Five-Year Review Report

First Five-Year Review Report
For
North Carolina State University Lot 86 Site
Raleigh
Wake County, North Carolina

September 2003

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Date: 9/25/03

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Five-Year Review Report

Table of Contents

List of Acronyms ..... **iii**
Executive Summary ..... **v**
Five-Year Review Summary Form ..... **vi**
I. Introduction **1**
II. Site Chronololgy **2**
III. Background **2**
A. Physical Characteristics 2
B. Land and Resource Use 5
C. History of Contamination 7
D. Initial Response 7
E. Basis for Taking Action 13
IV. Remedial Actions **14**
A. Remedy Selection 14
B. Remedy Implementation 15
C. System Operation/Operation and Maintenance 18
V. Progress Since The Last Five-Year Review **18**
VI. Five-Year Review Process **18**
A. Notification of Potentially Interested Parties 18
B. Five-Year Review Team Members 20
C. Schedule for the Five-Year Review 20
D. Document Review 20
E. Data Review and Evaluation 20
F. Site Inspection 23
G. Site Interviews 23
VII. Technical Assessment **25**
Question A: Is the remedy functioning as intended by the decision documents? 25
Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid? 26
Question C: Has any information come to light that could call into question the protectiveness of the remedy? 26
Technical Assessment Summary 27
VIII. Issues **27**
IX. Recommendations and Follow-up Actions **28**
X. Protectiveness Statements **29**
XI. Next Review **29**

List of Figures

Figure 1. General Location 3
Figure 2. Specific Site Location 4
Figure 3. Groundwater Potentiometric Surface Contour Map: Shallow Wells 6
Figure 4. Pre-Remediation Site Conceptual Model 8

Figure 5. Benzene Concentrations in Shallow Groundwater (October 1999) 9
Figure 6. Chloroform Concentrations in Shallow Groundwater (October 1999) 10
Figure 7. Carbon Tetrachloride Concentrations in Shallow Groundwater (October 1999)..... 11
Figure 8. Trichloroethylene Concentrations in Shallow Groundwater (October 1999) 12
Figure 9. Bedrock Delineation Map..... 16
Figure 10. Mixing Cell Map 19
Figure 11. Soil Sample Location for Perimeter Fence Relocation 22
Figure 12. Benzene Concentration Trend 35
Figure 13. Carbon Tetrachloride Concentration Trend 36
Figure 14. Chloroform Concentration Trend 36
Figure 15. Methylene Chloride Concentration Trend 37
Figure 16. Trichloroethylene Concentration Trend 37
Figure 17. Sediment and Surface Water Sample Locations for Richlands Creek 39

List of Tables

Table 1. Chronology of Events 2
Table 2. Five-Year Review Issues 27
Table 3. Recommendations and Follow-up Actions 28

List of Attachments

Attachment 1. List of Documents Reviewed 30
Attachment 2. Data Evaluation of Groundwater, Sediment and Surface Water..... 33
Attachment 3. Photographs of Site Visit..... 40
Attachment 4. ARARs 45

List of Acronyms

ARARs	Applicable or Relevant and Appropriate Requirements
AWQC	Ambient Water Quality Criteria
bgs	Below Ground Surface
CENWO-HX-G	Corps of Engineers Hazardous, Toxic and Radioactive Waste Center of Expertise
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CESAW-TS-EG	Wilmington District, Corps of Engineers Geotechnical and Environmental Remediation Section
CFR	Code of Federal Regulations
EPA	United States Environmental Protection Agency
ESA	Entertainment and Sports Arena
ESD	Explanation of Significant Difference
FS	Feasibility Study
IAG	Interagency Agreement
IC	Institutional Controls
IDW	Investigation Derived Waste
Kg	Kilogram
L	Liter
LLRW	Low-Level Radioactive Waste
MCL	Maximum Contaminant Levels
NCDENR	North Carolina Department of Environment and Natural Resources
NCDOT	North Carolina Department of Transportation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NCSU	North Carolina State University
NPL	National Priorities List
O&M	Operation and Maintenance
OU	Operable Unit
PAHs	Polynuclear Aromatic Hydrocarbons
POTW	Publicly Owned Treatment Works
psi	Pounds Per Square Inch
ppb	Parts Per Billion
ppm	Parts Per Million
RA	Remedial Action
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RG	Remediation Goal
RI	Remedial Investigation
ROD	Record of Decision
RP	Responsible Party
RPM	Remedial Project Manager

List of Acronyms (cont.)

SARA	Superfund Amendments and Reauthorization Act of 1986
SVOC	Semi-volatile Organic Compound
TCE	Trichloroethylene
TCLP	Toxicity Characteristic Leaching Procedure
USACE	United States Army Corps of Engineers
VOC	Volatile Organic Compound
WasteLAN	The Regional database related to CERCLIS
µg	Microgram

Executive Summary

The remedy for the North Carolina State University (NCSU) Lot 86 Superfund site in Raleigh, North Carolina included *in-situ* mixing and encapsulation of contaminated soil and waste material and pump and treat of contaminated groundwater. The site achieved construction completion for the soil portion of the remedy with the signing of the Draft Construction Report on January 31, 2000. The trigger for this five-year review was the completion of the Remedial Design on December 30, 1998.

This five-year review will address only the soil portion of the remedy because the groundwater remedy has not been implemented. The assessment of this five-year review found that the remedy was constructed in accordance with the Record of Decision (ROD). One Explanation of Significant Difference (ESD) was issued in 1999 to document a change in the implementation of the remedial technology. This change was a replacement of the crane mounted mixing unit with a trackhoe due to encountering competent bedrock in the shallow subsurface. The change eliminated the use of a hood for vapor containment and required a modification to the mixing and air monitoring procedures. The soil remedy is functioning as designed. The immediate threats have been addressed; however, for the remedy to be protective in the long-term, the groundwater should be addressed.

Five-Year Review Summary Form

Five-Year Review Summary Form		
Site Identification		
Site Name: NCSU Lot 86		
EPA ID: NCD98550656		
Region: 4	**State:** NC	**City/County:** Raleigh/Wake
[redacted]		
NPL status: ✓ Final ❒ Deleted ❒ Other:		
Remediation Status: ❒ Under Construction ❒ Operating ✓ Complete (for soils)		
Multiple OUs?* ❒ YES ✓ NO	**Construction Completion Date:** January 31, 2000	
Has site been put into reuse? ✓ NO		
[redacted]		
Reviewing agency: ✓ EPA ❒ State ❒ Other:		
Author name: Raymond Livermore		
Author title: Environmental Engineer	**Author affiliation:** USACE, Wilmington District	
Review period:** December 30, 1998 to December 30, 2003		
Date(s) of site inspection: April 14, 2003		
Type of review:*** ✓ Statutory ❒ Policy (❒ 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 On-site initiation by PRP ❒ Actual RA start at OU#____ ❒ Construction completion ❒ Previous Five-Year Review Report ✓ Other (specify) Completion of the RD		
Triggering action date: December 30, 1998		
Due date (five years after triggering action date): December 30, 2003		

* "OU" refers to operable unit.
** Review period should correspond to the actual start and end dates of the five-year review in WasteLAN.
*** See Chapter 1, Section 1.2 of EPA 540-R-01-007, Final June 2001 for further explanation.
**** See Chapter 1, Section 1.3 of EPA 540-R-01-007, Final June 2001 for further explanation.

Five-Year Review Summary Form
Issues: 1. The ROD identified acetone as a contaminant for the site and established a remediation goal. However, samples collected since the Remedial Investigation (RI) have not been analyzed for acetone. 2. Saturated soils at approximately 40 feet bgs may be a continuing source of contamination, as the soil remedy did not address soils at this depth. 3. Institutional controls were not included as part of the remedy for the soil, because no unacceptable risks were identified. However, remediation at the site has rendered it unsuitable for future building construction. 4. Institutional controls were not included as part of the remedy for the groundwater. Although there is not a current complete pathway, potential future risks may exist associated with exposure to the groundwater. 5. Monitoring wells exist along Wade Avenue without protection (i.e. protection posts). 6. Several monitoring wells at the site are no longer sampled and/or have not detected site-related contaminants in over 4 years.
Recommendations and Follow-up Actions: 1. Include acetone in the list of parameters for analysis or change the laboratory method to one that does include acetone (i.e. EPA Method 8260). 2. Address in the design of the groundwater remedy. 3. Institutional controls in the form of deed restrictions should be implemented for the soil to prevent construction (i.e. buildings) at the site. 4. Institutional controls in the form of deed restrictions should be implemented to prevent all human use of groundwater until unacceptable risks have been addressed. 5. Protection posts should be installed for those wells in vulnerable locations to prevent potential damage. 6. Monitoring wells that are no longer used or sampled should be removed from use and abandoned in accordance with North Carolina regulations.
Protectiveness Statement(s): All immediate threats at the site have been addressed and the site is protective in the short term; however, for the remedy to be protective in the long-term, the groundwater should be addressed.
Long-term Protectiveness: Long-term protectiveness of the remedial action will be provided in an estimated 30 years after the groundwater remedy is implemented. Although the groundwater remedy has not been implemented at this time, groundwater monitoring indicates the plume is not migrating beyond the current boundaries. Institutional controls should be implemented to address potential future risks associated with exposure to contaminated groundwater.
Other Comments: Additional characterization of the groundwater is currently being conducted for remedial design considerations. Therefore, the groundwater remedy specified in the ROD has not been implemented at the date of this report.

FIVE-YEAR REVIEW REPORT

I. INTRODUCTION

The purpose of the five-year review is to determine whether the remedy at a site is or is expected to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in five-year review reports. In addition, five-year review reports identify issues found during the review, if any, and recommendations to address them.

The United States Environmental Protection Agency (EPA) must implement five-year reviews consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substance Contingency Plan (NCP). CERCLA § 121(c), as amended 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 that each 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.*

The NCP part 300.430(f)(4)(ii) of the Code of Federal Regulations (CFR) 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.*

EPA Region 4 conducted a five-year review of the remedial action implemented at the NCSU Lot 86 Site in Raleigh, Wake County, North Carolina. The United States Army Corps of Engineers (USACE) provided technical assistance and analysis for the five-year review. The Geotechnical and Environmental Remediation Section, Engineering Branch, Technical Services Division of the USACE Wilmington District, Wilmington, North Carolina provided the lead for this review. The review was accomplished under EPA Work Authorization Form for Interagency Agreement (IAG) Number DW96945884. The USACE Hazardous, Toxic and Radioactive Waste Center of Expertise (CENWO-HX-G) located at the Omaha District, Nebraska supported the USACE Wilmington District in the performance of the review. This review was conducted from March 2003 through August 2003. The report documents the results of that review.

This is the first five-year review of the NCSU Lot 86 Site. The triggering action for this statutory review is the completion of the remedial design (RD) for soil on December 30, 1998. The five-year review is required due to the fact that hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure.

This review will be placed in the EPA site files and local repositories for the NCSU Lot 86 Site. The local repositories are located at the Cameron Village Regional Public Library, 1930 Clark Avenue, Raleigh, North Carolina and D.H. Hill library, NCSU, Raleigh, North Carolina.

II. SITE CHRONOLOGY

Table 1 lists the chronology for selected events for the NCSU Lot 86 site, as shown below.

Table 1: Chronology of Events

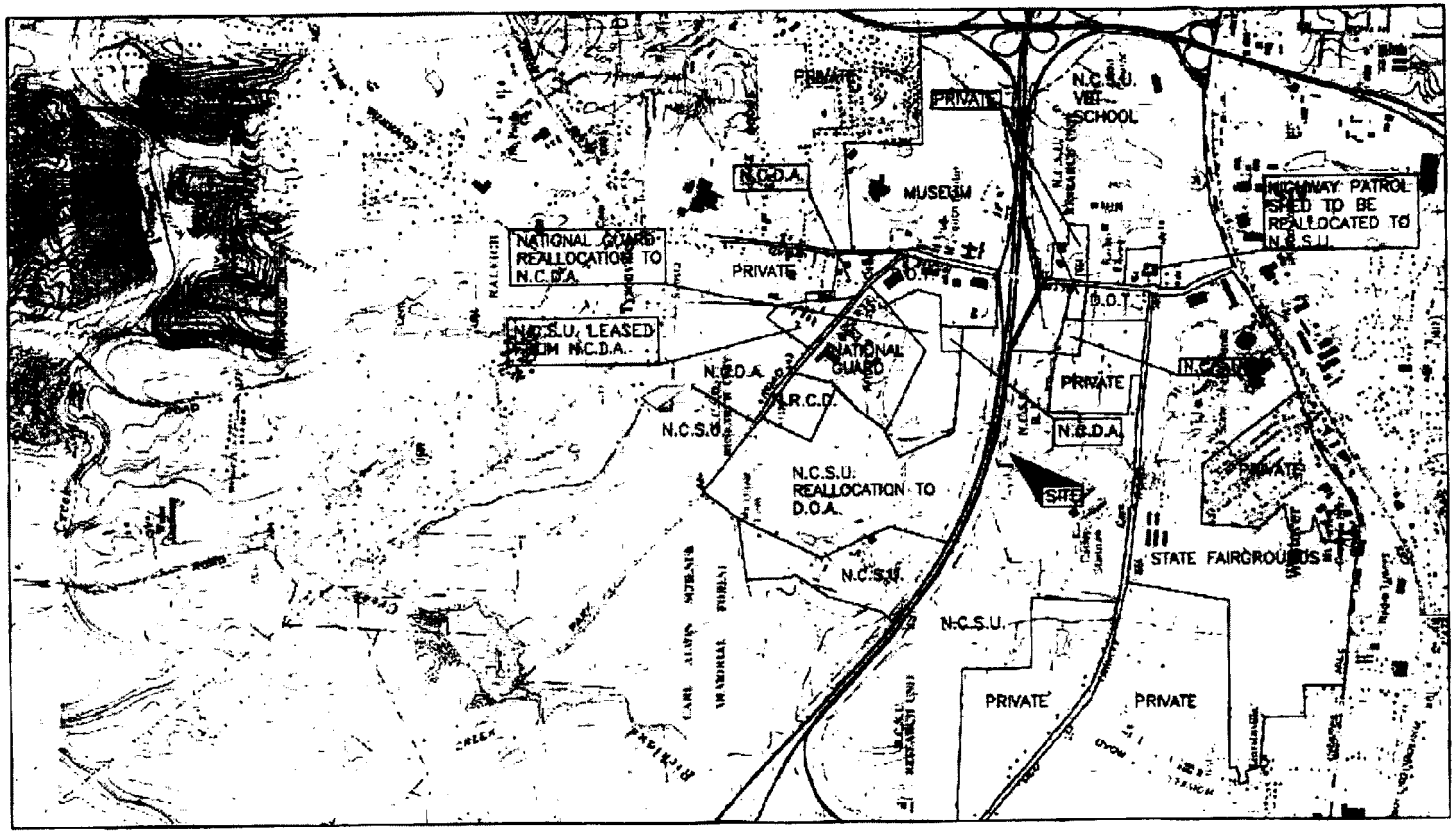
NCSU uses Lot 86 as a burial site for hazardous chemical and low level radioactive waste generated in the University's laboratories.	1969 to November 1980
NCSU reports on the CERLCA Section 103(c) Hazardous Waste Notification form of waste disposal.	June 8, 1981
Final listing on the National Priorities List (NPL)	June 10, 1986
Remedial Investigation (RI) Report completed	October 1994
Revised Feasibility Study (FS) completed	February 1996
Proposed plan identifying EPA's preferred remedy presented to public; start of public comment period.	June 1996
ROD selecting remedy is signed.	September 30, 1996
Start of on-site mobilization for initiation of soil mixing activities (remedy selected by ROD)	November 9, 1998
Consent Decree finalizing settlement for responsible party performance of remedy entered by Federal Court	November 13, 1998
Final Remedial Action Work Plan approved by EPA	December 30, 1998
Start of Remedial Action (RA).	January 19, 1999
Explanation of Significant Differences (ESD) issued by EPA to address the use of a trackhoe in lieu of crane for mixing operations and a change in mixing operations and air monitoring procedures.	July 1999
RA (soil mixing activities) completed	September 21, 1999
Draft Construction Report signed	January 31, 2000
Monitoring well sampling	Annual (ongoing)
Site inspection for the first five-year review.	April 14, 2003

III. BACKGROUND

A. Physical Characteristics

The NCSU Lot 86 Site is approximately 1.5 acres located on the west side of Raleigh, in western Wake County, North Carolina. The Site and the adjacent properties are owned by the State of North Carolina. The Site is currently fenced and padlocked. The Site is located immediately south of the Wade Avenue Extension, near Carter-Finley Stadium and the Centennial Sports Complex (Figure 1). Land to the north of the Site is sloped sharply approximately 50 feet downward to the Wade Avenue Extension (GEI Consultants, Inc. 2001). The Site is bordered on the east by wooded, undeveloped land. A grassy area exists to the west and is used for parking during stadium events. New football practice fields for NCSU exist to the south (Figure 2). The Lot 86 Site is situated on a broad crest of a low rolling hill. The site is covered with grass and weeds and no structures are present.

Figure 1. General Location



NOTES:

1. FIGURE REPRODUCED FROM U.S.G.S. 7.5 MINUTE SERIES – RALEIGH WEST, NORTH CAROLINA–WAKE CO. QUADRANGLE
2. PROPERTY BOUNDRIES ESTIMATED FROM "PROPERTY OWNERSHIP IN VICINITY OF NCSU LOT 86 SITE" SKETCH PROVIDED BY NCSU/ENVIRONMENTAL HEALTH DEPT. TO GEI ON 1/12/01

LEGEND:

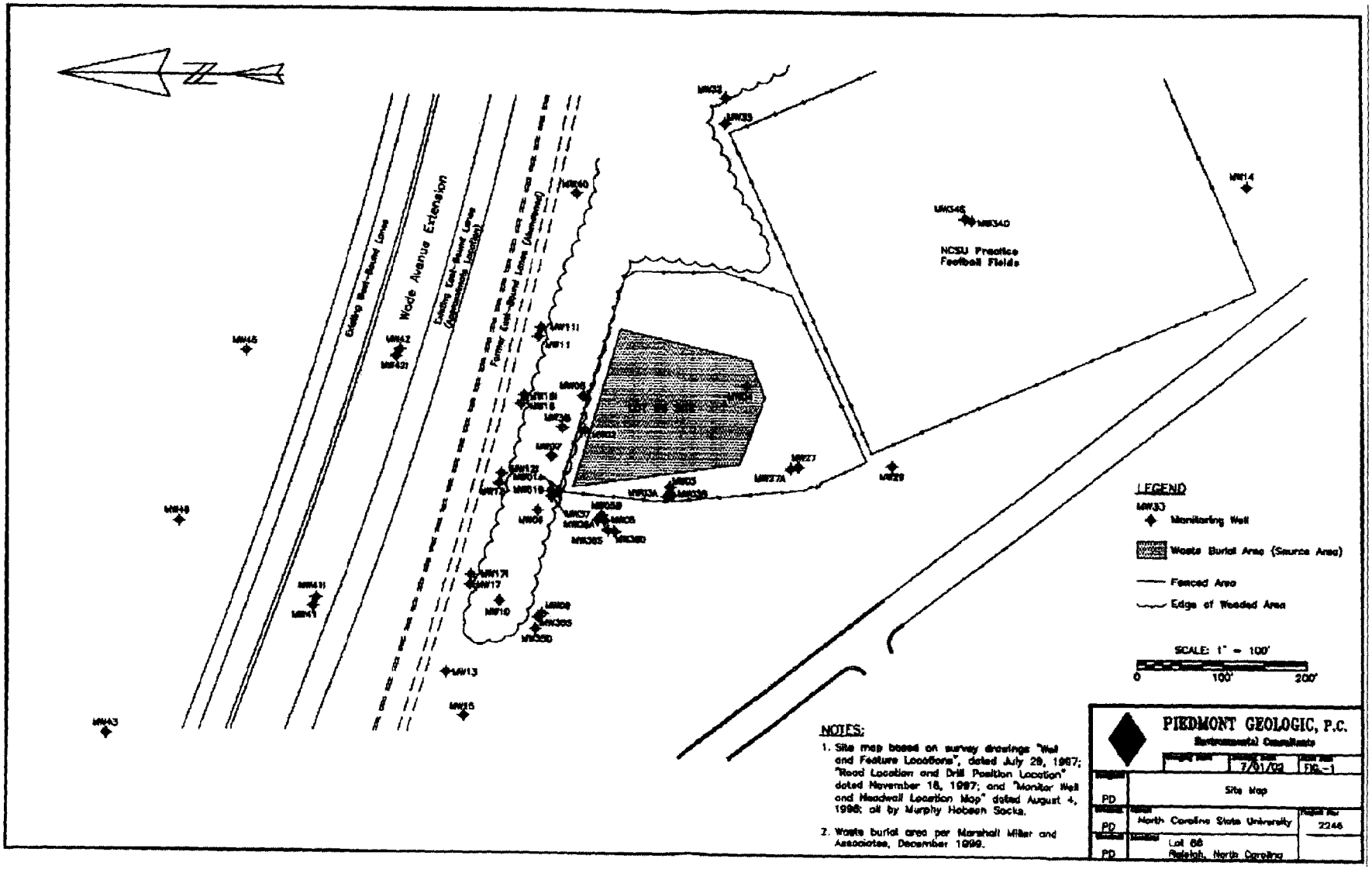
—— ESTIMATED PROPERTY BOUNDARY

HORIZONTAL SCALE, FEET
0 2000 4000

DRAFT

North Carolina State University Raleigh, North Carolina	Monitored Natural Attenuation Evaluation Lot 86 Superfund Site Raleigh, North Carolina	SITE LOCATION AND SURROUNDING AREA
GEI Consultants, Inc.	Project 98485	March 2001

Figure 2. Specific Site Location



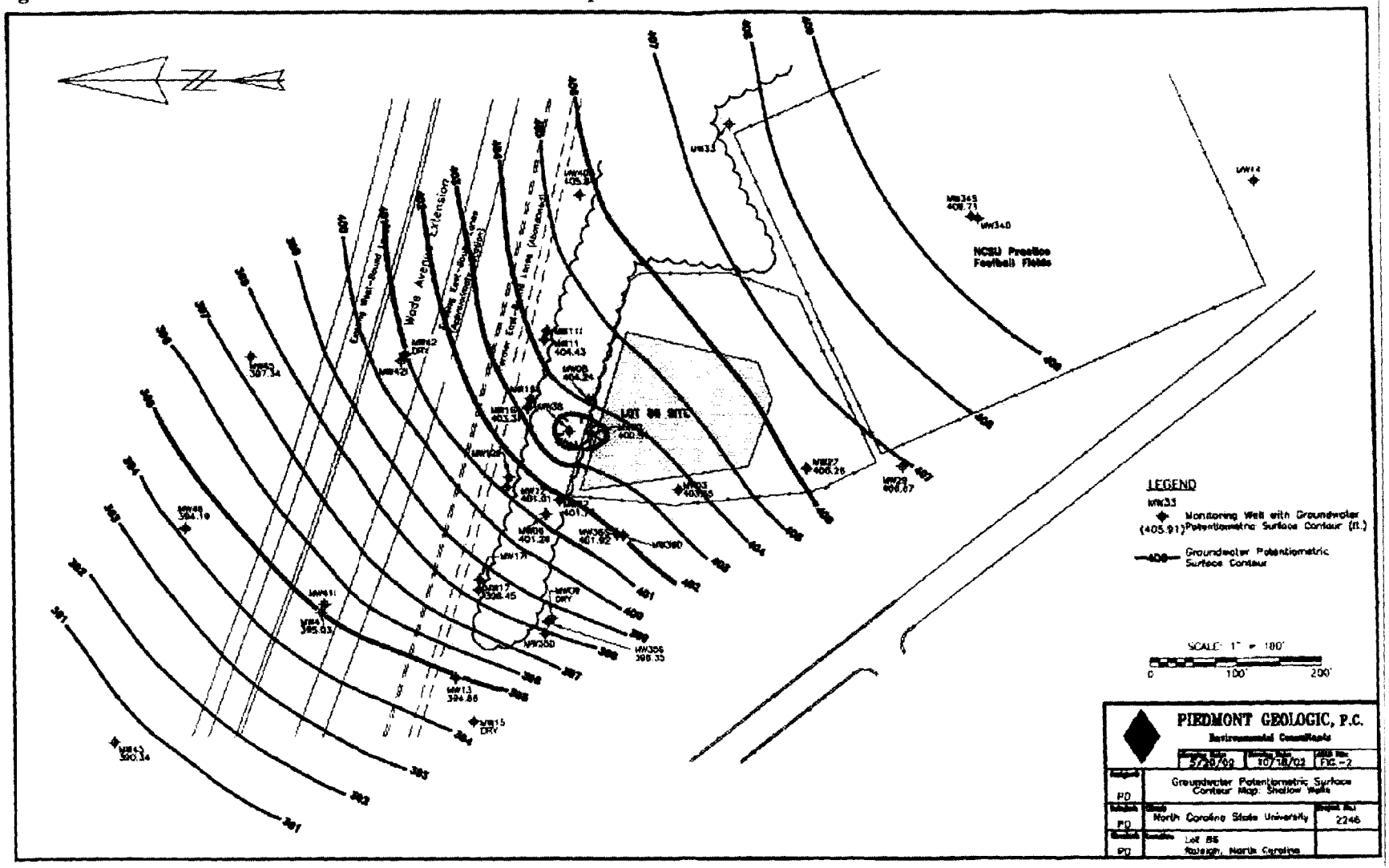
The Site topography is typical for uplands consisting of rolling hills and rounded ridge lines and lowlands with narrow and broad valleys. Site geology consists of residual soils at the surface, saprolite, and weathered rock. The residual soils and saprolite contain a shallow water-bearing unit. This layer consists of typical Piedmont materials including silts, clays, sandy clayey silts, sandy silty clays, and minor amounts of fine to medium gravel. The residual soil/saprolite zone ranges from a thickness of approximately 70 to 87 feet. However, during the soil remedial action the saprolitic zone/weathered bedrock interface was detected at shallow depths and competent bedrock was encountered as shallow as 3 feet below ground surface (bgs) (Marshall Miller & Associates 2000). Weathered bedrock is present directly beneath the residual soil/saprolite layer. The weathered bedrock consists of hard to very hard sandy clayey silt with gravel, sandy silty clay, and gravel. The weathered bedrock layer has variable thickness and there is no sharp delineation between the weathered bedrock and the saprolite. The bedrock layer beneath the weathered bedrock consists of felsic gneiss and interlayered schist.

Groundwater exists in the unconsolidated soils and in the bedrock layer. The shallow aquifer (unconsolidated soils) is recharged mostly by infiltration of precipitation. The bedrock layer contains groundwater under water table or semi-confined conditions in certain areas of the Site. The bedrock is recharged mostly by the unconsolidated soils, which act as a reservoir. Studies indicate groundwater at the site is approximately 35 feet bgs in the shallow unconsolidated residual/soil water-bearing unit (GEI Consultants, Inc. 2001). Groundwater flow is toward the northwest, in the direction of Wade Avenue and is shown for shallow groundwater on Figure 3. Intermediate and deep groundwater flow is in the same general direction.

B. Land and Resource Use

The current use of land to the east of the Site to the tributary of Richland Creek is undeveloped and wooded and there is no expected change in the future. Land to the south of the property is part of the Carter-Finley Stadium property and was previously wooded. This land has been developed into the new football practice fields. Current use of the land to the west of the Site includes grassed parking lots to the east for Carter Finley Stadium and the new Raleigh Entertainment and Sports Arena (ESA). Land further west of the Site to the Richland Creek includes wooded land, open fields, and roadways. There is no expected change in the future for land west of the Site to Richland Creek. Land immediately north of the site is wooded and sloped downward to the elevation of the Wade Avenue Extension right of way and there is no expected change in the future. Land north of the Wade Avenue Extension to the Richland Creek tributaries is currently non wooded land with no improvements. The 25-year development plan for the State of North Carolina has designated this area for State office buildings (GEI Consultants, Inc. 2001). Current land use has not changed since the signing of the ROD with the exception of the construction of the ESA to the southwest and the practice football fields to the south of the Site.

Figure 3. Groundwater Potentiometric Surface Contour Map: Shallow Wells



The groundwater aquifer underlying the site is not currently used as a drinking water source. The nearest down gradient well of the Site is approximately 2/3 mile and is on State Farm Road at the home of the caretaker of the North Carolina Research Farm, Fish and Wildlife Unit. The location of this well is considered beyond the inferred discharge boundaries of the Site (GEI Consultants, Inc. 2001). Figure 4 illustrates a pre-remediation site conceptual model and illustrates the components of groundwater flow from the site and nearby surface water bodies. The nearest surface water body is a seasonal stream located 500 feet east of the site. A second seasonal stream is approximately 1,600 feet west of the site and extends westward to the confluence with Richland Creek.

C. History of Contamination

The NCSU Lot 86 was used as a burial site for hazardous chemical and low-level radioactive waste (LLRW) beginning in 1969. The waste was generated in the University's educational and research laboratories. The western part of the site received the hazardous chemical waste, and the eastern part received the LLRW. Burial of the waste was discontinued in November 1980 to comply with regulations promulgated under the Resource Conservation and Recovery Act (RCRA) (Piedmont Geologic, PC 2002).

The chemical wastes were placed in approximately 22 trenches approximately 10 feet deep and varying from 50 to 150 feet in length. Chemical wastes buried at the site include solvents, pesticides, inorganics, acids, and bases. NCSU reported approximately 11,000 cubic yards of chemical wastes were disposed at the site. LLRW was disposed at the site in approximately 9 trenches (EPA 1996). The NCSU Radiation Protection Office controls records regarding radiological waste disposal, which indicate the LLRW was properly disposed at the site. The remedial action for the Site did not address the LLRW and is not a subject of this review.

Groundwater contamination consists primarily of Volatile Organic Compounds (VOCs) including chloroform, methylene chloride, benzene, carbon tetrachloride, and trichloroethylene (TCE). Additional groundwater contaminants include low-level concentrations of Semi-volatile Organic Compounds (SVOCs), pesticides, and inorganics. The extent of groundwater contamination for benzene, chloroform, carbon tetrachloride, and TCE is illustrated Figures 5,6,7, and 8 respectively. These figures were created based on data obtained in the October 1999 sampling event. Contamination in the soils consisted primarily of VOCs with higher concentrations in the subsurface soils and low concentrations of SVOCs and pesticides in the surface soil.

D. Initial Response

NCSU reported on the CERCLA 103(c) Hazardous Waste Notification form filed on June 8, 1981 documenting disposal of approximately 11,000 cubic yards of chemical waste at the Lot 86 Site (Marshall Miller & Associates 2000). A preliminary assessment was conducted on June 1, 1984. The EPA and the North Carolina Division of Solid Waste Management completed hazard ranking score sheets for the site and added the site to the NPL on October 15, 1984. The site was finalized on the NPL on June 10, 1986.

Figure 4. Pre-Remediation Site Conceptual Model

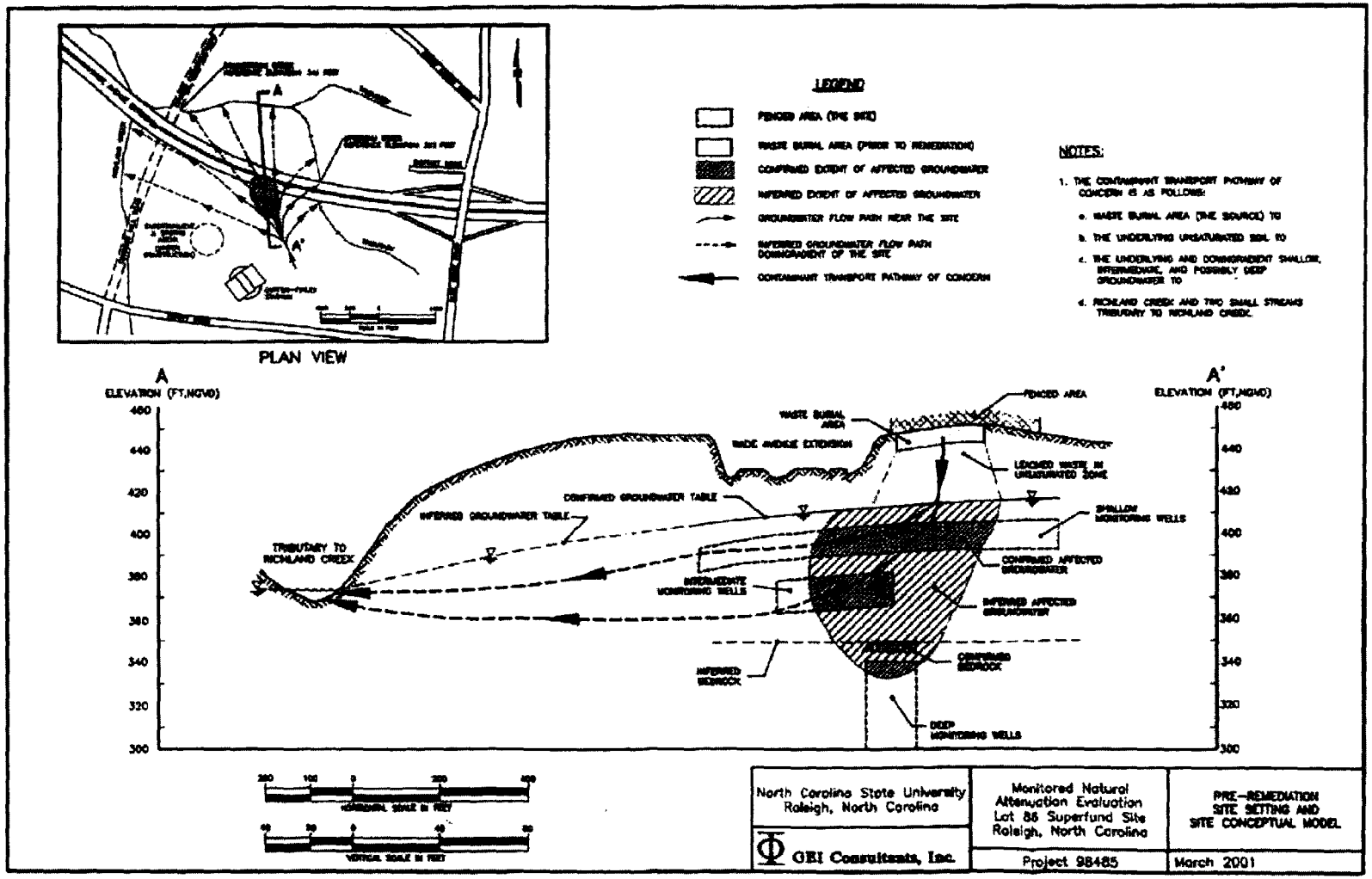


Figure 5. Benzene Concentrations in Shallow Groundwater (October 1999)

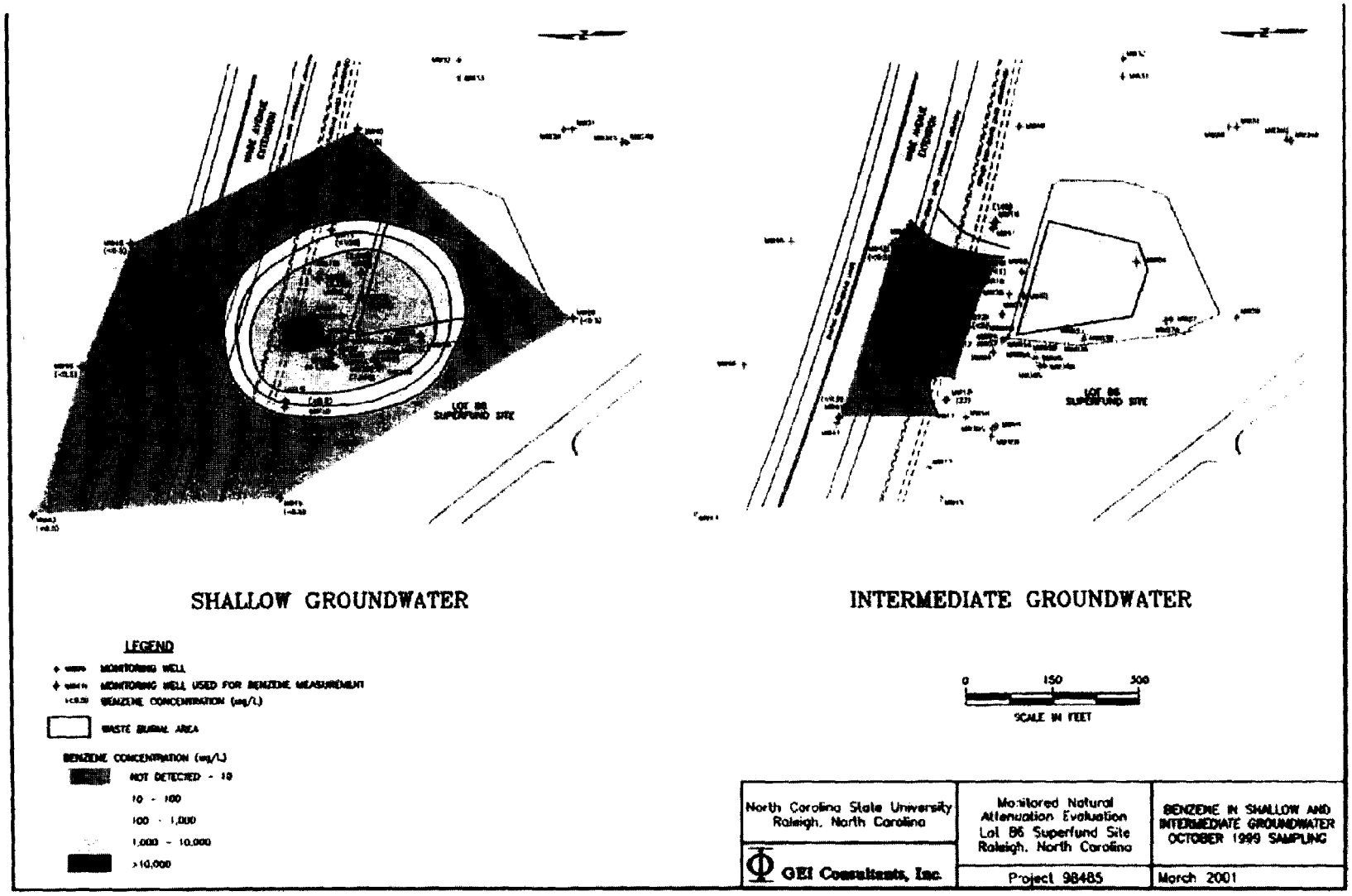


Figure 6. Chloroform Concentrations in Shallow Groundwater (October 1999)

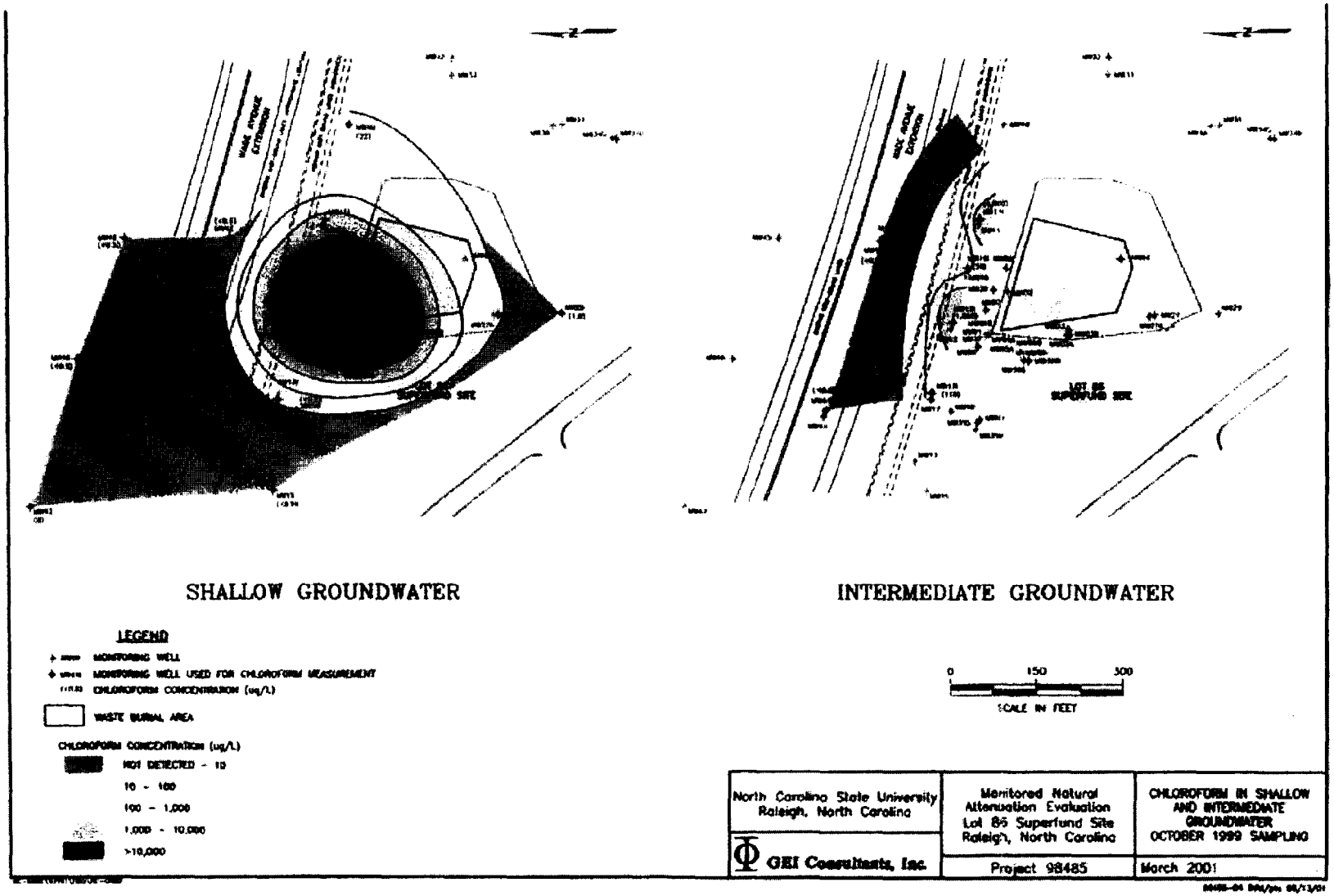


Figure 7. Carbon Tetrachloride Concentrations in Shallow Groundwater (October 1999)

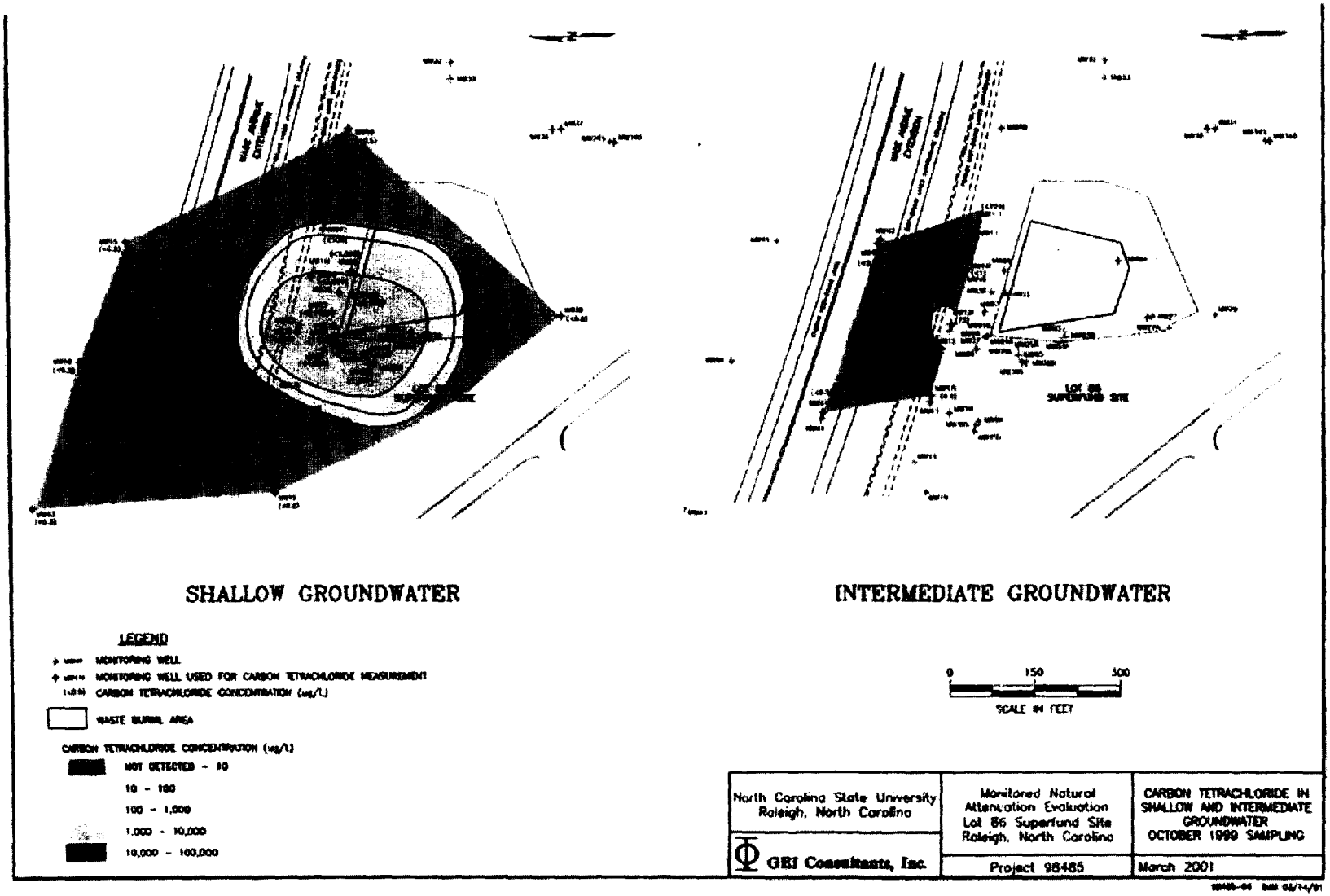
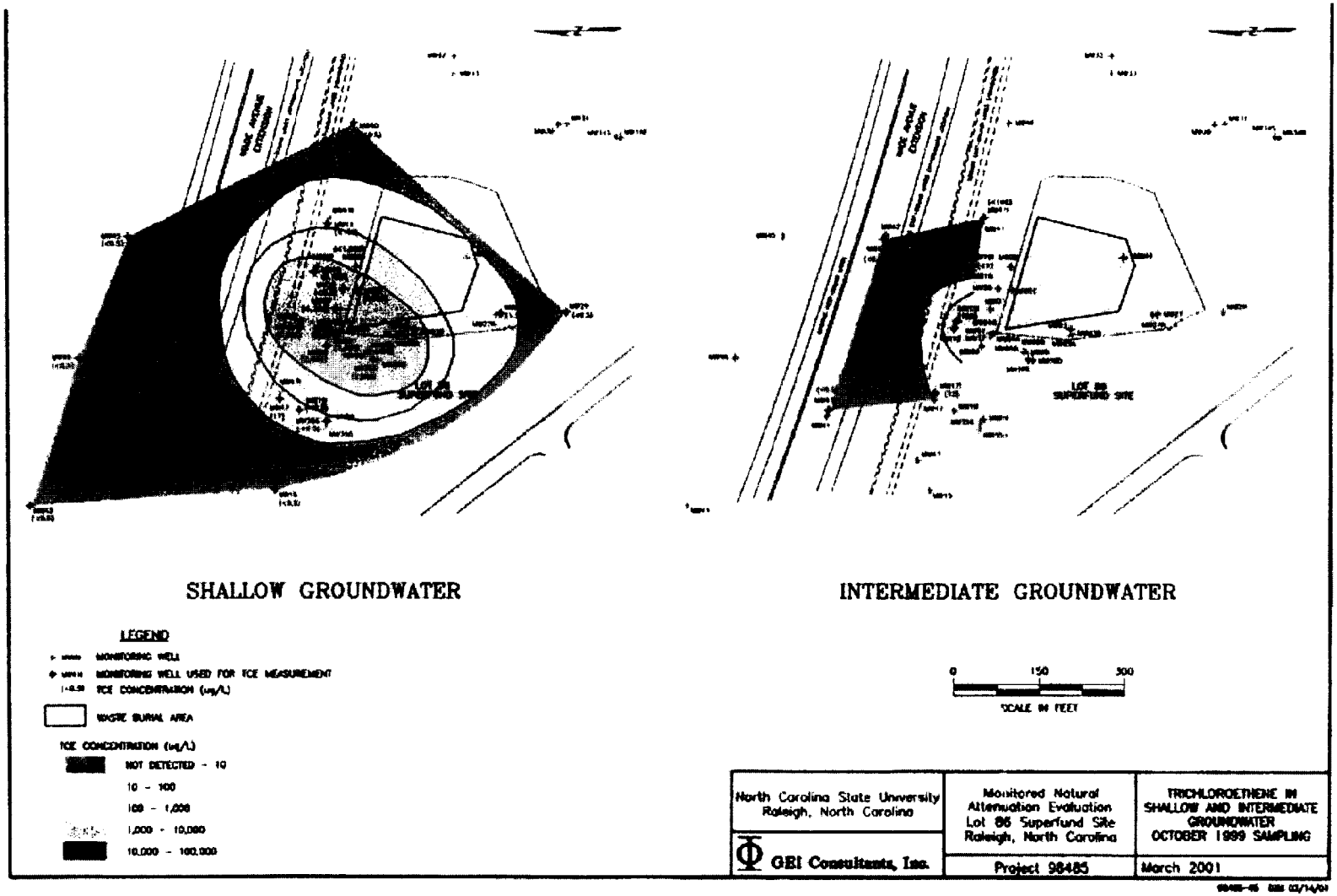


Figure 8. Trichloroethylene Concentrations in Shallow Groundwater (October 1999)



The site was fenced prior to any response action and continues to be fenced to this date. In June 1996, the Remedial Investigation/Feasibility Study (RI/FS) was made available to the public and the Proposed Plan identifying EPA's preferred remedy was presented to the public, starting the period for public comment.

E. Basis for Taking Action

Contaminants

Hazardous substances that have been released at the site in each media include:

Groundwater	Soil
Acetone	Acetone
Benzene	2-Butanone
Bromodichloromethane	Chloroform
Bromoform	1,2-Dichloroethane
Carbon Tetrachloride	1,2-Dichloropropane
Chlorobenzene	Methylene Chloride
Chloroform	4-Methyl-2 Pentanone
1,1-Dichloroethene	Tetrachloroethene
1,2-Dichloroethene	Toluene
1,2-Dichloropropane	Trichloroethene
Methylene Chloride	
1,1,2,2-Tetrachloroethane	
Tetrachloroethene	
1,1,2-Trichlorothene	
Trichloroethene	
Arsenic	
Manganese	

The human health risk assessment for the Site evaluated current and future use scenarios. Current receptors included a child, youth, and adult visitor and recreational person and an adult student. Future receptors included a child, youth, and adult resident. As stated in section III.B, the groundwater aquifer underlying the site was and is not currently used as a drinking water source. The nearest down gradient well of the Site is approximately 2/3 mile and is considered beyond the inferred discharge boundaries of the Site (GEI Consultants, Inc. 2001). Groundwater was evaluated and did present unacceptable risks to future residents. Surface soils were evaluated and did not present an unacceptable risk to human health or the environment via dermal contact or ingestion pathways for current or future receptors. The risk assessment for the soils evaluated surface soils from 0 to 1 feet bgs and did not include the soil sample results from 4 to 12 feet bgs. The soil remedy was implemented to address leaching of contaminants in the waste trenches and accessible subsurface soils (up to 10 feet bgs) that were a continuing source of contamination to the groundwater. Groundwater is the remaining media of concern at the Lot 86 Site.

The ecological risk assessment evaluated risks to ecological receptors qualitatively. The evaluation identified a potential concern for several site contaminants to terrestrial species; however, the risks to these receptors were determined to be low based on the low potential for exposure. Evaluation of the contaminants in the groundwater did not indicate adverse effects for aquatic life in Richland Creek.

IV. REMEDIAL ACTIONS

A. Remedy Selection

The ROD for the Lot 86 Site was signed on September 30, 1996. Remedial Action Objectives (RAOs) were developed as a result of data collected during the RI to aid in the development and screening of remedial alternatives to be considered for the ROD. The RAOs for the Lot 86 site were identified as follows:

- Prevent migration of contaminants to surface water that would result in contamination to levels greater than the Ambient Water Quality Criteria (AWQC).
- Control future releases of contaminants to ensure protection of human health and the environment.
- Permanently and significantly reduce mobility, toxicity, or volume of characteristic hazardous waste with treatment.

Soil Remedy

The selected remedy for contaminated soils was in-situ mixing and encapsulation. The major components of the remedy selected in the ROD include the following:

1. Drive-off and capture the volatiles via a specially designed bore hole shroud.
2. Treatment included liquid vapor separation, in-line filtration for dust and particulate removal followed by parallel activated carbon filter banks.
3. The remaining contaminants will be solidified in-situ, using various pozzolan-portland cement based formulations delivered to and dispersed within the soil column as a grout.
4. The extent of encapsulation would extend to encompass a two-foot radius around the trenches.
5. The Toxicity Characteristic Leaching Procedure (TCLP) would be included in the design of the remedy.

Groundwater Remedy

The selected remedy for the contaminated groundwater was extraction, treatment and discharge. The groundwater remedy has not been implemented at this time and will not be addressed in this document.

An ESD was issued in July 1999. During implementation of the soil RA competent bedrock was encountered at depths as shallow as 3 feet bgs. Other obstructions including debris and compressed gas cylinders were also encountered. In February 1999, a Geoprobe investigation was conducted and identified several locations of bedrock at depths less than 10 feet bgs and is shown on Figure 9. These obstructions caused damage to the crane mounted auger-mixing unit and would potentially compromise the integrity of the solidified grout/soil mixture. The ESD was issued to change the implementation of the technology. The shallow depths of the bedrock outcroppings caused the use of the crane-mounted auger-mixing unit to be ineffective; therefore, a trackhoe was selected to replace the crane for mixing and stabilizing the material. To address this change, the mixing and air monitoring procedures were revised. The primary changes documented in the ESD were:

- Use of trackhoe in lieu of crane for mixing operations
- Mixing procedure revision included the spraying of grout in the mixing area to suppress potential vapor emission and/or covering the emission with surrounding soils.
- The soils were mixed in individual cells of four feet wide by twelve feet long by ten feet deep.
- Air monitoring procedure revision included the collection of whole air samples on a daily basis from no more than 50 feet downwind of the mixing area.
- Real-time fence line monitors were used to identify potential exposure to off-site receptors.
- Passive dosimeter badges were placed at five locations around the site to monitor acute and cumulative exposures over the duration of the project.

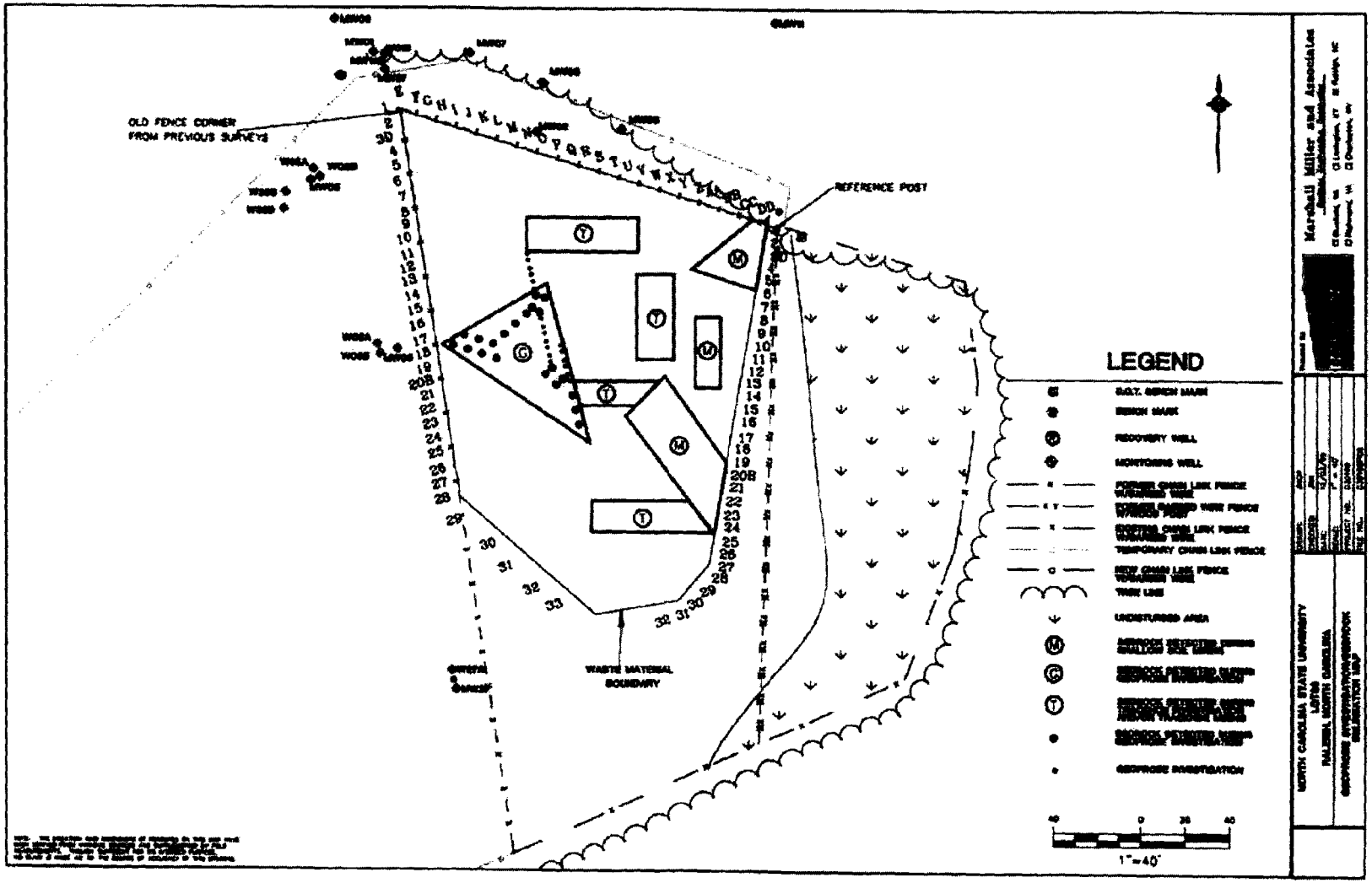
The trackhoe mixing process allowed for visual inspection of the extent of contamination. In addition, it was determined the trackhoe mixing process provided a superior homogenous mix over the auger mixing unit.

B. Remedy Implementation

A Treatability Study was conducted in February 1998 to evaluate the effectiveness of the ROD selected remedy for the soil. Representative samples were collected from the soil and waste material. The samples were collected by conducting exploratory test pits at the Site. A trackhoe bucket was used to mix the contents in the test pit (soil, containers, etc.) to mimic the in-situ soil mixing process. After a period of time composite samples were collected from the mixed material. During this investigation, exploratory excavations were conducted to determine the locations of drums and the waste trench boundaries. Test pit operations encountered various items including bottles, cans, drums, drum fragments, plastic, soil staining, and liquids of various color.

The representative samples from the test pits were analyzed for waste characterization and evaluated for design parameters such as cement mixture ratios and addition rates. Testing included the Toxicity Characteristic Leaching Procedure (TCLP) analysis, unconfined compressive strength, and hydraulic conductivity. The testing demonstrated mixing with a cement ratio of 15% was sufficient to pass the TCLP testing criteria for all constituents.

Figure 9. Bedrock Delineation Map



The results indicated the samples mixed with the cement ratio of 15% had compressive strengths above 30 pounds per square inch (psi) for a 28-day curing period. The results also indicated these cured samples were highly impervious with hydraulic conductivities of less than 1×10^{-7} cm/sec for all samples (Marshall Miller & Associates 2000).

Remediation goals were not identified for the soil and there were not any unacceptable risks associated with exposure to the surface soils. As stated before, the soil remedy was implemented to address leaching of contaminants in the trenches and accessible subsurface soils were a continuing source of contamination to the groundwater. Based on the results of the treatability study, the 15% cement mixture was selected as the design ratio for the soil remedy at the site. EPA approved the Remedial Design (RD) and RA plans in November 1998 that included the performance standard for the soil remedy of mixing with cement at a minimum ratio of 15% by weight and had a compressive strength of 30 psi after a 28-day curing period.

Site preparation activities for the RA began on November 9, 1998 and included erecting temporary site fencing, constructing gravel access areas, delineating work zones, removal of trees, establishing utilities and facilities for the Site, and setting up the mixing equipment. Prior to RA activities, buried drums were removed from the waste trenches. The buried drums were encountered during field activities prior to the RD. Drum removal prior to starting the RA was required in order to prevent several hazards including damage to the mixing equipment, potentially releasing the contents of a drum, and creating dangerous reactions due mixing substances contained in the drums. Eight drum carcasses were removed and placed in overpack containers. One drum contained a purplish liquid and was carefully removed to minimize spillage. A sample of the liquid was analyzed for hazardous characterization. The sample results indicated the material was non-hazardous.

The RA was implemented on January 19, 1999. The in-situ soil mixing was conducted using a crane mounted mixing auger while blending fluid grout. Mixing was conducted until a homogenous blend was achieved and overlapping was performed to provide complete coverage. A hood kept under negative pressure was used to contain vapors and treat air borne contaminants. Although the RI report indicated bedrock was encountered at a depth of 75 feet, competent bedrock was encountered on January 28, 1999 at shallow depths of 3 feet bgs. In February 1999, a Geoprobe investigation was conducted and identified several locations of bedrock at depths less than ten feet bgs. These locations are shown in Figure 9. The shallow depths of the bedrock outcroppings caused the use of the crane-mounted auger-mixing unit to be ineffective. A trackhoe was substituted for the crane and mixing activities continued; however, this change eliminated the use of the vapor hood. In March 1999, the EPA halted the soil remedial action to re-evaluate the process.

A revised Air Monitoring Plan was prepared that evaluated results of air modeling for the use of the trackhoe. This document indicated off-site impacts were below any health based levels. As mentioned earlier, an ESD was issued in July 1999 to document the change in implementation of the in-situ soil mixing. The change included substituting a trackhoe for the crane to allow for mixing to the surface of the bedrock located on the site. The ESD documented this change in implementation of the soil mixing and changes in the mixing and air monitoring

procedures. The trackhoe bucket was used to mix the contaminated soil and grout into a homogeneous blend in individual cells. The cells were the width of the bucket (four feet) by twelve feet long by ten feet deep or two feet past the depth of the visible waste material. The use of the trackhoe allowed for visual inspection to determine at what depth the waste material was present. Addendums to the Remedial Action Work Plan, Performance Standards Verification Plan, and Construction Health and Safety/Contingency Plan were submitted to incorporate the changes to the remedy. Once these addendums were approved, trackhoe-mixing operations commenced on August 27, 1999. Mixing operations were completed on September 21, 1999 and Figure 10 is provided to illustrate the mixing cells conducted during the RA.

Evaluation of the remedy was conducted by collecting samples from the midpoints of the soil columns approximately every 100 cubic yards or at least once per day when mixing occurred. For the duration of the RA, 113 samples were collected. Of the 113 samples, two failed the unconfined compressive strength testing criteria due to not following the sampling protocol. After remixing and resampling, two additional samples from the failed sample columns passed the unconfined compressive strength criteria. During the RA, approximately 10,090 cubic yards of soil and waste were treated (Marshall Miller & Associates 2000). Site restoration included grading and a one-foot soil cover was placed over the entire mixing area. The soil cover was shaped at a grade less than 25% to reduce infiltration and erosion.

The draft Construction Report was signed on January 31, 2000. It is expected that remediation levels for all groundwater contaminants will be reached in approximately 30 years after implementation of the groundwater remedy. After groundwater cleanup levels have been met, EPA will issue a Close Out Report.

C. System Operation/Operation and Maintenance

There are not any specific operation and maintenance (O&M) tasks associated with the soil remedy. Therefore, an O&M plan was not required nor prepared for the soil portion of the RA. Routine tasks have been conducted at the site that may be considered O&M and include semi-annual mowing and visual inspections of the site on a monthly basis. Costs associated with these tasks are minimal. Therefore, there is relatively no difference between costs for these tasks and the ROD estimated costs of no O&M costs.

V. PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

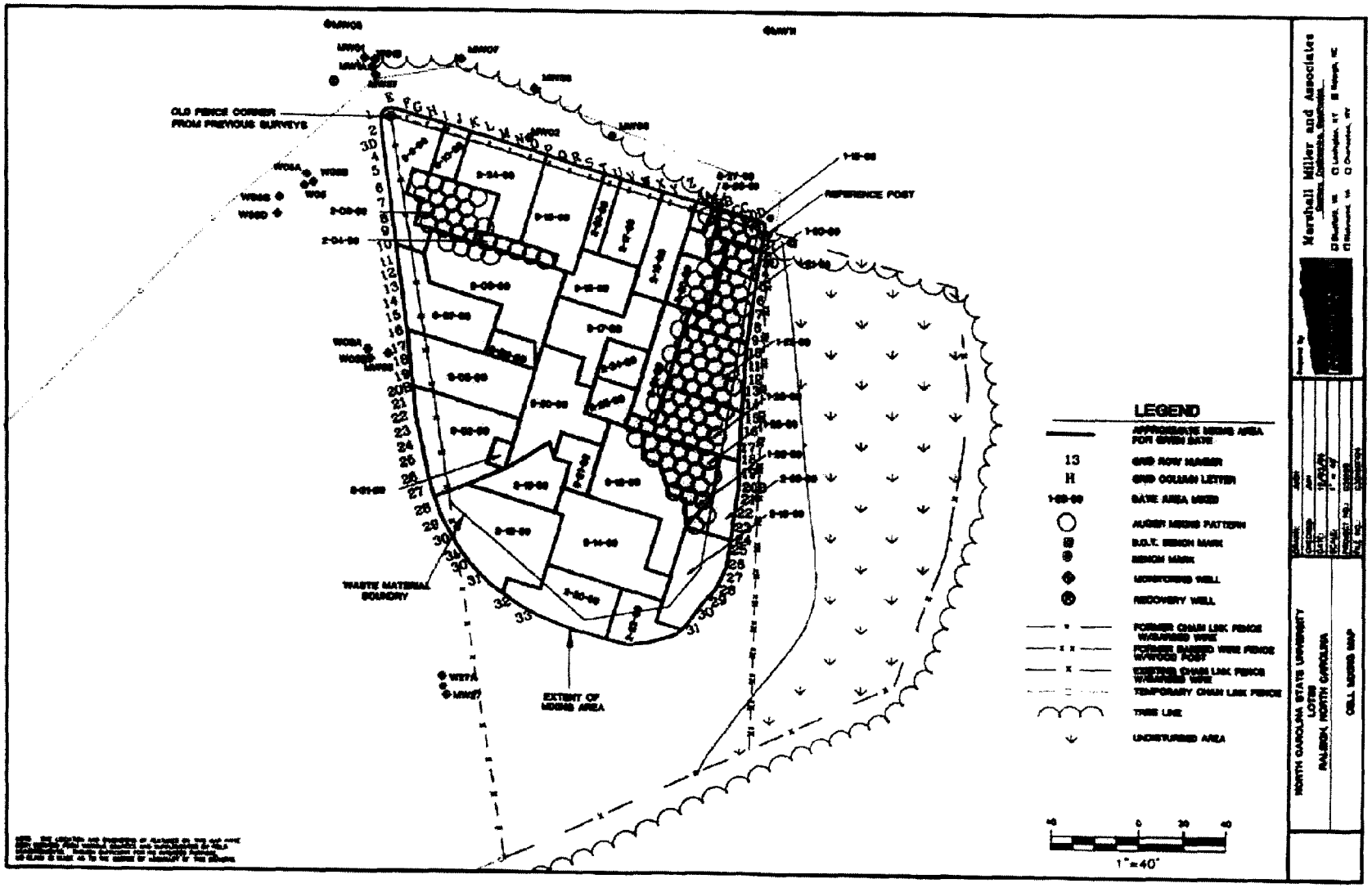
This was the first five-year review for the site.

VI. FIVE-YEAR REVIEW PROCESS

A. Notification of Potentially Interested Parties

Members of the EPA, NCSU and the North Carolina Department of Environment and Natural Resources (NCDENR) were notified of the initiation of the five-year review on March 17, 2003.

Figure 10. Mixing Cell Map



B. Five-Year Review Team Members

The NCSU Lot 86 five-year review was prepared by Raymond Livermore, U.S. Army Corps of Engineers, Wilmington District, Geotechnical and Environmental Remediation Section. Several individuals of various disciplines from the U.S. Army Corps of Engineers, Hazardous, Toxic, and Radioactive Waste Center of Expertise (CENWO-HX-G) provided a quality assurance review of the report.

C. Schedule for the Five-Year Review

A schedule was developed for the five-year review including review of documents, site visit, and preparation and review of the five-year review report. The schedule extended through August 30, 2003.

D. Document Review

This five-year review consisted of a review of relevant documents including recent sampling and monitoring data. A list of documents reviewed is provided in Attachment 1.

E. Data Review and Evaluation

As stated earlier, the groundwater remedy has not been implemented at this time. Only data for soil will be discussed in the body of the report. Data for all other media since the soil remedy was implemented has been provided as a status report in Attachment 2. Data review and evaluation for the soil included the following items:

- Construction Report, January 2000: Confirmation soil sampling for unconfined compressive strength for the soil RA.
- Soil sample results for perimeter fence relocation collected April 2002.

Soil Data

Soil data since the completion of the soil remedy is limited due to the nature of the RA which comprised of *in-situ* soil mixing and encapsulation using cement to form a monolith solidifying the waste material and reducing the permeability. The ROD did not identify remediation levels for the soil. The soil remedy was implemented to address leaching of contaminants in the waste trenches that were a continuing source of contamination to the groundwater. As discussed in section IV.B, a treatability study demonstrated mixing the soil and waste material with a cement ratio of 15% was sufficient to pass the TCLP analysis for all constituents and provided a hydraulic conductivity of 1×10^{-7} cm/sec. Confirmation sampling for the soil RA included testing for an unconfined compressive strength of 30 psi to evaluate the effectiveness of the mixing procedure.

Evaluation of the soil remedy was conducted by collecting samples from the midpoints of the soil columns approximately every 100 cubic yards or at least once per day when mixing occurred. A total of 113 confirmation samples were collected during the soil remedial activities.

Two of the 113 samples failed the unconfined compressive strength testing criteria due to not following the sampling protocol. After remixing and resampling, two additional samples from the failed sample columns passed the unconfined compressive strength criteria.

In April 2002 a soil sample was collected in order to relocate a small portion of the perimeter fence to allow for easier maintenance of the perimeter and for installation of a football practice field light. This area was identified as having no history of chemical contamination. The soil sample was collected from 1.5 to 2 feet bgs from the location shown in Figure 11. The sample was analyzed for volatile organics and radiological parameters. The results indicated all constituents were non-detect except bromoform. Bromoform was detected at 26 parts per million (ppm), which was less than the North Carolina action limit of 62 ppm (NCSU 2002).

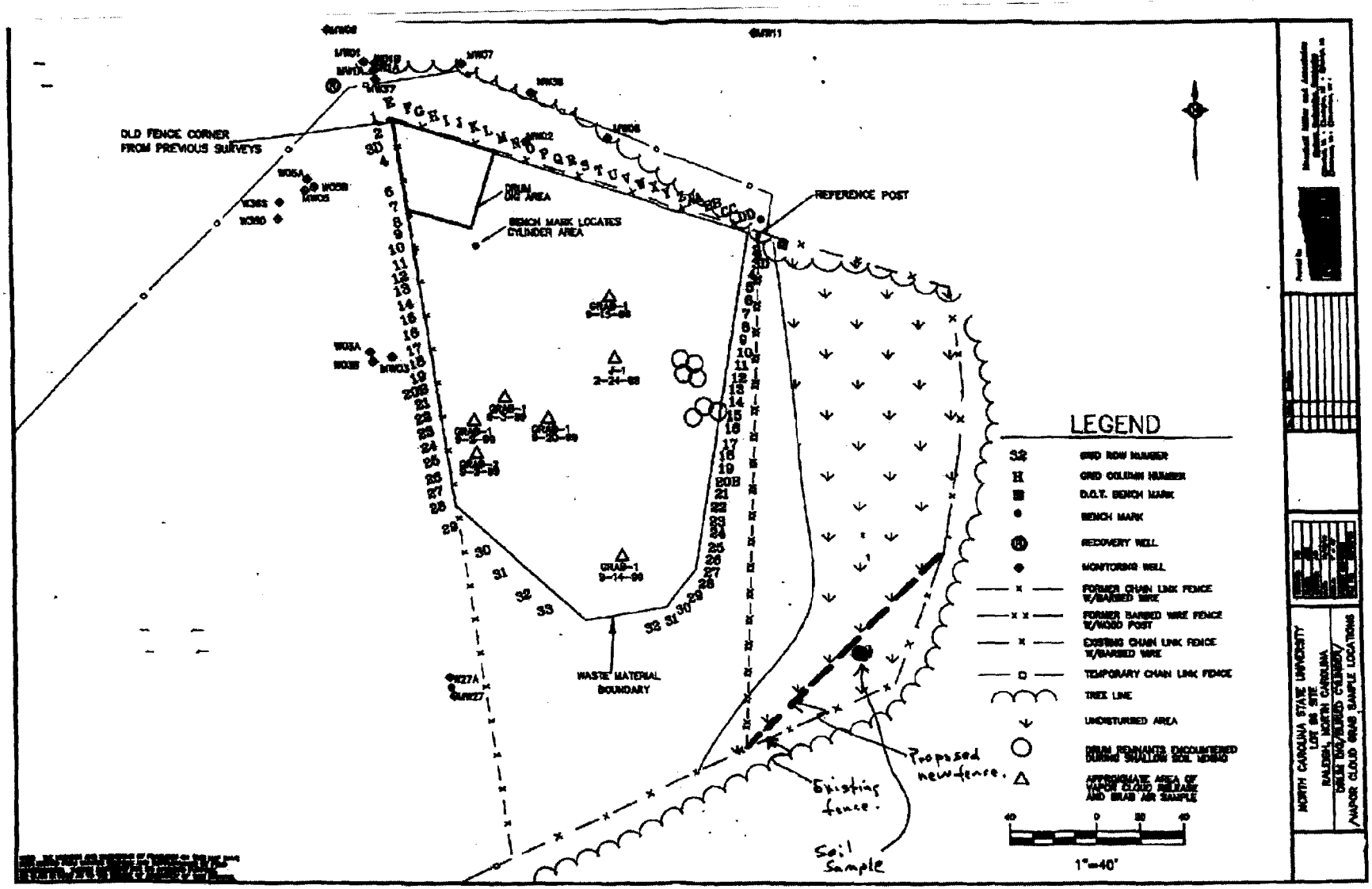
Site Risk

Section III.B of this review identified changes in land use since the ROD and future projected land use for the Site and surrounding area. Potential complete pathways evaluated for the ROD included incidental ingestion and dermal contact to surface soils and ingestion of drinking water and inhalation of VOCs released to indoor air. These potential pathways and current and future receptors for the Site and surrounding area remain consistent with those identified in the ROD. Confirmation sampling for the soil RA were in compliance with the RD standards, which indicate the samples would pass the TCLP criteria and be classified as non-hazardous. Therefore, current and future risks associated with the Site appear to be consistent with those identified in the ROD.

One concern identified during this review is groundwater contamination and the potential for VOCs to partition back to the soils (both on-site and off-site) and re-contaminate the soils. The soil RA was designed to prevent infiltration of surface water to the contaminated residual soils and continued dissolved contamination to the groundwater. Groundwater data evaluated is included in Attachment 2 and illustrates static and decreasing groundwater concentrations in various wells since the soil remedy was implemented. The shallow groundwater aquifer has been identified at approximately 35 ft. bgs. Although, re-contamination of subsurface soils may be possible, there is not an exposure pathway associated with this media. Subsurface soil sample results in the RI indicate elevated concentrations of VOCs in saturated soils at approximately 40 feet bgs and may be a continuing source of contamination, as the soil remedy did not address soils at this depth. Therefore, it is recommended this issue be addressed in the design of the groundwater remedy.

Another concern identified during the review was the potential pathway for inhalation of VOCs released to indoor air. This pathway was evaluated in the baseline risk assessment and documented in the ROD. There were no unacceptable risks associated with this pathway. There have been no changes in land use at or downgradient of the site. Future use of the area north of the Wade Avenue Extension (downgradient of Site) includes office buildings. Site-related contaminants have not been detected or detected just above the detection limit upgradient of this area. Therefore, risks associated for potential receptors for inhalation of VOCs from indoor air would be lower than the Site risks, which identified no unacceptable risks for this pathway.

Figure 11. Soil Sample Location for Perimeter Fence Relocation



F. Site Inspection

A site inspection of the NCSU Lot 86 Site was conducted on April 15, 2003. Attending the site visit were:

- Raymond Livermore, Environmental Engineer, U.S. Army Corps of Engineers, Wilmington District.
- Duane Knudson, Environmental Affairs Manager, North Carolina State University.
- Bruce Dickinson, Project Consultant for North Carolina State University.

For documentation of the site visit, photos of the site were taken and are included as Attachment 3. The site area has not been re-developed since the soil RA was completed in 1999 and remains fenced. The Environmental Health and Safety Office of NCSU currently controls access to the site. The area is currently vegetated with grasses and is mowed twice a year.

There were no significant issues identified during the site visit. The site was well vegetated and site drainage appeared to be in good condition in spite of the region receiving a great deal of precipitation recently. A new fence had been re-installed after the soil RA and was in good condition. Mr. Knudson indicated there have been trees that have fallen onto the fence, however, they are removed and the fence is replaced in a timely fashion. Mr. Dickinson indicates he walks the perimeter of the site once a month in order to inspect the fence and monitoring wells. It was noted the height of the area within the soil remedy boundary was crowned in the center and is approximately 6 feet above the perimeter in the south and approximately 10 feet above the perimeter in the north. Mr. Dickinson stated a sediment pond existed during the remedial activities at the north end of the site but was no longer in use and this area was vegetated at the time of the site visit.

Mr. Knudson and Mr. Dickinson indicated several of the monitoring wells are no longer sampled as part of the monitoring program due to various reasons including screening at depths that do not provide adequate information. Upon investigation of the exterior perimeter of the site, it was noted tree clearing had been performed by the North Carolina Department of Transportation (NCDOT) on the shoulder of the Wade Avenue Extension and on the slope up to the site. Tire tracks from the vehicles for tree clearing were present in close proximity to monitoring wells used for site and some of these wells were not protected by posts.

G. Site Interviews

Mr. Livermore interviewed various individuals associated with the Lot 86 Site RA. A summary of the interviews is provided below.

Mr. Michael Townsend, Remedial Project Manager (RPM), EPA Region IV:

In several telephone conversations between Mr. Townsend and Mr. Livermore, issues regarding the site and the five-year review were identified. Mr. Townsend indicated the groundwater remedy has not been implemented; therefore, this five-year review would focus on soil only. Mr. Townsend stated representatives from EPA, NCDENR, and the NCSU performed

a site inspection following the soil remedy implementation. Mr. Townsend indicated the groundwater has not been characterized particularly the bedrock aquifer, which has delayed implementation of the groundwater remedy and issuance of the close-out report for the site.

Mr. Dave Mattison, Environmental Engineer, North Carolina Department of Environment and Natural Resources, Division of Waste Management, Superfund Section, Federal Remediation Branch:

Mr. Mattison was interviewed through a phone conversation. Mr. Mattison indicated the soil remedy was implemented with no problems other than those addressed in the ESD. He stated he was not sure why State cleanup standards were not identified as ARARs for the site, but indicated no changes to State regulations have occurred since the soil remedy implementation that would impact the protectiveness. Mr. Mattison had similar comments to Mr. Townsend regarding the groundwater remedy and inadequate characterization.

Mr. Duane Knudson, Environmental Affairs Manager, North Carolina State University:

Mr. Knudson was interviewed through a phone conversation initially and subsequently at the Environmental Health and Safety Office of NCSU before the site visit. Mr. Knudson indicated there have been no problems with the site since the soil remedial action. The ROD did not identify institutional controls for the site; however, the Site remains fenced after completion of the soil RA. Mr. Knudson stated that NCSU has continued to keep the Site fenced to provide a level of comfort. Mr. Knudson stated NCSU is currently evaluating the groundwater by collecting data through sampling events and plans to install bedrock groundwater monitoring wells in the spring of 2003. There has not been much public involvement concerning the site and Mr. Knudson indicated there have never been any signs of vandalism.

Mr. Bruce Dickinson, Project Consultant for North Carolina State University:

Mr. Dickinson was interviewed at the Environmental Health and Safety Office of NCSU before the site visit. Mr. Dickinson talked about the soil remediation activities and discussed the bedrock features of the site relating to the soil remedy and groundwater. He stated a sediment and erosion control pond was used at the base of the site during construction but was no longer in use and indicated the current drainage of the site is good with no erosion problems. Mr. Dickinson and Mr. Knudson discussed the cover for the site and indicated once the soil mixing activities were completed, a clay and topsoil cover of 2 to 3 feet was installed. The construction report prepared by Marshall Miller and Associates refers to a 1-foot soil cover only. However, Mr. Dickinson and Mr. Knudson stated Mr. Mattison of NCDENR requested the clay composition and additional depth of the cover.

Ms. Diane Barrett, a Communications Coordinator with EPA Region 4, interviewed several individuals regarding the Lot 86 Site also. These individuals included:

Ms. Ethel Medlin, Former Resident at Old Trinity Road:

Ms. Medlin stated she lived near the Site from 1950 to 1999. She indicated she was vaguely familiar with the project and didn't have any impression of the project because she was not involved. She stated the EPA and NCSU adequately informed her of project activities. Ms. Medlin did not have any other information to provide regarding the project.

Ms. Barrett also interviewed Mr. Mattison of NCDENR and Mr. Knudson of NCSU. In these interviews Mr. Mattison stated he visits the Site once a quarter to inspect. Mr. Mattison indicated he is well informed of the Site and stated the RA has had a positive impact on the community from the standpoint that the soil remedy has mitigated concerns regarding the Site. Mr. Knudson stated the soil remedy is functioning as designed.

Ms. Barrett also interviewed Mr. Richard Miller, Environmental Manager for the University of North Carolina at Chapel Hill (UNC) and Ms. Debbie Griffith, Public Relations Office for NCSU. Mr. Miller stated UNC was interested due to similar areas at the university. Mr. Miller and Ms. Griffith did not have any specific comments regarding the RA due to their lack of involvement with the Site.

VII. TECHNICAL ASSESSMENT

Question A: Is the remedy functioning as intended by the decision documents?

Yes, this review indicates the soil remedy is functioning as intended by the ROD. The *in-situ* soil mixing and encapsulation of contaminated soils and waste appears to have met the remedial objectives of preventing migration of contaminants to the surface water, controlling future releases of contaminants to the environment, and permanently reducing the mobility and toxicity of the waste. An ESD was prepared to document the change in the implementation of the technology during the *in-situ* soil mixing activities. This change concerned only remedy implementation and does not affect the post-remedy evaluation. As stated earlier, the groundwater remedy has not been implemented at this time.

The site data since completion of the soil RA indicates the source has been addressed effectively. Sampling conducted during the soil remedial activities met the requirements for the compressive strength testing, thereby, encapsulating and reducing the mobility of the waste. Surface water and sediment sample results for samples collected since the RA was completed have indicated no detections of site-related contaminants. Finally, groundwater sampling results from monitoring wells immediately down gradient of the source area indicate the majority of the site-related contaminants have decreased or remain constant since the soil remedy was implemented.

Institutional controls (ICs) were not identified as part of the remedy for soil or groundwater. However, implementation of ICs is recommended and discussed in detail in section VIII and IX of this review.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Yes, the assumptions used for the remedy selection remain valid. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Therefore, there are not any changes in the exposure pathways. There has been no change in land use and there have not been any new contaminants or sources identified.

The exposure assumptions used in the Human Health Risk Assessment included both current exposures for the soil (visitor, recreational person, and adult student), potential future exposures for the soil (child, youth, and adult) and potential future exposures for the groundwater (child, youth, and adult). The groundwater at the site is considered Class GA, which is a potential source of drinking water supply. Potential uses of groundwater include drinking water, irrigation, and maintenance use. The groundwater is not currently used as a drinking source at the Site or downgradient of the Site. These assumptions were used for the baseline risk assessment and there have been no changes in these assumptions. There has been no change to the standardized risk assessment methodology that could affect the protectiveness of the remedy.

Applicable or relevant and appropriate requirements (ARARs) were identified in the ROD for the site. Only those ARARs addressing risk posed to human health or the environment (i.e., addressing the protectiveness of the remedy) were reviewed which is consistent with current EPA guidance on five-year reviews. These ARARs are identified in Attachment 4. There were no remediation levels identified in the ROD for soil. ARARs for the soil consisted of action-specific ARARs only and were addressed during the *in-situ* mixing remedial activities.

ARARs for the groundwater still must be met and include the North Carolina Drinking and Groundwater Standards (15A NCAC 2L) from which the majority of the groundwater remediation levels were derived. There has been a change to the Federal Maximum Contaminant Levels (MCLs) for arsenic since the ROD was signed. The Federal MCL for arsenic has been reduced to 10 parts per billion (ppb). However, the groundwater remediation level for the Site for arsenic was based on the North Carolina Drinking and Groundwater Standard and is 10 ppb. Therefore, the change to this Federal standard does not affect the protectiveness of the remedy. In addition, there have been no other changes for the site-related ARARs and no new standards affecting the protectiveness of the remedy.

Question C: Has any information come to light that could call into question the protectiveness of the remedy?

No, there is no new information that questions the protectiveness of the remedy. Unacceptable risks to ecological receptors were not identified in the baseline risk assessment and none were identified during this five-year review. Environmental monitoring conducted since completion of the soil RA included surface water and sediment sampling. Results of these sampling activities have not detected any site-related contaminants.

Technical Assessment Summary

According to document and data review, the site inspection, and the interviews, the remedy is functioning as intended by the ROD, as modified by the ESD. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. All of the ARARs for the soil contamination identified in the ROD were met during implementation of the soil RA. There have been no changes in the exposure assumptions and no change in the standardized risk assessment methodology that could affect the protectiveness of the remedy. There is no other information that calls into the question the protectiveness of the remedy.

VIII. ISSUES

Table 2. Five-Year Review Issues

Issue	Currently Affects Protectiveness	Affects Future Protectiveness
The ROD identified acetone as a site contaminant. However, samples collected since the RI have not been analyzed for acetone.	No	Yes
Saturated soils at approximately 40 feet bgs may be a continuing source of contamination, as the soil remedy did not address soils at this depth.	No	Yes
Institutional controls (ICs) were not included as part of the remedy for the soil, because no unacceptable risks were identified. However, remediation at the site has rendered it unsuitable for future building construction.	No	No
ICs were not included as part of the remedy for the groundwater. However, unacceptable risks still exist for exposure to the groundwater.	No	Yes
Monitoring wells exist along Wade Avenue without protection (i.e. protection posts).	No	No
Several monitoring wells at the site are no longer sampled or have not detected site-related contaminants for 4 years.	No	No

IX. RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Table 3. Recommendations and Follow-Up Actions

Issue(s)	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness?	
					Current	Future
The ROD identified acetone as a site contaminant. However, samples collected since the RI have not been analyzed for acetone.	Include acetone in the list of parameters for analysis or change the laboratory method to one that includes acetone (i.e. EPA Method 8260)	NCSU	EPA and State	Next sampling event.	No	Yes
Saturated soils at approximately 40 feet bgs may be a continuing source of contamination, as the soil remedy did not address soils at this depth.	Address in the design of the groundwater remedy.	NCSU	EPA and State	GW Design	No	Yes
Remediation at the site has rendered it unsuitable for future building construction.	ICs in the form of deed restrictions should be implemented for the soil to prevent construction in form of buildings at the site.	EPA and State	EPA and State	Before next five-year review.	No	No
Unacceptable risks exist for exposure to the groundwater.	ICs in the form of deed restrictions should be implemented prevent all human use of groundwater until unacceptable risks have been addressed.	EPA and State	EPA and State	Before next five-year review.	No	Yes
Monitoring wells exist along Wade Avenue without protection.	Protection posts should be installed for those wells in vulnerable locations to prevent potential damage.	NCSU	EPA and State	Before next five-year review	No	No
Some site monitoring wells are no longer sampled or have not detected contaminants in 4 years.	Abandon monitoring wells that are no longer used in accordance with North Carolina regulations.	NCSU	EPA and State	Before next five-year review	No	No

X. PROTECTIVENESS STATEMENT

The remedy at the NCSU Lot 86 Site is expected to be protective of human health and the environment upon attainment of the groundwater remediation goals, which is expected to require 30 years through pump and treat. Currently, there is not a complete exposure pathway for contaminated groundwater. However, ICs should be implemented to address potential future unacceptable risks associated with exposure to contaminated groundwater. All immediate threats at the site have been addressed through *in-situ* mixing and encapsulation of contaminated soils. However, for the remedy to be protective in the long-term, the groundwater should be addressed.

XI. NEXT REVIEW

The next five-year review for the NCSU Lot 86 Site is required within five years of the date of signature of this report.

ATTACHMENT 1. List of Documents Reviewed

List of Documents Reviewed

Brown and Caldwell Consultants. October 1994. Revised Remedial Investigation Report, Lot 86 Site, North Carolina State University, Raleigh, North Carolina.

East Coast Environmental, P.A. May 2001. Correspondence from Thomas Will to Duane Knudson. Re: Results for Sediment and Surface Water Sampling at Richlands Creek adjacent to NCSU Lot 86, Raleigh, NC.

GEI Consultants, Inc. March 2001. Draft Evaluation of Monitored Natural Attenuation Lot 86 Superfund Site, Raleigh, North Carolina.

GEI Consultants, Inc. March 2000. Correspondence from Kevin Boyer to Duane Knudson. Re: Collection and Analysis of a Surface Water Sample, Lot 86 Superfund Site, Raleigh, North Carolina.

Marshall Miller & Associates, Inc. March 1999. Addendum 1 to the Remedial Action Work Plan, North Carolina State University Lot 86 Site, Raleigh, North Carolina.

Marshall Miller & Associates, Inc. November 1998. Final Performance Standards Verification Plan, North Carolina State University Lot 86 Site, Raleigh, North Carolina.

Marshall Miller & Associates, Inc. November 1998. Final Plans and Specifications, North Carolina State University Lot 86 Site, Raleigh, North Carolina.

Marshall Miller & Associates, Inc. November 1998. Final Project Delivery Strategy, North Carolina State University Lot 86 Site, Raleigh, North Carolina.

Marshall Miller & Associates, Inc. November 1998. Final Remedial Action Work Plan, North Carolina State University Lot 86 Site, Raleigh, North Carolina.

Marshall Miller & Associates, Inc. January 2000. Draft Construction Report Volumes 1-4, North Carolina State University Lot 86 Site, Raleigh, North Carolina.

North Carolina State University, Environmental Health and Safety Center. April 2002. Correspondence from Duane Knudson to Michael Townsend for Soil Sample Results for Relocation of Perimeter Fence.

Piedmont Geologic, P.C. October 2002. Final Report of Results: May-July 2002 Groundwater Sampling and Analysis Event, Lot 86 Site, North Carolina State University, Raleigh, North Carolina.

S&ME Environmental Services. February 1996. Draft Revised Feasibility Study, North Carolina State University Lot 86 Site, Raleigh, North Carolina.

U.S. Environmental Protection Agency, Region IV. July 1999. Explanation of Significant Difference, N.C. State University Lot 86 Site, Raleigh, North Carolina.

U.S. Environmental Protection Agency, Region IV. September 30, 1996. Record of Decision, North Carolina State University (Lot 86, Farm Unit #1) OU 1, Raleigh, North Carolina.

U.S. Environmental Protection Agency, Region IV. June 1996. Proposed Plan, North Carolina State University Lot 86 Site, Raleigh, Wake County, North Carolina.

ATTACHMENT 2. Data Evaluation of Groundwater, Sediment and Surface Water

This attachment provides a status report of the data evaluation for groundwater, sediment, and surface water for the Lot 86 Site. As stated in the report, only the soil remedy has been implemented. Therefore, only data for the soils was evaluated in the body of the report. The information in this attachment is included to illustrate the effect of the soil RA on media other than soil. The review included data from the following documents/information:

- Report for May-July 2002 Groundwater Sampling and Analysis Event, October 2002: Groundwater sample results from various site monitoring wells collected May 2002.
- Groundwater sample results from various site-monitoring wells collected April 2001.
- Sediment and surface water sample results from nearby streams collected April 2001.
- Evaluation of Monitored Natural Attenuation, March 2001: Groundwater sample results for various site monitoring wells from June 1997 to July 2000.
- Surface water sample results from ponded water after completion of soil remediation activities collected February 2000.

Groundwater Data

Groundwater monitoring has been conducted at the site since the early 1980s. The main resource for review of groundwater data was the Evaluation of Monitored Natural Attenuation report prepared by GEI Consultants in March 2001. This document contained sampling data for groundwater monitoring of various site wells from June 1997 to July 2000. Since July 2000, groundwater sampling has been conducted on an annual basis in April 2001 and May 2002 and this data was also reviewed.

The sampling data indicates the groundwater contamination does not appear to be migrating beyond the current boundaries of the plume. The site-related constituents are not present or have only been detected at low concentrations north of the Wade Avenue Extension. Monitoring wells MW13, MW41, MW45, and MW46 have had no detections of site contaminants since April 1999. Monitoring well MW42 has had one detection of chloroform that was below the remediation goal (RG) and MW43 has had low detections of chloroform above the RG. Other wells that have never had detections of site-related contaminants or no detections since April 1999 include MW-34S, MW-34D, MW-35S, MW-38, and MW41I.

The sampling data was plotted from February 2000 to May 2002 for the highest detected constituents, which include benzene, chloroform, carbon tetrachloride, methylene chloride, and TCE. Only data obtained since completion of the soil remedial activities in December 1999 was plotted to evaluate the effect of the soil RA on the groundwater. Figures 12, 13, 14, 15, and 16 show the concentration trends for benzene, chloroform, carbon tetrachloride, methylene chloride, and TCE respectively. The trends for the concentrations of these constituents were plotted for wells MW2, MW3, MW8, MW12, and MW36S. The locations for these wells are shown on Figure 2. Results that were qualified as non-detect were plotted as one half of the detection limit. In addition, results that were qualified as blank contaminated were not plotted. The wells selected to graph the concentration trends represent locations immediately down gradient of the boundaries of the soil RA and are good indicators of the contaminants in the groundwater near

the former source area. The figures indicate trends are generally constant or decreasing. One exception to this trend is carbon tetrachloride in the most recent sampling event (May 2002). The May 2002 results for all 5 wells indicate an increase in carbon tetrachloride after constant or decreasing levels in the 3 sampling events since the soil remedy was implemented.

Figure 12. Benzene Concentration Trend

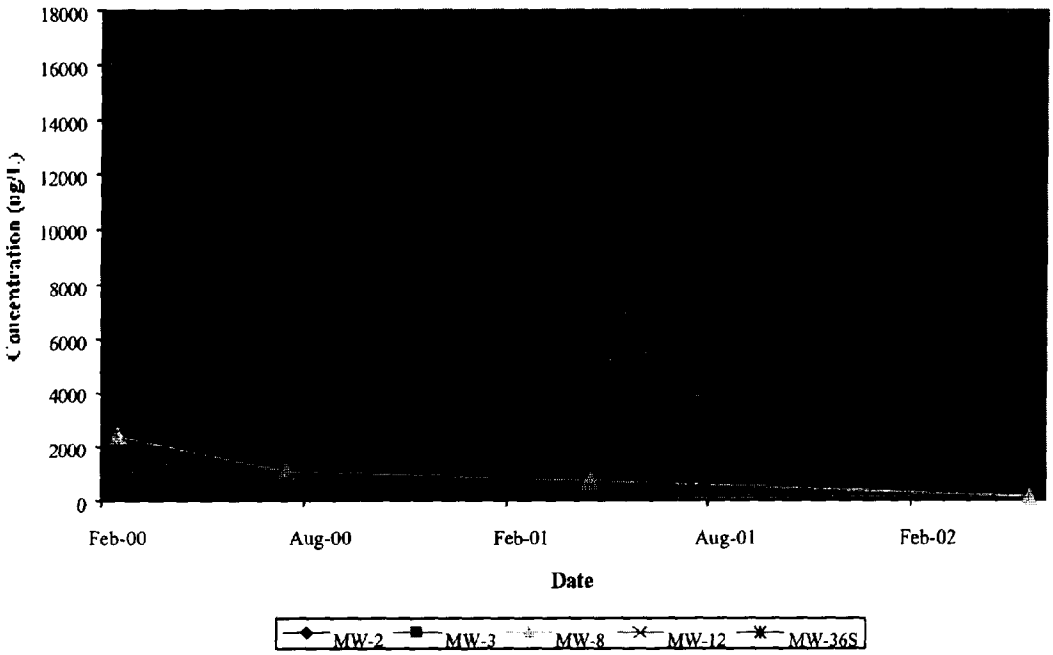


Figure 13. Carbon Tetrachloride Concentration Trend

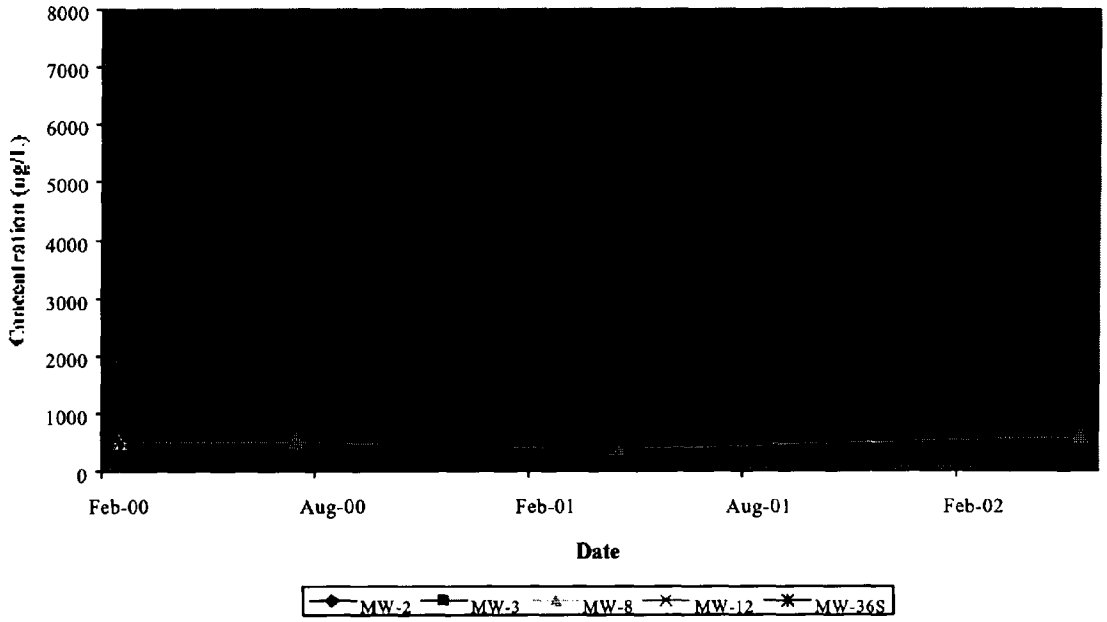


Figure 14. Chloroform Concentration Trend

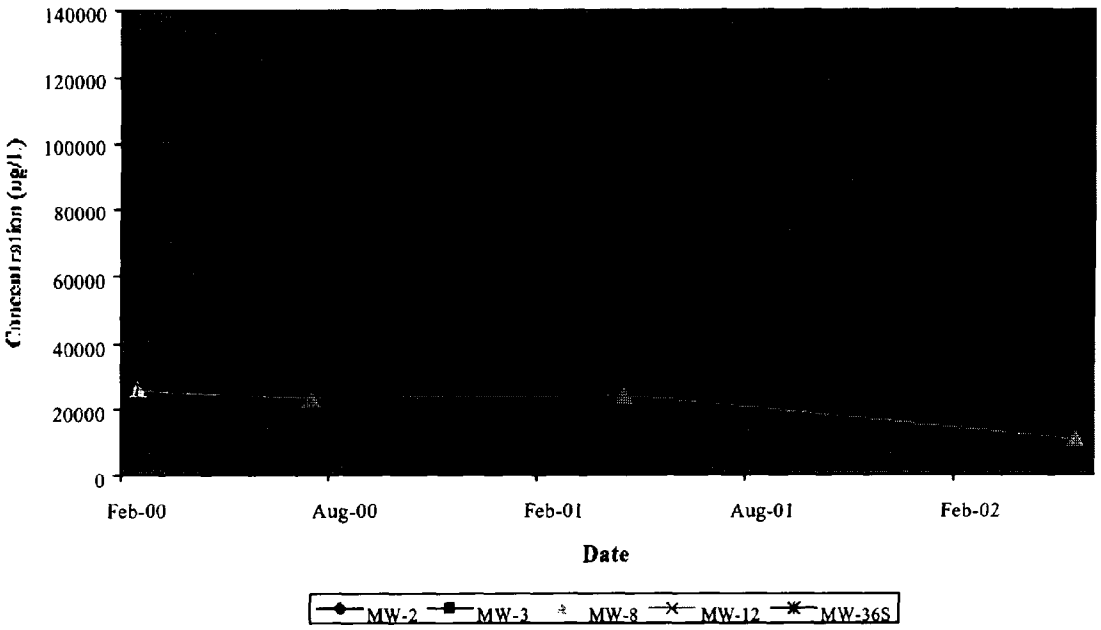


Figure 15. Methylene Chloride Concentration Trend

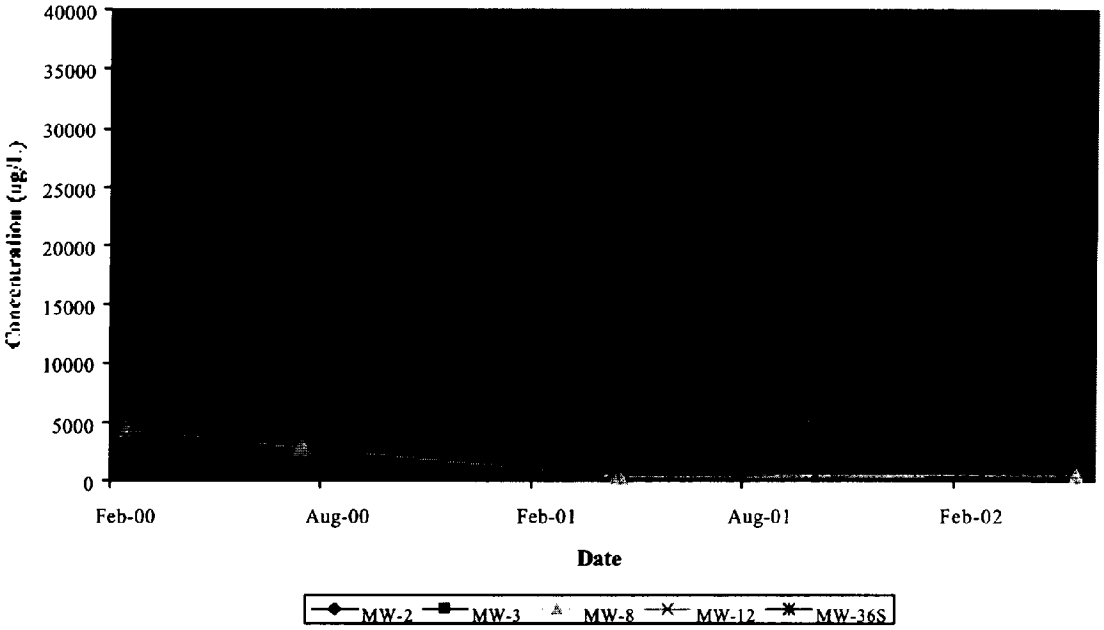
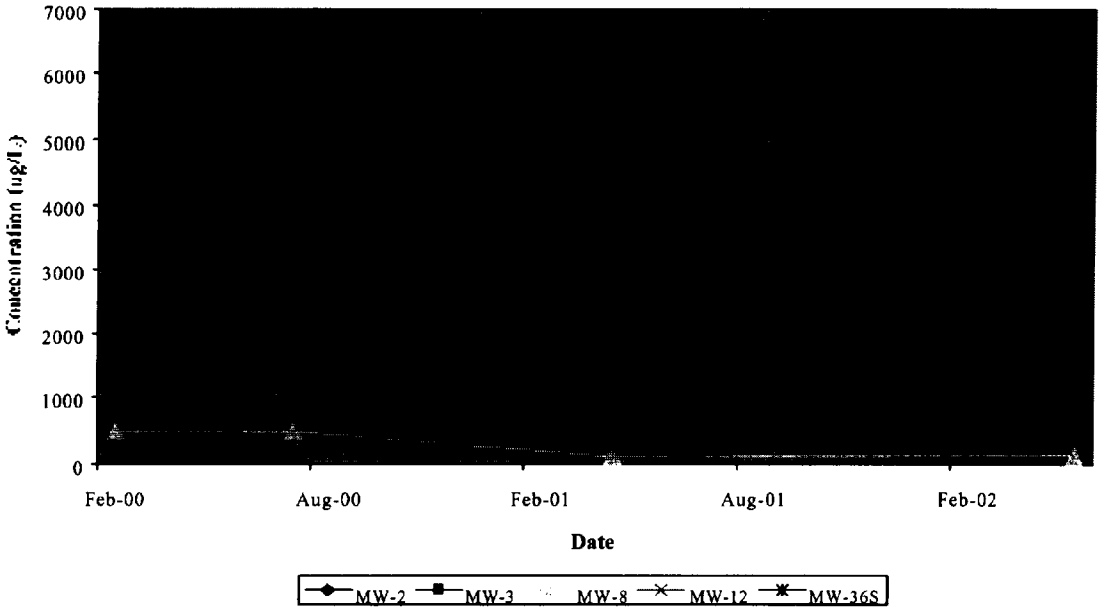


Figure 16. Trichloroethylene Concentration Trend



Sediment and Surface Water

During the installation of the soil cover after the *in-situ* mixing activities, a surface water and sediment sample was collected in the northwest corner from a depression formed in the area when the erosion control structure was removed. The samples were analyzed for VOCs, SVOCs, pesticides and herbicides, and inorganics and there were no constituents above regulatory limits in either sample (Marshall Miller & Associates 2000).

A surface water sample was collected after completion of the soil remedial action in February 2000. The sample was collected from an area containing puddle water less than 50 feet from the northwest corner of the boundaries of the soil remedial action and approximately 30 feet south of MW06 (see Figure 2). The sample was analyzed for VOCs. The results indicated VOCs were not detected above the detection limits.

In April 2001, surface water and sediment samples were collected from three locations near the site. The locations included a background location, from the middle of Richland Creek and from the confluence of Richland Creek and an unnamed tributary and are shown on Figure 17. The samples were analyzed for VOCs and the results indicated VOCs were not detected above the detection limits in any sample.

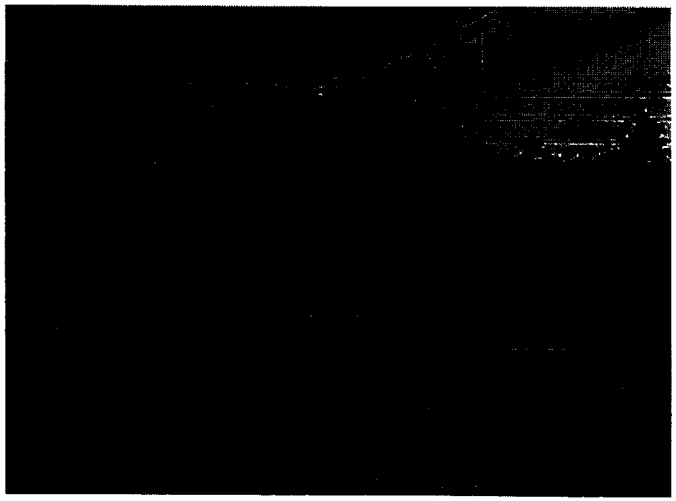
Figure 17. Sediment and Surface Water Sample Locations for Richlands Creek

REFERENCE:
United States Department of the Interior,
Geological Survey
U.S.G.S. Quadrangle for:
RALEIGH WEST, NORTH CAROLINA
PHOTOREVISED 1987
SCALE 1:24000

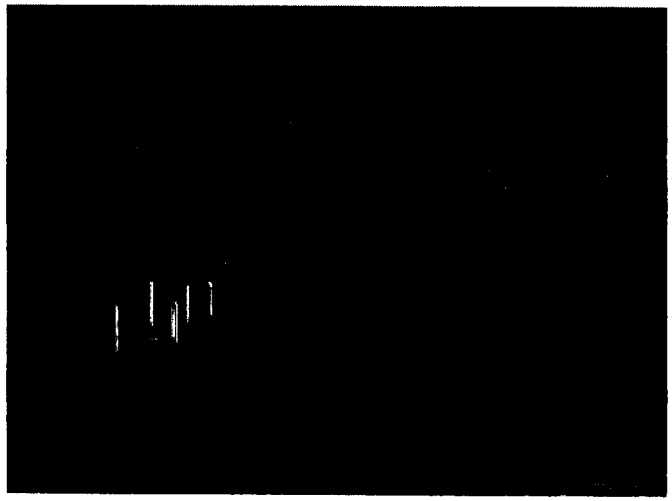
0.0 1000 2000 3000 4000 5000 6000 7000 8000

East Coast Environmental, P.A.	LOCATIONS OF STREAM SAMPLES NORTH CAROLINA STATE UNIVERSITY LOT 86 SUPERFUND SITE RALEIGH, WAKE COUNTY, NORTH CAROLINA			NOTES
CAD FILE: AREA.DWG	PREP. BY: KBB	REV. BY: TRW	DATE: 05/25/01	PROJECT NO.

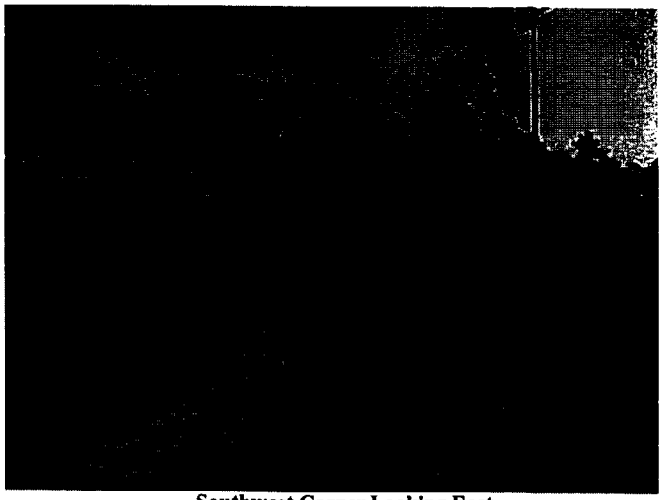
ATTACHMENT 3. Photographs of Site Visit



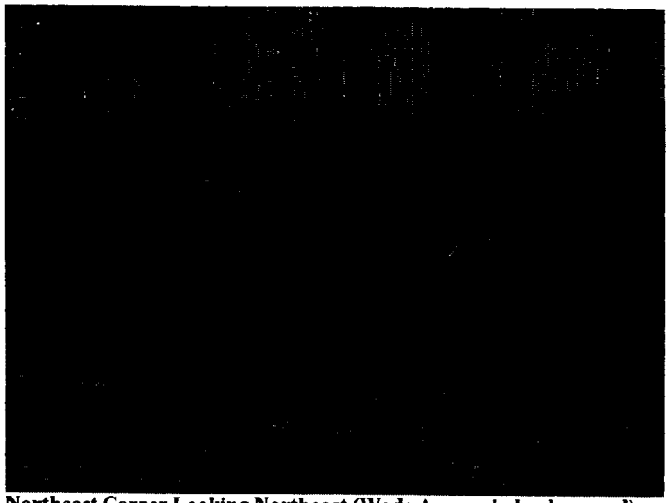
Looking East Outside Gate (Southwest Corner)



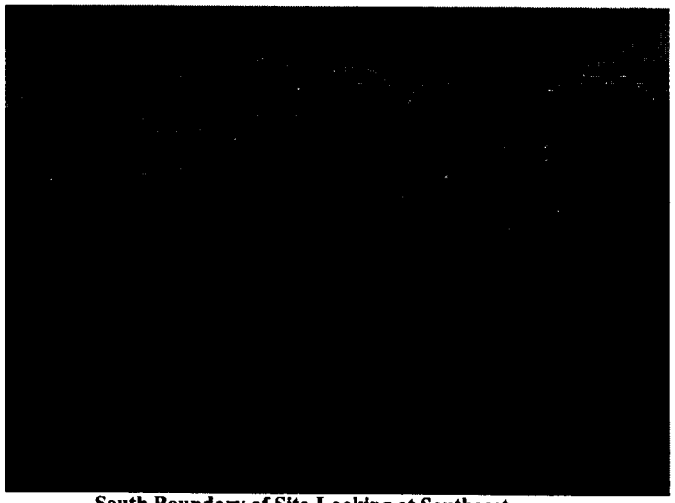
West Boundary of Site Looking North (MW-3 wells in foreground)



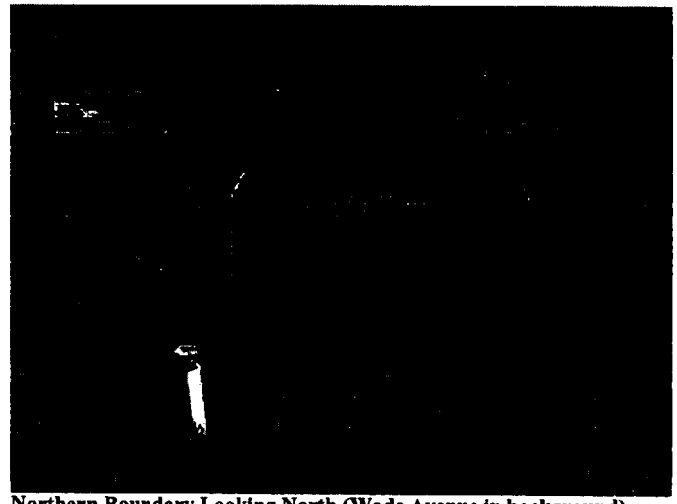
Southwest Corner Looking East



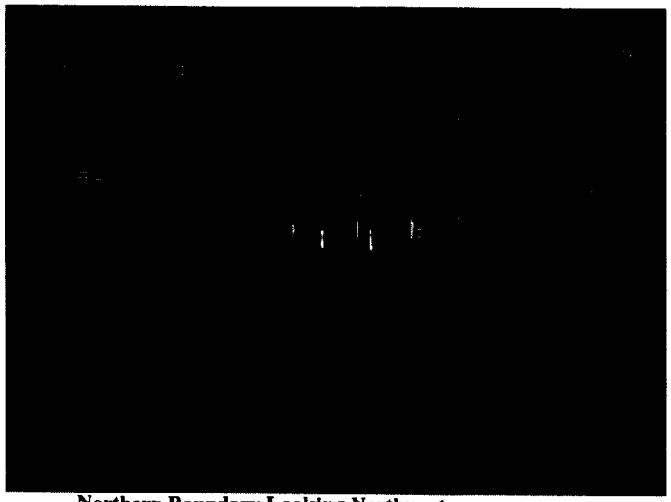
Northeast Corner Looking Northeast (Wade Avenue in background)



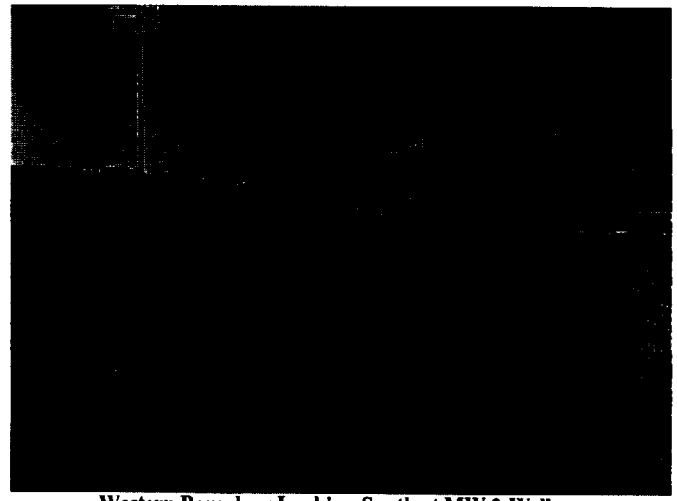
South Boundary of Site Looking at Southeast Corner in Direction of LLRW Trenches



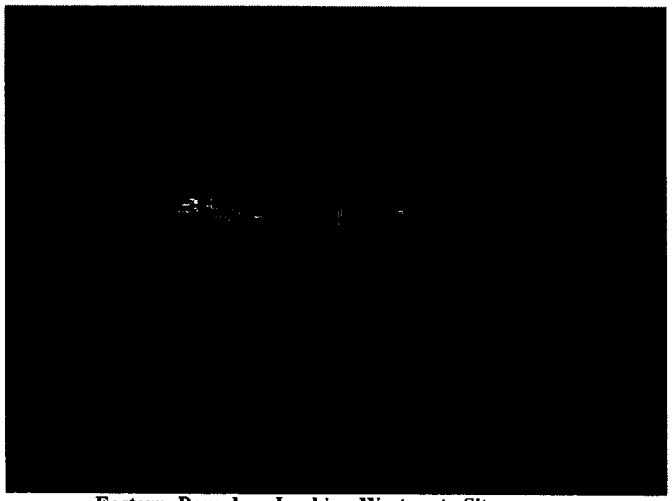
Northern Boundary Looking North (Wade Avenue in background)



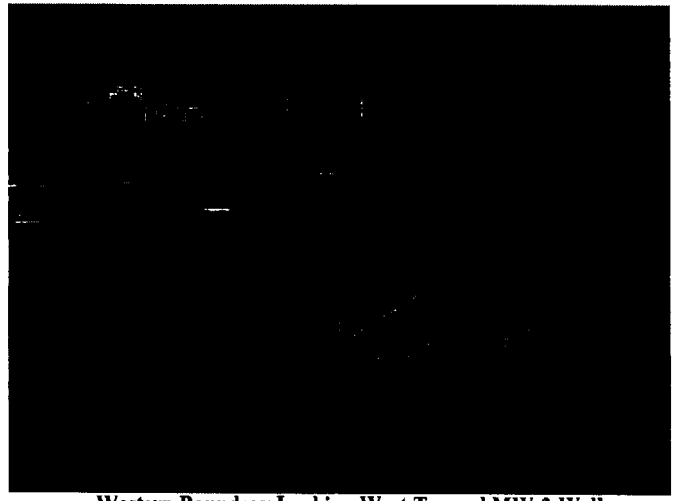
Northern Boundary Looking Northwest



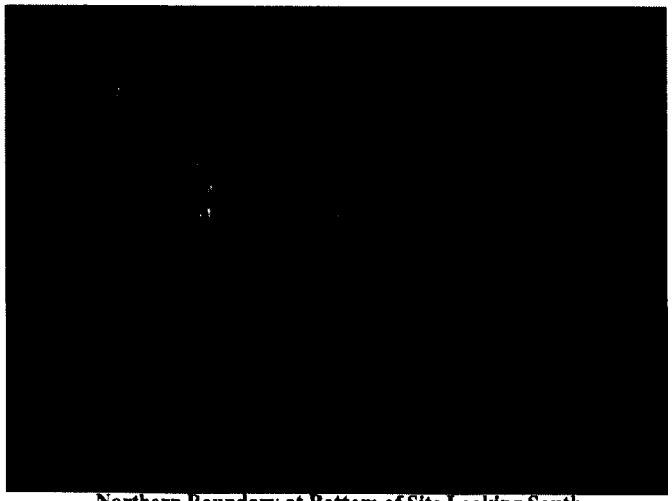
Western Boundary Looking South at MW-3 Wells



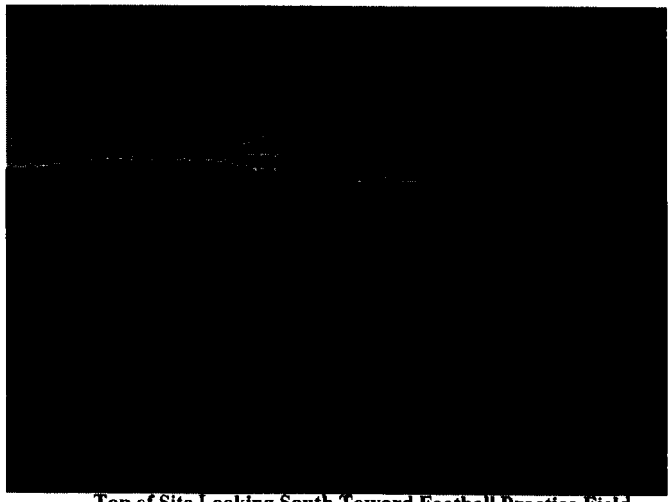
Eastern Boundary Looking West up to Site



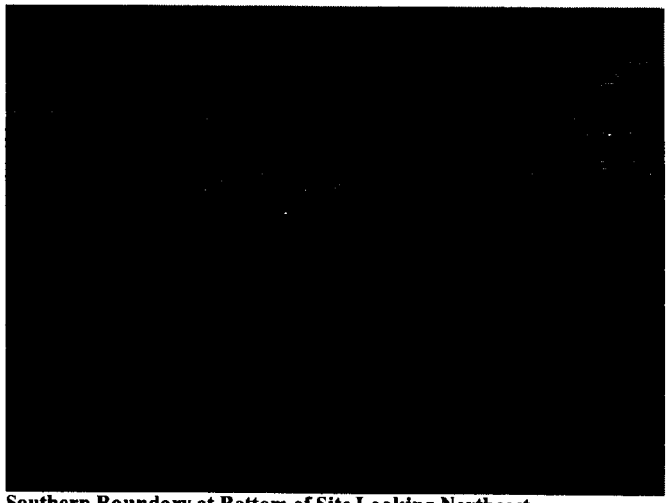
Western Boundary Looking West Toward MW-3 Wells



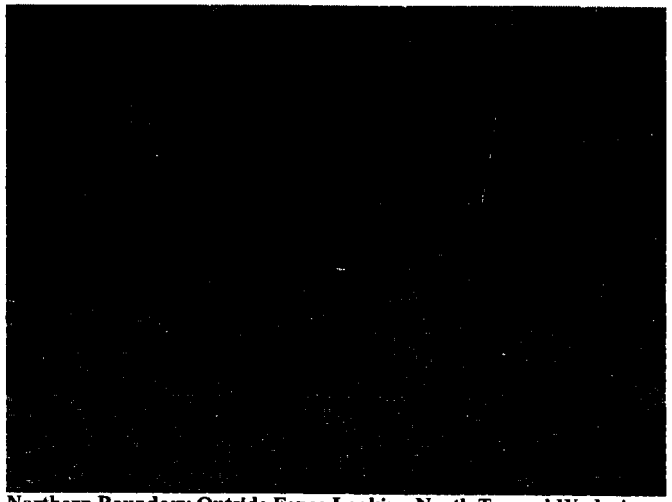
Northern Boundary at Bottom of Site Looking South



Top of Site Looking South Toward Football Practice Field



Southern Boundary at Bottom of Site Looking Northeast



Northern Boundary Outside Fence Looking North Toward Wade Avenue

ATTACHMENT 4. ARARs

ARARs

Medium	ARAR	Status	Requirement Synopsis	Action to be taken to attain ARAR
Groundwater	Federal – SDWA – Maximum Contaminant Levels (MCLs) (40 CFR Part 141)	Relevant and Appropriate	MCLs have been adopted as enforceable standards for the protection of human health.	MCLs were used as the basis for developing the Remediation Goals (RGs). RGs will be attained through the groundwater remedy.
Groundwater	North Carolina Drinking Water and Groundwater Standards (15A NCAC 2L)	Applicable	Standards are allowable levels of contaminants in groundwater used for drinking water.	Standards were used as the basis for developing the RGs. RGs will be attained through the groundwater remedy.
Surface Water	North Carolina Water Quality Standards (15A NCAC 2B.0100 & 0200) and Surface Water Effluent Limitations (15A NCAC 2B.0400)	Applicable	Standards are applicable to treated groundwater is discharged to surface water.	Remedial activities will comply with all provisions of this regulation.
Air	North Carolina Air Pollution Control Regulations (15A NCAC 2D, 2H, & 2Q)	Applicable	Standards are applicable to on-site treatment as part of the remedial action.	Remedial activities have complied with all provisions of this regulation.
Soil	North Carolina Hazardous Waste Management Rules (15A NCAC 13A.0009 & .0012)	Applicable	Standards are applicable to excavation and on-site treatment.	Remedial activities have complied with all provisions of this regulation.
Surface Water	Federal – 40 CFR 131	Relevant & Appropriate	Criteria for water quality based on toxicity to aquatic organisms and human health.	Remedial activities will comply with all provisions of this regulation.
Air	Federal – National Primary and Secondary Ambient Air Quality Standards (40 CFR 50) and National Emission & Standards for Hazardous Air Pollutants (40 CFR 61)	Relevant & Appropriate	Air standards and standards for hazardous air pollutants for protection of public health and welfare.	Remedial activities have complied with all provisions of this regulation.