RI and FS activities began
April 1993	Base wide Phase II RI and FS activities completed
September 30, 1996	NADC Warminster operations ceased pursuant to BRAC
June 1998	Action Memo signed – OU-9, Area A soil removal
August 25, 1998	OU-9, Area A Soils Action Memo signed, began removal action
January 1999	OU-9, Area A soils removal action completed
April 28, 2000	OU-9 RI/FS completed
June 26, 2000	OU-9 ROD signed
June 26, 2000	OU-9 remedial design began
August 11, 2000	OU-9 remedial design completed
August 14, 2000	OU-9 remedial action construction began
September 20, 2000	OU-9 remedial action construction completed; Close-Out Report for OU-9
September 28, 2000	Construction complete for entire base; Preliminary Close-Out Report signed

11.3 REMEDIAL ACTIONS

11.3.1 Remedy Selection

Soils, surface water, and sediment associated with Area A have been defined as OU-9. Prior to selecting the final remedy and preparing the ROD, an Action Memorandum was prepared for a removal action in

June 1998. The removal action in Area A was required due to the presence of hazardous substances in surface soils, subsurface soils, and buried materials in the vicinity. The ROD for OU-9 was signed on June 26, 2000.

The RAOs for the OU-9 remedy based on an anticipated future industrial development land use scenario were as follows:

- Prevent the migration of Area A soils that present a threat to ecological receptors associated with the unnamed tributary of Little Neshaminy Creek.

- Eliminate unacceptable risk to soils by implementing institutional controls (e.g., land use restrictions) to ensure the Area A parcel is not used for residential purposes.

- Mitigate potential risks associated with existing contaminants in sediment and, to a lesser extent, surface water in the unnamed tributary of Little Neshaminy Creek.

The major components of the remedy for OU-9 were as follows:

- Erosion controls to ensure that surface soils exceeding concentrations protective of sediment do not migrate to the unnamed tributary of Little Neshaminy Creek.

- Institutional controls in the form of deed restrictions to ensure permanent maintenance of the erosion controls.

- Institutional controls in the form of deed restrictions to require prior approval by the Navy and/or USEPA of any plans for excavation within specified portions of Area A where contaminant concentrations in subsurface soils exceed concentrations protective of sediment.

- Institutional controls in the form of deed restrictions prohibiting non-industrial use of the Area A parcel.

- Periodic monitoring to identify maintenance activities required for erosion controls and to ensure adherence to deed restrictions.

- Periodic stream monitoring to identify the extent of any contaminant loading to the stream, to assess the ecological effects of any such loading, and to determine the nature of any necessary actions based on these evaluations.

The deed restrictions will be included in the deed entered into for transfer of Area A property from the Navy to the next property owner.

The Action Memorandum referenced risk-based target cleanup levels for the COCs associated with Area A soils that were developed in the draft Area A Removal Site Evaluation (U.S. Navy, 1998). No specific soil cleanup goals were established for the OU-9 remedy. However, to be protective of the unnamed tributary of Little Neshaminy Creek and associated environmental receptors, the remedy was designed to prevent the migration of soils at Sites 2 and 3 that contain hazardous substances at concentrations that exceed those listed in Table 11-1. These concentrations are based on the protective sediment quality concentrations developed in Appendix J of the OU-9 RI/FS Report (Tetra Tech NUS, 2000o) and established in the Technical Memorandum (TtNUS, 2000g) supporting the selection of institutional controls for the OU-9 ROD.

11.3.2 Remedy Implementation

A removal action was conducted in 1996 to remove soils at two locations beneath the footprint of the treatment plant building and surrounding property. An additional removal action based on preliminary RI results was conducted in 1998 that included excavation, transportation, and disposal in an off-base landfill of approximately 6,700 tons of nonhazardous Area A surface and subsurface soils. A small amount (about 100 pounds) of flammable solids or corrosive liquids was also disposed. Soils were excavated from two separate locations within Site 1, three locations within Site 2, and one location near Site 3. Post-removal soil sampling was performed to confirm that cleanup goals established for the protection of groundwater and human health were attained with the designated removal action areas.

In July 2000, the Navy implemented erosion and sedimentation controls in the vicinity of Area A to prevent erosion of surface soils of concern to the stream. The erosion and sedimentation controls were established on August 15, 2000 and included the following:

- Removal of the existing damaged silt fence.
- Removal of sediment between the dike and perimeter fence to grade.
- Removal of sediment within the sediment basin. The sediment was used to fill the ruts that formed south of the existing stone dike due to excessive runoff.
- Installation of 6- to 8-inch stone (approximately 160 tons) to the north of the existing stone dike.
- Increasing the height of the existing dike by at least 1 foot to create a uniform height along the dike.

The remedial action completion report was issued on September 20, 2000 for the Site 2 erosion controls.

11.3.3 Remedy Cost

In the Action Memorandum, the Navy estimated the capital cost of the removal action for OU-9 at $1,069,000. The capital cost for implementation of the selected remedy was estimated in the ROD at $46,483 for Sites 1, 2, and 3. This estimate included costs associated with institutional controls and environmental monitoring. The actual cost for the implementation of the remedy has not yet been tabulated.

11.3.4 System Operations/Operation and Maintenance

11.3.4.1 Long-Term Monitoring Program

The O&M Manual for OU-9 was released on November 2001 and identifies the type and frequency of inspections for Site 2 surface soils to help determine whether the existing erosion controls require maintenance. These inspections will also facilitate the evaluation and implementation of any new controls, if needed.

The O&M Manual indicates that post-closure care will be performed for 30 years. Monitoring and inspection of the erosion and sedimentation control measures will be conducted quarterly for the first 2 years of the post-closure care period and semi-annually thereafter for the remaining 28 years. The Site 2 controls will be inspected for erosion, differential settling, coverage of vegetation, and any evidence of burrowing animals. Settlement will be monitored once per year through a periodic visual survey. If settlement greater than 6 inches is observed, the erosion and sedimentation controls will be repaired and a topographic survey completed to determine the extent of the settlement.

Any erosion of soil-covered areas will be repaired using appropriate clean fill or topsoil materials. The stormwater controls will be evaluated for sediment accumulation, subsidence, ponding, flow obstructions, erosion, and vegetation that could prevent the free flow of stormwater in the vicinity of Site 2. Accumulated sediment and vegetative growth that is found to obstruct stormwater flow will be removed.

The Navy's Remedial Action Contractor implemented the first year of quarterly monitoring from October 2000 to October 2001, according to the O&M User Manual. The first year report of the quarterly monitoring was prepared and submitted to the Navy in November 2001. Observations/comments and action items conducted were reported in the first year report. The inspection form for the quarterly monitoring report indicated that no erosion or settlement problems were identified and that the grass was mowed (Foster Wheeler, 2001d). Monitoring has not been conducted since September 2001.

In addition, the unnamed tributary of Little Neshaminy Creek was periodically monitored to identify the extent of contaminant loading to the stream, to assess the ecological effects of contaminant loading, and to determine the nature of necessary actions based on these assessments. Eight rounds of stream monitoring were conducted between September 1999 and November 2001.

The institutional controls for OU-9 have been implemented. On October 3, 2000, the Navy signed the FOST for Sites 1 and 2 (designated as Parcels 6 and 7). Parcel 6, which includes Site 1, the Impoundment Area, and the on base wastewater treatment plant, were transferred to Warminster Township Municipal Authority as part of a PBC. Parcel 7, which includes a portion of Site 2, was transferred to Bucks County for use as a morgue. The deeds for these parcels included the land use controls and restrictions specified in the OU-9 ROD.

On July 5, 2000, the Navy signed the FOST for the Phase III EDC property. A portion of this property, which includes Site 3, was transferred and deeded to the FLRA on July 12, 2000. The deed(s) prepared by the Navy for transfer of the properties described above provide that the erosion controls established at the time of transfer remain in place permanently.

Institutional controls in the form of deed restrictions will also provide for excavation control in areas where subsurface soils exceed soil concentrations protective of sediment. The subsurface soils of concern are located within Site 2 and Site 3. Prior approval by the Navy and/or USEPA is required for excavation plans within Sites 2 and 3. Such approval will consider the available information and will be contingent on the submission and approval of a plan that ensures that necessary measures are undertaken to prevent migration of the subject soils to the unnamed tributary of Little Neshaminy Creek and to otherwise protect human health and the environment. The information to be considered will include data regarding the nature and extent of subsurface soils exceeding the soil concentrations protective of sediment quality. The deeds will also provide that Area A will not be used for non-industrial purposes such as residential, recreational, and child daycare land uses.

11.3.4.2 Cost

The costs for periodic O&M (every 5 years for 30 years) were estimated as $20,000 in the Action Memorandum. The present worth of the O&M costs (includes long-term monitoring, erosion and sedimentation control, five-year reviews, etc.) are estimated at $249,000 for the first 5 years based on the ROD. The average annual O&M costs are estimated at $31,749 per year for 5 years, and five-year reviews costs are estimated at $12,000. The actual costs for the implementation of maintenance and periodic monitoring have not yet been tabulated.

11.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

The following recommendations and required actions were developed by the BCT based on the previous five-year review for OU-9.

Previous Recommendation/ Required Action	Current Status
O&M Manual requires finalization; O&M activities need to be assigned to a Navy subcontractor.	Completed O&M Manual, Conducted 1 year of quarterly monitoring until September 2001. Monitoring has not been conducted since September 2001.
Deeds for Area A parcels do not reflect the boundaries of the Site 2 erosion controls.	Unknown

11.5 FIVE-YEAR REVIEW PROCESS

11.5.1 Document and Analytical Data Review

This second five-year review consisted of a review of relevant documents for OU-9 including the ROD, remedial design, O&M plan, and O&M reports. The remedial action (erosion controls) has been completed at OU-9. Quarterly O&M was conducted for 1 year but has not been continued since September 2001.

11.5.2 Site Inspection

A site inspection was conducted in March 2006. No unusual observations were documented during the visit. Access to Site 3 is restricted by fencing, and signs are posted denoting the area as federal government property. Visual observations at Site 2 revealed no problems with regard to sediment accumulation, subsidence, erosion, ponding, and obstructions to flow. The storm drainage system at Site 2 appeared to be in good condition. Only Site 2 has off-site discharge within Area A.

Sites 1 and 2 have been redeveloped. Adjacent to Site 1 and the Impoundment Area, the WTMA has built a wastewater treatment plant for its use. Near Site 2, a morgue for the Bucks County Department of Health has been built. At the time of the site inspection, a surveyor was laying out boundaries of areas where excavation was prohibited in several areas. The land use controls appear to be in effect for these sites. The Five-Year Review Site Inspection Checklist from the March 2006 inspection is included in Appendix A.

11.6 TECHNICAL ASSESSMENT

11.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents?

The remedy selected for OU-9 was erosion controls, institutional controls, monitoring of the erosion and institutional controls, and environmental monitoring of the stream. The review of documents, ARARs, and risk assumptions and the results of the site inspection indicate that the remedy is functioning as intended by the ROD. However, post-closure monitoring activities (stream sampling and erosion and sedimentation control inspections) have not been conducted since September 2001.

Based on the completed activities, the intent and goals of ROD have been met, and there are no deficiencies or early indicators of potential remedy failure.

11.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid?

There have been no significant changes in the physical conditions for OU-9, changes in the ARARs, or changes in exposure pathways that would affect the protectiveness of the remedy. There have been no changes in the risk assessment methodologies or exposure assumptions. Therefore, there have been no significant changes in the cleanup goals established for OU-9.

11.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No human health or ecological risks have been identified, and no weather-related events have affected the protectiveness of the remedy. No other information has come into light that could call into question the protectiveness of the remedy.

11.6.4 Technical Assessment Summary

The remedy as specified in the ROD includes erosion controls, institutional controls, monitoring of erosion and institutional controls, and environmental monitoring of the stream. According to the information reviewed and the site inspection, the remedy is functioning as intended by the ROD. However, post-closure monitoring activities (stream sampling and erosion and sedimentation control inspections) have not been conducted since September 2001.

There have been no significant changes in the physical condition of the OU, to toxicity factors, or to the standardized risk assessment methodology that would affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

11.7 ISSUES

One issue was identified during the Five-Year Review that is related to the monitoring aspect of the remedial action. One year of quarterly post-closure monitoring (erosion and sedimentation control inspections) was conducted; however, post-closure monitoring activities have not been conducted since September 2001. This monitoring activity has been discontinued.

This issue is not sufficient enough to warrant a finding of not protective for OU-9.

11.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

The recommendations and required actions based on the inspection and five-year review are as follows.

Recommendations/ Required Actions	Responsible Party	Oversight Agency	Milestone Date
Conduct sediment sampling and analysis as necessary	Navy	USEPA and PADEP	Summer 2006
Conduct/continue post-closure monitoring activities	Navy	USEPA and PADEP	Summer 2006
Evaluate post-ROD information and prepare a memo for an insignificant change or an Explanation of Significant Differences	Navy	USEPA and PADEP	Winter 2007

11.9 PROTECTIVENESS STATEMENT

The remedy implemented at OU-9 is protective of human health and the environment. The source of contamination is contained, and the exposure pathways that could result in unacceptable risks are being controlled. Proper implementation institutional controls and O&M will maintain the effectiveness of the remedy into the future.

The Navy, USEPA, and PADEP have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner at OU-9. Based on the completed activities, the intent and goals of the ROD are being met.

Because contaminated media remains on the site at concentrations above the cleanup criteria, additional five-year reviews will be required.

TABLE 11-1

SURFACE SOIL CONCENTRATIONS PROTECTIVE OF SEDIMENT/ECOLOGICAL RECEPTORS
NAWC WARMINSTER, PENNSYLVANIA

Parameter	Soil Concentration Protective of Sediment		Site 2 Maximum Concentration		Site 3 Maximum Concentration	
	Site 2	Site 3	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil
INORGANICS (mg/kg)						
Cadmium	7.69	9.08	20.3	293	--	67.1
Chromium	531	531	133	3,840	36.8	83.4
Copper	202	238	1,140	7,980	42.3	3,760
Lead	365	365	994	2,060	30.4	4,570
Mercury	2.32	2.32	1.1	0.98	--	9.7
Nickel	143	143	47	143	21.5	230
Selenium	3.32	3.32	1.6	7.3	--	2.9
Silver	3.32	3.92	58.4	317	--	368
Zinc	895	895	4,800	5,640	167	9,100
ORGANICS (µg/kg)						
2-Methylnapthalene	129	153	21,000	360	--	690
4,4'-DDD	25.9	25.9	19	45	--	150
4,4'-DDE	49.4	58.4	8	82	--	42
Acenaphthene	164	194	180	1,400	--	4,400
Acenaphthylene	239	283	440	--	120	1,200
Anthracene	458	541	640	2,200	220	21,000
Benzo(a)anthracene	2,290	2,290	3,300	5,200	1,200	53,000
Benzo(a)pyrene	2,520	2,520	3,400	3,800	1,400	44,000
Benzo(b)fluoranthene	5,860	1,060	5,300	4,900	1,300	45,000
Benzo(g,h,i)perylene	1,230	2,220	4,400	2,100	320	26,000
Benzo(k)fluoranthene	5,860	1,060	1,800	2,200	1,000	34,000
Chrysene	2,820	2,820	3,300	4,900	1,200	51,000
Dibenzo(a,h)anthracene	464	464	470	450	99	9,400
Fluoranthene	4,970	4,970	6,200	13,000	3,300	120,000
Fluorene	464	464	250	1,000	41	4,500
Indeno(1,2,3-cd)pyrene	1,100	1,990	5,000	2,500	380	29,000
Naphthalene	0.73	0.86	52	250	--	450
Pyrene	4,640	4,640	4,600	9,800	1,800	97,000

12.0 OPERABLE UNIT 10

12.1 INTRODUCTION

Implementation of the remedial actions at OU-10 began in 2000. This five-year review provides a current status update for OU-10. OU-10 consists of Site 5 soils and waste and surface water and sediment associated with Area B.

12.2 SITE BACKGROUND AND CHRONOLOGY

OU-10 (Site 5) consists of up to eight trenches used for the disposal of demolition wastes, paint, solvents, scrap metal, aircraft paints, cans, and asphalt. OU-10 (Site 5) is located within the housing area (see Figure 2-9). The trenches were approximately 12 feet by 70 feet by 8 feet in dimension and were covered with 2 feet of fill, graded, and seeded. Site 5 is located within a parcel of land that will be retained by a nearby Navy base (NAS JRB Willow Grove). Historical aerial photographs indicate these housing units were constructed within the apparent disposal area after disposal occurred.

A list of important OU-10 historical events and relevant dates in the site chronology is shown below. The identified events are illustrative, not comprehensive.

DATE(S)	EVENT
1955 to 1970	Site 5 operated trenches for disposal.
September 1979	Initial discovery of contamination at NAWC Warminster
October 4, 1989	NPL listing of NAWC Warminster
October 1989	Base wide Phase I RI activities began
September 20, 1990	FFA signed
April 1991	Base wide Phase I RI activities completed
May 1992	Base wide Phase II RI and FS activities began
April 1993	Base wide Phase II RI and FS activities completed
September 30, 1996	NADC Warminster operations ceased pursuant to BRAC
September 30, 1998	OU-10 RI began
September 28, 2000	OU-10 NFA ROD signature; RI completed
September 28, 2000	Construction complete for entire base; Preliminary Close-Out Report signed

12.3 REMEDIAL ACTIONS

12.3.1 Remedy Selection

OU-10 includes of soils and waste at Site 5 and surface water and sediment potentially impacted by Area B. The results of the risk assessment and the RI indicated that, based on available information, OU-10 soils and sediment did not present an unacceptable risk to human health and the environment. A no action alternative was the selected remedy for OU-10.

However, the ROD indicated that the Navy would conduct additional stream monitoring to confirm that potential impacts to stream sediment by Area B [which includes OU-10 (Site 5) and OU-7 (Sites 6 and 7)] are mitigated by response actions for Area B and OU-7. The sediment had not been characterized since the completion of a removal action at OU-7 (the excavation and disposal of contaminated soils and waste) and the remedial action consisting of a vegetated soil cover at Sites 6 and 7 was being constructed at the time the OU-10 ROD was being prepared. It was assumed for the OU-10 ROD that the OU-7 response action will mitigate potential unacceptable risks presented by sediment impacted by Area B. If this is the case, no action will be necessary to directly address the sediments.

The OU-10 ROD indicated that a work plan describing the sediment confirmation sampling and analysis program would be developed, submitted to USEPA and PADEP for comment, and implemented to achieve the confirmation monitoring goals. This work plan would require the periodic collection and analysis of sediment samples. A report summarizing the results of the confirmation monitoring for each stream monitoring event would be prepared and submitted to USEPA and PADEP for comment.

12.3.2 Remedy Implementation

No remedial action was required in the OU-10 ROD for Site 5 soils and sediment and surface water associated with Area B; however, the ROD indicated that the Navy would prepare a sediment confirmation sampling and analysis work plan and conduct additional stream monitoring. As part of post-ROD activities, a sampling and analysis plan for OU-7 was submitted on September 27, 2000 for the Area B stream. This plan described the scope of additional stream monitoring to confirm that potential impacts to stream sediment by Area B sites were mitigated by response actions for Area B, including response actions for OU-7. The plan was not approved by USEPA and no sediment sampling has been conducted to date.

In October 2001, an O&M User Manual for Area B, Sites 6 and 7 Vegetated Soil Cover was submitted. This O&M User Manual was prepared to guide site personnel in performing post-closure operation and maintenance of the vegetative soil cover area. The O&M User Manual also included monitoring and

inspection of the storm water drainage system, drainage swales along the perimeter of the sites that discharge into the stream by Area B. Quarterly visits for 1 year were conducted using the O&M User Manual as a guide. Minor problems were corrected during these visits. No major problems were identified during the visits. However, no semi-annual site visits have been conducted in the following years as identified in the O&M User Manual.

12.3.3 Remedy Cost

No remedial action costs were required for OU-10 other than the costs for the sediment sampling and analysis program. The actual costs for the sediment sampling and analysis program for OU-10 have not been tabulated.

12.3.4 System Operations/Operation and Maintenance

12.3.4.1 Long-Term Monitoring Program

A long-term monitoring program was not required for OU-10. However, sediment sampling and operation and maintenance activities for OU-7 are required but have not been conducted as recommended.

12.3.4.2 Cost

Because no long-term monitoring was required for OU-10, there are no costs associated with long-term monitoring. However, sediment sampling for OU-10 and O&M activities for OU-7 are required.

12.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

No deficiencies, recommendations, or follow-up actions were identified in the first five-year review for OU-10. O&M activities for OU-7 were conducted until September 2001. No additional activities or remedial actions have been conducted since the O&M activities.

12.5 FIVE-YEAR REVIEW PROCESS

12.5.1 Document and Analytical Data Review

No new documents were available for review.

12.5.2 Site Inspection

A site inspection was conducted in March 2006. No unusual observations were documented during the visit. The Five-Year Review Site Inspection Checklist from the March 2006 inspection is included in Appendix A.

12.6 TECHNICAL ASSESSMENT

12.6.1 Question A: Is the Remedy Functioning as Intended by Decision Documents?

The remedy selected for OU-10 was No Action with sediment confirmation sampling and analysis. The review of documents, ARARs, and risk assumptions and the results of the site inspection indicate that the remedy is functioning as intended by the ROD. It was assumed for the OU-10 ROD that OU-7 response actions would mitigate potential unacceptable risks presented by sediment impacted by Area B and that no action would be necessary to directly address the sediments. However, this has not been confirmed with sediment sampling and analysis. Based on the completed activities (RI and risk assessment), the intent and goals of ROD have been met.

12.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid?

There have been no changes in the physical conditions for OU-10, changes in the ARARs, or changes in exposure pathways that would affect the protectiveness of the remedy. The remedy is complete for OU-10.

12.6.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No human health or ecological risks have been identified, and no weather-related events have affected the protectiveness of the remedy. No other information has come into light that could call into question the protectiveness of the remedy.

12.6.4 Technical Assessment Summary

The remedy as specified in the ROD is No Action with sediment confirmation sampling and analysis. According to the information reviewed and the site inspection, the remedy is functioning as intended by the ROD. However, the sediment sampling and analysis program has not been conducted to confirm that the OU-7 response actions mitigated potential unacceptable risks. There have been no changes in the physical condition of the OU, to toxicity factors, or to the standardized risk assessment methodology that

would affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

12.7 ISSUES

A sampling and analysis work plan was prepared and submitted in September 2000, but was not approved by the USEPA. The sediment sampling and analysis program has not been implemented to confirm that the OU-7 response actions mitigated potential unacceptable risks. This issue is not sufficient enough to warrant a finding of not protective for OU-10.

12.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

The recommendations and required actions based on the inspection and five-year review are as follows.

Recommendations/ Required Actions	Responsible Party	Oversight Agency	Milestone Date
Complete review of sediment sampling and analysis work plan	USEPA and PADEP	Navy	December 2006
Conduct/implement sediment sampling and analysis	Navy	USEPA and PADEP	Spring 2007
Evaluate post-ROD information and prepare a memo for an insignificant change or an Explanation of Significant Differences	Navy	USEPA and PADEP	Winter 2007

12.9 PROTECTIVENESS STATEMENT

The remedy implemented at OU-10 is protective of human health and the environment. Based on the activities completed, the intent and goals of the ROD are being met.

13.0 PROTECTIVENESS STATEMENTS AND OTHER COMMENTS

The base-wide protectiveness statement and a summary of the requirements of the next five-year review are presented below. The remedial actions at the OUs at the former NAWC Warminster are expected to be protective of human health and the environment.

Remedial actions have been completed for OU-2, OU-5, OU-6, OU-8, and OU-10 with RODs that specify NFA. Remedial actions at OU-1A, OU-3, and OU-4 have been implemented that require long-term groundwater monitoring and O&M programs to provide a degree of protection of human health and the environment. Remedial actions at OU-7 and OU-9 have also been completed and require long-term O&M programs to provide a degree of protection of human health and the environment.

Implementation of the LUCs at OU-1A, OU-3, OU-4, OU-7, and OU-9 are currently providing a significant degree of protectiveness of human health and the environment until completion of the remedy is achieved to provide full protectiveness. Upon completion of the on-going remedial actions (monitoring and O&M) for OU-1A, OU-3, OU-4, OU-7, and OU-9, the remedies are expected to be protective of human health and the environment.

This five-year review shows that the Navy is meeting or exceeding the requirements of the RODs for the OUs at the former NAWC Warminster and is constantly re-evaluating to utilize permanent remedies and alternative treatment technologies and to optimize monitoring programs to the maximum extent practical for each OU.

The specific protection of human health and the environment by the remedial actions at OU-1A, OU-3, OU-4, OU-7, and OU-9 are discussed below in more detail. A Health and Safety Plan for the O&M and long-term performance monitoring personnel is in place for the groundwater remedies (i.e., OU-1A, OU-3, and OU-4) is sufficient to control risks, and is properly implemented. The Contingency Plan is also in place, but has not been rehearsed with local emergency response authorities.

13.1 OPERABLE UNIT 1A

The remedy at OU-1A is expected to be protective of human health and the environment. The OU-1A remedy is OPS and is satisfying the remedial action objectives as specified in the ROD. The Navy has demonstrated that a well-developed cone of depression has formed within the hydrogeologic unit that contains the maximum concentrations of TCE around the Area A extraction wells. The capture zone analysis for the extraction wells indicates that capture of the plume exists to a point off Navy property and

that the source area of DNAPL has been hydraulically contained. Sampling data indicates that contaminant concentrations are steadily declining outside the source area.

The institutional controls for the OU-1A remedy have been implemented and are expected to be effective in protecting human health and the environment. These controls consist of restrictions on future well drilling within and in the vicinity of the Area A groundwater plume.

13.2 OPERABLE UNIT 3

The remedy at OU-3 is protective of human health and the environment, and immediate threats have been addressed. The OU-3 remedy is OPS and will satisfy the RAOs as specified in the ROD when the revised standard (i.e., federal MCLs) for groundwater cleanup is adopted.

The Navy has demonstrated that a well-developed cone of depression has formed within the hydrogeologic unit contains the maximum concentrations of PCE around the Area C extraction wells. The capture zone analysis for the extraction wells indicates that capture of the plume exists to a point off Navy property. PCE concentrations and the aerial extent of the plume have generally been slowly decreasing due to the operation of the Area C extraction wells.

The institutional controls for the OU-3 remedy have been fully implemented and are expected to be effective in protecting human health and the environment. These controls consist of restrictions on the use of water from existing wells, on the future installation of wells, and on the use of water from wells installed in the future. Existing supply wells will not be used, additional supply wells will not be installed, and groundwater will not be withdrawn without the approval of the Navy and/or USEPA. The controls for private property consist of the continued enforcement of Ordinance No. 32 by Warminster Township, which regulates well drilling in the Township to promote the health of residents.

13.3 OPERABLE UNIT 4

The remedy at OU-4 is expected to be protective is human health and the environment. The remedy is OPS and satisfying the RAOs as specified in the ROD. Similar to OU-1A and OU-3, a cone of depression has formed within the hydrologic unit with maximum concentrations of VOCs around the Area D extraction wells, which indicates that inward gradients have been achieved in the plume area along the base boundary. The capture zone analysis shows that the capture of the plume exists to a point offbase and that the source area has been hydraulically controlled. Analysis of performance monitoring data since start-up (July 1999) shows that the Area D groundwater plume is contained in the vicinity of the base boundary and that overall groundwater contaminant concentrations are remaining at steady state or were decreasing. The performance monitoring data further indicate that natural attenuation processes

(primarily dilution and dispersion) are active in limiting the migration of the contaminants from the source area within Area D.

The institutional controls for the OU-4 remedy have been fully implemented and are expected to be effective in protecting human health and the environment. As discussed in the FOST and deed for the Area D property, these controls prevent the use of Area D groundwater that presents an unacceptable risk and protect the integrity and effectiveness of the extraction well system and natural attenuation processes. The institutional controls also consist of the enforcement of a municipal ordinance that restricts well drilling to protect the health of residents.

13.4 OPERABLE UNIT 7

The remedy at Sites 6 and 7 (OU-7) is expected to be protective of human health and the environment. The soil cover is effective in preventing human exposure to subsurface soil concentrations that present an unacceptable risk under the planned recreational use of the property.

The O&M Manual for OU-7 has been prepared and the Navy has assigned O&M responsibilities to a subcontractor for long-term maintenance of the soil cover. However, only 1 year of quarterly maintenance was conducted. The FOST for Sites 6 and 7 includes appropriate institutional controls that provide for the following:

- Maintenance of the 2-foot vegetated soil cover.
- The Navy and/or USEPA must approve any plans for excavation below 2 feet within the area of site-wide subsurface soils.
- Residential use of the parcel is prohibited. Industrial and commercial use is prevented without approval of a risk assessment for such uses.

In addition, the ROD for OU-10 indicated that the Navy would prepare a sediment confirmation sampling and analysis work plan and conduct additional stream monitoring to confirm that the OU-7 response actions mitigated potential unacceptable risks presented by sediment impacted by Sites 6 and 7 in Area B. As part of post-ROD activities, a sampling and analysis plan for OU-7 was submitted on September 27, 2000 for the Area B stream, but has not been approved by USEPA and no sediment sampling has been conducted to date.

The draft remedial action close-out report for OU-7 was submitted on August 30, 2002 and is currently under review. The Navy will respond to comments on this document when USEPA and PADEP provide comments.

13.5 OPERABLE UNIT 9

The remedy at OU-9 is expected to be protective of human health and the environment. The erosion controls installed at Site 2 are effective in ensuring that surface soils exceeding concentrations protective of sediment do not migrate to the unnamed tributary of Little Neshaminy Creek.

The O&M Manual for OU-9 (specifically Site 2) has been prepared and the Navy has assigned O&M responsibilities to a subcontractor for long-term maintenance of the erosion and sedimentation controls. However, only 1 year of quarterly maintenance was conducted. The FOST and deed for Site 3 include appropriate institutional controls that require prior approval of plans for any excavation where subsurface soils exceed concentrations protective of sediment and that prohibit non-industrial use of this parcel.

For the remainder of Area A, including Sites 1 and 2 and the Impoundment Area, the various FOSTs include institutional controls that require prior approval of any plans for excavation within specified portions of Area A where subsurface soils exceed concentrations protective of sediment, and that prohibit non-industrial use of the Area A parcel. In addition, the Navy tasked a subcontractor to perform periodic stream monitoring of the nearby unnamed tributary of Little Neshaminy Creek to identify the extent of any contaminant loading to the stream, to assess the ecological effects of any such loading, and to determine the nature of any necessary actions based on these evaluations. Eight rounds of sampling was performed, after which the Navy determined that further sampling was not necessary.

13.6 TIMETABLE FOR NEXT REVIEW

Former NAWC Warminster has several OUs that are considered statutory sites that require ongoing five-year reviews. The next review will be conducted within 5 years of the completion of this five-year review. The completion date is the date of the signature shown on the Five-Year Summary Form included in the front of the report.

REFERENCES

EA Engineering, 2000a. Groundwater Collection Standard Operating Procedure at NAWC Warminster, Pennsylvania. Iselin, New Jersey. May.

EA Engineering, 2000b. Pre-Startup and Startup Performance Monitoring Report for Remedial Action at Operable Unit 1 and Operable Unit 4 at NAWC Warminster, Pennsylvania. Iselin, New Jersey. September 18.

EA Engineering, 2000c. Area C First Quarter Year 5 Monitoring Report (September 2000 through November 2000) for Remedial Action at Operable Unit 3 at NAWC Warminster, Pennsylvania. Iselin, New Jersey. December 29.

EA Engineering, 2001b. Area A and Area D First Quarter Year 2 Monitoring Report (September 2000 through November 2000) for Remedial Action at Operable Unit 1 and Operable Unit 4 at NAWC Warminster, Pennsylvania. Iselin, New Jersey. January 31.

ECOR Solutions, Inc., 2005. Long-Term Performance Monitoring Plan for Operable Units 1A, 3, and 4 Remedial Actions, Former Naval Air Warfare Center, Warminster, PA. Prepared for Engineering Field Activity Northeast, Naval Facilities Engineering Command. November.

ECOR Solutions, Inc., 2006. Final Quarterly Monitoring Report for the July 2005 Performance Monitoring Event (Fourth Quarter FY 2005) for Long-Term Environmental Monitoring at Operable Units 1A, 3, and 4 at the Former NAWC, Warminster, PA. Prepared for Engineering Field Activity Northeast, Naval Facilities Engineering Command. February.

ECOR Solutions, Inc., 2006. Final Quarterly Monitoring Report for the Third Quarter FY 2006 Performance Monitoring Event for Long-Term Environmental Monitoring at Operable Units 1A, 3, and 4 at the Former NAWC, Warminster, PA. Prepared for Engineering Field Activity Northeast, Naval Facilities Engineering Command. September.

Foster Wheeler, 1997. Close-Out Report for Site 4 Removal Action at NAWC Warminster, Pennsylvania. Langhorne, Pennsylvania. January 30.

Foster Wheeler, 1999. Close-Out Report for Removal of Contaminated Soils at Area A (Sites 1, 2, and 3) at NAWC Warminster, Pennsylvania. Langhorne, Pennsylvania. September 3.

Foster Wheeler, 2000a. O&M Manual for the Interim Remedial Groundwater Treatment System at NAWC Warminster, Pennsylvania. Langhorne, Pennsylvania. January.

Foster Wheeler, 2000d. Draft Remedial Action Close-Out Report for OU-7 Soils and Waste at Area B – Sites 6 and 7 Vegetated Soil Cover at NAWC Warminster, Pennsylvania. Langhorne, Pennsylvania. August 30.

Foster Wheeler, 2000f. Remedial Action Close-Out Report for Site 2 Erosion Controls at Area A at NAWC Warminster, Pennsylvania. Langhorne, Pennsylvania. September.

Foster Wheeler, 2001a. November 2000 Groundwater Pump and Treat System Monthly Report for NAWC Warminster, Pennsylvania. Langhorne, Pennsylvania. January.

Foster Wheeler, 2001b. Operation and Maintenance User Manual for Area A – Site 2 at NAWC Warminster, Pennsylvania. Langhorne, Pennsylvania. October.

Foster Wheeler, 2001c. Operation and Maintenance User Manual for Area B – Sites 6 and 7 Vegetated Soil Cover at NAWC Warminster, Pennsylvania. Langhorne, Pennsylvania. November.

Foster Wheeler, 2001d. Report on 30 September 2001 Inspection – Area A, Site 2 at Former NAWC Warminster, Pennsylvania. Langhorne, Pennsylvania. November 5.

Foster Wheeler, 2001e. Report on 30 September 2001 Inspection – Area B Sites 6 and 7 Vegetated Soil Cover at Former NAWC Warminster, Pennsylvania. Langhorne, Pennsylvania. November 5.

Tetra Tech NUS, Inc. (TtNUS), 2000e. Operating Properly and Successfully (OPS) Demonstration for OU-3 (Area C Groundwater) at NAWC Warminster, Pennsylvania. Pittsburgh, Pennsylvania. June 12.

TtNUS, 2000f. Operating Properly and Successfully (OPS) Demonstration for OU-4 (Area D Groundwater) at NAWC Warminster, Pennsylvania. Pittsburgh, Pennsylvania. June 22.

TtNUS, 2000g. Technical Memorandum Regarding Institutional Controls for OU-9 (Area A Soils, Surface Water, and Sediment) at NAWC Warminster, Pennsylvania. King of Prussia, Pennsylvania. June 22.

TtNUS, 2000h. Final RI/FS Report for OU-1A (Area A Groundwater) at NAWC Warminster, Pennsylvania. King of Prussia, Pennsylvania. June 29.

TtNUS, 2000i. RI Report for OU-10 (Site 5 Media Other than Groundwater) at NAWC Warminster, Pennsylvania. King of Prussia, Pennsylvania. August 4.

TtNUS, 2000j. Stream Monitoring Fourth Quarter Report for Unnamed Tributary to Little Neshaminy Creek, Area A Sites at NAWC Warminster, Pennsylvania. King of Prussia, Pennsylvania. September 15.

TtNUS, 2000k. Casey Village/Shenandoah Woods Area Groundwater Investigation Results. Pittsburgh, Pennsylvania. September 18.

TtNUS, 2000l. Operating Properly and Successfully (OPS) Demonstration for OU-1A (Area A Groundwater) at NAWC Warminster, Pennsylvania. Pittsburgh, Pennsylvania. September 27.

TtNUS, 2000m. Proposed Scope of Work at Area B Stream Monitoring Program at NAWC Warminster, Pennsylvania. King of Prussia, Pennsylvania. September 27.

TtNUS, 2000n. Draft Long Term Performance Monitoring Plan for Operable Units 1A, 3, and 4 Remedial Actions at NAWC Warminster, Pennsylvania. King of Prussia, Pennsylvania. November 21.

TtNUS, 2000o. Remedial Investigation /Feasibility Study Report for Operable Unit 9 (OU-9) (Area A Media Other Than Groundwater) at NAWC Warminster, Pennsylvania. April.

TtNUS, 2001. Five-Year Review for Various Operable Unit Remedial Actions for Former NAWC Warminster, Pennsylvania. King of Prussia, Pennsylvania. February.

U.S. Army Corps of Engineers, 2000. Operation and Maintenance of Extraction and Injection Wells at HTRW Sites. EP 1110-1-27. Washington, DC. January 27.

USEPA, 1993. Approval of Removal Action for OU-2 (Public Water Supply Line and Connections) at NAWC Warminster, Pennsylvania. Philadelphia, Pennsylvania. July 14.

USEPA, 1996. Interim Guidance for Evaluation of Federal Agency Demonstrations that Remedial Actions are Operating Properly and Successfully under CERCLA Section 120(h)(3). Office of Solid Waste and Emergency Response. Washington, DC. August.

USEPA, 2000a. Approval of OPS Demonstration for OU-4 (Area D Groundwater) Remedial Action at NAWC Warminster, Pennsylvania. Philadelphia, Pennsylvania. June 23.

USEPA, 2000b. Approval of OPS Demonstration for OU-3 (Area C Groundwater) Remedial Action at NAWC Warminster, Pennsylvania. Philadelphia, Pennsylvania. September 7.

USEPA, 2000c. Approval of OPS Demonstration for OU-1A (Area A Groundwater) Remedial Action at NAWC Warminster, Pennsylvania. Philadelphia, Pennsylvania. September 28.

USEPA, 2000d. Preliminary Close Out Report for NAWC Warminster, Pennsylvania. Philadelphia, Pennsylvania. September 28.

USEPA, 2000a. Institutional Controls and Transfer of Real Property under CERCLA Section 120(h)(3)(A), (B), or (C). Office of Solid Waste and Emergency Response. Washington, DC. January.

USEPA, 2000b. Institutional Controls: A Site Manager's Guide to Identifying, Evaluating, and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups. Office of Solid Waste and Emergency Response. EPA 540-F-00-005. Washington, DC. September.

USEPA, 2001. Comprehensive Five-Year Review Guidance. Office of Solid Waste and Emergency Response. EPA 540-R-01-007. Washington, DC. June.

U.S. Navy, 2001. Policy for Conducting Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Statutory Five-Year Reviews. November.

U.S. Navy and EPA, 1993. CERCLA Interim Remedy Record of Decision for OU-1 (Area A and Area B Groundwater) at NAWC Warminster, Pennsylvania. September 30.

U.S. Navy and EPA, 1995. CERCLA Record of Decision for OU-3 (Area C Groundwater) at NAWC Warminster, Pennsylvania. March 10.

U.S. Navy, 1997. Request for a Removal Action at Sites 6 and 7 at NAWC Warminster, Pennsylvania. Lester, Pennsylvania. May 1.

U.S. Navy and EPA, 1997. CERCLA Interim Remedy Record of Decision for OU-4 (Area D Groundwater) at NAWC Warminster, Pennsylvania. September 30.

U.S. Navy, 1998. Action Memorandum for Area A Soil Removal Action at NAWC Warminster, Pennsylvania. Lester, Pennsylvania. June 3.

U.S. Navy, 1999. Action Memorandum for Site 8 Removal Action at NAWC Warminster, Pennsylvania. Lester, Pennsylvania. February 2.

U.S. Navy and USEPA, 1999a. CERCLA Explanation of Significant Differences for OU-3 (Area C Groundwater) at NAWC Warminster, Pennsylvania. September 29.

U.S. Navy and USEPA, 1999b. CERCLA Record of Decision for OU-5 (Site 8 Soils, Surface Water and Sediment) at NAWC Warminster, Pennsylvania. September 29.

U.S. Navy and USEPA, 2000a. CERCLA Record of Decision for OU-6 (Site 4 Soils, Surface Water, and Sediment) at NAWC Warminster, Pennsylvania. June 19.

U.S. Navy and USEPA, 2000b. CERCLA Record of Decision for OU-7 (Sites 6 and 7 Soils and Wastes) at NAWC Warminster, Pennsylvania. June 20.

U.S. Navy and USEPA, 2000c. CERCLA Record of Decision for OU-8 (Area D Soils) at NAWC Warminster, Pennsylvania. June 20.

U.S. Navy and USEPA, 2000d. CERCLA Final Remedy Record of Decision for OU-4 (Area D Groundwater) at NAWC Warminster, Pennsylvania. June 26.

U.S. Navy and USEPA, 2000e. CERCLA Record of Decision for OU-9 (Area A Soils, Surface Water, and Sediment) at NAWC Warminster, Pennsylvania. June 26.

U.S. Navy and USEPA, 2000f. CERCLA Final Remedy Record of Decision for OU-1B (Area B Groundwater) at NAWC Warminster, Pennsylvania. September 6.

U.S. Navy and USEPA, 2000g. CERCLA Final Remedy Record of Decision for OU-1A (Area A Groundwater) at NAWC Warminster, Pennsylvania. September 27.

U.S. Navy and USEPA, 2000h. CERCLA Record of Decision for OU-10 (Site 5 Soils and Area B Surface Water and Sediment) at NAWC Warminster, Pennsylvania. September 28.

APPENDIX A

FIVE-YEAR REVIEW SITE INSPECTION CHECKLISTS

FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST
NAWC WARMINSTER

I. SITE INFORMATION	
Site name: NAWC Warminster	**Date of inspection: March 27, 2006**
Location and Region: Warminster, PA/Region 3	**EPA ID: PA6170024545**
Agency, office, or company leading the five-year review: TtNUS	**Weather/temperature: 65°F, Sunny**

Remedy Includes: (Check all that apply)

☒ Landfill cover/containment ☐ Monitored natural attenuation
☐ Air sparging (AS) ☒ Land use controls (LUCs)
☐ Air sparging/vapor extraction (AS/VE)
☒ Other: Groundwater extraction, treatment, and discharge system (OU-1A, OU-3, and OU-4); extension of public water supply system to provide drinking water to residents of the affected area (OU-2)

OU-1A: Contaminated groundwater attributable to Area A
OU-1B: Contaminated groundwater attributable to Area B
OU-2: Contamination of domestic well water for residences near the base
OU-3: Contaminated groundwater attributable to Area C
OU-4: Contaminated groundwater attributable to Area D
OU-5: Soils, sediment, and surface water associated with Site 8 at Area C (See Note Below)
OU-6: Soils, sediment, and surface water associated with Site 4 at Area C (See Note Below)
OU-7: Soils and wastes associated with Sites 6 and 7 at Area B
OU-8; Soils associated with Area D
OU-9: Soils, surface water, and sediment associated with Area A
OU-10: Site 5 soils, sediment, and surface water associated with Area B

Notes:
OU-1A, OU-3, and OU-4 are the same remedy of groundwater extraction, treatment, and discharge.

OU-5 and OU-6 no longer exist due to land redevelopment.

OU-1B, OU-8, and OU-10 have no-action RODs.

II. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☒ Gates secured ☐ N/A
Remarks: Access to Area A (particularly Site 3) is restricted by fencing. Fencing around the groundwater treatment plant was secure.

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A
Remarks: Signs are posted around Sites 6 and 7 denoting that the general area is a natural preserve. Signs near Area A and groundwater treatment plant are posted denoted federal government property

FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST
NAWC WARMINSTER

II. ACCESS AND INSTITUTIONAL CONTROLS (continued)

C. Land Use Controls (LUCs)

1. **Implementation and enforcement**

Site conditions imply LUCs not properly implemented ☐ Yes ☒ No ☐ N/A
Site conditions imply LUCs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by): Self-reporting; visual inspections, written reports
Frequency: Semi-annually or periodically
Responsible party/agency: U.S. Navy, other property owners
Contact: Lonnie Monaco BRAC Environmental Coordinator 27 March 2006 (610) 595-0567

Reporting is up to date ☐ Yes ☒ No ☐ N/A
Reports are verified by the lead agency ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☒ No ☐ N/A
Violations have been reported ☐ Yes ☒ No ☐ N/A
☐ Report attached

Other problems or suggestions:

The O&M manual for Area A, Site 2 was published in November 2001. The last known inspection of Site 2 was conducted on Sept. 20, 2001 by Foster Wheeler. At that time, all erosion and sedimentation controls and storm drainage systems were found to be in good condition. These inspections were being performed on a quarterly basis from September 2000 through August 2002; thereafter, the frequency was to be semi-annual. There is no record that semi-annual inspections are currently being performed.

The O&M manual for the vegetative soil cover at Sites 6 and 7 was published in November 2001. The last known inspections of these sites were conducted on Sept. 30, 2001 by Foster Wheeler. The O&M manual calls for quarterly inspections from October 2000 through September 2002; thereafter, the frequency was to be semi-annual for 28 years. Settlement is evaluated annually. There is no record that semi-annual inspections are currently being performed.

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident
Remarks: No significant vandalism was observed during the visit at any site or area.

2. **Land use changes on site** ☐ N/A
Remarks: Significant land use changes have occurred since the RODs for various sites and areas were signed by EPA and the Navy. Most of the facility west of Jacksonville Road (particularly Area D) is part of the North American Technology Center and has been transferred by the Navy to the private sector. Properties west of Jacksonville Road and along this road are part of various commercial, residential housing, and recreational developments. Site 8 is now a catch basin for stormwater capture from two large housing projects. Site 4 is now a catch basin for a large, assisted living development.

Sites 6 and 7 are part of open space nature planning for Warminster Township. Site 5 is retained by the Navy as government housing for military personnel stationed at nearby JRFB Willow Grove. Sites 1, 2, and 3 (Area A) have not been extensively developed, although construction near Site 2 is about to start. A morgue for Bucks County will be built south of Site 2. With the exception of Site 5, land use controls appear to be in effect for these sites.

FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST
NAWC WARMINSTER

II. ACCESS AND INSTITUTIONAL CONTROLS (continued)
3. **Land use changes off site** ☒ N/A Remarks: None noted
III. GENERAL SITE CONDITIONS
A. Roads ☒ Applicable ☐ N/A
1. **Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A Remarks: The road network in and around the remaining sites are in good condition, and consist of asphalt and gravel. No significant damages were noted.
B. Other Site Conditions
Remarks: The remaining sites were well maintained, accessible, and secure to the extent required.
C. Perimeter Ditches/Off-Site Discharge ☒ Applicable ☐ N/A
1. **Siltation** ☐ Location shown on site map ☒ Siltation not evident Areal extent: 0.5 acre Depth: None Remarks: Visual observations for Site 2 revealed no problems with regard to sediment accumulation, subsidence, erosion, ponding, and obstructions to flow. Due to prolonged dry weather, no stormwater drainage was observed; however, the storm drainage system appeared to be in good condition. Only Site 2 has off-site discharge within Area A. Grass-lined drainage swales are present along the perimeter of Sites 6 and 7. Visual observations for Sites 6 and 7 revealed no problems that might prevent the free flow of storm water.
2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A ☒ Vegetation does not impede flow Areal extent: About 5 acres Type: Grasses, wild flowers, and trees Remarks: The area around Sites 6 and 7 has been revegetated and returned to its natural state. Some minor eroded areas were noted. Deer were prevalent in the general area. The vegetative soil cover appeared to have been mowed in the fall of 2005. Areas outside the vegetative soil cover showed evidence of being maintained and mowed. Some trees showed evidence of deer damage (e.g., missing bark); however, the trees had been mulched, fitted with a special watering bag device, and appeared to healthy based on branch buds. However, the trees should be inspected in late spring to determine canopy cover. In the past, the capped area has been hydroseeded, and topsoil and grass seed have been applied to eroded areas. There is no formal record of inspections since September 2001.
3. **Erosion** ☐ Location shown on site map ☒ Erosion not evident Areal extent NA Depth NA Remarks: For all sites, no significant erosion was evident. No noticeable settlement of the capped area at Sites 6 and 7 was noted.
4. **Discharge Structure** ☐ Functioning ☐ N/A Remarks: Site 2 consists of erosion and sediment controls, mainly 6-12" riprap and a riprap stone dike. The riprap helps drain the area through a culvert with a cement retaining wall above the intermittent tributary north of Area A (including Sites 2 and 3). No flow was observed in the culvert due to dry conditions. No obstructions to the free flow of storm water were noted.

FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST
NAWC WARMINSTER

IV. LANDFILL COVER ☐ Applicable ☒ N/A			
A. Landfill Surface ☐ Applicable ☒ N/A			
1.	**Settlement** (Low spots) Areal extent_____ Remarks	☐ Location shown on site map Depth_____	☐ Settlement not evident
2.	**Cracks** Lengths_____ Widths_____ Depths_____ Remarks	☐ Location shown on site map	☐ Cracking not evident
3.	**Erosion** Areal extent_____ Remarks	☐ Location shown on site map Depth_____	☐ Erosion not evident
4.	**Holes** Areal extent_____ Remarks	☐ Location shown on site map Depth_____	☐ Holes not evident
5.	**Vegetative Cover** ☐ Grass ☐ Cover properly established ☐ No signs of stress ☐ Trees/Shrubs (indicate size and locations on a diagram) Remarks **Excessive Vegetative Growth** Type_____ ☐ No evidence of excessive growth ☐ Vegetation in channels does not obstruct flow ☐ Location shown on site map Areal extent_____ Remarks		
6.	**Alternative Cover (armored rock, concrete, etc.)** ☐ N/A Remarks		
7.	**Bulges** Areal extent_____ Remarks	☐ Location shown on site map Height_____	☐ Bulges not evident
8.	**Wet Areas/Water Damage** ☐ Wet areas ☐ Ponding ☐ Seeps ☐ Soft subgrade Remarks	☐ Wet areas/water damage not evident ☐ Location shown on site map ☐ Location shown on site map ☐ Location shown on site map ☐ Location shown on site map	 Areal extent_____ Areal extent_____ Areal extent_____ Areal extent_____
9.	**Slope Instability** ☐ Slides ☐ Location shown on site map ☐ No evidence of slope instability Areal extent_____ Remarks		

FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST
NAWC WARMINSTER

IV. LANDFILL COVER (continued) ☐ Applicable ☒ N/A			
B. Cover Penetrations ☐ Applicable ☒ N/A			
1.	**Monitoring Wells** (within surface area of landfill) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐N/A Remarks		
2.	**Settlement Monuments** ☐ Located ☐ Routinely surveyed ☐ N/A Remarks:		
V. GROUNDWATER REMEDY ☒ Applicable ☐ N/A			
A. Treatment System ☒ Applicable ☐ N/A Type: Extraction, Treatment using Combination of Air Stripper, Ion Exchange, Liquid Phase Carbon, and Vapor Phase Carbon; Discharge to Stream (3 separate well fields for Area A, Area C, and Area D)			
1.	**Electrical Enclosures and Panels** ☐ N/A ☒ Good condition ☐ Needs Maintenance Remarks: Both indoor and outdoor enclosures and panels were in good condition.		
2.	**Tanks, Vaults, Storage Vessels** ☐ N/A ☒ Good condition ☒ Proper secondary containment ☐ Needs Maintenance Remarks: Tanks and other process vessels were in good condition. Secondary containment consists of a sump. Air stripper is cleaned according to O&M manual. Carbon exchange for vapor-phase units was recently accomplished in March 2006.		
3.	**Treatment Train** (Check components that apply) ☒ Metals removal ☐ Oil/water separation ☐ Bioremediation ☒ Air stripping ☒ Carbon adsorbers ☒ Filters_____ ☐ Additive (*e.g.*, chelation agent, flocculent): Chemical feed systems are not operating. ☒ Others : Ion Exchange ☒ Good condition ☐ Needs Maintenance ☒ Sampling ports properly marked and functional ☒ Sampling/maintenance log displayed and up to date ☒ Equipment properly identified ☒ Quantity of groundwater treated annually: 72,000,000 gallons (see below) ☐ Quantity of surface water treated annually_____ Remarks: All treatment components were in good working condition. Total monthly flow for Area A is about 1.9 million gallons. Total monthly flow for Area C is about 1.1 million gallons. Total monthly flow for Area D is about 2.9 million gallons. Monthly pump and treat system operating reports explain maintenance and repairs to process equipment and other components of the groundwater remedy. O&M checks are conducted twice per week on average by the on-site engineering technician (operator).		

FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST
NAWC WARMINSTER

V. GROUNDWATER REMEDY (continued)
4. **Treatment Building(s)** ☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair ☒ Chemicals and equipment properly stored Remarks: Some chemicals are stored at the treatment building. Equipment, spare parts, and chemicals were properly stored
5. **Monitoring Wells** ☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition ☐ All required wells located ☐ Needs Maintenance ☒ Well tag ☐ N/A Remarks: Selected wells were inspected. All wells appeared to be properly locked. Selected monitoring wells are sampled according to the long-term groundwater monitoring plan. A few wells along Kirk Road near Area C still need to be properly abandoned.
B. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A
1. **Pumps, Wellhead Plumbing, and Electrical** ☒ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A Remarks: Selected extraction wells, plumbing, and pipelines were inspected and found to be in good working order. Some wells were not operating at the time of the site visit and were being further investigated, awaiting repair parts, or being repaired. The O&M contractor was well aware of the status of operating extraction wells and was taking measures to correct any problems. 2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☒ Good condition ☐ Needs Maintenance Remarks: All appurtenances were in good condition and there were no exposed extraction system pipelines. Valves were clean and functioning as intended. 3. **Spare Parts and Equipment** ☒ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks: Spare parts were available and organized. An inventory of significant spare parts was not available for review.
C. Monitored Natural Attenuation ☐ Applicable ☒ N/A
1. **Monitoring Wells** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ Well tag ☐ N/A Remarks: Not Applicable.

FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST
NAWC WARMINSTER

VI. INTERVIEWS (Check all that apply)

1. **O&M site manager:** Lonnie Monaco BRAC Environmental Coordinator March 27, 2006
Name Title Date

Interviewed _X_ at site ___ at office ___ by phone Phone No. 610-595-0567
Problems, suggestions: See attached report.

Items not included elsewhere are as follows:

(1) The O&M site manager was under the impression the Navy previously provided funds to Warminster Municipal Authority (WMA) to install an air stripper on Well 13 (WMA-13), which is located downgradient of Area C. Follow-up indicated that WMA-13 currently does not have an air stripper.

(2) The draft groundwater remedy optimization report prepared by Battelle at the Navy's request has not been finalized. This report should be completed so that it can be referenced in the 5-Year Review Report for the base.

(3) Although PADEP was not present, there was discussion regarding whether air and water discharge permits need to be prepared for the groundwater remedies at the base. This item requires follow-up with PADEP.

(4) There has been no surface water or sediment sampling for the base in recent years. This item may require follow-up. The OU-10 ROD requires periodic stream monitoring to identify the extent of any contaminant loading to the nearby stream, to assess the ecological effects of any such loading, and to determine the nature of any necessary actions based on these evaluations.

(5) While the remedy for Area B surface water and sediment is no action, the OU-10 ROD indicates that additional stream monitoring will be performed to confirm that any future impacts on Area B sediment have been mitigated. A work plan describing the confirmation sampling and analysis program was prepared, but has not been implemented by the Navy.

(6) There have been no recent operations and maintenance (O&M) for Sites 1, 2, and 3 as part of Area A, or for Sites 6 and 7 as part of Area B, according to available records.

(7) Formal access agreements for long-term groundwater monitoring apparently have not been arranged for several monitoring wells, particularly wells that are located off former Navy property.

2. **O&M staff** Bob Powell ECOR Solutions Site Superintendent March 27, 2006
Name Title Date

Interviewed _X_ at site ___ at office ___ by phone Phone no. _____
Problems, suggestions: See below
Bob Powell, ECOR, Site Superintendent (484) 645-2665
Rich Evans, ECOR, Project Engineer, (610-431-8731
Patrick Schaub, ECOR, Project Manager, (610) 431-8731

(1) The availability of as-built drawings (particularly for underground piping and utilities associated with the various groundwater remedies) has hindered ECOR's long-term O&M responsibilities.
(2) The Navy has not established an O&M staff for remedies not pertaining to groundwater.
(3) ECOR has a Navy task to abandon several residential wells along Kirk Road near Area C. Not all of these wells have been abandoned.

FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST
NAWC WARMINSTER

VI. INTERVIEWS (continued)

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency EPA Region 3
Contact Dennis Orenshaw EPA Remedial Project Manager Not Interviewed (215) 814- 3361
Name Title Date Phone no.

Problems; suggestions: Needs to be interviewed.

Agency PADEP
Contact April Flipse PADEP Project Manager Not Interviewed (215) _____
Name Title Date Phone no.

Problems; suggestions: Needs to be interviewed.

Agency Warminster Township
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions: Needs to be interviewed.

4. **Other interviews** (optional) Report attached.

Interviews with a few stakeholders (e.g., EPA, PADEP, Warminster Municipal Authority, Ivyland Borough, Warminster Township, other municipal authorities or land use/property developers) still need to be conducted. This item requires follow-up by TtNUS, and could be conducted as part of the May 2006 RAB meeting (schedule permitting).

VII. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**

☒ O&M manual	☒ Readily available	☐ Up to date	☐ N/A
☐ As-built drawings	☐ Readily available	☐ Up to date	☐ N/A
☒ Maintenance logs	☒ Readily available	☒ Up to date	☐ N/A

Remarks: The groundwater remedies for Area A, Area C, and Area D groundwaters of concern share a single O&M manual since the groundwater influent flows are treated by a common treatment system. Comments from the Navy O&M subcontractor indicated that the original O&M manual is still being followed. Revisions to the groundwater O&M manual should include maintaining extraction wells on a regular basis, as well as O&M requirements for the ion exchange unit.

The availability of as-built drawings (particularly for underground piping and utilities associated with the various groundwater remedies) has hindered ECOR's long-term O&M responsibilities.

2. **Site-Specific Health and Safety Plan** ☒ Readily available ☒ Up to date ☐ N/A
☒ Contingency plan/emergency response plan ☒ Readily available ☒ Up to date ☐ N/A

Remarks: The contingency plan/emergency response plan is part of the site-specific HASP.

3. **O&M and OSHA Training Records** ☐ Readily available ☐ Up to date ☒ N/A
Remarks: These records were not reviewed during the site visit.

VII. ON-SITE DOCUMENTS & RECORDS VERIFIED (continued) (Check all that apply)

4. **Permits and Service Agreements**

☐ Air discharge permit	☐ Readily available	☐ Up to date	☒ N/A
☐ Effluent discharge	☐ Readily available	☐ Up to date	☒ N/A
☒ Waste disposal, POTW	☐ Readily available	☒ Up to date	☐ N/A
☐ Other permits_____	☐ Readily available	☐ Up to date	☒ N/A

Remarks: Although PADEP was not present, there was discussion regarding whether air and water discharge permits need to be prepared for the groundwater remedies at the base. This item requires follow-up with PADEP. Carbon exchange services had recently been performed at the time of the site visit as part of a service agreement implemented by ECOR.

With PADEP concurrence, NPDES sampling of the extraction system effluent outfall no longer occurs. Instead, the Navy samples the discharge water from the treatment plant to ensure that the system is removing contaminants prior to discharge at the outfall. An effluent discharge permit is no longer required.
Air emissions from the treatment system are screened with a PID on a regular basis to ensure that the vapor-phase carbon units are removing VOCs from this release. An air discharge permit is not required.

5. **Gas Generation Records** ☐ Readily available ☐ Up to date ☒ N/A
Remarks: Not applicable.

6. **Settlement Monument Records** ☐ Readily available ☐ Up to date ☒ N/A
Remarks: Not applicable.

7. **Groundwater Monitoring Records** ☒ Readily available ☒ Up to date ☐ N/A
Remarks: Monthly operating reports and periodic groundwater monitoring reports are prepared by ECOR.

8. **Leachate Extraction Records** ☐ Readily available ☐ Up to date ☒ N/A
Remarks: Not applicable.

9. **Discharge Compliance Records**

☐ Air	☐ Readily available	☐ Up to date	☒ N/A
☐ Water (effluent)	☐ Readily available	☐ Up to date	☒ N/A

Remarks: See Item 4 above.

10. **Daily Access/Security Logs** ☒ Readily available ☒ Up to date ☐ N/A
Remarks: Appeared to be regularly maintained and up-to-date.

FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST
NAWC WARMINSTER

VIII. O&M COSTS

1. **O&M Organization**

☐ State in-house ☐ Contractor for State ☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house ☒ Contractor for Federal Facility
☐ Other: Environmental Construction Operations & Remediation (ECOR) Solutions, 1075 Andrew Drive, Suite I, West Chester, PA 19380 performs groundwater O&M work under subcontract to the Navy.

2. **O&M Cost Records**

☐ Readily available ☐ Up to date ☒ Funding mechanism/agreement in place
Original O&M cost estimate: Unknown ☐ Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons:

(1) O&M cost records are maintained by the Navy, and were not available for review as part of the 5-year review site visit. The Navy estimates that groundwater O&M costs average about $500,000 per year.

(2) O&M costs also include groundwater optimization evaluations conducted by Battelle and technical assistance provided by Tetra Tech NUS.

FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST
NAWC WARMINSTER

IX. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

Not completed at this time. Must add discussion of whether the groundwater remedies are effective and functioning as designed.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

(1) The various groundwater remedies appear to be operating properly and successfully. There is room for some improvement in monitoring the remedies that do not involve groundwater (i.e., Sites 6 and 7 capped area within Area B; Site 2 erosion and sediment controls; and institutional controls for Sites 1, 2, and 3 within Area A.

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

(1) There does not appear to any early indicators of potential remedy problems as part of this 5-year review.

(2) The remedies appear to be protective, but require periodic inspections and reporting.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

(1) The draft groundwater remedy optimization report prepared by Battelle at the Navy's request has not been finalized. This report should be completed so that it can be referenced in the 5-Year Review Report for the base. It is assumed that the optimization report will include recommendations for cost-effective groundwater O&M requirements (e.g., reducing the frequency of groundwater monitoring, reducing the number of wells required to be sampled, changing the level of data validation, reducing the contents of the groundwater monitoring reports.

FORMER NAWC WARMINSTER
5-YEAR REVIEW QUESTIONNAIRE
MAY 2006

Date/Time: 5/17/06, 9:30 AM
Location: NA, phone interview
Phone: 484/250-5721
Interviewee: Ms. April Flipse
Position: PA Department of Environmental Protection Remedial Project Manager
Interviewer: Jeff Orient

1. Do you have any past or present knowledge of the Site? If you are aware of the Site, what is your overall impression of the Site?

Yes. The Navy is doing a pretty good job there with the cleanup.

2. What effects do you think the Site operations may have had on the surrounding community?

The cleanups have removed real/potential problems and are protecting the community adequately.

3. Are you aware of any community concerns regarding the Site or its operation and administration?

Warminster Municipal Authority has concerns regarding actual (Well 26) and potential (Well 13) impacts to their municipal water supply wells.

4. Are you aware of any events, incidents, or activities at the Site such as vandalism, trespassing or emergency responses from local authorities?

No.

5. Do you feel well informed about the Site's activities and progress?

Yes.

6. **Do you have any comments, suggestions or recommendations regarding the Site's management or operation?**

Comments were provided on the draft Optimization Plan regarding DEP permits that need to be addressed – renewal/update of the NPDES Permit is about 5 years overdue, and the Navy also needs to do a Request for Determination to see whether they need an air discharge permit or not.

7. **Additional Comments?**

No – things seem to be working pretty well.

FORMER NAWC WARMINSTER
5-YEAR REVIEW QUESTIONNAIRE
MAY 2006

Date/Time: 5/17/06, 11:30 AM
Location: NA, phone interview
Phone: 215/675-1157
Interviewee: Mr. Norm Kelly
Position: RAB Co-Chair
Interviewer: Jeff Orient

2. Do you have any past or present knowledge of the Site? If you are aware of the Site, what is your overall impression of the Site?

Yes. The Site is in pretty good shape.

2. What effects do you think the Site operations may have had on the surrounding community?

Some people have been put on public water due to groundwater contamination concerns. No housing price impacts that I'm aware of.

3. Are you aware of any community concerns regarding the Site or its operation and administration?

There used to be a higher level of concern with the local residents, not so much now. Most people are not aware of current activities, mostly because they don't go to the effort to stay informed – the information is out there for anyone who wants it.

Kirk Road people used to have concerns about their water supplies (wells).

4. Are you aware of any events, incidents, or activities at the Site such as vandalism, trespassing or emergency responses from local authorities?

Don't recall any.

5. Do you feel well informed about the Site's activities and progress?

Yes. The information is provided in both meetings and reports.

6. Do you have any comments, suggestions or recommendations regarding the Site's management or operation?

Interactions among RAB members are good. There are a lot of knowledgeable people that can bring up past information to augment/clarify/provide additional perspective on new data presented.

7. Additional Comments?

When problems with the site were identified, the Navy went after them in a professional manner and worked through them.

FORMER NAWC WARMINSTER
5-YEAR REVIEW QUESTIONNAIRE
MAY 2006

Time/Date: May 23, 2006
Location: Earth Data Northeast, Inc offices, Exton, Pennsylvania
Phone: 610-524-9466
Interviewee: W. David Fennimore
Position: Consultant to Warminster Municipal Authority

1. Do you have any past or present knowledge of the Site? If you are aware of the Site, what is your overall impression of the Site?

I have some knowledge regarding the environmental impacts resulting from the storage, use, management, handling and disposal of hazardous substances and wastes.

2. What effects do you think the Site operations may have had on the surrounding community?

Site operations significantly degraded groundwater resources below and in the vicinity of the site. Not all source areas have been remediated, so this is a continuing problem. Among other things, the presence of hazardous substances in groundwater below the Base and migrating from it continues to threaten public water supplies, in particular, public water supplies operated by the Warminster Township Municipal Authority.

3. Are you aware of any community concerns regarding the Site or its operation and administration?

See 1 and 2 above.

4. Are you aware of any events, incidents, or activities at the Site such as vandalism, trespassing or emergency responses from local authorities?

No

5. Do you feel well informed about the Site's activities and progress?

While the Base remained under Navy ownership and control, it appears that more of an effort was made through RAB, BRAC and other meetings to keep interested parties informed of site investigation and remediation issues. There are now fewer meetings and it appears less public involvement in the site remediation process.

6. **Do you have any comments, suggestions or recommendations regarding the Site's management or operation?**

More transparency in decision-making regarding groundwater remedial systems.

7. **Additional Comments?**

None