Site: NC STATE
Break: 8.6
Other: 1.2

NCDENR
North Carolina Department of Environment and Natural Resources

NORTH CAROLINA
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF WASTE MANAGEMENT

Second Five-Year Review Report
North Carolina State University Lot 86 Site
Raleigh, Wake County, North Carolina
US EPA ID: NCD 980557656

Prepared for
US EPA Region 4
September 2008

SECOND FIVE-YEAR REVIEW REPORT
NORTH CAROLINA STATE UNIVERSITY LOT 86 SITE
US EPA ID: NCD 980557656

Prepared for the
US Environmental Protection Agency
Region 4

Prepared by the
State of North Carolina
Department of Environment & Natural Resources

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Prepared for the
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Prepared by the
North Carolina Department of Environment & Natural Resources

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List of Acronyms

ARAR	Applicable or Relevant and Appropriate Requirement
AWQC	Ambient Water Quality Criteria
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Contaminant of Concern
CRQL	Contract Required Quantitation Limit
CSE	Carolina Solar Energy
DOE	Department of Energy
EISOPQAM	Environmental Investigation Standard Operating Procedure and Quality Assurance Manual
GAC	Granular Activated Carbon
GWE	Groundwater Extraction
HDPE	High-Density Polyethylene
IC	Institutional Controls
LLRW	Low Level Radioactive Waste
MCL	Maximum Contaminant Level
MNA	Monitored Natural Attenuation
MW	Monitoring Well
NCAC	North Carolina Administrative Code
NC DWA	North Carolina Drinking Water Act
NC 2L	North Carolina Groundwater Standards
NC DENR	North Carolina Department of Environment and Natural Resources
NC DOT	North Carolina Department of Transportation
NCP	National Contingency Plan

NCSU	North Carolina State University
NC SWQS	North Carolina Surface Water Quality Standards
NGVD	National Geodetic Vertical Datum
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	Operation and Maintenance
POTW	Publicly Owned Treatment Works
psi	Pounds per square inch
PVC	Polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
RPM	Remedial Project Manager
SOP	Standard Operating Procedure
TCLP	Toxicity Characteristic Leaching Procedure
US EPA	United States Environmental Protection Agency
ug/l	micrograms per liter or ppb

Executive Summary

The North Carolina State University (NCSU) Lot 86 site is located on the west side of Raleigh, Wake County North Carolina, near Carter-Finley Stadium, immediately south of the southern right-of-way of Wade Avenue Extension, a limited access highway that connects to Interstate 40. The site is located on the north side of a development complex containing Carter Finley Stadium (NCSU football stadium) and the RBC Center (NCSU basketball and professional hockey facility). A wooded area is situated between the site and Wade Avenue Extension to the north, and a parking area for Carter Finley Stadium and the RBC Center is located south of the site. A NCSU football practice facility is located east of the site. NCSU agriculture research farms and facilities are located north of the site across Wade Avenue Extension.

The approximately 1.5 acre site is located on and surrounded by State-owned property. A six-foot high chain link fence topped with barbed wire surrounds the entire Site, and the only gate into the area is secured with a padlock. The site is covered with grass that is maintained by NCSU. A metal building housing the site groundwater extraction system is located inside the fenced enclosure. Since 2007, Carolina Solar Energy has leased the property from the State of North Carolina for a project in partnership with the Department of Energy. The project consists of ground mounted photovoltaic panels arranged in 12 solar arrays located on top of the capped and stabilized mound.

NCSU selected Lot 86 of Farm Unit No. 1 in 1969 as a burial site for hazardous chemical waste and low level radioactive waste generated in the University's education and research laboratories. Chemical wastes were placed in trenches located in the northwest portion of the Site. The University records show that 22 trenches, totaling approximately 2,000 linear feet, were used. The types of chemicals buried at the Site purportedly include solvents, pesticides, inorganics, acids, and bases. Although some of the liquid chemicals disposed during the initial site operations were poured into the trenches, both liquid and solid chemicals were generally buried in metal, glass, or plastic containers.

Radiological wastes were buried in the eastern portion of the site in trenches, similar to the other trenches in the northwest portion of the property, approximately six feet deep and 50 to 150 feet long. Nine trenches were reportedly excavated and used for Low Level Radioactive Waste (LLRW) disposal. The NCSU Radiation Protection Office maintains records concerning waste disposal in this area. These records indicate that the wastes were properly disposed at the Site. Most of the LLRW is in solid form, primarily animal carcasses that were not containerized. Radionuclides present in the waste indicate tritium, carbon-14, iron-59, phosphorous-30, and phosphorous-32.

The Site consists of one operable unit; the remedial actions provide remediation of contaminated soil and the remediation of contaminated groundwater. According to the September 1996 ROD, contaminated groundwater represents the primary medium of concern at the site. Surficial soils were determined to pose no substantial risk to human health or the environment. Subsurface soils were determined to represent a continuing source of additional groundwater contamination warranting address under the ROD. To achieve site remediation goals, the ROD specified the following actions:

- In-situ mixing and encapsulation was selected as the remedy for soil contamination. The technology involves in-place mechanical homogenization of buried wastes and soils and stabilization/solidification of the homogenized material through mixing with cement grout. The result of the process is a macro-encapsulated monolith that serves three functions: 1) gross waste materials are solidified in the monolith; 2) waste constituents that could potentially leach are micro-encapsulated within the cement matrix; and 3) the permeability of the waste material and soil are greatly reduced. The goal of the technology is to stabilize and solidify the waste material and associated contaminated soils, thereby eliminating further leaching of contaminants to groundwater.
- Groundwater extraction (GWE) was selected as the remedy for groundwater contamination. The technology involves pumping of contaminated groundwater from recovery wells, treatment of groundwater using air stripping and carbon adsorption to remove contaminants, and discharge of treated groundwater to a suitable receptor, such as surface water or the local publicly owned treatment works (POTW). The goal of the technology is to reduce site groundwater concentrations to the groundwater cleanup levels.

Since the last Five-Year Review, Carolina Solar Energy LLC (CSE) proposed and built a 70 kW photovoltaic solar generation project on Lot 86 for a renewable energy project. The project has been designated a Solar "Brownfields to Brightfields" Technology Demonstration Project by the US Department of Energy. Twelve solar arrays are located on the capped mound to generate electricity that is sold back to Progress Energy. CSE will own and operate the solar energy system for 20 years under a lease from the State of North Carolina.

This Five-Year Review for the NCSU Lot 86 Site is a statutory review. The triggering action is the signing date of the First Five-Year Review Report, September 25, 2003. The purpose of this Five-Year Review is to evaluate the remedies at the Site and to determine if the remedies and clean-up goals specified in the ROD remain protective of human health and the environment.

According to documents, the site inspection, and interviews with the US EPA and NCSU personnel, the soil remedy is complete and the groundwater remedy is currently operating and functional. The encapsulation soil remedial action began January 19, 1999 and was completed on September 21, 1999. The groundwater extraction (GWE) system was inspected by representatives of NCSU and their design and engineering firm on September 30, 2006, and

declared to be in commercial operation. The groundwater remedy is currently operational and functional as demonstrated by monthly compliance with all NPDES discharge requirements; however, no post-extraction analytical data is yet available to determine how effective the groundwater remedy is hydraulically containing the contaminant plume.

The remedies at the Site are currently protective of human health and the environment in the short-term as the main source of contamination was remediated through in-situ mixing and encapsulation of contaminated soils; groundwater contamination is actively being remediated through extraction and treatment; and currently no human exposure pathways exist to contaminated soil and/or groundwater. For the remedy to be protective in the long-term, permanent land use restrictions or other appropriate institutional controls need to be implemented and the remediation goals need to be achieved for groundwater.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name *(from WasteLAN)*: North Carolina State University Lot 86 Site		
US EPA ID *(from WasteLAN)*: NCD **980557656**		
Region: 4	**State:** NC	**City/County:** Raleigh, Wake County

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 / 27 / 2006
Has site been put into reuse? ☒ YES ☐ NO	

REVIEW STATUS	
Lead agency: ☒ US EPA ☐ State ☐ Tribe ☐ Other	
Author(s) name: David Mattison / Stephanie Grubbs	
Author(s) title: Engineer/Hydrogeologist	**Author(s) affiliation:** NC DENR
Review period: 2 / 1 / 2008 to 9 / 25 / 2008	
Date(s) of site inspection: 4 / 16 / 2008	
Type of review: Statutory	
Review number: ☐1 (first) ☒ 2 (second) ☐ 3 (third) ☐ Other	
Triggering Action: ☐ Actual RA Onsite Construction at OU #____ ☐Actual RA Start ☐ Construction Completion ☒ Previous Five-Year Review Report ☐ Other	
Triggering action date *(from WasteLAN)*: 9 / 25 / 2003	
Due date *(five years after triggering action date)*: 9 / 25 / 2008	

Issue:

1. Institutional controls have not been finalized for the Site. The Draft *Declaration of Perpetual Land Use Restrictions for a Federal Superfund Site* has been drafted and was recently revised in May 2008. The institutional controls are currently under review by NCSU, EPA and NC DENR and should be finalized as soon as possible.

Recommendations and Follow-up Actions:
Implement perpetual land use restrictions or other appropriate institutional controls at the Site.

Protectiveness Statement:

The remedies at the Site are currently protective of human health and the environment in the short-term as the main source of contamination was remediated through in-situ mixing and encapsulation of contaminated soils; groundwater contamination is actively being remediated through extraction and treatment; and currently no human exposure pathways exist to contaminated soil and/or groundwater. For the remedy to be protective in the long-term, permanent land use restrictions or other appropriate institutional controls need to be implemented and the remediation goals need to be achieved for groundwater.

1.0 Introduction

The purpose of conducting a Five-Year Review is to determine whether the remedy implemented at a Site is protective of human health and the environment. The methods, findings, and conclusions of this review are documented in the Five-Year Review report. In addition, Five-Year Review reports identify issues found during the review, if any, and identify recommendations to address them.

The North Carolina Department of Environment and Natural Resources (NC DENR), Division of Waste Management, Superfund Section, on behalf of the United States Environmental Protection Agency (US EPA), Region IV, has conducted a Five-Year Review of the remedial actions implemented at the North Carolina State University Lot 86 Site (Site) (US EPA ID# NCD 980557656). The Site is located on the west side of Raleigh, Wake County, North Carolina. The review was conducted from February 2008 through September 2008 and the results of the review are documented in this report. The review was conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) §121 and the National 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 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. 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 the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The US EPA interpreted this requirement further in the National Oil and Hazardous Substance Pollution Contingency Plan (NCP); 40 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.*

The methods, findings, conclusions, and significant issues found during the review are documented in this Five-Year Review report. This Five-Year Review was performed in a manner consistent with the latest US EPA Comprehensive Five-Year Review Guidance (US EPA, 2001).

The Site consists of one operable unit; the remedial action provides remediation of contaminated soil and the remediation of contaminated groundwater. Site-related contaminants associated with the soil were remediated through in-situ mixing and encapsulation. Contaminated groundwater is currently being extracted and treated via air stripping, filtration, activated carbon polishing and mercury-specific ion exchange treatment to meet discharge limits.

The triggering action for this review is the signing date of the First Five-Year Review Report, September 25, 2003. This Five-Year Review for the North Carolina State University Lot 86 (NCSU) Site is a statutory review. A statutory review is conducted when "upon completion of the remedial action, hazardous substances, pollutants, or contaminants will remain on Site above levels that allow for unlimited use and unrestricted exposure" (US EPA Comprehensive Five-Year Review Guidance, June 2001, Section 1.3.1). In accordance with CERCLA §121 and the NCP, a statutory review is triggered by the initiation of the first remedial action that leaves hazardous substances, pollutants, or contaminants on site above levels that allow for unlimited use and unrestricted exposure. As stated in the 1996 Record of Decision (ROD), the goal of the remedial action is to prevent migration of contaminants to surface water that would result in contamination to levels greater than the Ambient Water Quality Criteria (AWQC), control future release of contaminants to ensure protection of human health and the environment, and permanently and significantly reduce mobility, toxicity, or volume of characteristic hazardous waste with treatment.

The purpose of this Five-Year Review is to evaluate the remedy at the Site and to determine if the action remains protective of human health and the environment. More specifically, the purpose is:

- To confirm that the remedies, as specified in the 1996 ROD, remain effective at protecting human health and the environment (i.e., the remedies are operating and functioning as designed), and
- To evaluate whether the clean-up levels specified in the RODs remain protective of human health and the environment.

The next Five-Year Review for the Site will be due in September 2013.

2.0 Site Chronology

Table 1 lists the Site chronology for selected events for the Site.

3.0 Background

3.1 Site Description

The North Carolina State University (NCSU) Lot 86 site is located on the west side of Raleigh, Wake County North Carolina, near Carter-Finley Stadium, immediately south of the southern right-of-way of Wade Avenue Extension, a limited access highway that connects to Interstate 40. The site location is shown in Figure 1, and a site map is provided as Figure 2.

The site is located on the north side of a development complex containing Carter Finley Stadium (NCSU football stadium) and the RBC Center (NCSU basketball and professional hockey facility). A wooded area is situated between the site and Wade Avenue Extension to the north, and a parking area for Carter Finley Stadium and the RBC Center is located south of the site. A NCSU football practice facility is located east of the site. NCSU agriculture research farms and facilities are located north of the site across Wade Avenue Extension.

The approximately 1.5 acre site is located on and surrounded by State-owned property. A six-foot high chain link fence topped with barbed wire surrounds the entire Site, and the only gate into the area is secured with a padlock. The site is covered with grass that is maintained by NCSU. A metal building housing the site groundwater extraction system is located inside the fenced enclosure. Since 2007, Carolina Solar Energy has leased the property from the State of North Carolina for a project in partnership with the Department of Energy who designated it a Solar "Brownfields to Brightfields" Technology Demonstration Project. The project consists of ground mounted photovoltaic panels arranged in 12 solar arrays located on top of the capped and stabilized mound for a renewable energy project. The electricity that is generated is sold back to Progress Energy. CSE will own and operate the solar energy system for 20 years under a lease from the State of North Carolina.

3.2 Site Topography, Geology, and Hydrogeology

The Site area lies within the upland division of the Piedmont Physiographic Province of the eastern United States. The Piedmont occurs as a wide belt extending along the east margin of the Appalachian chain. Wake County ground surface elevations range from 140 feet to a high of 545 feet relative to mean sea level. Relief on the order of 50 to 100 feet, measured from upland to adjacent stream valleys, is common. The topography of the area surrounding the Site is that of upland consisting of rolling hills and rounded ridgelines and lowlands characterized by narrow to broad valleys.

Groundwater occurs in the silty clay/granular soils and in the underlying crystalline bedrock under general water table (unconfined) conditions. The unconsolidated soils aquifer is recharged mainly by the infiltration of precipitation where it is exposed. The bedrock water-bearing unit at the Site is a felsic gneiss. The bedrock unit contains groundwater under either water table or semi-confined conditions, depending on the thickness of the overburden, slopes, and other factors. Based on past studies at the Site, groundwater was encountered in the shallow unconsolidated residual soil/saprolite water-bearing unit at depths ranging from 20 to 40 feet below grade. Past studies also have indicated that the groundwater flow in the surficial aquifer, as well as the bedrock aquifer, is toward the northwest, in the direction of Wade Avenue.

The Site is situated on a broad crest of a low rolling hill and occupies a generally level tract of land. The study area is drained by two intermittent (seasonal) unnamed tributaries and one perennial tributary of Richland Creek. One seasonal stream, which runs in a north-south alignment, is located approximately 500 feet east of the Site. The second seasonal stream begins at a lake located approximately 1,600 feet west of the Site and extends generally westward toward its confluence with Richland Creek. The perennial stream originates at the North Carolina State Fairgrounds Lake, 2,100 feet south of the Site, and flows generally west to its confluence with Richland Creek.

3.3 Land and Resource Use

Athletic practice fields border the Site to the south and east and the grassy area to the west of the Site is used for parking during events held at Carter Finley Stadium or the RBC Center. Land further west of the Site to Richland Creek includes wooded land, open fields, and a roadway. Land immediately north of the Site is wooded and sloped downward to Wade Avenue. The closest residents and water supply well is located approximately 2,000 feet southeast (and hydraulically upgradient) of the Site.

Two changes regarding the use of the property have occurred since the last five-year review. As stated previously, Carolina Solar Energy is currently utilizing the Site for a renewable energy project. Twelve solar arrays are located on the capped mound to generate electricity that is sold back to Progress Energy. The second change is the groundwater extraction system is currently operating and the building on site was erected to house the treatment system. The entire Site is fenced to prevent trespassing and tampering of both the solar and groundwater systems. Currently no groundwater is being used at the Site or surrounding properties. The ROD did not describe the current or future land use for the Site; however, the land has been put into beneficial reuse with the installation of the renewable energy project.

3.4 History of Contamination

NCSU selected Lot 86 of Farm Unit No. 1 in 1969 as a burial site for hazardous chemical waste and low level radioactive waste generated in the University's education and research

laboratories. Chemical wastes were placed in trenches located in the northwest portion of the Site. The trenches were approximately eight feet deep and varied from 50 feet to 150 feet long. After the trenches were filled, approximately two feet of native soil, which was excavated during trench construction, was used as cover material. Later, the disturbed area was seeded with grass. The University records show that 22 trenches, totaling approximately 2,000 linear feet, were used. The types of chemicals reported to have been buried at the Site include solvents, pesticides, inorganics, acids, and bases. Although some of the liquid chemicals disposed during the initial site operations were poured into the trenches, both liquid and solid chemicals were generally buried in metal, glass, or plastic containers.

Radiological wastes were buried in the eastern portion of the site in trenches, similar to the other trenches in the northwest portion of the property, approximately six feet deep and 50 to 150 feet long. Nine trenches were reportedly excavated and used for Low Level Radioactive Waste (LLRW) disposal. The NCSU Radiation Protection Office maintains records concerning waste disposal in this area. These records indicate that the wastes were properly disposed at the Site. Most of the LLRW is in solid form, primarily animal carcasses that were not containerized. Radionuclides present in the waste indicate tritium, carbon-14, iron-59, phosphorous-30, and phosphorous-32.

NCSU reported on the CERCLA Section 103(c) Hazardous Waste Notification Form, completed in June 1981, that it had disposed of approximately 300,000 cubic feet or about 11,000 cubic yards of chemical waste at the Site. The Site was proposed for listing on the National Priorities List (NPL) on October 15, 1984 and placed on the final NPL on July 10, 1986. The NPL is a list of priority releases for long-term evaluation and remedial response, and was promulgated pursuant to section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended. The NPL list is found in the NCP (Appendix B of 40 CFR part 300).

3.5 Initial Response

No removal or remedial activities occurred at the Site prior to the signing of the ROD.

3.6 Basis for Taking Action

Environmental investigations have been ongoing at the Site since the early 1980s. After the initial phase of the work identified the presence of impacted groundwater beneath the Site, thirty-three monitoring wells were advanced near the Site for the purpose of evaluating potential groundwater impacts. From September 1993 through February 1994, a Remedial Investigation (RI) was conducted to confirm that contaminants were present and to assess the extent, magnitude, and impact of contamination. Following the findings of the RI, a Feasibility Study (FS) and then a Revised FS were performed to evaluate potential remedial approaches for addressing the soil and groundwater contamination at the Site. As part of the effort associated with conducting the Revised FS, a Limited Site Assessment and Source Characterization was

completed, soil samples were collected from hand augers and GeoProbe borings, and a soil vapor extraction test was conducted. Both the RI (completed in October 1994) and the FS (the Revised FS was completed in February 1996) were conducted in accordance with the NCP, and as specified by the Administrative Order on Consent for RI/FS. The Baseline Risk Assessment for the Site was completed in March 1995. On November 13, 1998, the Consent Decree was finalized for the settlement of the responsible party (NCSU) performance of the remedial design, remedial action and operation and maintenance, and the Consent Decree was entered in by the Federal Court. The US EPA, in developing the ROD for the Site, used the FS in combination with the RI and the baseline risk assessment.

As summarized in the 1996 ROD, *"The Baseline Risk Assessment (BRA) report presents the results of a comprehensive risk assessment that addresses the potential threats to public health and the environment posed by the Site under current and future conditions, assuming that no remedial actions take place, and that no restrictions are placed on future use of the Site. The BRA being summarized considered the Site risks associated with the soils, groundwater and the air pathways associated with those two media.*

Data collected during the RI was reviewed and evaluated to determine the contaminants of concern at the Site, which are most likely to pose risk to the public health. These contaminants were chosen for each environmental media sampled. Once these contaminants of concern were identified, exposure concentrations in each media were estimated. Exposure point concentrations were calculated for groundwater and surface soils using the lesser of the 95% upper confidence limit concentration or the maximum detected value as the reasonable maximum exposure point concentration.

The exposure assessment evaluates and identifies complete pathways of exposure to human population on or near the Site. Current and future exposure scenarios include potential surface soil exposure via incidental ingestion and dermal contact; ingestion of groundwater; and inhalation of volatiles evolved from groundwater during household water use."

Exposure point concentrations for groundwater are presented in Table 2. Exposure point concentrations for the surficial soils are presented in Table 3.

Based on all the information gathered during the RI, FS, and risk assessment, the ROD specified in situ soil stabilization to address the source material and surrounding subsoils and groundwater extraction and treatment as the selected remedy for addressing the groundwater contamination beneath the Site.

4.0 Remedial Actions

In accordance with CERCLA and the NCP, the overriding goals for any remedial action are protection of human health and the environment and compliance with ARARs. A number of remedial alternatives were considered for the Site, and final selection was made based on an

evaluation of each alternative against nine evaluation criteria that are specified in Section 300.430(f)(5)(i) of the NCP. The nine criteria include:

1. Overall Protectiveness of Human Health and the Environment
2. Compliance with ARARs
3. Long-Term Effectiveness and Permanence
4. Reduction of Toxicity, Mobility or Volume of Contaminants through Treatment
5. Short-term Effectiveness
6. Implementability
7. Cost
8. State Acceptance
9. Community Acceptance

The purpose of the remedial actions, as stated in the 1996 ROD, was to address contaminated media at the Site by eliminating, to the extent practicable, the volume and migration of contaminants present and to remediate all areas of contamination at the Site. As stated in the ROD, the remedial action objectives (RAOs) for groundwater are:

- Prevent migrations 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; and
- Permanently and significantly reduce mobility, toxicity, or volume of characteristic hazardous waste with treatment.

As noted within the selected remedy within the ROD, the goal of the selected groundwater remedy is to restore the groundwater to its beneficial use. Because this remedy resulted in hazardous substances, pollutants, or contaminants remaining on site above levels that allow unlimited use and unrestricted exposure (i.e., contaminated soil and groundwater), Five-Year Reviews will be completed to assess site conditions, contaminant distributions, and any other associated site hazards.

4.1 Remedy Selection

4.1.1 1996 Record of Decision

The remedies set forth in the September 30, 1996 ROD provide for remediation of contaminated soil and groundwater. The major components of the remedy include:

- In-situ mixing and encapsulation of the contaminated soils;
- Extraction of groundwater and treatment by air stripping and carbon adsorption; and

- Discharge of treated groundwater to surface water or local publicly owned treatment works (POTW).

The ROD stated, "groundwater remediation will consist of air stripping to remove volatile organics, and carbon adsorption to remove organics. The groundwater system will operate 24 hours per day. System controls will allow complete automatic operation with minimal operator attention. Long-tem monitoring for clean-up verification purposes and to track contaminant plume migration will be required. The system is expected to operate 30 years; samples will be collected from existing wells on a semi-annual basis for the first five years, and on an annual basis for the following 25 years. The groundwater treatment system will also require monitoring and maintenance. Monitoring of the influent and effluent from the treatment system and analysis in accordance with the permit requirements."

Provisions for surface water sampling were not described in the ROD; however, indications are that the groundwater plume is under hydraulic containment and is not projected to reach any surface water bodies. Table 4 shows the remediation goals for groundwater under the 1996 ROD.

4.1.2 Explanation of Significant Difference

On July 21, 1999 an Explanation of Significant Difference was signed to modify the soil remedy at the Site. The basic technology remained the same; however, the method for mixing the soil and cement was modified due to Site conditions. The auger mixing method was no longer capable of completing the soil remedy, and a trackhoe was used to remove the top two feet of soil from each trench and the evacuated space was then filled with cement. The cement and the underlying soils within each trench were then mixed by the trackhoe using a combination of digging and mixing to achieve a soil and cement mixture that was thoroughly mixed.

4.2 Remedy Implementation

Soil

Based on findings of the RI, it was determined that the surface soils did not pose a risk to human health and the environment. However, the subsurface soils were found to be a continuing source of contamination to the groundwater and needed to be addressed. The remedy described in the ROD for the soils was in situ mixing and encapsulation. The soils were to be mixed within the borehole via a mixing auger. The VOCs that were released as a result of the mixing would be captured by a specially designed borehole shroud, and treated. The treatment would possibly include, but not limited to, liquid vapor intrusion separation, in-line prefiltration for dust and particle removal, followed by parallel activated carbon filter banks. The remaining contaminants would be solidified in situ using various pozzolan-portland cement based formulations, delivered to and dispersed within the soil column as grout. The specific remedial action objectives were not developed at the time of the ROD.

There were concerns at the time of the Remedial Design (completed in November 1998) that the shallow soil mixing presented several complicating factors. These complicating factors included: the possible inability to reduce and/or eliminate the leaching of highly concentrated (pure) chemicals buried at the Site; the potential mixing of constituents could react and generate harmful/explosive by-products; and the presence of drums and other obstructive material would inhibit thorough mixing. In order to evaluate the implementability of the remedy, a treatability study was conducted along with bench scale testing of the encapsulating process. The results of the bench scale test identified that a 15% mixture of reagent (water cement mixture) by weight would satisfactorily encapsulate the Site contaminants. This meant meeting the TCLP toxicity characteristic criteria for non-hazardous material, as defined by 40 CFR 261.24. The performance standard selected to assume the proper mixture was based on the compressive strength of the cured soils mixture. The compressive strength selected was 30 psi, with no more than 10% of the collected samples having strengths below 30 psi, and no sample's compressive strength falling below 20 psi. The frequency of testing would occur every 100 cubic yards or at a minimum once per day during the mixing operation.

This specified treatment addresses the waste material buried in trenches, as well as soils surrounding the trenches, at the Site using in-situ mixing and encapsulation. In January 1999, Marshall Miller and Associates began implementing this technology at the Site. Based on the Limited Site Assessment conducted during the Treatability Study, the northwest corner of the Site was suspected of having a fair concentration of drums. Disposal records and practices suggested that drums were isolated and scattered throughout the Site. During the operation, eight drum carcasses were unearthed and were placed in five 95-gallon overpack drums. The overpack drums were removed and disposed off-site by the University's laboratory disposal contractor.

Actual soil mixing began on January 19, 1999 using a crane mounted, eight-foot diameter mixing auger. The fluid grout was blended into the soils. The grout doubled as a drilling fluid and assisted the mixer in penetrating the ground. Mixing continued until a homogeneous blend was achieved within the column of material. Successive columns were overlapped to provide complete coverage of the treatment area. During the mixing operations, a hood shrouded the immediate mixing area, which was kept under negative working pressure to evacuate any liberated vapors through the treatment train to address air-borne contaminants. The off-gas treatment train consisted of a flame catalytic oxidizer with a 7.5 horsepower blower to maintain the necessary negative pressure on the shroud. The oxidizer was capable of 95% destruction efficiency with a retention time of 0.5 seconds. The uncontrolled output from the trenches was estimated to be 600 pounds for the sixty-day operation period, which would result in approximately 30 pounds of hydrocarbons from the oxidizer. The estimated uncontrolled output from the trenches was well below the North Carolina DENR mandated limit of five tons per year. The controlled output from the trenches, which was 5% of the total estimated uncontrolled output, was also within the NC DENR mandated limit of five tons per year.

During the soil mixing operation, bedrock outcroppings were encountered at depths as shallow as three feet below ground surface. Upon this discovery, a Geoprobe™ direct push unit was brought in to map the bedrock outcroppings. In addition to the bedrock, compressed gas cylinders of various shapes and sizes were encountered. Ultimately, as a result of continual damage to the auger by the obstructions, the crane mounted mixing unit was abandoned and replaced by a trackhoe to encapsulate the soil. The basic technology remained unchanged; however, instead of using an auger to mix the material, a trackhoe was used to remove the top two feet of the soil from each trench and the excavated space was then filled with cement. The cement and the underlying soil in each trench was then mixed using a combination of digging and mixing motions to ensure that the soil and cement material were thoroughly mixed. The trackhoe operation was initiated on February 15, 1999 and was operated until February 26, 1999, at which time the operation was suspended to evaluate the air monitoring protocol and any potential health and safety concerns that might arise from the trackhoe mixing operation. Mixing with the trackhoe met the same performance standards as the crane mounted operation; and, the trackhoe provided a greater amount of control over the mixing operation as the result of the improved down hole visibility. The disadvantage of using the trackhoe was that the shrouded hood no longer contained the vapor emissions. During implementation of the trackhoe mixing and encapsulation process, releases of vapors to the atmosphere occurred in small vapor clouds, referred to as "puff" releases. From March to August 1999 results of air-dispersion modeling of the puff releases were submitted to the U.S. EPA and evaluated by the Agency. Based on the results of the modeling, which indicated no off-site impacts above health-based criteria, Agency approval to continue with trackhoe mixing and encapsulation was provided. As stated in the Explanation of Significant Difference (ESD), "*the new method is accompanied by operational techniques that are designed to extinguish any chemical reactions as they occur; therefore, minimizing the fugitive emissions in this manner, the need for the shrouded hood is alleviated.*" The change in the mixing methodology was addressed in the July 21, 1999 ESD. The operation recommenced on August 27, 1999 and continued until the final day of mixing, September 21, 1999.

During the remedial activities, a total of 113 samples of stabilized material were obtained to demonstrate conformance with the performance standards established for the Site. Approximately 2,240 tons of cement and approximately 743,000 gallons of water were used to stabilize almost 11,000 cubic yards of waste material and impacted soil. Through quality control during remedial action and verified by cement weight tickets, the soil mixture contained at least 15% cement by weight, and statistical analysis suggests that the solidified monolith has a compressive strength in excess of 30 psi. As demonstrated in the Treatability Study, this correlates with the passing of the Toxicity Characteristic Leaching Procedure (TCLP) criteria, thus passing the performance standards stipulated in the ROD. To prevent extensive erosion, the Site was re-graded with no slope exceeding a 4:1 ratio. The soil covers from the surrounding areas were crowned to deter infiltration and to direct runoff away from the monolith. The Site was covered with one foot of clean soil and all disturbed areas were reseeded. Since the source is immobilized and the encapsulation of the waste resulted in a relatively impervious concrete cap over the Site, no further action is required to address this media.

Groundwater

Prior to the initiation of any remedial activities at the Site, NCSU retained GEI Consultants, Inc. (GEI) in 1997 to conduct a comprehensive groundwater sampling and evaluation process to investigate the performance of monitored natural attenuation (MNA) at the Site. This process continued through July 2000 with the results of the analysis summarized in the Draft Evaluation of Monitored Natural Attenuation (March 2001). On a parallel track, in 1999, the University retained Mid-Atlantic Associates, to develop a Remedial Design to actively address the groundwater impacts at the Site while continuing to study the effectiveness of MNA as a potential treatment strategy. The conclusion of the evaluation report prepared by GEI indicated that while natural attenuation of the constituents was occurring at the Site, there was insufficient evidence to comment on the degradation capabilities in the bedrock aquifer. In order to further evaluate the bedrock aquifer, the University retained East Coast Environmental in 2003 to advance an additional seven deep monitoring wells (installed at a depth of approximately 100 feet below land surface). These new wells, along with the other site wells, were sampled in June 2003 and the results of the well installation and sampling event were reported in the Fractured Rock Assessment, September 2, 2003. The conclusion as stated in the report was:

" In conclusion, the analytical results for this most recent June 2003 groundwater sampling event show a general decrease of contaminant concentrations in the most highly contaminated monitoring wells when compared to historical data from previous monitoring events.

Further, the installation and sampling of seven deep wells screened in the fractured bedrock have determined that contaminants have migrated into the fractured bedrock just northwest of Lot 86 and are concentrated in the vicinity of the well networks MW12D, MW17D, and MW36D. However, the fractured bedrock contaminant plume appears to be limited to this area and contaminant levels drop off considerably in all directions from these wells. This statement is supported by the fact that samples collected from six other nearby "deep" wells were found to contain only chloroform at an average concentration of 1.8 ug/l while its North Carolina Groundwater Standard is 0.19 ug/l."

Figure 2 is a complete map depicting the locations of all of the monitoring wells installed at the Site. Figures 3 through 12 are contaminant specific isoconcentration maps of the shallow and deep wells at the Site. These maps include chloroform, tetrachloroethene, methylene chloride, carbon tetrachloride, and benzene.

As specified in the ROD, groundwater extraction and treatment was selected as the remedial strategy for addressing the groundwater impact beneath Lot 86. In February and March 2005, a comprehensive field-testing program was conducted to develop initial design criteria for the Groundwater Extraction (GWE) system. Slug testing to evaluate aquifer hydraulic conductivity was conducted using 22 monitoring wells screened in the shallow, intermediate, and

deep aquifer zones. In addition, a 36-hour aquifer stress test (i.e., pump test) was conducted using a dedicated, fully penetrating, 4-inch diameter, stainless-steel recovery well, which was installed along with three dedicated observation wells.

Based on the data collected during the slug and pump test, a design radius of influence of 50 feet was selected for the GWE well system. Extraction-well locations were selected such that radii of influence of adjacent wells overlap. The shallow wells were also located in parallel, overlapping, rows with respect to the static direction of groundwater flow, such that a well in one row is in the gap between the wells of the adjacent row. The well arrangement provides for multiple overlapping zones of influence with respect to directions of groundwater flow and contaminant plume migration. The wells were also arranged to maximize coverage of the areas of highest groundwater contaminant concentrations and to take advantage of existing cleared areas and suitable topography wherever possible.

Based on the above GWE well design criteria, a total of thirteen shallow GWE well locations, and four deep GWE locations, were selected for GWE system construction. Based on the maximum stabilized pumping rate observed during the pump test, a minimum design groundwater recovery and treatment rate of 8.5 gallons per minute (gpm) was selected for the GWE system.

To evaluate and verify that the proposed GWE well field would meet the GWE system performance goal of contaminant plume containment, computerized groundwater flow modeling was conducted using Visual Modflow Pro, a three-dimensional numeric model used for simulating groundwater flow and contaminant transport. Results of groundwater modeling indicated that the proposed GWE system would achieve the groundwater contaminant capture and containment goals with the optimum number and spacing of the recovery wells.

Contaminant loading for the groundwater treatment system design was based on laboratory analysis of a groundwater influent sample collected during the pump test for VOCs, SVOCs, and metals. Detected contaminant concentrations were compared to remedial action objectives listed in the ROD, and the design concentration was designated as the higher of the influent sample concentrations versus remedial action objectives.

A summary of the GWE system process and design is provided as follows:

- A conservative GWE system recovery and treatment design flow rate of 20 gallons per minute was selected based on the results of the pre-design pump test and groundwater flow modeling.
- The GWE system incorporates thirteen shallow GWE wells and four deep GWE wells. The shallow GWE wells are constructed of 4 inch inside diameter (I.D.), stainless-steel, well screen/casing and are installed to depths ranging from approximately 50 to 80 feet below grade (approximately 378 to 345 feet National Geodetic Vertical Datum (NGVD). The deep GWE wells are constructed of 4 inch I.D., stainless-steel, well screen/casing

and are installed to depths ranging from approximately 118 to 152 feet below grade (approximately 310 to 265 feet NGVD), with outer 6 inch Schedule 40 PVC casings grouted into the top of bedrock. Each GWE wellhead is enclosed in a concrete vault that houses electrical and plumbing connections.

- Pumping depths of 380 feet NGVD for shallow GWE wells and 370 feet NGVD for deep GWE wells were selected to maximize induced groundwater flow from deeper to shallower aquifer zones.
- Contaminated groundwater is pumped from the GWE wells using dedicated, stainless-steel, variable-frequency drive, electric submersible pumps.
- Individual pump recovery lines manifold into a 2 inch I.D., high-density polyethylene (HDPE) header line that conveys recovered groundwater to the treatment building.
- Upon entering the treatment building, the GWE well header discharges to a 2,000 gallon equilibration tank. The equilibration tank incorporates ultrasonic level controls to provide for shut down of the system during high-level and low-level conditions. The effluent tank is controlled by a variable speed drive so that transfer-pump rates may be programmed to match influent groundwater recovery rates.
- Recovered groundwater is pumped from the equilibration tank through two bag filters plumbed in series (skid #1) to remove particulate matter from the raw groundwater influent.
- After passing through the skid #1 bag filters, influent groundwater is discharged to two, 10 gpm, four-tray, low-profile airstrippers plumbed in parallel for dissolved VOC removal. The airstripper sumps incorporate high-level and low-level controls that turn-on and turn-off, respectively, the airstripper sump transfer pumps.
- Treated groundwater effluent from the airstripper sumps is pumped to a 300 gallon intermediate tank. The intermediate tank incorporates high-level and low-level controls that turn-on and turn-off, respectively, the skid #2 transfer pump.
- Treated groundwater effluent is pumped from the intermediate tank through two bag filters plumbed in series (skid #2) to remove particulate matter generated from the airstripper treatment.
- After passing through the skid #2 bag filters, treated groundwater effluent from the airstrippers passes through two, 500 gallon, granular activated carbon (GAC) filter canisters plumbed in series for removal of organic compounds remaining following airstripping.
- After passing through the GAC filters, the treated groundwater effluent passes through two, 500 gallon, ion exchange filter canisters plumbed in series for removal of mercury and other inorganics.
- After passing through the ion exchange filters, the final treated groundwater effluent discharges to a 350-gallon effluent tank. The effluent tank incorporate high-level and low-level controls that turn-on and turn-off, respectively, the effluent tank transfer pump.
- Final treated groundwater effluent is pumped from the effluent tank to the surface water discharge point through a 2-inch HDPE discharge pipe.

Treated groundwater in the effluent tank is also used to backflush the carbon and ion exchange filters using an integral reversible piping system and the effluent discharge pump. Backwash effluent water is discharged into a 425-gallon backwash tank, and then pumped back to the initial equilibration tank for reprocessing.

Based on a review of available options for discharge of treated groundwater effluent from the GWE system, discharge to surface water under a National Pollution Discharge Elimination System (NPDES) permit was selected as the best available method for the site. NPDES Permit NC0088129 was received from the NC DENR, Division of Water Quality in January 2006. The receiving stream is an unnamed tributary of Richland Creek, and the surface-water discharge point is located directly northeast of the site adjacent to Wade Avenue Extension.

A NC DENR recovery well permit was required for installation of the groundwater recovery well system. A revised permit for installation of shallow and deep GWE wells was issued on April 17, 2006. A North Carolina Department of Transportation (NC DOT) encroachment permit was required for installation of GWE system wells and components within the right-of-way of Wade Avenue Extension. The NC DOT Encroachment Permit was issued on March 28, 2006.

The airstripping process results in generation of vapor phase contaminants as dissolved phase volatile organics are stripped from groundwater. Vapor-phase emissions are discharged directly to the atmosphere through roof stacks. Based on the maximum groundwater influent contaminant concentrations from the pump test and the estimated total groundwater extraction rates, vapor phase contaminant discharge rates will not exceed the permit-threshold limits of 100 tons of contaminants per year.

Installation of the GWE system was completed from April to September 2006. The GWE system installation is summarized as follows.

- April-June 2006: shallow GWE wells RW-1 through RW-13 and deep GWE wells DRW-1 through DRW-4 were installed by air rotary drilling.
- July-August 2006: foundation and building construction completed.
- August-September 2006: groundwater treatment system equipment installed in building. Submersible pumps, electrical supply lines, and groundwater effluent lines installed.
- September 29, 2006: startup and testing of GWE system completed.

The GWE system was inspected by representatives of the design/engineering firm, Marshall Miller &Associates, and NCSU on September 30, 2006, and declared to be in commercial operation.

During the initial GWE system operational period from September 26, 2006 to December 2006, treated groundwater effluent was discharged to the City of Raleigh sanitary sewer system

until NCSU and NCDENR, Division of Water Quality were fully assured that, based on acceptable testing results over a significant period of time, the GWE system effluent was meeting requirements of the NPDES permit. Following achievement of the NPDES permit discharge requirements in the initial monthly discharge samples, discharge of GWE system effluent to surface water began under the terms of the site NPDES permit in December 2006.

4.3 System Operation/Operation and Maintenance

Operations and Maintenance (O&M) at the Site is completed by the subcontractors for NCSU, Piedmont Geologic. Primary activities associated with O&M include:

- Weekly to twice weekly changing of 50-micron bag filters in each of the four bag filter canisters;
- Monthly to quarterly backflushing of GAC filters to remove sediment buildup;
- Disassembly and cleaning of the airstripper trays is conducted on an as-needed basis based on airstripper blower pressure readings. Changing of GAC and ion exchange medium is conducted on an as-needed basis based on results of breakthrough calculations and/or laboratory analysis of effluent samples;
- Weekly system visits by the Operator in Responsible Charge to meet NPDES permit requirements and maintain the Groundwater Treatment System Log;
- Sampling and analysis of groundwater treatment system effluent in accordance with the system NPDES permit;
- Remote monitoring of the system operation and onsite response to system upset conditions;
- Quarterly collection and evaluation of groundwater potentiometric surface data from site monitoring wells; and,
- Maintenance and monitoring of the soil remedy consists of mowing the grass and visually inspecting the cap for irregularities and potential problems (i.e. puddles of colored water or erosion).

O&M began in August 2007. Piedmont Geologic has consistently provided reports and updates to the agencies on a regular basis. Monthly sampling and laboratory analysis of groundwater treatment system effluent is conducted in accordance with the requirements of the site NPDES permit. Sampling activities are documented using the system log described above, and all samples are analyzed by a subcontracted North Carolina certified laboratory. Monthly groundwater samples are analyzed for the following: manganese, mercury, benzene, carbon tetrachloride, toluene, 1,1,2,2-trichloroethane, trichloroethene, and pH. In addition to the monthly sampling, quarterly (i.e., one sample every 3 months) GWE system effluent samples are analyzed for the following: arsenic, copper, iron, lead, zinc, chloroform, 1,2-dibromoethane, 1,2-dichloropropane, tetrachloroethene, and chronic toxicity. Under the terms of the NPDES permit, chronic toxicity testing is being conducted in October 2006, February 2007, May 2007, and August 2007, and then will be discontinued. Although there have been inconsistencies in monitoring for all ROD COCs, all efforts will be made to ensure that all ROD COCs are properly

monitored. No other problems exist regarding the O&M at the Site.

The cost of the source remediation from the ROD is $931,000. The actual cost (in 1996 dollars) was approximately $1,500,000. The actual cost was higher due to limited site assessment and lack of experience with the selected remedy. The contained mixing device, which was selected for application at the site, was not suitable. The contained mixing equipment was abandoned early in the remediation and replaced with an open trench mixing process. This transition was associated with substantial downtime and re-evaluation, which contributed to the increased cost to the remediation. The cost of the groundwater remediation given in the ROD is $2,100,000. The actual cost of groundwater remediation is estimated at approximately $2,000,000.

The ROD specified projected O&M costs for the groundwater extraction/treatment system at the Site to be $1,762,190 present worth for 30 years. This calculates to projected annual O&M costs of $142,009, assuming 7% interest. Since the last five-year review, O&M costs are have been approximated at $60,000 per year. These costs include monthly routine O&M, NPDES sampling, electricity, annual groundwater sampling, and miscellaneous costs (i.e. replacement parts for the treatment system). There have been no unusual or unanticipated O&M costs since the last five-year review.

5.0 Progress Since Last Five-Year Review

Protectiveness Statements from the Previous Five-Year Review:

This is the Second Five-Year Review Report. The Protectiveness Statement for the first five-year review in 2003 expressed the protectiveness of the remedial action and that the site was protective of human health and the environment. The protectiveness statements, as written in the 2003 Five-Year Review, stated:

> *"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.*
>
> *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 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 associates with exposure to contaminated groundwater."

As addressed previously in Section 4.2 *Remedy Implementation* of this report, the groundwater extraction system has been operational since September 2006 and the remedy is currently functioning as designed as demonstrated by monthly compliance with all NPDES discharge requirements; however, no analytical post-extraction data is yet available to determine how effective the groundwater remedy is hydraulically containing the contaminant plume. Currently, no human or ecological exposure pathways exist to contaminated soil or groundwater.

Recommendations from the Previous Five-Year Review:

The following discussion summarizes the issues and recommendations made in the 2003 Five-Year Review and any follow up actions that have been taken to address those recommendations. During the First Five-Year Review, several issues were reported. The six issues identified during the Five-Year Review Report dated September 25, 2003 were:

1. The ROD identified acetone as a contaminant for the Site and established a remediation goal. However, samples collected since the Remedial Investigation have not been analyzed for acetone.
2. Saturated soils at approximately 40 feet below ground surface 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 groundwater. Although there is not a current complete pathway, potential future risks may exist associated with exposure to the groundwater.
5. Monitoring wells exists along Wade Avenue without protections (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.

Table 5 is the Recommendations and Follow-Up Action from the 2003 Five-Year Review.

Since the last five-year review, the issues as stated above have been or are in the process of being addressed. The actions associated with these issues are clarified below:

1. Acetone will be analyzed during all annual groundwater sampling events starting in June 2008.
2. The groundwater extraction system was designed to have complete hydraulic control over the area where material was stabilized and was designed to capture leaching contaminants from soils beneath the stabilized material.
3. Institutional controls for the Site are currently being reviewed by NCSU, EPA and NC DENR for implementation in the very near future.
4. Institutional controls for the Site are currently being reviewed by NCSU, EPA and NC DENR for implementation in the very near future.
5. Discussions with the North Carolina Department of Transportation indicated that it would be a traffic hazard for any protection devises to be installed around the existing monitoring wells. No further action is proposed; however, it is recommended to continue inspections of the well conditions and well security and to maintain these wells as necessary.
6. There has been no well abandonment to date. Post groundwater extraction conditions need to be evaluated before abandoning any current monitoring wells within the network.

Since the last Five-Year Review, Carolina Solar Energy LLC (CSE) proposed and built a 70 kW photovoltaic solar generation project on Lot 86. The project has been designated a Solar "Brownfields to Brightfields" Technology Demonstration Project by the US Department of Energy (DOE Grant DE-PS26-04NT42068-00). CSE will own and operate the solar system for 20 years under a lease from the State of North Carolina. The electricity generated will be sold to Progress Energy under an avoided cost contract and the renewable energy certificates will be sold to NC GreenPower under a separate contract.

CSE was formed in 2004 to build renewable energy generation in North Carolina. The project at the NCSU Lot 86 Site consists of 432 ground mounted high efficiency Sunteck 170 Watt photovoltaic panels arranged in 12 arrays of 36 collectors each. The power is converted to AC voltage by a three-phase converter and supplies energy to a new Progress Energy transformer.

The renewable energy generation project was completed in June 2007. CSE carefully designed the solar project so as not to interfere with the subsurface buried materials, the soil covering the cap, the ongoing remediation at Lot 86 and the maintenance/grass mowing of the Site. The solar collector arrays are located on top of the capped and stabilized mound; however, there were no penetrations or excavations on the mound for the structures or wiring associated with the 12 solar arrays. The foundation for the 12 arrays are recycled concrete highway barriers placed on top of the cap with small amounts of coarse clean gravel that was used to level the area under each barrier. The total bearing weight of the structures is 2.6 pounds per square inch (psi), which is less than one tenth the 30 psi allowable bearing weight capacity of the cap.

6.0 Five-Year Review Process

6.1 Administrative Components

The NC DENR, Superfund Section, performed the five-year review process for the NCSU Lot 86 Site. David Mattison (Environmental Engineer) and Stephanie Grubbs (Hydrogeologist) from NC DENR were responsible for gathering and reviewing data for this review and compiling all the information into the Five-Year Review Report for the US EPA. Telephone and/or email discussions/interviews with Michael Townsend, US EPA Remedial Project Manager were conducted. Other activities conducted for this review include document review (see Attachment 1), completion of a Site Inspection Checklist (see Attachment 2), a public notice submitted to the local newspaper, community interview documentation (see Attachment 3), and the Five-Year Review Report preparation.

6.2 Community Involvement

The US EPA conducts all community involvement activities regarding the remedial activities for the Site. After the five-year review has been approved and signed by the US EPA, a notice will be placed in The Raleigh News and Observer announcing the release of the final Five-Year Review report and copies will be placed for the public to view at: the US EPA Record Center, 11th Floor, 61 Forsyth Street, SW, Atlanta, GA 30303; the information repositories located at the Cameron Village Regional Public Library, 1930 Clark Avenue, Raleigh, North Carolina and the D.H. Hill Library, Government Reference Section, North Carolina State University, Raleigh, North Carolina; and, on the US EPA website (http://www.epa.gov/superfund/index.htm).

As part of community involvement and public information, all records held in the public repository need to be updated with periodic O&M reports and other information generated for this Site.

6.3 Document Review

This Five-Year Review consisted of a review of relevant documents including the signed ROD (1996), Explanation of Significant Difference (1999), Draft Construction Report (2000), Soil Encapsulation Remedial Action Report (2003), Fractured Rock Assessment (2004), May 2005 Report of Results: Groundwater Monitoring Report (2005), Final Design Criteria Report (2006), Draft Construction Report for the Groundwater Remediation Phase (2007), Final Remedial Action Report (2007), Operations and Maintenance Plan - Groundwater Extraction System (2007), monthly O&M monitoring reports (2007 to present), and the previous Five-Year Review Report (2003). Applicable soil and groundwater clean-up standards and other ARARs, as listed in the RODs, were also reviewed and checked for updates. As of August 2007, all O&M monthly reports have been consistently provided to the agencies for review on a regular basis. See Attachment 1 for a complete list of documents reviewed.

6.4 ARAR Review

Section 121 (d) (2) (A) of CERCLA specifies that Superfund remedial actions must meet any federal standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate requirements (ARARs). ARARs are those standards, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. To-Be-Considered criteria (TBCs) are nonpromulgated advisories and guidance that are not legally binding, but should be considered in determining the necessary level of cleanup for protection of human health or the environment. While TBCs do not have the status of ARARS, EPA's approach to determining if a remedial action is protective of human health and the environment involves consideration of TBCs along with ARARs.

Chemical-specific ARARs are specific numerical quantity restrictions on individually listed contaminants in specific media. Examples of chemical-specific ARARs include the MCLs specified under the Safe Drinking Water Act as well as the ambient water quality criteria that are enumerated under the Clean Water Act. Because there are usually numerous contaminants of potential concern for any Site, various numerical quantity requirements can be ARARs. The final remedies selected for this Site were designed to meet or exceed all chemical-specific ARARs and meet location- and action-specific ARARs.

Chemical-specific ARARs identified in the selected remedy within the ROD for the groundwater at this Site and considered for this five-year review for continued groundwater treatment and monitoring are listed in Table 4. The review of ARARs for the groundwater contaminants identified with cleanup goals in the 1996 ROD suggests that federal standards (i.e., MCLs) and state standards for these contaminants have changed for several COCs, as discussed below.

In performing the Five-Year Review for compliance with ARARs, only those ARARs addressing risk posed to human health and the environment (i.e., addressing the protectiveness of the remedy) were reviewed. This is in keeping with current US EPA guidance on five-year reviews.

6.4.1 Original ARARs from the 1996 ROD

Federal ARARs

- Federal Groundwater Classification (55 Federal Register Part 8733)
- Safe Drinking Water Act (40 CFR Part 141)
- Clean Water Act
- Safe Drinking Water Contaminant Secondary Drinking Water Standards (40 CFR Part 143)
- Clean Water Act National Pretreatment Standard for Indirect Discharge to POTW
- Clean Water Act National Pollutant Discharge Elimination System (NPDES) Requirements (40 CFR Part 122)
- National Primary Drinking Water Standards (40 CFR 141)
- Clean Air Act (40 USC 1857)
- National Emissions Standards for Hazardous Air Pollutants (40 CFR 61)

State ARARs

- North Carolina Solid Waste Disposal Regulations (North Carolina Administrative Code (NCAC), Title 15A, Chapter 13B)
- Regulations for the Management of Hazardous Waste promulgated under the authority of the NC Waste Management Act (NCAC Title 15A, Chapter 13A)
- NC Drinking Water and Groundwater Standards; Groundwater Classifications and Standards (NCAC Title 15 Chapter 2L)
- NC Surface Water Quality Standards (NCSWQS) Classification and Water Quality Standards (NCAC Title 15A Chapter 2B)
- NC Drinking Water Act (NCDWA) (General Statutes Chapter 130A, NCAC 311-327)
- NCSWQS Technology-Based Effluent Limitations (NCAC Title 15A Chapter 2, Subchapter 2B.0400)
- NC Sedimentation Control Regulations (NCAC Title 15A 4)

6.4.2 Current Applicable ARARs

For the current groundwater remedy, site-specific ARARs are identified as follows: Contract Required Quantitation Limit (CRQL) and groundwater standards specified in NCAC 2L are ARARs for site groundwater. The naturally occurring element, manganese, has a remediation goal based on the background levels found in undisturbed, natural areas within the vicinity of the Site. The federal MCLs for arsenic has decreased from 50 ppb to 10 ppb since the signing of the ROD; however, because the ROD included 10 ppb as the remediation goal, the

change does not affect the protectiveness of the remedy. At the time the ROD was prepared, a baseline risk assessment was conducted. The current NC 2L Groundwater Standards, the US EPA CRQLs, and/or the federal MCLs for volatile and inorganic compounds are still valid for the groundwater remedial action objectives as stated in the ROD. Refer to Table 4 for the COCs and the associated ARARs.

The NCAC 2L standards were last amended on December 7, 2006 and are based on the use of groundwater for human consumption. Since there are no current users of groundwater at the site or in areas downgradient of the site where site contamination has spread, the revisions to the North Carolina Groundwater Quality Standards do not affect remedy protectiveness in the short term.

No remediation levels for soil were established in the ROD due to the nature of the remedial action. The ROD does state that the groundwater RAOs for the clean up of the Site are to prevent migrations 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; and to permanently and significantly reduce mobility, toxicity, or volume of characteristic hazardous waste with treatment. The soil remedy has effectively completed the remedial action objectives for the Site.

6.5 Data Review

As stated in the previous Five-Year Review, soil data since the completion of the soil remedy is limited due to the nature of the remedial action which was comprised of in-situ soil mixing and encapsulation using cement to form a monolith solidifying the waste material. The ROD did not specify any remediation levels for the soil. No soil sampling has been conducted since the last Five-Year Review.

As of August 31, 2007, the GWE system has recovered and treated a total of approximately 914,421 gallons of contaminated groundwater at an overall mean recovery rate of approximately 2.4 gallons per minute. Groundwater levels are being measured in site monitoring wells on a quarterly basis to evaluate performance of the GWE system with respect to the goal of contaminant plume containment and capture. Quarterly potentiometric-surface contour maps for the shallow, intermediate, and deep aquifer zones are presently being compiled to assist in this effort. Routine groundwater monitoring is being conducted to evaluate performance of the site GWE system with respect to the goal of reducing groundwater contaminant concentrations. Groundwater sampling/analysis is conducted in accordance with the controlling documents. Results of monthly sampling/analysis of GWE system effluent samples conducted since system installation in September 2006, as required under the NPDES permit, have indicated no exceedances of NPDES permit discharge limits.

Currently no post-extraction monitoring well groundwater data or influent data exists at the time of this report. The first round of post-extraction groundwater sampling is being conducted in June 2008 and will be reviewed once the data is received. There are several reasons for the delay in the sampling and analysis of groundwater. The initial lack of action was due to an extensive shakedown period after the extraction and treatment system start-up. A delay in securing a subcontractor to conduct the sampling and analysis also prolonged this process. The first post-treatment groundwater sampling has been scheduled for June 2008.

During the five-year review process, inconsistencies in monitoring for all ROD COCs were discovered. All efforts will be made to ensure that all ROD COCs are properly monitored in future sampling events. Once the most current groundwater data is submitted and reviewed, the agencies will determine whether additional monitoring wells may be needed to assess whether containment is occurring and/or whether groundwater contamination is spreading beyond areas currently understood to be the limits of groundwater contamination.

6.6 Site Inspection

The Site inspection of the NCSU Lot 86 Site was conducted on April 16, 2008. Attending the Site visit was: David Mattison, Environmental Engineer, NC DENR, Superfund Section; Stephanie Grubbs, Hydrogeologist, NC Superfund; Duane Knudson, Environmental Supervisor, NCSU; and, Bruce Stewart, Environmental Department, NCSU.

During the inspection, all groundwater treatment system monitoring records were noted as readily available in office and up-to-date. The treatment system was noted as being in good condition and operating and functioning properly. The Site is fenced and secured with locks. The cap was in good condition with no erosion and the monolith was vegetated and well kept. The solar arrays were also in good condition and posed no distress to the cap. Piedmont Geologic, the subcontractor for NCSU, conducts all O&M for the site. All O&M records are up-to-date and available in the office. See Attachment 2 for the completed site inspection checklist.

6.7 Interviews

The following persons were interviewed regarding the activities and implementation of the remedial actions at the NCSU Lot 86 Site. Only a portion of the interview is stated below. For the complete interview statement see Attachment 3.

Michael Townsend, US EPA RPM:
Overall impression of the project: "The process for this site was somewhat lengthy, but my overall impression is that the actual work at the site was implemented in a thorough and highly competent manner. The resulting remedy met the statutory preferences for treatment to reduce toxicity and mobility of contaminants present at the site."

7.0 Technical Assessment

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

The remedies at the Site are currently protective of human health and the environment in the short-term as the main source of contamination was remediated through in-situ mixing and encapsulation of contaminated soils; groundwater contamination is actively being remediated through extraction and treatment; and currently no human exposure pathways exist to contaminated soil and/or groundwater. However, for the remedy to be protective in the long-term, permanent land use restrictions or other appropriate institutional controls (ICs) need to be implemented and the remediation goals need to be reached for groundwater.

ICs were not required in the selected remedy within the ROD. The US EPA will document the decision to put ICs in place pursuant to the US EPA's ROD guidance found at http://www.epa.gov/superfund/policy/remedy/rods/index.htm. Depending on the extent or scope of the modification to the ROD, the US EPA will decide to implement one of three documentation procedures: (1) a memo or note to the post-ROD file for an insignificant or minor change to the ROD; (2) an ESD for a significant change to the ROD; or (3) a ROD amendment for a fundamental change to the ROD.

ICs in the form of restrictive covenants will be placed on properties where the soil remedy occurred, in order to prevent disturbance of the soil remedy. ICs in the form of restrictive covenants will be placed on all properties which has groundwater contamination affected by the site above site cleanup levels, in order to prevent future potential users of the aquifers from being exposed to contaminated groundwater within the aquifers beneath the Site above cleanup goals as specified in the 1996 ROD.

As stated within this Five-Year Review report, the groundwater remedy is currently operational and functional as demonstrated by monthly compliance with all NPDES discharge requirements; however, no analytical post-extraction data is yet available to determine how effective the groundwater remedy is hydraulically containing the contaminant plume. Currently, no human or ecological exposure pathways exist to contaminated soil or groundwater.

The contractor for NCSU, Piedmont Geologic, conducts O&M activities at the Site. As stated by NCSU, the estimated cost of O&M per year has been variable, although the estimated annual O&M costs (which include monthly routine O&M, sampling for the NPDES permit, electricity, annual groundwater sampling, and any miscellaneous site maintenance) is $60,000.

7.2 *Question B: Are the exposure assumptions, toxicity data, clean-up levels and remedial action objectives (RAOs) used at the time of the remedy still valid?*

The exposure assumptions, toxicity data, clean-up levels, and RAOs used at the time of the remedy are still valid for the contaminants of concern (COCs). The chemical-specific ARARs (i.e., CRQLs and the State Groundwater Standards) have not changed for the COCs from the Remediation Goals given in the ROD; however, the federal MCL for arsenic has been lowered but the remediation goal stated in the ROD reflects the new lower MCL. Currently, the land use at the Site has two new changes since the previous review. Carolina Solar Energy is currently utilizing the Site for a renewable energy project. Twelve solar arrays are located on the capped mound to generate electricity that is sold back to Progress Energy. The second change is the groundwater extraction system is currently operating and the building on site was erected to house the treatment system. No new human health or ecological routes of exposure have been identified or modified in any way that would change the protectiveness of the remedy.

No vapor intrusion assessments have occurred at the Site due the lack of an occupied building over the plume. The only building that is within the plume boundaries is the groundwater treatment building, which is not occupied except during O&M operations. Unless Site conditions change, no further assessment regarding vapor intrusion will be completed. If conditions do change, the US EPA will revisit the possibility of a vapor intrusion assessment.

There have been no changes in the physical conditions of the Site that would negatively affect the protectiveness of the remedy; however, a positive reuse of the Site has been initiated. The project has been designated a Solar "Brownfields to Brightfields" Technology Demonstration Project by the US Department of Energy. The project at the NCSU Lot 86 Site consists of 432 ground mounted high efficiency Sunteck 170 Watt photovoltaic panels arranged in 12 arrays of 36 collectors each. The electricity generated will be sold to Progress Energy under an avoided cost contract and the renewable energy certificates will be sold to NC GreenPower. However, for the Site to be fully protective, institutional controls need to be implemented. These are matters discussed further in the Issues and Recommendations section of this review.

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

No additional information has come to light that could call into question the protectiveness of the remedy.

7.4 Technical Assessment Summary

According to documents, the site inspection, and interviews with the US EPA and NCSU, the soil remedy is complete and the groundwater remedy is currently operating and functional. Groundwater levels are being measured in site monitoring wells on a quarterly basis to evaluate performance of the GWE system with respect to the goal of contaminant plume containment and capture. Quarterly potentiometric-surface contour maps for the shallow, intermediate, and deep aquifer zones are presently being compiled to assist in this effort. Routine groundwater monitoring is being conducted to evaluate performance of the site GWE system with respect to the goal of reducing groundwater contaminant concentrations. Results of monthly sampling/analysis of GWE system effluent samples conducted since system installation in September 2006, as required under the NPDES permit, have indicated no exceedances of NPDES permit discharge limits. The first post-extraction groundwater analytical data will be collected in June 2008 and evaluated to determine how effective the groundwater extraction system is in hydraulically containing the contaminant plume.

The exposure assumptions, toxicity data, clean-up levels and RAOs used at the time of the remedy are still valid for the COCs. There are no current exposure routes to the groundwater or soil and the remedy, in the short-term, is still protective of human health and the environment. No other information has come to light that would call into question the short-term protectiveness of the remedy; however, in order for the remedy to be protective in the long-term, permanent land use restrictions or other appropriate institutional controls must be implemented at the Site.

8.0 Issues

There is one issue that has been identified during this review.

1. Implement permanent land use restrictions or other appropriate institutional controls at the Site. The Draft *Declaration of Perpetual Land Use Restrictions for a Federal Superfund Site* has been drafted and was recently revised in June 2008. The institutional controls are currently under review by NCSU, EPA and NC DENR and should be finalized as soon as possible (possibly by early 2009).

9.0 Recommendations and Follow-up Actions

Table 6 lists the Recommendations and Follow-up Actions for the NCSU Site.

10.0 Protectiveness Statement

As stated in the 1996 ROD, the remedial action objectives for groundwater were to prevent migrations of contaminants to surface water that would result in contamination to levels greater than the AWQC; control future releases of contaminants to ensure protection of human health and the environment; and, permanently and significantly reduce mobility, toxicity, or volume of characteristic hazardous waste with treatment.

The remedies at the Site are currently protective of human health and the environment in the short-term as the main source of contamination was remediated through in-situ mixing and encapsulation of contaminated soils; groundwater contamination is actively being remediated through extraction and treatment; and currently no human exposure pathways exists to contaminated soil and/or groundwater. For the remedy to be protective in the long-term, permanent land use restrictions or other appropriate institutional controls need to be implemented and the remediation goals need to be achieved for groundwater.

11.0 Next Review

The next Five-Year Review for the NCSU Lot 86 Site is required to be completed by September 2013, and within five years from the US EPA Region 4 Superfund Division Director's (or his designee) signature/approval date of this document.

Table 1: Chronology of Events
NCSU Lot 86

NCSU uses Lot 86 as a burial site for hazardous chemical and low level radioactive waste generated by the University's laboratories.	1969 to November 1980
NCSU reports on the CERCLA Section 103© Hazardous Waste Notification form of waste disposal.	June 8, 1981
Final listing on National Priorities List (NPL)	June 10, 1986
Remedial Investigation (RI) Report completed	October 1994
Revised Feasibility Study (FS) completed	February 1996
ROD selecting the remedy is signed	September 30, 1996
Start of on-site mobilization for initiation of soil mixing activities	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	January 19, 1999
Explanation of Significant Difference (ESD) issued by the US EPA to address the use of a trackhoe in lieu of a crane for mixing operations and air monitoring.	July 21, 1999
Remedial action for soil is completed	September 21, 1999
Evaluation of Monitored Natural Attenuation Report completed by GEI Consultants	March 2001
First Five-Year Review is completed.	September 25, 2003
Fractured Rock Assessment completed by East Coast Environmental	April 2004
Draft Remedial Action Work Plan for Groundwater completed	November 2005
Final Design Criteria Report for the Groundwater Remediation Phase is completed by Marshall Miller & Associates	March 2006
Shallow Groundwater Extraction (GWE) wells and deep GWE wells installed by air rotary drilling.	April through November 2006
Groundwater treatment system equipment installed in building and submersible pumps, electrical supply lines, and groundwater effluent lines installed.	August through September 2006
Groundwater Extraction system start-up.	September 26, 2006
Monthly NPDES monitoring begins on Site.	August 2007

Table 2: Exposure Point Concentrations for Groundwater

(As summarized in the 1996 ROD)

Groundwater Analyte	95% UCL of Mean concentration (Ug/L)	Maximum Concentration (Ug/L)	Exposure Point Concentration (Ug/L)
SHALLOW Groundwater Exposure Point Concentrations			
Inorganics			
Barium	2,780	950	950
Chromium	919	17.0	17.0
Cobalt	4,936	88.0	88.0
Lead	1,440	31.0	31.0
Manganese	54,400	20,000	20,000
Nickel	5,051	73.0	73.0
Volatile Organics			
Acetone	72,200	15,500	15,500
Benzene	45,300	14,000	14,000
Bromodichloromethane	209,800	280	280
Bromoform	22,715	35.5	35.5
Carbon Tetrachloride	17,100	6,400	6,400
Chlorobenzene	75,967	150	150
Chloroform	312,000	63,000	63,000
Dibromochloromethane	4,609	3.35	3.35
1,1-Dichloroethene	27,500	21.0	21.0
1,2-Dichloroethene (total)	9,191	31.0	31.0
1,2-Dichloropropane	41,800	865	865
2-Hexanone	4,952	5.45	5.45
Methylene Chloride	64,500	18,000	18,000
4-Methyl-2-Pentanone	66,682	110	110
1,1,2,2-Tetrachloroethane	246,676	200	200
Tetrachloroethene	697,000	5,000	5,000
Toluene	455,000	1,500	1,500
1,1,2-Trichloroethane	74,091	135	135
Trichloroethene	904,000	1,250	1,250
Vinyl Chloride	4,774	3.7	3.7

Ug/L = Micrograms per liter
pCi/L = PicoCuries per liter

Groundwater Analyte	95% UCL of Mean concentration (Ug/L)	Maximum Concentration (Ug/L)	Exposure Point Concentration (Ug/L)
Semi-Volatiles/Organics			
Isophorone	2,880	570	570
Pesticides/PCBs			
Gamma-BHC	0.05	0.016	0.016
Dieldren	13.4	0.013	0.013
Radionuclide (concentration in pCi/L)			
Tritium	1,200	6,000	1,200
DEEP Groundwater Exposure Point Concentrations			
Inorganics			
Arsenic	2,350	110	110
Chromium	4,003	20.0	20.0
Copper	11,403	48.0	48.0
Manganese	3,130	460	460
Zinc	8,600	67.0	67.0
Volatile Organics			
Acetone	959	190	190
Benzene	549	7.3	7.3
Bromodichloromethane	541	44.0	44.0
Carbon Tetrachloride	199	39.0	39.0
Chlorobenzene	2.8	1.0	1.0
Chloroform	640	510	510
1,2-Dichloroethane	2,947	2.5	2.5
1,2-Dichloropropane	699	28.0	28.0
Methylene Chloride	155	59.0	59.0
4-Methyl-2-pentanone	3.3	3.0	3.0
1,1,2,2-Tetrachloroethane	101	5.8	5.8
Tetrachloroethene	5,546	5.7	5.7
Toluene	16.8	1.3	1.3
Trichloroethene	88,159	20.0	20.0

Ug/L = Micrograms per liter
pCi/L = PicoCuries per liter

Groundwater Analyte	95% UCL of Mean concentration (Ug/L)	Maximum Concentration (Ug/L)	Exposure Point Concentration (Ug/L)
Radionuclide (concentrations in pCi/L)			
Carbon-14	1,679	522	522
Tritium	7,560	3,890	3,890

Ug/L = Micrograms per liter
pCi/L = PicoCuries per liter

Table 3: Exposure Point Concentrations for Surficial Soils

(As summarized in the 1996 ROD)

Groundwater Analyte	95% UCL of Mean concentration (mg/kg)	Maximum Concentration (mg/kg)	Exposure Point Concentration (mg/kg)
Inorganics			
Chromium	65.3	89.0	65.3
Nickel	7.2	13.0	7.2
Semi-Volatile Organics			
Bis(2-ethylhexyl)phthalate	1.32	1.5	1.32
Pesticides/PCBs			
Aroclor 1260	0.03	0.04	0.03
Alpha-Chlordane	0.006	0.005	0.005
Gamma-Chlordane	0.004	0.003	0.003
P,P'-DDE	0.008	0.007	0.007
P,P'-DDT	0.007	0.006	0.006
Dieldrin	0.006	0.005	0.005
Volatile Organics			
Chloroform	0.01	0.006	0.006
1,2-Dichloroethane	0.01	0.003	0.003
1,2-Dichloropropane	0.01	0.013	0.01
Methylene Chloride	0.01	0.003	0.003

mg/kg = milligrams per kilogram

Table 4: Groundwater Remediation Goals
1996 ROD

CONTAMINANT	Groundwater Remediation Goal (ug/L)	Basis for Remediation Goal
Benzene	1	NC 2L*
Carbon Tetrachloride	1	CRQL**
Chloroform	1	CRQL
Methylene Chloride	5	NC 2L
Tetrachloroethene	1	CRQL
Acetone	700	NC 2L
Bromodichloromethane	1	CRQL
1,2-Dichloropropane	1	CRQL
1,1,2-Trichloroethane	1	CRQL
Trichloroethene	2.8	NC 2L
Manganese	370	Background Concentration***
Arsenic	10	CRQL

*NC 2L: North Carolina Administrative Code, Title 15A, Subchapter 2L, Classifications and Water Quality Standards Applicable to the Groundwater of North Carolina.
** US EPA Contract Quantitation Limits for volatile compounds are still valid for the groundwater remedial action objectives as stated in the ROD.
*** The naturally occurring element, manganese, has a remediation goal based on the background levels found in undisturbed, natural areas within the vicinity of the Site.

Table 5: 2003 Five-Year Review Recommendations and Follow-Up Actions

IX. RECOMMENDATIONS AND FOLLOW-UP ACTIONS

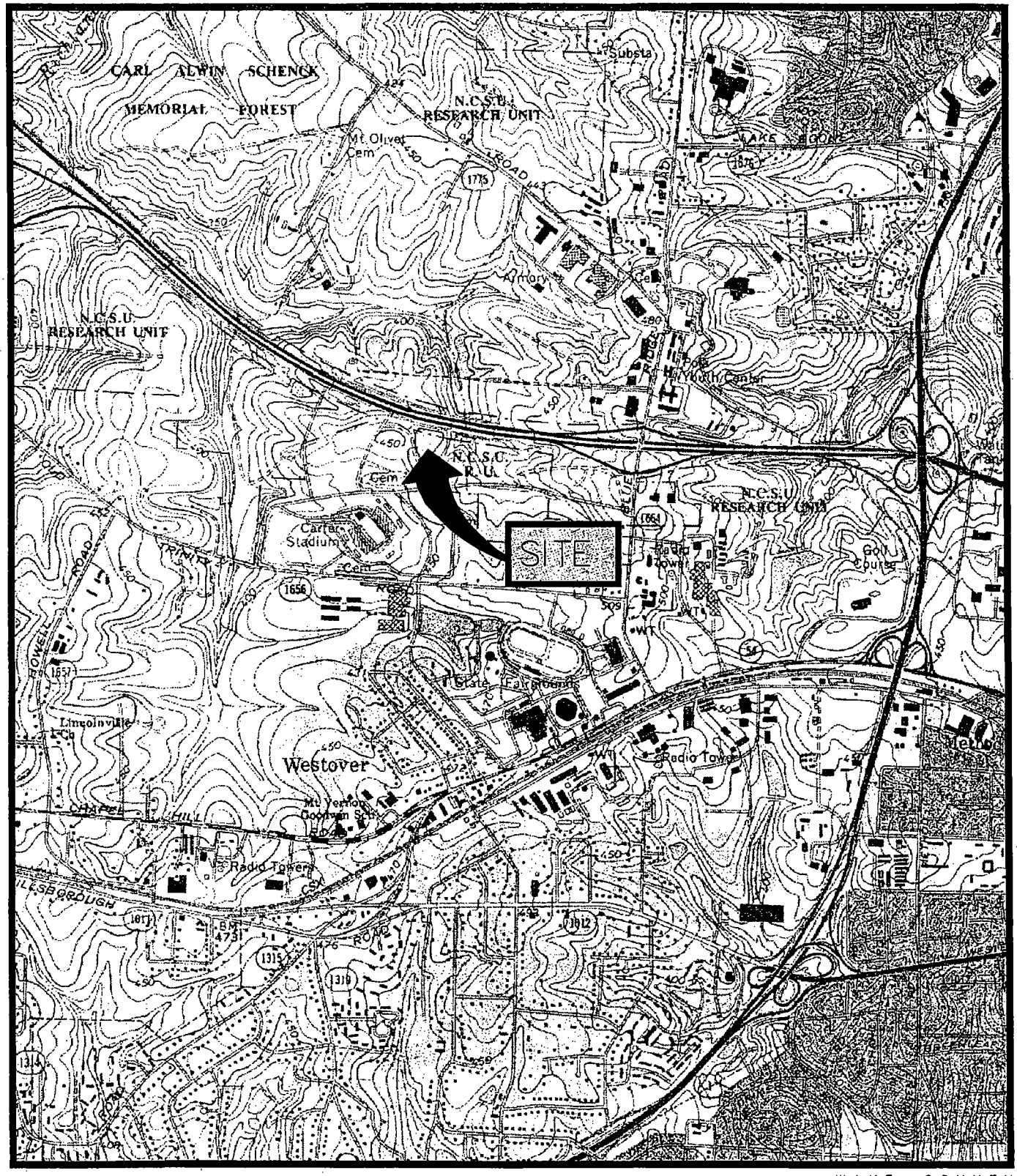
Recommendations and Follow-Un Actions

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

Table 6: Recommendations and Follow-up Actions

Issues	Recommendations& Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Y/N)	
					Current	Future
Institutional Controls have not been implemented.	Finalize the *Draft Declaration of Perpetual Land Use Restrictions for a Federal Superfund Site, June 2008* and implement land use restrictions as soon a possible.	EPA & State	EPA & State	Sept. 2009	N	Y

FIGURES



NORTH CAROLINA STATE UNIVERSITY
NCSU LOT 86 SITE, RALEIGH, NORTH CAROLINA
USGS 7.5 MINUTE RALEIGH WEST, NC QUADRANGLE

Prepared by:

MARSHALL MILLER & ASSOCIATES

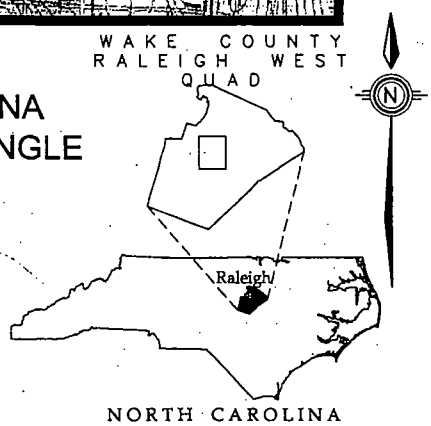
C30104 01/2005

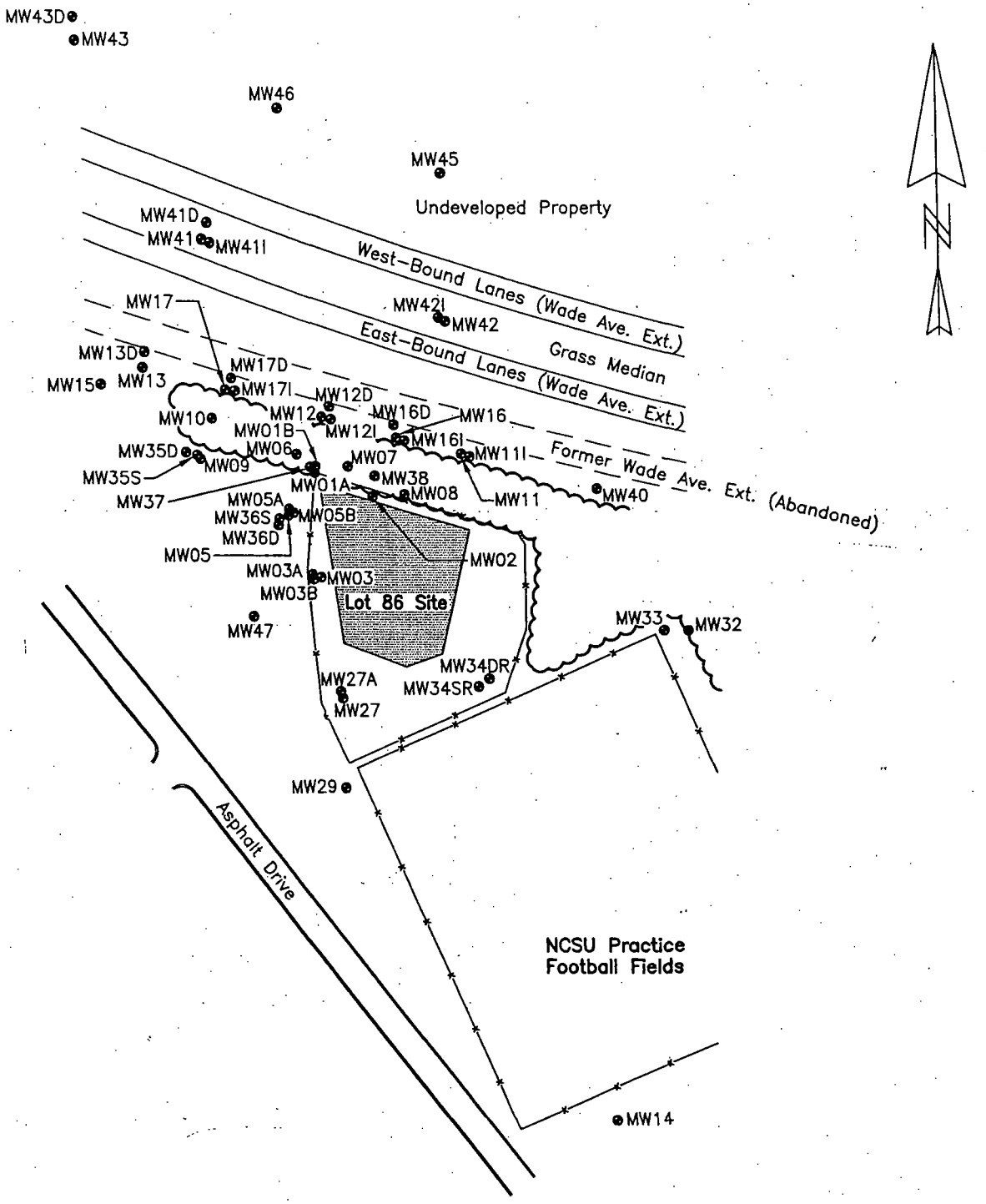
2,000' 0 2,000'

SCALE 1:24,000

VICINITY MAP

FIGURE 1





LEGEND

MW33 Monitoring Well

Waste Burial Area (Source Area)

Fenced Area

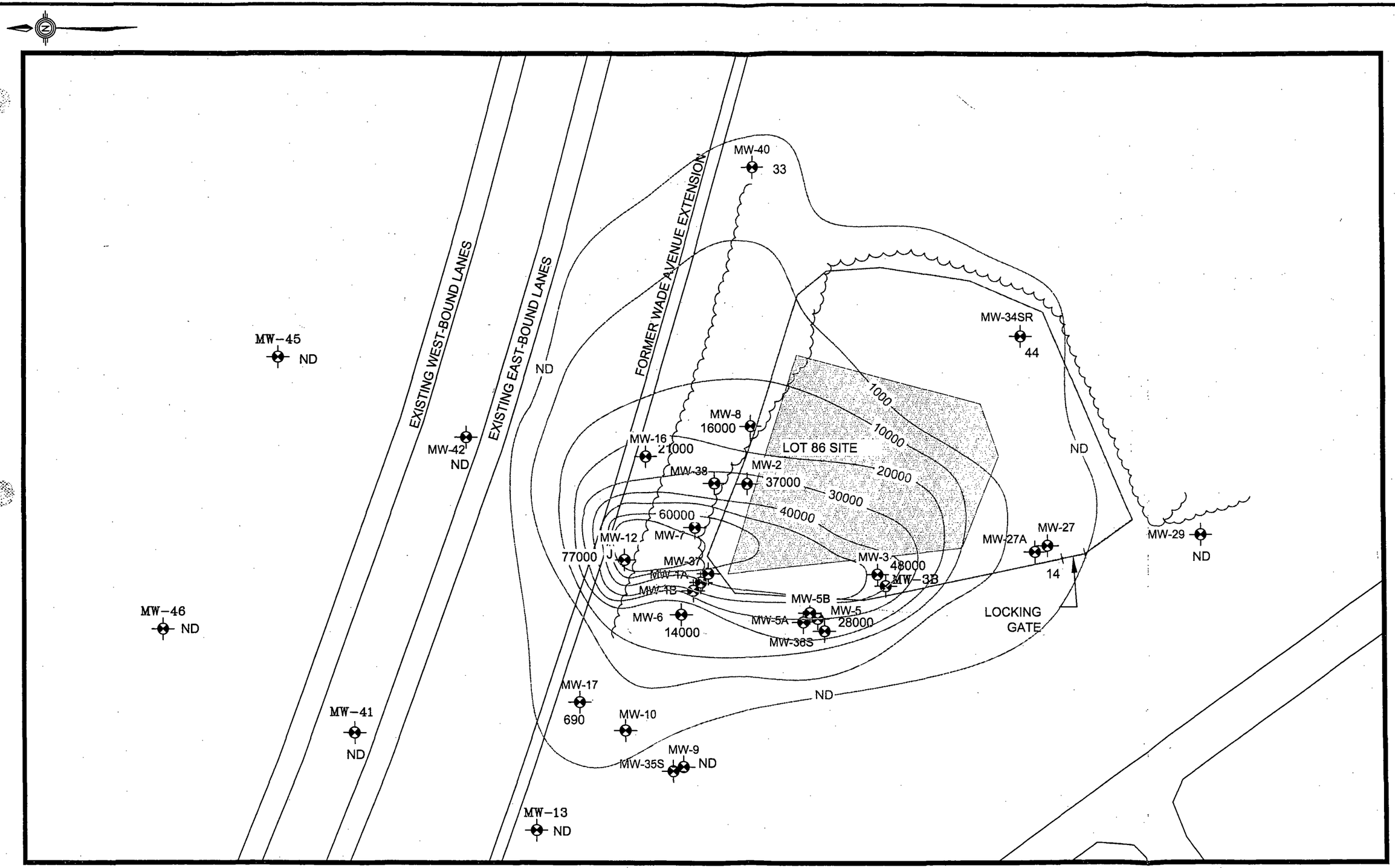
Edge of Wooded Area

PIEDMONT GEOLOGIC, P.C.

Environmental Consultants

Gauging Date:	Drawing Date:	ACAD File:
	7/20/04	FIG-2.dwg

Designed: PD	Site Map	
Detailed: PD	Client: North Carolina State University	Project No.: 2420
Checked: PD	Location: Lot 86 Raleigh, North Carolina	Figure: 2



LEGEND

TREELINE

ISOCONCENTRATION (1 µg/l)

FENCE

CHLOROFORM ISOCONCENTRATION MAP
SHALLOW MONITORING WELLS

80' 0 80'

1" = 80'

Prepared By:

Marshall Miller and Associates
Geology, Environmental Sciences & Engineering, Geophysics
Blacksburg, VA · Lexington, KY · Raleigh, NC
Richmond, VA · Charleston, WV · Harrisburg, PA

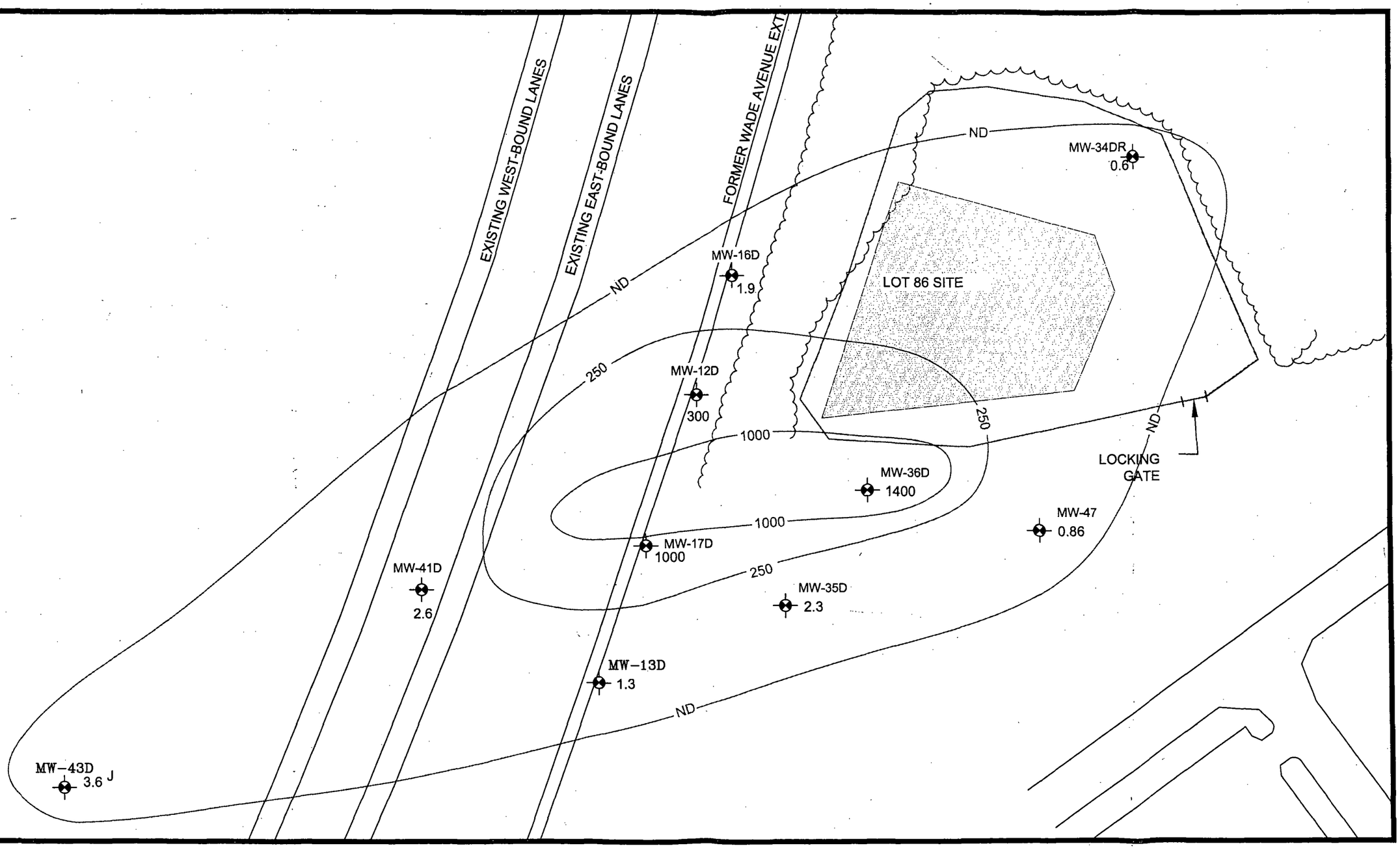
No.	Date	Revision

DESIGNED: DS
DRAWN: AHR
CHECKED: DS
DATE: 10/2004
SCALE: 1" = 150'
PROJECT NO.: C30104
FILE NO.: C30104.dwg

NORTH CAROLINA STATE UNIVERSITY
LOT 86, WADE AVENUE EXTENSION
RALEIGH, WAKE COUNTY, NORTH CAROLINA

SITE MAP WITH ISOCONCENTRATION MAPS

SHEET NUMBER
3



CHLOROFORM ISOCONCENTRATION MAP
DEEP MONITORING WELLS

LEGEND
- TREELINE
- ISOCONCENTRATION (1 µg/l)
- FENCE

80' 0 80'
1" = 80'

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Geology, Environmental Sciences & Engineering, Geophysics
Blacksburg, VA · Lexington, KY · Raleigh, NC
Richmond, VA · Charleston, WV · Harrisburg, PA

Prepared By:

No.	Date	Revision

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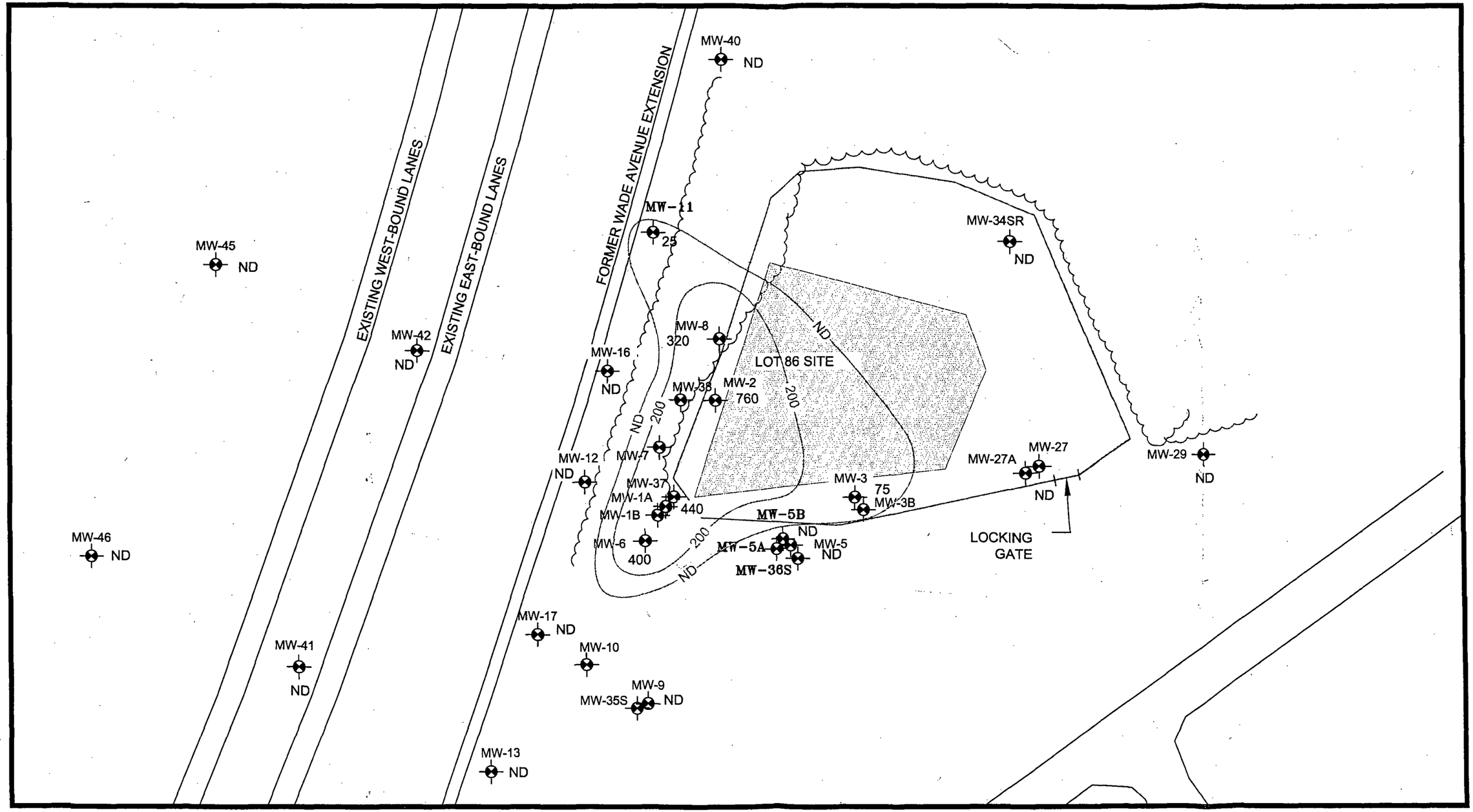
SCALE:	1" = 150'
PROJECT NO.:	C30104
FILE NO.:	C30104.dwg

NORTH CAROLINA STATE UNIVERSITY
LOT 86, WADE AVENUE EXTENSION
RALEIGH, WAKE COUNTY, NORTH CAROLINA

SITE MAP WITH ISOCONCENTRATION MAPS

SHEET NUMBER
4



TETRACHLOROETHENE ISOCONCENTRATION MAP
SHALLOW MONITORING WELLS

LEGEND

- TREELINE
- ISOCONCENTRATION (1 µg/l)
- FENCE

80' 0 80'

1"=80'

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Geology, Environmental Sciences & Engineering, Geophysics
Bluefield, VA · Lexington, KY · Raleigh, NC
Richmond, VA · Charleston, WV · Harrisburg, PA

Prepared By:
MARSHALL MILLER & ASSOCIATES

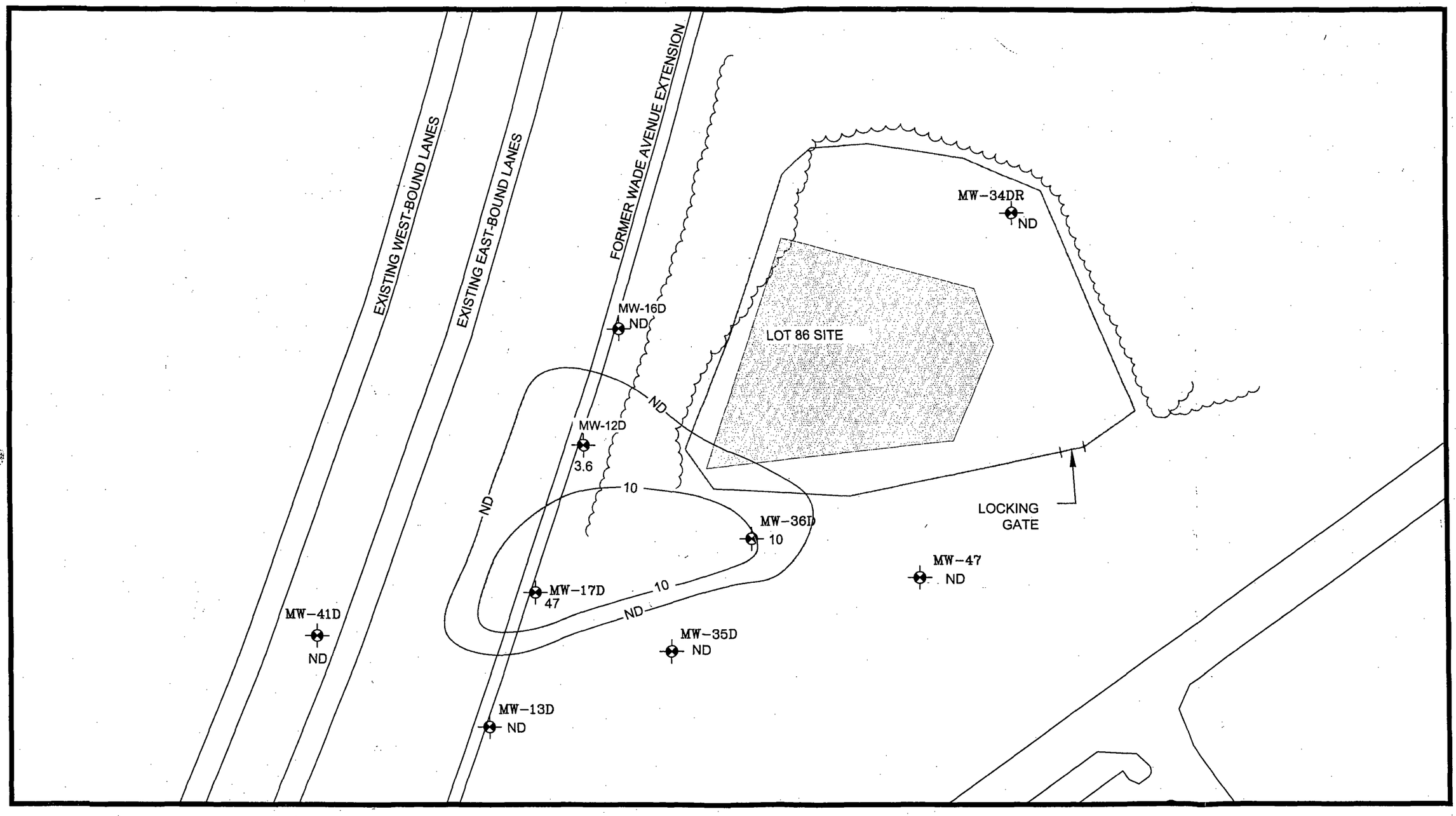
No.	Date	Revision

DESIGNED:	DS
DRAWN:	AHR
CHECKED:	DS
DATE:	10/2004
SCALE:	1" = 150'
PROJECT NO.:	C30104
FILE NO.:	C30104.dwg

NORTH CAROLINA STATE UNIVERSITY
LOT 86, WADE AVENUE EXTENSION
RALEIGH, WAKE COUNTY, NORTH CAROLINA

SITE MAP WITH ISOCONCENTRATION MAPS

SHEET NUMBER
5



TETRACHLOROETHENE ISOCONCENTRATION MAP
DEEP MONITORING WELLS

LEGEND

- TREELINE
- ISOCONCENTRATION (1 µg/l)
- FENCE

80' 0 80'

1" = 80'

Marshall Miller and Associates
Geology, Environmental Sciences & Engineering, Geophysics
Blacksburg, VA · Lexington, KY · Raleigh, NC
Richmond, VA · Charleston, WV · Harrisburg, PA

Prepared By:

No.	Date	Revision

DESIGNED:	DS
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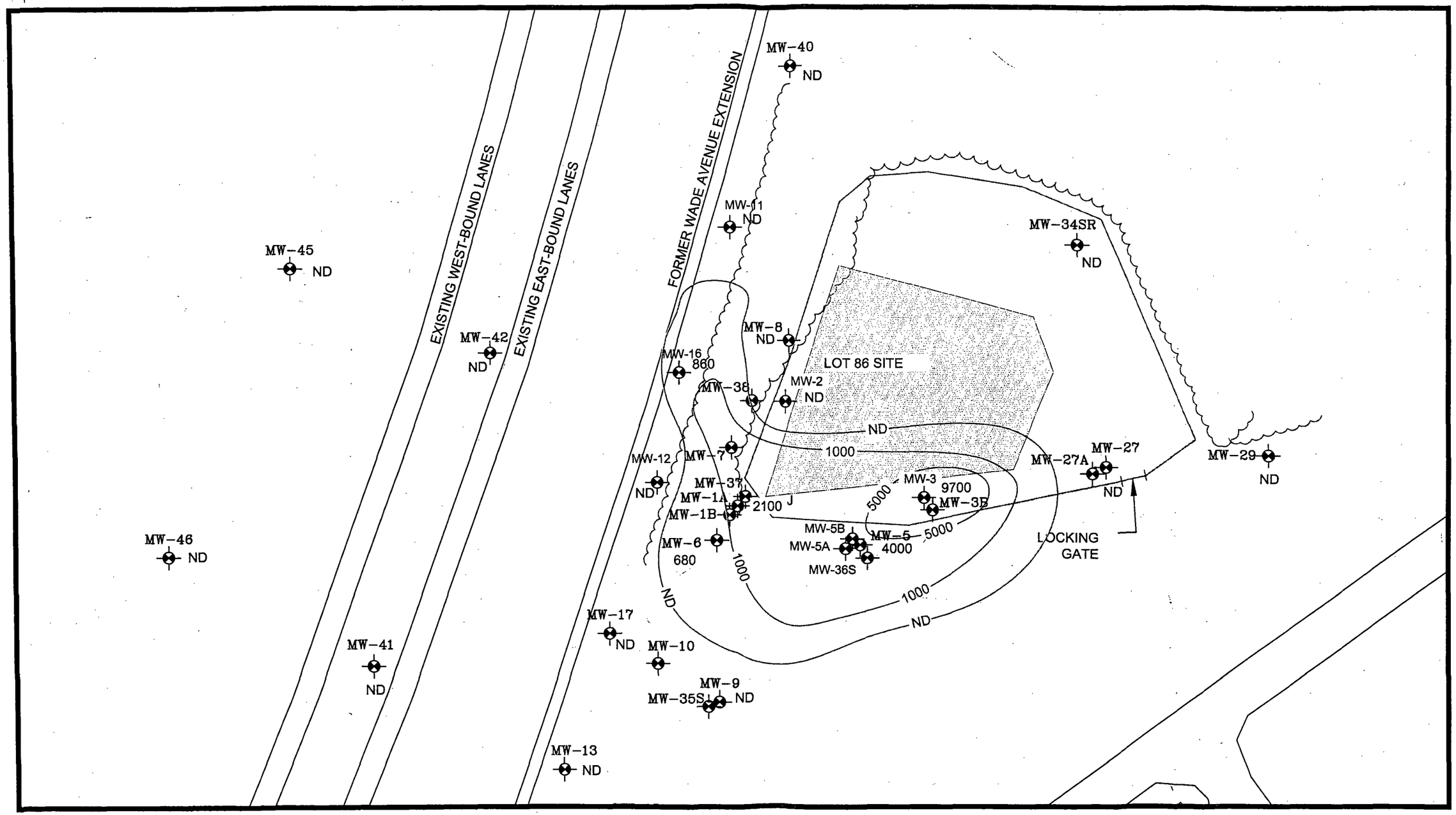
FILE NO.:	C30104.dwg

NORTH CAROLINA STATE UNIVERSITY
LOT 86, WADE AVENUE EXTENSION
RALEIGH, WAKE COUNTY, NORTH CAROLINA

SITE MAP WITH ISOCONCENTRATION MAPS

SHEET NUMBER
6



METHYLENE CHLORIDE ISOCONCENTRATION MAP
SHALLOW MONITORING WELLS

LEGEND
- TREELINE
- ISOCONCENTRATION (1 µg/l)
- FENCE

80' 0 80'
1" = 80'

Marshall Miller and Associates
Geology, Environmental Sciences & Engineering, Geophysics
Bluefield, VA · Lexington, KY · Raleigh, NC
Richmond, VA · Charleston, WV · Harrisburg, PA

Prepared By:

No.	Date	Revision

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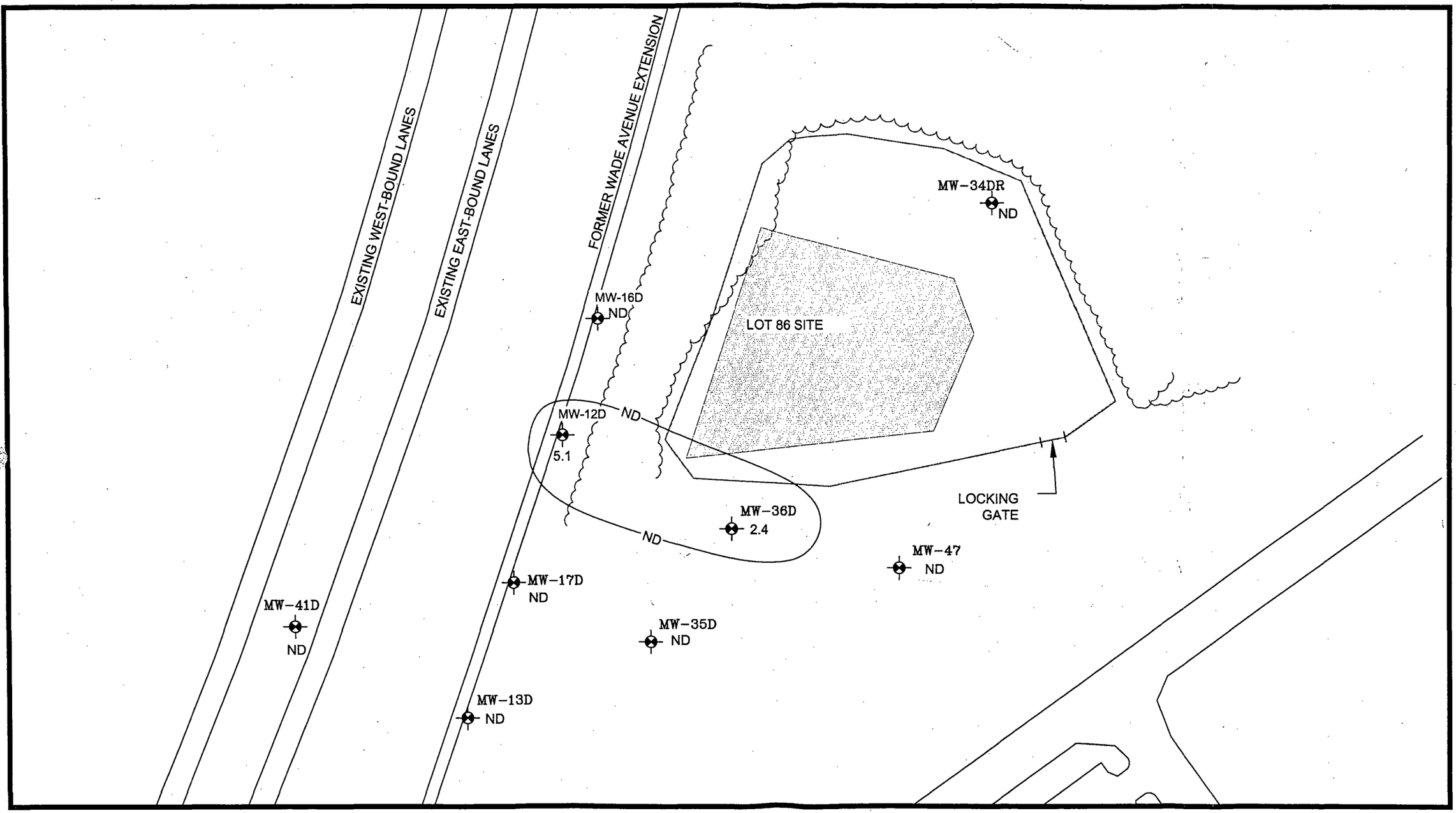
FILE NO.:	C30104.dwg

NORTH CAROLINA STATE UNIVERSITY
LOT 86, WADE AVENUE EXTENSION
RALEIGH, WAKE COUNTY, NORTH CAROLINA

SITE MAP WITH ISOCONCENTRATION MAPS

SHEET NUMBER
7



METHYLENE CHLORIDE ISOCONCENTRATION MAP
DEEP MONITORING WELLS

LEGEND

TREELINE

ISOCONCENTRATION (1 µg/l)

FENCE

80' 0 80'

1" = 80'

Marshall Miller and Associates
Geology, Environmental Science & Engineering, Geophysics
Bluefield, VA · Lexington, KY · Raleigh, NC
Richmond, VA · Charleston, WV · Harrisburg, PA

Prepared By:

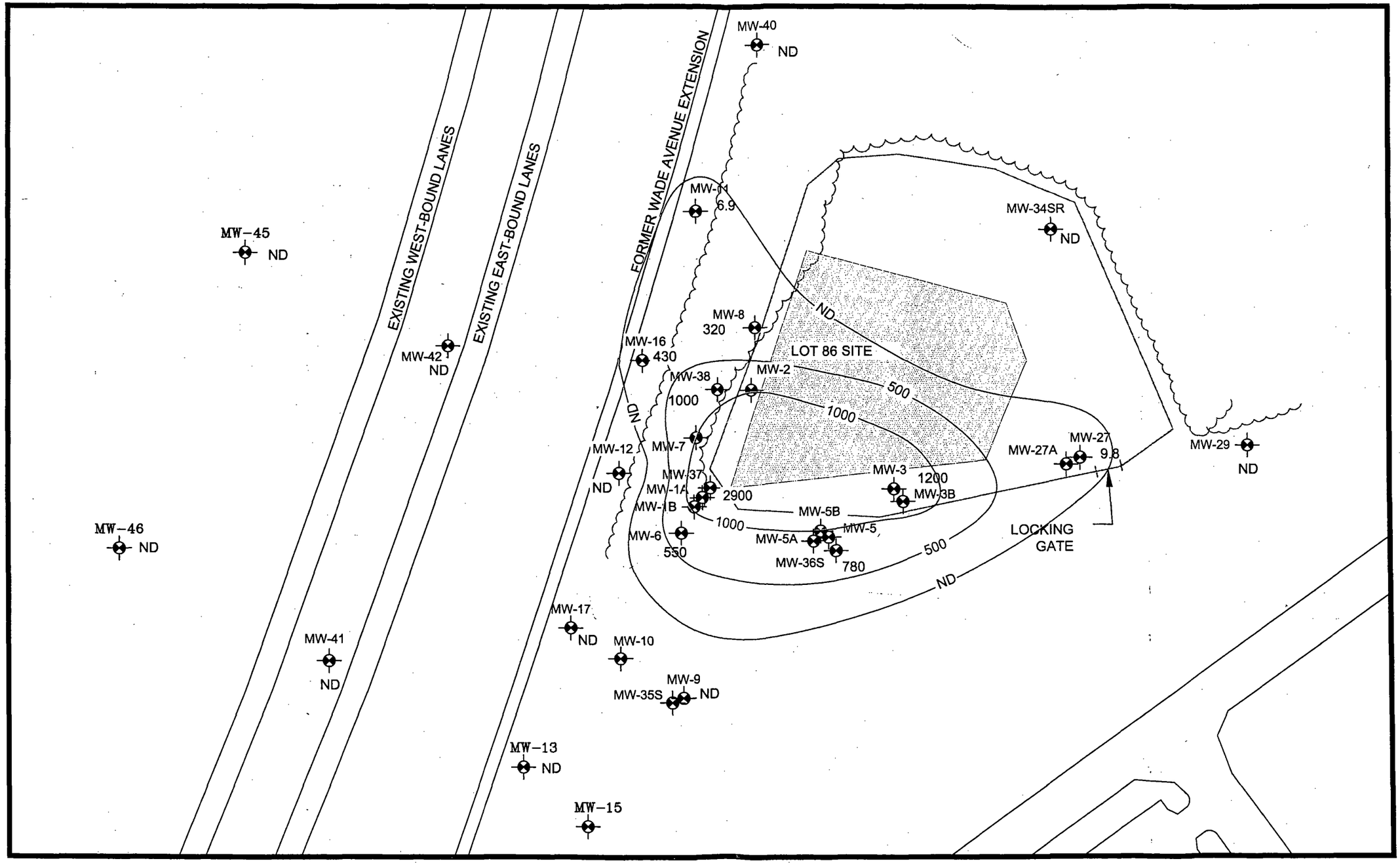
No.	Date	Revision

DESIGNED: DS
DRAWN: AHR
CHECKED: DS
DATE: 10/2004
SCALE: 1" = 150'
PROJECT NO.: C30104
FILE NO.: C30104.dwg

NORTH CAROLINA STATE UNIVERSITY
LOT 86, WADE AVENUE EXTENSION
RALEIGH, WAKE COUNTY, NORTH CAROLINA

SITE MAP WITH ISOCONCENTRATION MAPS

SHEET NUMBER
8



CARBON TETRACHLORIDE ISOCONCENTRATION MAP
SHALLOW MONITORING WELLS

LEGEND
- TREELINE
- ISOCONCENTRATION (1 µg/l)
- FENCE

80' 0 80'
1" = 80'

Marshall Miller and Associates
Geology, Environmental Science & Engineering, Geophysics
Bluefield, VA · Lexington, KY · Raleigh, NC
Richmond, VA · Charleston, WV · Harrisburg, PA

Prepared By:

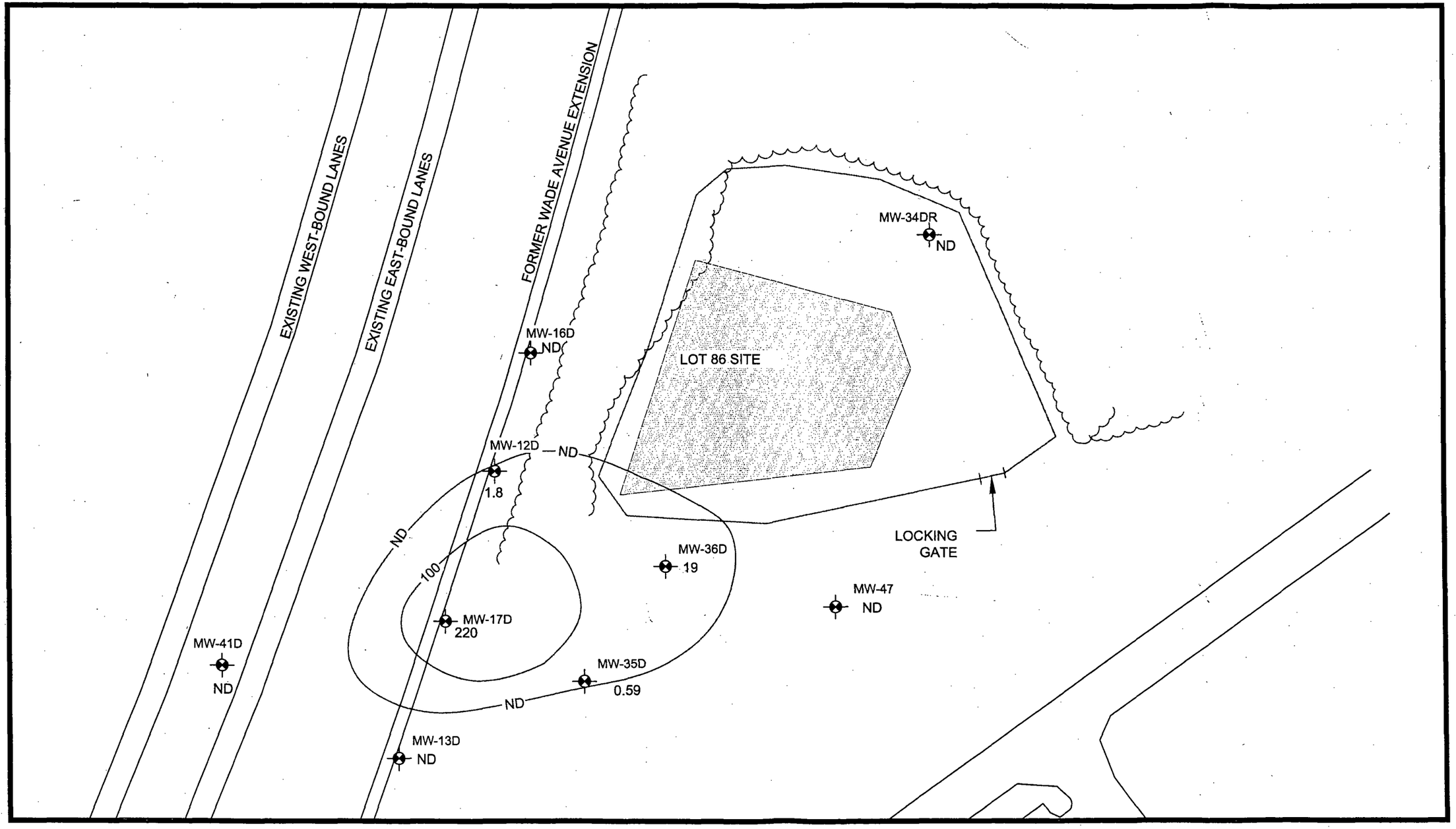
No.	Date	Revision

DESIGNED:	DS
DRAWN:	AHR
CHECKED:	DS
DATE:	10/2004
SCALE:	1" = 150'
PROJECT NO.:	C30104
FILE NO.:	C30104.dwg

NORTH CAROLINA STATE UNIVERSITY
LOT 86, WADE AVENUE EXTENSION
RALEIGH, WAKE COUNTY, NORTH CAROLINA

SITE MAP WITH ISOCONCENTRATION MAPS

SHEET NUMBER
9



CARBON TETRACHLORIDE ISOCONCENTRATION MAP
DEEP MONITORING WELLS

LEGEND
- TREELINE
- ISOCONCENTRATION (1 µg/l)
- FENCE

80' 0 80'
1" = 80'

Marshall Miller and Associates
Geology, Environmental Sciences & Engineering, Geophysics
Bluefield, VA · Lexington, KY · Raleigh, NC
Richmond, VA · Charleston, WV · Harrisburg, PA
Prepared By:

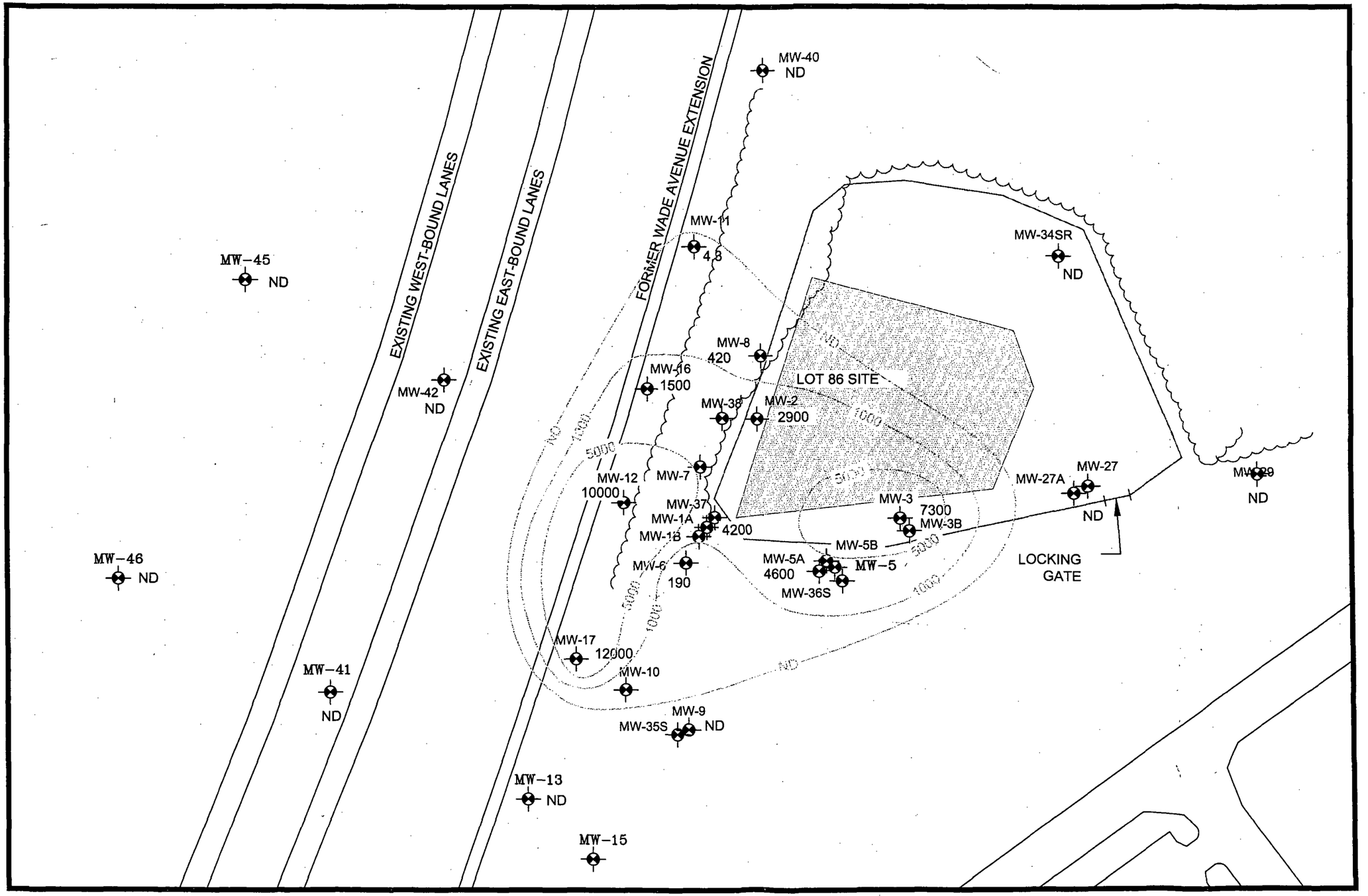
No.	Date	Revision

DESIGNED: DS
DRAWN: AHR
CHECKED: DS
DATE: 10/2004
SCALE: 1" = 150'
PROJECT NO.: C30104
FILE NO.: C30104.dwg

NORTH CAROLINA STATE UNIVERSITY
LOT 86, WADE AVENUE EXTENSION
RALEIGH, WAKE COUNTY, NORTH CAROLINA

SITE MAP WITH ISOCONCENTRATION MAPS

SHEET NUMBER
10



LEGEND

TREELINE

ISOCONCENTRATION (1 µg/l)

FENCE

BENZENE ISOCONCENTRATION MAP
SHALLOW MONITORING WELLS

80' 0 80'

1" = 80'

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Richmond, VA · Charleston, WV · Harrisburg, PA

Prepared By:

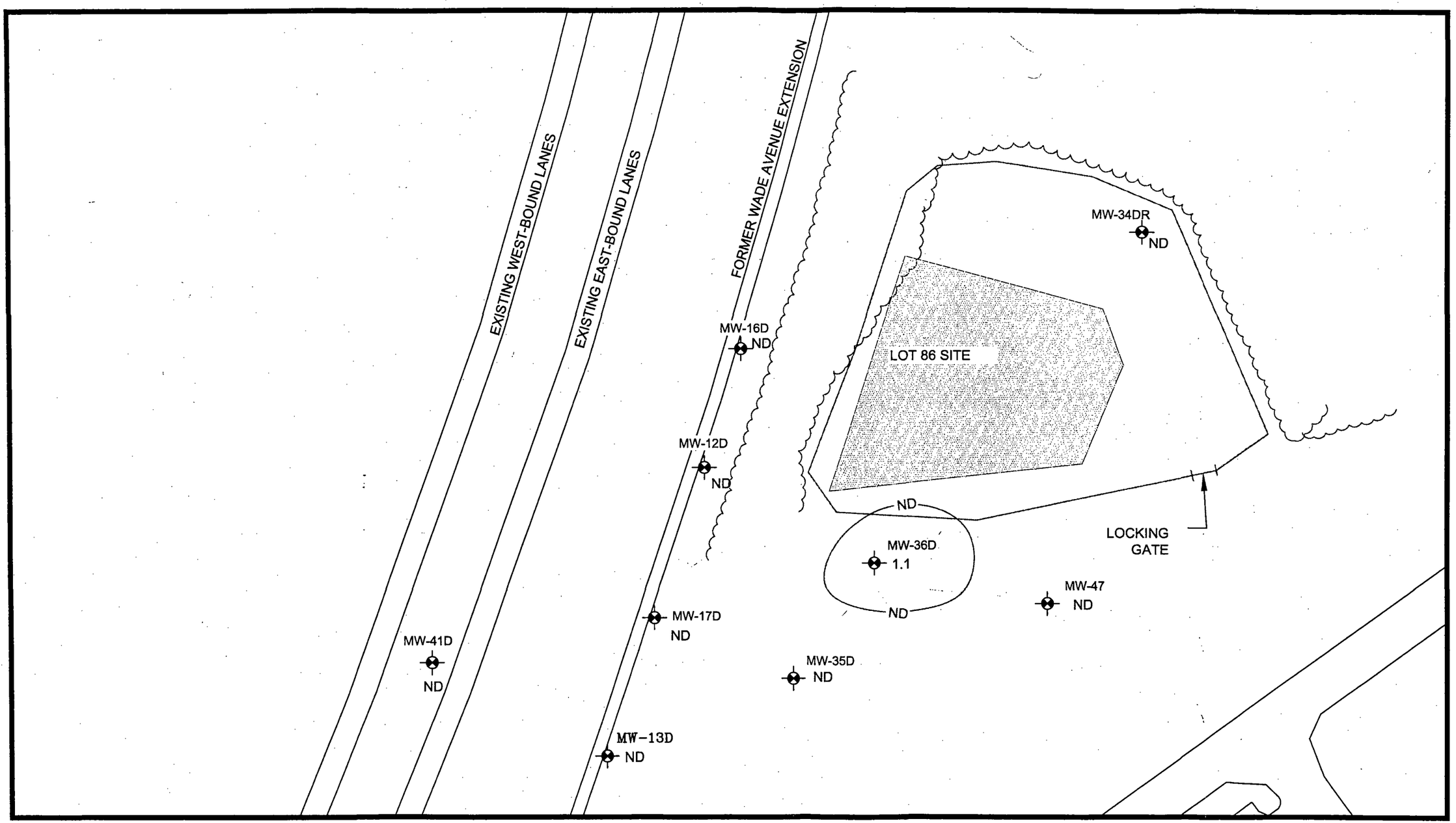
No.	Date	Revision

DESIGNED: DS
DRAWN: AHR
CHECKED: DS
DATE: 10/2004
SCALE: 1" = 150'
PROJECT NO.: C30104
FILE NO.: C30104.dwg

NORTH CAROLINA STATE UNIVERSITY
LOT 86, WADE AVENUE EXTENSION
RALEIGH, WAKE COUNTY, NORTH CAROLINA

SITE MAP WITH ISOCONCENTRATION MAPS

SHEET NUMBER
11



BENZENE ISOCONCENTRATION MAP
DEEP MONITORING WELLS

LEGEND

TREELINE

ISOCONCENTRATION (1 µg/l)

FENCE

80' 0 80'

1" = 80'

Marshall Miller and Associates
Geologic, Environmental Science & Engineering, Geophysics
Bluefield, VA · Lexington, KY · Raleigh, NC
Richmond, VA · Charleston, WV · Chambersburg, PA

Prepared By:

No.	Date	Revision

DESIGNED: DS
DRAWN: AHR
CHECKED: DS
DATE: 10/2004
SCALE: 1" = 150'
PROJECT NO.: C30104
FILE NO.: C30104.dwg

NORTH CAROLINA STATE UNIVERSITY
LOT 86, WADE AVENUE EXTENSION
RALEIGH, WAKE COUNTY, NORTH CAROLINA

SITE MAP WITH ISOCONCENTRATION MAPS

SHEET NUMBER
12

ATTACHMENT 1
List of Documents Reviewed

List of Documents Reviewed
NCSU Lot 86
Second Five-Year Review

U. S. Environmental Protection Agency, Region IV. September 30, 1996. Record Of Decision, NCSU Lot 86 Superfund Site, Raleigh, North Carolina.

North Carolina Department of Environment and Natural Resources. September 25, 2003. Five-Year Review Report. NCSU Lot 86 Superfund Site, Raleigh, North Carolina.

East Coast Environmental. March 16, 2004. Fractured Rock Assessment. NCSU Lot 86 Superfund Site, Raleigh, North Carolina.

Marshall Miller and Associates. November 10, 2005. Draft Remedial Action Work Plan. NCSU Lot 86 Superfund Site, Raleigh, North Carolina.

Marshall Miller and Associates. Soil Encapsulation Remedial Action Report. NCSU Lot 86 Superfund Site, Raleigh, North Carolina.

Marshall Miller and Associates. March 29, 2006. Final Design Criteria Report for the Groundwater Remediation Phase. NCSU Lot 86 Superfund Site, Raleigh, North Carolina.

Carolina Solar Energy, LLC. January 2, 2007. Memorandum: Health and Safety Issues Involved in CSE's Proposed Solar Project. NCSU Lot 86 Superfund Site, Raleigh, North Carolina.

Piedmont Geologic, P.C. September 24, 2007. Remedial Action Report. NCSU Lot 86 Superfund Site, Raleigh, North Carolina.

ATTACHMENT 2
Site Inspection Checklist

Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Five-Year Review Site Inspection Checklist (Template)

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION	
Site name: NCSU Lot 86	**Date of inspection: 4 / 16 / 2008**
Location and Region: Raleigh, NC Region 4	**EPA ID: 980557656**
Agency, office, or company leading the five-year review: NC DENR	**Weather/temperature: Sunny, 65°**

Remedy Includes: (Check all that apply)

- ☒ Landfill cover/containment
- ☐ Access controls
- ☐ Institutional controls
- ☒ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other _____
- ☐ Monitored natural attenuation
- ☒ Groundwater containment
- ☐ Vertical barrier walls

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Duane Knudson (Name) NCSU Env. Engineer (Title) April 16, 2008 (Date)
   Interviewed ☒ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached _____

2. **O&M staff** Bruce Stewart (Name) NCSU Environmental Dept. (Title) April 16, 2008 (Date)
   Interviewed ☒ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached _____

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 _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached _____
_____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached _____
_____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached _____
_____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached _____
_____

4. **Other interviews** (optional) ☐ Report attached.

III. 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			
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			
3.	**O&M and OSHA Training Records**	☒ Readily available	☒ Up to date	☐ N/A
	Remarks: Maintained in the office			
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			
5.	**Gas Generation Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
6.	**Settlement Monument Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
7.	**Groundwater Monitoring Records**	☒ Readily available	☒ Up to date	☐ N/A
	Remarks			
8.	**Leachate Extraction Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
9.	**Discharge Compliance Records**			
	☐ Air	☐ Readily available	☐ Up to date	☐ N/A
	☒ Water (effluent)	☒ Readily available	☒ Up to date	☐ N/A
	Remarks			
10.	**Daily Access/Security Logs**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			

IV. 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_____

2. **O&M Cost Records**

☐ Readily available ☐ Up to date
☐ Funding mechanism/agreement in place
Original O&M cost estimate_____ ☒ Breakdown dicussed in 5 yr review report

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

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS ☐ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☒ Gates secured ☐ N/A
Remarks_____

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A
Remarks: signage

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented *☒ Yes ☐ No ☐ N/A
Site conditions imply ICs not being fully enforced *☒ Yes ☐ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) _____
Frequency _____
Responsible party/agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.

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
Other problems or suggestions: ☐ Report attached

* The Draft *Declaration of Perpetual Land Use Restrictions for a Federal Superfund Site* has been drafted and was recently revised in May 2008. The institutional controls are currently under review and should be finalized as soon as possible.

2. **Adequacy** ☐ ICs are adequate ☒ ICs are inadequate ☐ N/A
Remarks: However, ICs are in progress.

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident
Remarks _____

2. **Land use changes on site** ☐ N/A
Remarks: no

3. **Land use changes off site** ☐ N/A
Remarks: no

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. **Roads damaged** ☒ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks _____

B. Other Site Conditions

Remarks _____

VII. LANDFILL COVERS ☒ Applicable ☐ N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map ☒ Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Cracks** ☐ Location shown on site map ☒ Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks_____

3. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Holes** ☐ Location shown on site map ☒ Holes not evident
   Areal extent_____ Depth_____
   Remarks_____

5. **Vegetative Cover** ☒ Grass ☒ Cover properly established ☒ No signs of stress
   ☐ Trees/Shrubs (indicate size and locations on a diagram)
   Remarks_____

6. **Alternative Cover (armored rock, concrete, etc.)** ☒ N/A
   Remarks_____

7. **Bulges** ☐Location shown on site map ☒ Bulges not evident
   Areal extent_____ Height_____
   Remarks

8. **Wet Areas/Water Damage** ☒ Wet areas/water damage not evident
   ☐ Wet areas ☐ Location shown on site map Areal extent_____
   ☐ Ponding ☐ Location shown on site map Areal extent_____
   ☐ Seeps ☐ Location shown on site map Areal extent_____
   ☐ Soft subgrade ☐ Location shown on site map Areal extent_____
   Remarks_____

9. **Slope Instability** ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability
   Areal extent_____
   Remarks_____

B. Benches ☐ Applicable ☒ N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** ☐ Location shown on site map ☒ N/A or okay
   Remarks_____

2. **Bench Breached** ☐ Location shown on site map ☒ N/A or okay
   Remarks_____

3. **Bench Overtopped** ☐ Location shown on site map ☒ N/A or okay
   Remarks_____

C. Letdown Channels ☐ Applicable ☒ N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** ☐ Location shown on site map ☐ No evidence of settlement
   Areal extent_____ Depth_____
   Remarks_____

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation
   Material type_____ Areal extent_____
   Remarks_____

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion
   Areal extent_____ Depth_____
   Remarks_____

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting
   Areal extent_____ Depth_____
   Remarks_____

5. **Obstructions** Type_____ ☐ No obstructions
   ☐ Location shown on site map Areal extent_____
   Size_____
   Remarks_____

6. **Excessive Vegetative Growth** Type_____
   ☐ No evidence of excessive growth
   ☐ Vegetation in channels does not obstruct flow
   ☐ Location shown on site map Areal extent_____
   Remarks_____

D. Cover Penetrations ☐ Applicable ☒ N/A

1. **Gas Vents** ☐ Active ☐ Passive
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs Maintenance
   ☐ N/A
   Remarks_____

2. **Gas Monitoring Probes**
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
   Remarks_____

3. **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_____

4. **Leachate Extraction Wells**
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks_____

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☐ N/A
Remarks_____

E. Gas Collection and Treatment ☐ Applicable ☒ N/A

1. **Gas Treatment Facilities**
☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
☐ Good condition ☐ Needs Maintenance
Remarks_____

2. **Gas Collection Wells, Manifolds and Piping**
☐ Good condition ☐ Needs Maintenance
Remarks_____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
☐ Good condition ☐ Needs Maintenance ☐ N/A
Remarks_____

F. Cover Drainage Layer ☐ Applicable ☒ N/A

1. **Outlet Pipes Inspected** ☐ Functioning ☐ N/A
Remarks_____

2. **Outlet Rock Inspected** ☐ Functioning ☐N/A
Remarks_____

G. Detention/Sedimentation Ponds ☐ Applicable ☒ N/A

1. **Siltation** Areal extent_____ Depth_____ ☐ N/A
☐ Siltation not evident
Remarks_____

2. **Erosion** Areal extent_____ Depth_____
☐ Erosion not evident
Remarks_____

3. **Outlet Works** ☐ Functioning ☐ N/A
Remarks_____

4. **Dam** ☐Functioning ☐ N/A
Remarks_____

H. Retaining Walls ☐ Applicable ☒ N/A

1. **Deformations** ☐ Location shown on site map ☐ Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks_____

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident
   Remarks_____

I. Perimeter Ditches/Off-Site Discharge ☐ Applicable ☒ N/A

1. **Siltation** ☐ Location shown on site map ☐ Siltation not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
   Γ Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks_____

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Discharge Structure** ☐ Functioning ☐ N/A
   Remarks_____

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

1. **Settlement** ☐ Location shown on site map ☐ Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Performance Monitoring** Type of monitoring_____
   ☐ Performance not monitored
   Frequency_____ ☐ Evidence of breaching
   Head differential_____
   Remarks_____

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable ☒ N/A

A. 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_____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   ☒ Good condition ☐ Needs Maintenance
   Remarks_____

3. **Spare Parts and Equipment**
   ☒ Readily available ☒ Good condition ☐ Requires upgrade ☐Needs to be provided
   Remarks_____

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A

1. **Collection Structures, Pumps, and Electrical**
   ☐ Good condition ☐ Needs Maintenance
   Remarks_____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   ☐ Good condition ☐ Needs Maintenance
   Remarks_____

3. **Spare Parts and Equipment**
   ☐Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided
   Remarks_____

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
   ☒ Metals removal ☐ Oil/water separation ☐ Bioremediation
   ☒ Air stripping ☒ Carbon adsorbers
   ☒ Filters: sediment
   ☐ Additive (*e.g.*, chelation agent, flocculent)_____
   ☐ Others_____
   ☒ 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: 10,000 gallons/month or 120,000 gallons per year.
   Remarks_____

2. **Electrical Enclosures and Panels** (properly rated and functional)
   ☐ N/A ☒ Good condition ☐ Needs Maintenance
   Remarks_____

3. **Tanks, Vaults, Storage Vessels**
   ☐ N/A ☒ Good condition ☒ Proper secondary containment ☐ Needs Maintenance
   Remarks_____

4. **Discharge Structure and Appurtenances**
   ☒ N/A ☐ Good condition ☐ Needs Maintenance
   Remarks_____

5. **Treatment Building(s)**
☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair
☐ Chemicals and equipment properly stored
Remarks_____

6. **Monitoring Wells** (pump and treatment remedy)
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☒ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks_____

D. Monitoring Data

1. Monitoring Data
☒ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring data suggests:
☒ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs Maintenance ☒ N/A
Remarks_____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. 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.).

The soil was treated and properly contained. The groundwater is hydraulically contained and is currently being treated and monitored.

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.

All issues are up to date and in good working order.

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, which suggest that the protectiveness of the remedy may be compromised in the future.

Not applicable

D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. It is unclear at this point to make a decision regarding optimization in monitoring or operation of the remedy.

ATTACHMENT 3
Complete Interviews

NCSU, Lot 86 Superfund Site
Raleigh, Wake County, NC
EPA ID: NCD 980557656
Superfund Five-Year Review Report

Interview Questionnaire
Completed by Michael Townsend, US EPA RPM

1. What is your overall impression of the project? (general sentiment)

   The process for this site was somewhat lengthy, but my overall impression is that the actual work at the site was implemented in a thorough and highly competent manner. The resulting remedy met the statutory preferences for treatment to reduce toxicity and mobility of contaminants present at the site.

2. What effects have site operations had on the surrounding community?

   The sites is fairly remote as it pertains to the surrounding community, therefore the actual community should have experience very limited to no impact from the site.

3. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.

   I am not aware of any concerns expressed by the surrounding community

4. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.

   I have not received any complaints, notices of violations or incidents.

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?

   No.

7. What is the current status of construction (*e.g.*, budget and schedule)?

   The site is currently construction complete and is currently in the long term remedial action phase.

8. Have any problems been encountered which required, or will require, changes to this remedial design or this ROD?

   Currently there are no problems that have come to light that would require a change to the remedy.

9. Have any problems or difficulties been encountered which have impacted construction progress or implementability?

   No.

10. Do you have any comments, suggestions, or recommendations regarding the project (i.e., design, construction documents, constructability, management, regulatory agencies, etc.)?

No.

11. Is the remedy functioning as expected? How well is the remedy performing?

Yes.

Five Year Review – 2008
NC State Lot 86, Raleigh, North Carolina
Community Interviews

Community interviews were conducted, by telephone, as part of the Five Year Review for the NC State Lot 86 Site located in Raleigh, Wake County, North Carolina. All individuals that were interviewed were notified that the Five Year Review was being conducted at the Site and that a final report will be placed in the information repositories located at the Cameron Village Regional Public Library located in Raleigh, North Carolina and also at the D.H. Hill Library, Government Reference Section, NC State University located in Raleigh, North Carolina, for the public to review.

Several interviews were conducted with staff at the North Carolina State University. They stated that there has been no intense interest in the NC State Lot 86 Site for quite some time. Citizens are pleased that the problem was remediated.

Attempts to contact former residents on Old Trinity Road were made but not successful.

Community Interviews were conducted by:
Angela R. Miller, Public Affairs Specialist
United States Environmental Protection Agency

ATTACHMENT 4
Photographs

Photograph Log

Photo 1: On-site monitoring well
Photo 2: Monolith with solar panels
Photo 3: On-site monitoring well
Photo 4, 5, 6 & 7: Views from inside the Treatment Building, which houses the groundwater treatment and extraction system.

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 8