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FINAL VAPOR INTRUSION EVALUATION WORK PLAN MCB CAMP LEJEUNE NC
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CH2M HILL

Final

Vapor Intrusion Evaluation Work Plan

Marine Corps Base Lejeune
Jacksonville, North Carolina

Task Order 21

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5-1 Risk Evaluation Strategy

Appendixes

A Field Sampling Plan
B Uniform Federal Policy—Sampling and Analysis Plan
C Health and Safety Plan
D Project Schedule

Acronyms and Abbreviations

AFVR	Aggressive Fluid Vapor Recovery
amsl	above mean sea level
AS	air sparge
ASD	active soil depressurization
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
AST	aboveground storage tank
bgs	below ground surface
BS	biosparge
BTEX	benzene, toluene, ethylbenzene, and xylenes
CAP	Corrective Action Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeter
cm^3/cm^3	cubic centimeter per cubic centimeter
COC	contaminant of concern
Comm Bn	Communications Battalion
COPC	constituent of potential concern
CSM	conceptual site model
CSC	Soil Conservation Survey
CSI	Confirmatory Sampling Investigation
CSFF	Campbell Street Fuel Farm
CSM	conceptual site model
°F	degrees Fahrenheit
DCA	dichloroethane
DCE	dichloroethene
DLA	Defense Logistics Agency
DoN	Department of the Navy
DQO	data quality objective
DRMO	Defense Reutilization and Marketing Office
DRO	diesel range organics
ERD	enchanced reductive dechlorination
FFA	Federal Facility Agreement
FID	flame ionization detector
FSP	Field Sampling Plan
ft	feet/foot
GIS	geographical information system
GRO	gasoline range organic
HASP	Health and Safety Plan
HPFF	Hadnot Point Fuel Farm

HPIA	Hadnot Point Industrial Area
HQ	hazard quotient
HSWA	Hazardous and Solid Waste Amendments
HVAC	heating, ventilating, and air conditioning
ISCO	*in situ* chemical oxidation
IM	Interim Measure
IR	Installation Restoration
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
J&E	Johnson and Ettinger
JP-5	jet-propulsion fuel, grade 5
LNAPL	light nonaqueous phase liquid
LSA	Limited Site Assessment
LTM	long-term monitoring
LUC	land use control
µg/L	microgram per liter
MARDIV	Marine Division
MCB	Marine Corps Base
MCCS	Marine Corps Community Service
MCSC	I don't know what this is – Marine Corp …….
MEC	Munitions and Explosives of Concern
MEF	Marine Expeditionary Force
MEU	Marine Expeditionary Unit
MEK	methyl-ethyl-ketone
MNA	monitored natural attenuation
MRP	Munitions Response Program
MTBE	methyl tert butyl ether
NACIP	Navy Assessment and Control of Installation Pollutants
NAPL	nonaqueous phase liquid
NCDENR	North Carolina Department of Environment and Natural Resources
NAES	Natural Attenuation Evaluation Study
NCGWQS	North Carolina Groundwater Quality Standards
NFA	No Further Action
NJDEP	New Jersey Department of Environmental Protection
NPL	National Priorities List
NTCRA	Non-Time-Critical Removal Action
OU	operable unit
OWS	oil/water separator
PAH	polycyclic aromatic hydrocarbon
PCA	tetracholorethane
PCE	tetrachloroethene
PMO	Project Management Office
ppbv	parts per billion by volume

PRG	preliminary remediation goal
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
RAO	remedial action objective
RCAP	RCRA Corrective Action Plan
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RFP	Request for Proposal
RI	Remedial Investigation
ROD	Record of Decision
ROICC	Resident Officer in Charge of Construction
RR	Rapid Refueler
SARA	Superfund Amendments and Reauthorization Act
SB	Statement of Basis
SI	Site Investigation
SOP	standard operating procedure
SVE	soil vapor extraction
SVOC	semivolatile organic compound
SWMU	solid waste management unit
Tank Bn	Tank Battalion
TCE	trichloroethene
TOC	total organic carbon
TPH	total petroleum hydrocarbon
UFP-SAP	Uniform Federal Policy-Sampling and Analysis Plan
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VC	vinyl chloride
VOC	volatile organic compound
WP	Work Plan
WTP	water treatment plant
ZVI	zero valent iron

SECTION 1

Introduction

A vapor intrusion evaluation is being performed for the Marine Corps Base (MCB), Camp Lejeune under the AGVIQ-CH2M HILL Joint Venture 2 (JV 2) Contract No.: N62467-03-D-0260, Task Order 21, in accordance with the Scope of Work included in the Request for Proposal (RFP) dated September 14, 2007. The purpose of this vapor intrusion evaluation is to begin collecting the data that will help the Marine Corps identify potential vapor intrusion pathways at Camp Lejeune.

This Work Plan (WP) describes the process that was used to evaluate existing environmental sampling data to identify buildings with potential vapor intrusion pathways. Additional analytical data then will be collected at these buildings to further assess the potential for vapor intrusion. Detailed plans for sample collection at each building identified with a potential for vapor intrusion are also included in a Field Sampling Plan (FSP) which is included as Appendix A of this WP.

1.1 Objectives and Scope of Work

The primary objective of the vapor intrusion evaluation project is to provide the Base with information on the potential for vapor intrusion within buildings located within 100 feet of known groundwater volatile organic compound (VOC) contamination. As described in the RFP, the objectives of this vapor intrusion evaluation are as follows:

1. Identify the buildings located 100 feet (ft) vertically or horizontally of existing monitoring wells with groundwater VOC concentrations exceeding North Carolina Groundwater Quality Standards (NCGWQS), and if present,
2. Identify that a complete vapor intrusion exposure pathway exists (through a preliminary Conceptual Site Model [CSM]) for vapor intrusion of subsurface VOC contamination into the buildings, and if so
3. Identify if contamination is present inside the buildings at levels that could affect building occupants.

If necessary, these objectives will be supported through groundwater, near-slab soil gas, soil and subslab sampling. The need to conduct indoor air sampling in buildings will be dependant on the results obtained from these other sampling activities.

It should be noted that performing a full vapor intrusion risk assessment is outside the scope of this project. However, the results of this evaluation can be used to rank the priority of buildings requiring further vapor intrusion evaluation and risk assessment. Additionally, the scope is limited to currently occupied buildings. Should land use change, groundwater data can be re-screened against the site-specific screening levels developed as part of this evaluation.

For purposes of implementation of this vapor intrusion evaluation, the base has been divided into six investigation areas. This WP provides the overall data evaluation

framework that was used to identify the buildings with potential vapor intrusion pathways for initial sampling. The six investigation areas of the Base are as follows:

- Mainside
- Hadnot Point
- Air Station
- Courthouse Bay
- Camp Geiger
- Tarawa Terrace

1.2 Vapor Intrusion Evaluation Approach

The overall project approach which will be applied to each of the six investigation areas of the Base is described in detail below and depicted in the approach flow chart presented in Figure 1-1. Steps 1 and 2 have been completed in preparation of this WP.

The primary steps depicted in Figure 1-1 are described as follows:

- **Step 1—Identification of Buildings of Interest**
  - Identification of Installation Restoration (IR), Resource Conservation and Recovery Act (RCRA), Underground Storage Tank (UST), and Military Munitions Response Program (MMRP) sites. Available information for active IR, RCRA, and UST sites will be reviewed to determine the site use, type of contamination present, geology, and current regulatory status.
  - Selection of Constituents of Potential Concern (COPCs). Groundwater data collected from the identified sites from 2002 to 2007 will be screened against NCGWQS and generic vapor intrusion screening levels to identify COPCs to be used as indicator compounds. COPCs will be identified as VOCs detected most frequently and with the greatest maximum detections above the screening levels within each area.
  - Identification of Buildings of Interest. Buildings located within 100 ft of groundwater containing COPC concentrations exceeding screening levels will be selected as buildings of interest for further vapor intrusion evaluation.
- **Step 2—Desktop Risk Evaluation**
  - Site-specific modeling will be conducted for each area of the Base using the Johnson and Ettinger (J&E) model and the available groundwater monitoring data to better identify the potential for vapor intrusion risk in the affected buildings. A preliminary CSM will be developed for the buildings identified with potential vapor intrusion pathways, and those buildings were identified for further sampling as part of this WP. The intent of this step is to focus sampling activities as part of this WP on the buildings with the highest potential for vapor intrusion pathways. The investigation results from those buildings will be used, along with the available groundwater monitoring data, to identify additional buildings, if any, which should undergo vapor intrusion investigation.

- **Step 3—Sampling and Analysis**
  - Sampling will be conducted at the buildings identified through Steps 1 and 2, to further characterize potential vapor intrusion pathways. Types of sampling to be conducted will include shallow groundwater, soil gas, subslab, and indoor air sampling. Data quality objectives (DQOs) have been developed to identify the appropriate numbers, types and locations of samples for each building that was retained for sampling. During field activities, the presence of potential preferential pathways (e.g., utility corridors) will be identified.
- **Step 4—Risk Evaluation**
  - **Risk Evaluation.** The sampling results will be evaluated to refine the CSMs for buildings being evaluated for the vapor intrusion pathway. These data will be evaluated using a multiple lines of evidence approach, as outlined in the vapor intrusion guidance document published by the Interstate Technology and Regulatory Council (ITRC, 2007). Predictive modeling (using the J&E model) will be updated using these sampling results and the data re-screened. Upon evaluation of the sampling results, identified preferential pathways will be evaluated to determine whether any additional buildings may require further investigation.

    The results of this risk evaluation can be used to make decisions regarding further investigation of vapor intrusion pathways, or, if appropriate, to evaluate mitigation measures for specific buildings. However, a full vapor intrusion risk assessment and evaluation of mitigation measures are outside the scope of this evaluation.
  - **Documentation.** The sampling results and risk evaluations will be documented in a summary report. The summary report will include the building inventory, analytical results and comparison to screening levels, and Geographical Information System (GIS) maps showing sampling and building locations.

    The vapor intrusion evaluation approach, results of the initial screening activities, and proposed sampling locations are described in detail in Sections 3, 4 and 5.

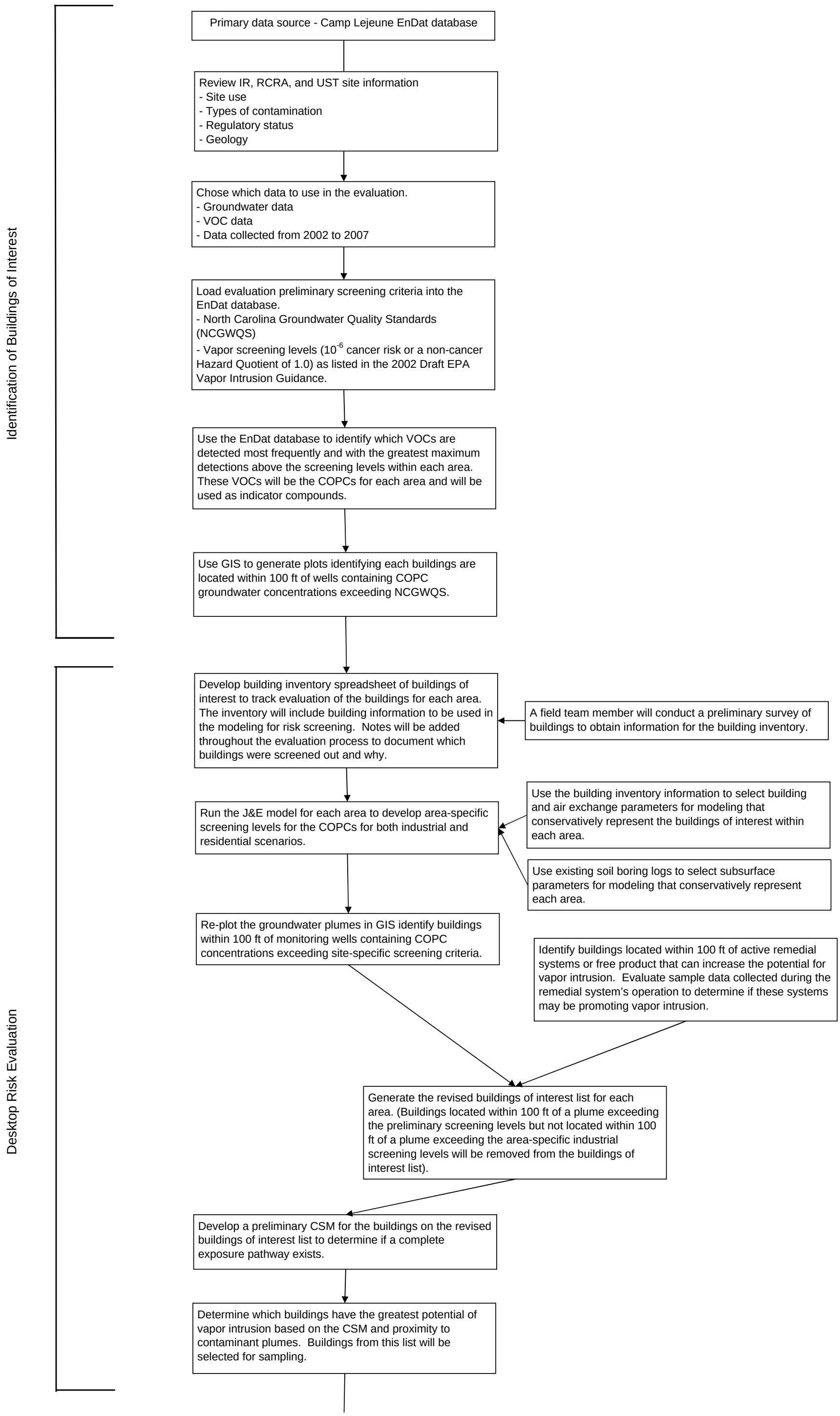
1.3 Work Plan Organization

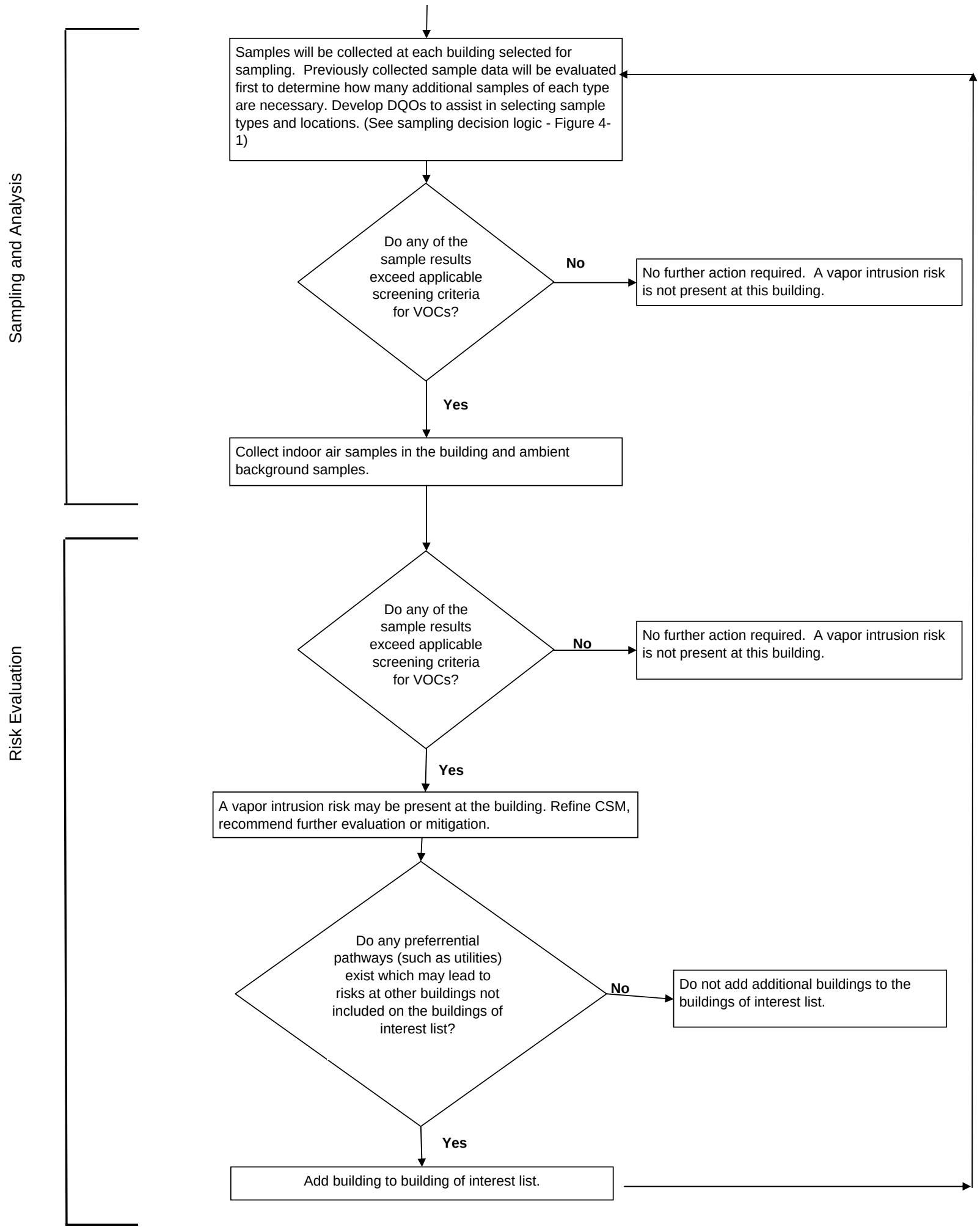
This WP is divided into the following sections:

- **Section 1—Introduction**. This section provides a description of the scope of work, project objectives, and a general overview of the project approach.
- **Section 2—Site Background.** This section provides a general Base background, description of the different investigation areas, and an evaluation of identified IR, RCRA, UST, and MMRP sites.
- **Section 3—Identification of Buildings of Interest.** This section presents the process for identifying buildings of interest (i.e., buildings where further evaluation of vapor intrusion may be warranted) and describes the preliminary risk evaluation, which involves calculating area-specific vapor intrusion screening levels using J&E modeling.

- **Section 4—Additional Data Requirements.** This section presents the preliminary CSMs and DQOs developed to determine additional data requirements for the vapor intrusion evaluation conducted as part of this WP. The proposed sampling locations are also provided in this section. The standard operating procedures for sample collection and analysis are presented in the FSP (Appendix A).
- **Section 5—Data Evaluation and Reporting.** This section describes the risk and data evaluation process and reporting to be conducted as part of this vapor intrusion investigation. It also identifies the deliverables which will be produced as part of this investigation.
- **Section 6—Project Schedule.** This section presents the proposed project schedule.
- **Section 7—References.**
- **Appendix A—FSP.** The FSP documents the procedures for sample collection and handling.
- **Appendix B—Uniform Federal Policy-Sampling and Analysis Plan (UFP-SAP) Worksheets.** A full UFP-SAP was not prepared for this project as work will be performed under the master Quality Assurance Project Plan (QAPP) (CH2M HILL, 2005b). However, UFP-SAP Worksheet #2, the crosswalk table, and associated worksheets deemed necessary were completed for this effort.
- **Appendix C—Health and Safety Plan (HASP)**. The HASP documents procedures which will be followed during field work to ensure the safety of site workers.

Figure 1-1
Vapor Intrusion Evaluation Approach




Sampling and Analysis
Risk Evaluation
Samples will be collected at each building selected for sampling. Previously collected sample data will be evaluated first to determine how many additional samples of each type are necessary. Develop DQOs to assist in selecting sample types and locations. (See sampling decision logic - Figure 4-1)
Do any of the sample results exceed applicable screening criteria for VOCs?
No
No further action required. A vapor intrusion risk is not present at this building.
Yes
Collect indoor air samples in the building and ambient background samples.
Do any of the sample results exceed applicable screening criteria for VOCs?
No
No further action required. A vapor intrusion risk is not present at this building.
Yes
A vapor intrusion risk may be present at the building. Refine CSM, recommend further evaluation or mitigation.
Do any preferrential pathways (such as utilities) exist which may lead to risks at other buildings not included on the buildings of interest list?
No
Do not add additional buildings to the buildings of interest list.
Yes
Add building to building of interest list.

SECTION 2

Background Information

A general base description is provided in Section 2.1. Section 2.2 provides the results of the site evaluation process and provides a detailed description of sites retained as candidates for vapor intrusion evaluation.

2.1 Base Description

The mission of MCB Camp Lejeune is to maintain combat-ready units for expeditionary deployment. MCB Camp Lejeune provides housing, training facilities, logistical support, and administrative supplies for Fleet Marine Force units and other assigned units. MCB Camp Lejeune is home to an active duty, dependent, retiree, and civilian population of approximately 150,000, of which approximately 47,000 are military personnel.

MCB Camp Lejeune covers approximately 236 square miles in Onslow County, North Carolina and is bisected by the New River, which flows in a southeasterly direction and forms a large estuary before entering the Atlantic Ocean (Figure 2-1). MCB Camp Lejeune lies within the outer part of the Atlantic Coastal Plain Physiographic Province in North Carolina. Low elevations and relatively low relief characterize topography across MCB Camp Lejeune. The surface elevations range from sea level to approximately 70 ft above mean sea level (amsl), with most of MCB Camp Lejeune's elevation ranging from 20 to 40 ft amsl.

Climatic conditions southeastern North Carolina and at MCB Camp Lejeune are characterized by winters that are mild with occasional short, cold periods. Summers are long, hot, and humid. Average annual net precipitation is approximately 50 inches. Ambient air temperatures generally range from 33 to 53 degrees Fahrenheit (°F) in the winter months and 71°F to 88°F during the summer months. Winds are generally south-southwesterly in the summer, and north-northwesterly in the winter (WAR, 1983).

MCB Camp Lejeune has been actively engaged in environmental investigations and remediation programs since 1983, beginning with the Navy Assessment and Control of Installation Pollutants (NACIP) Program. The IR Program (IRP) was initiated in 1986 following enactment of the Superfund Amendments and Reauthorization Act (SARA) legislation. The IRP, which was implemented to follow the requirements of SARA, replaced the NACIP. MCB Camp Lejeune was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL) on October 4, 1989 (54 *Federal Register* 41015, October 4, 1989). Following that listing, a Federal Facility Agreement (FFA) between USEPA Region 4, North Carolina Department of Environment, Health, and Natural Resources (NCDENR), and the Department of the Navy (DoN) was signed in February 1991.

MCB Camp Lejeune was issued a RCRA Hazardous Waste Management Permit in September 1984. Subsequently the permit was modified, and on January 10, 1997 the RCRA Part B Permit was approved to include corrective action at treatment storage and disposal

facilities. Camp Lejeune has a Hazardous and Solid Waste Amendments (HSWA) Permit that is scheduled to take effect in 2008, replacing the Part B Permit, which expired in January 2007.

Leaking petroleum UST sites are also present at the Base. These USTs are regulated under the NCDENR Division of Waste Management UST Section.

As indicated in Section 1, the investigation areas identified for assessment of potential vapor intrusion pathways on the Base are Mainside, Hadnot Point Industrial Area (HPIA), Air Station, Tarawa Terrace, Camp Geiger, and Courthouse Bay (Figure 2-2).

2.2 Investigation Area Location and Description

As the first step in the evaluation process, available information for IR, RCRA, and UST sites was reviewed to determine which sites contain VOC groundwater contamination that may present vapor intrusion risks to nearby buildings. The site use, type of contamination present, geology, and current regulatory status were reviewed. The NCGWQS were used as to identify areas of groundwater VOC contamination. Sites where VOC concentrations have been detected in groundwater above NCGWQS and where buildings are located within 100 ft of monitoring wells containing VOC concentrations above NCGWQS were retained for further evaluation (Tables 2-1 through 2-6).

In addition, sites where free product has been detected or where a remediation system that may contribute to potential vapor intrusion risks (such as air sparging, biosparging, or biopulsing) were retained for further evaluation.

Sites where no groundwater data has been collected were not evaluated. Sites which have received No Further Action (NFA) status have been listed on Table 2-7. Data from the NFA sites was not reviewed at this time. However, should the results of the vapor intrusion evaluation indicate a need to evaluate NFA sites, new information be discovered indicating potential VOC groundwater contamination, additional evaluation may be required to ensure continued protection of human health.

Twenty-nine IR sites, 13 RCRA sites, 35 UST sites, and three MMRP sites (total of 80 sites) were evaluated for potential vapor intrusion assessment in the investigation areas. Only 25 sites were retained for further evaluation based on the presence of VOC groundwater concentrations above NCGWQS, free product, or remediation systems within 100 ft vertically or horizontally of an existing building. A complete list of sites evaluated is provided in Tables 2-1 through 2-6 and a description of sites retained for further evaluation is provided by investigation area below. For ease of reference, pertinent tables and figures from existing reports were pulled into this document. Site-specific Tables 2-8 through 2-30 and Figures 2-3 to 2-90 were pulled from multiple sources and have not been re-created.

2.2.1 Mainside

One IR site (Site 88), one RCRA site (Solid Waste Management Unit [SWMU] 118), and two UST sites (Building 820 and Building LCH-4015) were retained for further evaluation of vapor intrusion pathways in the Mainside area. A complete list of sites evaluated in the Mainside area is provided in Table 2-1.

Site 88

Site 88 is located within Operable Unit (OU) 15 and is the former Base Dry Cleaning Facility (former Building 25). Building 25 operated as a dry cleaning facility beginning in the 1940s. tetrachloroethene (PCE) was used as the dry cleaning fluid beginning in the 1970s. During this time, facility employees have reported that spent PCE was disposed of in floor drains. The dry cleaning operations ceased in January 2004, and the building was demolished to slab in August 2004.

An Engineering Evaluation/Cost Analysis (EE/CA) for removal of the soil source under Building 25 was completed in September 2004. Shallow soil mixing with clay-zero valent iron (ZVI) and dual phase extraction was the recommended technology presented in the EE/CA. In 2005, the removal action was completed, treating approximately 7,050 cubic yards (yd^3) of impacted soil. Within the treatment area PCE concentrations in the soil were reduced by greater than 99 percent (JV 2, 2006). Despite the significant source area reduction, residual dissolved phase groundwater VOC contamination remains over a large portion of the surrounding and downgradient areas.

A Final Amended Remedial Investigation (RI) Report was submitted in March 2008 (CH2M HILL, 2008e). The Final Amended RI Report suggests that Site 88 is also the source of the chlorinated VOCs that are currently observed in the groundwater within the shallow aquifer zones. In addition to the primary source area adjacent to the former Building 25, the former leaking sanitary sewer line created a series of secondary sources along its westward alignment. In the shallow zone, the distribution of chlorinated VOCs is closely related to the sewer alignment and the former footprint of Building 25.

Figures showing the most recent groundwater data, including groundwater elevation data, are provided as Figures 2-3 through 2-7. The groundwater flow direction in the shallow aquifer is complex, partially due to mounding created by the clay mixing. The geology at Site 88 consists of primarily sands (Figures 2-8 through 2-14). Depth to groundwater in shallow monitoring wells, measured during the August 2007 sampling event, ranged from approximately 7 to 15 ft below ground surface (bgs) (Table 2-8).

Building 820

Building 820 is an active Marine Corps Exchange gas station. Four USTs are located south of the building. These include three 10,000-gallon gasoline USTs and one 10,000-gallon diesel UST. The USTs were upgraded in the late summer of 1995. Petroleum constituents including benzene, toluene, ethylbenzene, and xylene (BTEX) and methyl tert butyl ether (MTBE) are present in groundwater above NCGWQS (Shaw, 2007a).

A passive free product recovery system recovered approximately 43 gallons of free product from March 1994 through February 1997. An air sparge (AS)/soil vapor extraction (SVE) system was installed in 1997 and is presently in operation. Groundwater data from February 2006 indicates BTEX and MTBE still exceed NCGWQS; however, no free product is present.

Figures showing the most recent groundwater data, including groundwater elevation data, are provided as Figures 2-15 through 2-16. The shallow groundwater flow direction is generally to the south. The remediation system layout is provided as Figure 2-17. Depth to groundwater, measured in shallow monitoring wells during the October 2006 sampling event, ranged from approximately 10 to 14 ft bgs (Table 2-9).

Building LCH-4015

Building LCH-4015 is the community center building (LCH-4014), former fueling and maintenance area (LCH-4015, removed), Marine Corps Exchange Convenience Store (LCH-4034), and the former fuel tank farm. A former aboveground storage tank (AST) system began operation in 1945 at the site. Gasoline, diesel, and fuel oil were stored in the ASTs. A number of smaller storage tanks were also located at the site. Fuel was distributed through a number of underground product piping systems. ASTs at former Building LCH-4015 were emptied of product, and were removed from the site.

In 1996, a Corrective Action Plan (CAP) was prepared and recommended installation of a biosparge (BS)/SVE system for the remedial action (Law, 1996a). The treatment system was constructed and began remediation activities in November 1998. The groundwater treatment system has operated continuously since 1998, with the exception of occasional maintenance repairs and groundwater sampling events.

The LCH-4015 remediation system includes 38 vertical BS wells and five SVE wells. The BS wells reportedly were installed with a 1.5 to 3.5 ft screen interval ranging from 4.5 to 8.0 ft bgs. The SVE wells consist of a 2-inch diameter 0.02-inch slot width polyvinyl chloride (PVC) horizontal well screen reportedly to be installed slightly above the shallow groundwater table.

Figures showing the most recent groundwater data, including groundwater elevation data, are provided as Figures 2-18 through 2-19. The remediation system layout is provided as Figure 2-20. The shallow groundwater flow direction is generally to the southeast. Depth to groundwater, measured during the February 2007 sampling event, ranged from approximately 1 to 5 ft bgs (Table 2-10). The shallow groundwater elevations are likely influenced by operation of the remediation system.

SWMU 118

SWMU 118 is a former 1,000-gallon UST and fuel line at the Gottschalk Marina. The UST, historically used for storing and supplying fuels for the marina, was removed in July 2005 under State UST guidelines.

A soil and groundwater investigation was conducted during the UST removal in 2005. Elevated gasoline range organics were reported in a soil sample collected adjacent to the fuel line and near Building S195 (Gazebo). Benzene and methyl-ethyl-ketone (MEK) were reported in groundwater at concentrations above the screening criteria. Because MEK is not considered a petroleum constituent, the site was transferred to the RCRA program in 2006.

A CSI was conducted in June 2007 (CH2M HILL, 2007d). Results of the CSI indicate the presence of VOCs above NCGWQS (Figure 2-21). Within the vicinity of SWMU 118, the uppermost undifferentiated formation consists of an assortment of sands silts and clays (Versar, 1992). Groundwater flow direction in the shallow aquifer at the site is north/northwest towards Wallace Creek and the New River (Figure 2-22). Water-level elevations from the wells ranged from approximately 8 ft to 13 ft bgs (Table 2-11).

2.2.2 Hadnot Point

One IR site (Site 78), one RCRA site (SWMU 360), and three UST sites (Building 900, Building 1101, and Building 1613) were retained for further evaluation of vapor intrusion pathways in the Hadnot Point area. A complete list of sites evaluated in the Hadnot Point area is provided in Table 2-2.

Site 78

Site 78 is HPIA and covers approximately 590 acres comprised of maintenance shops, warehouses, painting shops, printing shops, auto body shops, and other small industrial facilities. HPIA, constructed in the late 1930s, was the first developed area at MCB Camp Lejeune. Due to the industrial nature of the site, many spills and leaks have occurred over the years.

Numerous site investigations have identified three contaminant plumes within the shallow aquifer at Site 78. However, one plume was determined to be associated with the Hadnot Point Fuel Farm (HPFF) (Site 22) and was addressed under a separate UST program. The second plume was located in the vicinity of Building 903. This plume contained solvent contamination (e.g., trichloroethene [TCE]) and low-levels of fuel-related contamination (BTEX). The third plume was believed to originate in the vicinity of Buildings 1502, 1601, and 1602, and contained solvent-related compounds, fuel-related compounds, and lead.

Remediation of shallow groundwater involving groundwater extraction and treatment through two separate pump and treat systems constructed in the northern and southern portions of the site began operation in December 1994. The groundwater extraction system continues to operate on a limited basis.

The Final Record of Decision (ROD) for OU 1 (Sites 21, 24, and 78) (Baker, 1994b) identified land use controls (LUCs) to address soil contamination and continuation and expansion of the groundwater treatment system and implementation of long-term monitoring (LTM) to address groundwater contamination as the selected remedies for Site 78. LTM at Site 78 was implemented in 1995 and is on-going, in accordance with the recommendations of the LTM Optimization Report (CH2M HILL, 2005a).

Figures showing the most recent groundwater data from the August 2007 sampling event are provided as Figures 2-23 through 2-26. The geology at Site 78 consists of primarily silty sands (Figures 2-27 through 2-29). Shallow groundwater flows to the west and southwest as shown on Figure 2-30. Depth to groundwater, measured during the August 2007 sampling event, ranged from approximately 7 to 21 ft bgs (Table 2-12).

SWMU 360

SWMU 360 is the site of a former 300-gallon waste oil UST, positioned near Building 1817. The former UST was located in the eastern portion of the compound, which is being used as a temporary staging area for batteries, refrigeration units and other used equipment prior to disposal and or reutilization (CH2M HILL, 2007e). The 300-gallon waste oil UST was removed in July of 1997.

PCE and TCE were detected in groundwater samples collected around SWMU 360 during the RCRA Facility Investigation (RFI) and Amended RFI that took place in 2005 and 2006

(Baker 2005c; CH2M HILL, 2006d). The maximum concentrations of PCE and its degradation products in groundwater were detected from samples collected at the original UST location. No remedial actions have been implemented to date.

The groundwater VOC data from the 2006 Amended RFI is provided on Figure 2-31 and cross sections are provided as Figures 2-32 through 2-34. The predominant soil type at the site is sands with some clay lenses present. Shallow groundwater flows to the southeast as shown on Figure 2-35. The depth to groundwater at SWMU 360 is approximately 15 to 22 ft bgs (Table 2-13).

Building 900

Building 900 is located in the HPIA and was historically used as an equipment and maintenance facility. The former leaking UST system consisted of a 5,000 gallon UST and its associated piping. The UST held diesel fuel and possibly gasoline and was removed in November 1994. During this removal, petroleum hydrocarbons were detected in the site soil (Sovereign, 2007c).

Between 1996 and 1997, the site investigations took place to define to the extent of the soil and groundwater contamination. A CAP was developed in 1998 for the site identifying groundwater and soil remedial goals and which recommended an AS/SVE system be used for onsite remediation of the petroleum contamination. The AS/SVE system was installed in 1999 and operated continuously until June 2004 (Sovereign, 2007c).

The site is currently in the post-operational groundwater monitoring program phase of remediation. The results of the March 2007 sampling event indicate groundwater concentrations of benzene, naphthalene, 1,2-dichloroethane (1,2-DCA), TCE, cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride (VC) are present above NCGWQS (Figure 2-36). No free product was detected.

Groundwater generally flows toward recovery well IR78-RW-10, located northwest of the former UST (Figure 2-37). The shallow depth to groundwater in the vicinity of Building 900 is approximately 4 to 7 ft bgs (Table 2-14).

Building 1101

Building 1101 was formerly known as HPFF. The HPFF operated as a fuel storage and dispensing site. In 1993, all fuel storage tanks and some associated piping were removed. Benzene is the primary contaminant of concern (COC). The extent of benzene above 1 microgram per liter (µg/L) (NCGWQS) covers an area of approximately 15 to 20 acres. The concentration ranges from non-detect to 23,900 µg/L. Free product is also present at the HPFF. The extent of free product at the HPFF site as indicated by the 2006 HPFF Annual Monitoring Report is presented in Figure 2-38.

In addition, several remediation systems are presently operating in the HPFF. These systems include the following:

- Southeast SVE/AS/BS System
- Northwest SVE/AS/BS System
- Building 1101 SVE/Vapor Abatement System
- Southeast Product Recovery System

- Aggressive Fluid/Vapor Recovery
- Bio-Pulse Sparging System

Southeast and Northwest SVE/AS/BS Systems The Southeast and Northwest sparge/SVE systems and the bio-pulse wellfield are located in an area which extends approximately 400 ft north of Holcomb Boulevard. The extent of these systems is shown in Figure 2-39. The bio-pulse well configuration is shown in Figure 2-40.

The Northwest treatment system includes 12 BS wells and nine AS wells with associated horizontal SVE wells. The Southeast treatment system includes 10 BS wells and 45 AS wells with associated horizontal SVE wells. The SVE wells are comprised of four 20-ft sections of horizontal screen laid out in a cross pattern above each AS well.

Building 1101 SVE/Vapor Abatement System Vapor intrusion issues were observed in Building 1101 following the startup of the Southeast and Northwest sparge systems. In order to mitigate the intrusion of VOCs into Building 1101, two SVE collection trenches, located east and south of Building 1101, were installed. The Building 1101 SVE system began operation in February 2000 (OHM, 2000). Prior to activation of the bio-pulse system in 2005, a vapor abatement component was added to the Building 1101 SVE system, which collects sub-slab vapors from the eastern portion of the building. The vapor abatement off-gas is discharged through the SVE system blower to the atmosphere above the building roofline. Air monitoring inside the building following startup of the SVE system indicates that it is effective at mitigating vapor migration into the building. The current Operation and Maintenance (O&M) Plan for the SVE system at Building 1101 does not require the collection of system operating data such as airflow rates and system uptime data needed to calculate mass removal. Therefore, for the purpose of this assessment, it is assumed that the Building 1101 SVE/vapor abatement system is operating at the design capacity of the system blower (CH2M HILL, 2008c).

Southeast Product Recovery System and AFVR The product recovery methods current in operation at the HPFF include the aggressive fluid vapor recovery (AFVR) system .Product recovery efforts are currently ongoing in 16R and RW5. AFVR events are presently being conduced at monitoring wells USTHPFFC-MW72 and USTHPFFC-MW15.

Bio-Pulse Sparging System The bio-pulse system wells are located throughout the HPFF impacted area and consists of 25 bio-pulse wells. Active soil depressurization (ASD) systems were installed to provide vapor intrusion protection in Buildings 1101, 1108, 1200, 1201, 1202, and 1301. Flame ionization detector (FID) readings are collected in these buildings three times a week to monitor the effectiveness of the ASD systems.

Building 1613

Building 1613 consists of an active Marine Corps Community Service (MCCS) gas station. The building contains three concrete pump islands with two petroleum dispensers per pump island. The dispensers located on the outer islands were removed in the mid-1980s. Four gasoline USTs were installed in the 1950s and removed in January 1995 (Sovereign, 2006a).

During the 1990s, plumes of free phase and dissolved phase gasoline compounds were identified. The USTs were removed in 1995 along with 2,128 tons of petroleum

contaminated soil. A CAP was developed in 1998 to present remedial options which included an AFVR coupled with an AS/SVE to remediate the soil and groundwater at the site. The AS/SVE system was installed in 1998 in accordance with the CAP. In 2001, the AS/SVE was expanded to cover an area of the site that was not being addressed (Sovereign, 2006a).

In 2004, NCDENR reclassified the site as a residential land use site due to the existence of bordering vacant properties (NCDENR, 2004). The low risk and residential land use ranking reclassified the target cleanup goals for the site. Several reports that were submitted including the Remedial Action Objective (RAO), RCRA CAP (RCAP), and 2005 Annual Report (Sovereign, 2006a) recommended the sustained shutdown of the existing AS/SVE system and continued monitoring of the groundwater wells.

No measureable free product was detected at any well in April 2006. However, two wells contained VOC concentrations above NCGWQS (Sovereign, 2006a).

Cross sections from the 1996 Comprehensive Site Assessment (Law Catlin, 1996b) are provided as Figures 2-41 to 2-43. The geology at Building 1613 consists primarily of sands with minor amounts of clay. In April 2006, depth to groundwater at Building 1613 was approximately 11 to 14 ft bgs (Table 2-15). Groundwater flows to the northeast across the site (Figure 2-44).

2.2.3 Air Station

One IR site (Site 86), two RCRA sites (SWMU 299 and SWMU 475), and five UST sites (USTAS4141, USTAS4158, USTAS843, USTASCSFF, and USTRR) were retained for further evaluation of vapor intrusion pathways in the Air Station area. A complete list of sites evaluated in the Air Station area is provided in Table 2-3.

Site 86

Site 86 is a heavily industrialized flight support area of MCB Camp Lejeune. Site 86 covers approximately 54 acres. The flight line at MCB Camp Lejeune, constructed with a Tarmac cover, has been in service since 1951. Over time, the surrounding area has been developed to provide support for aircraft and personnel. Most of Site 86 is developed with buildings and is paved.

The former AST Area (AS419-AS421) was located within the boundary of Site 86. From 1954 to 1988 it served as a storage area for petroleum products. The tanks were emptied in 1988 and removed in 1992.

Former Aircraft Wash Rack AS513 was located east of hangar AS515 on the edge of the flight line. This area was reportedly used for washing aircraft prior to the installation of the wash rack in 1968 and cleaning waters were washed directly onto the soil. The helicopter wash pad was constructed with concrete with two drains and the associated piping to transfer the liquids to an oil-water separator (OWS). Solvents were used for aircraft washing. The use of this wash rack was discontinued and the area was excavated in 2005. The area of Former Aircraft Wash Rack AS513 is currently grass covered. An aircraft washing area (referred to as the “bird bath”) located immediately southeast of AS513, sprayed water through a series of nozzles embedded in the Tarmac to clean the aircraft.

Wash water drained into storm drains located on the flight line. The “bird bath” was installed in 1967 and operated until the late-1990’s, when maintenance problems left the facility inoperable. The “bird bath” was abandoned in 2001.

Also within the boundaries of Site 86 are SWMUs 303 and 318, adjacent to the former helicopter wash rack. SWMU 303 consists of two former steel ASTs that were contained within a concrete, bermed structure. The tanks were installed in 1983 and labeled as "Hydraulic Fluid, Engine and Transmission Oils Only, No Solvents or Other Chemicals". The tanks were taken out of service in 2005. SWMU 318 is a former concrete, multi-chambered oil/water separator and grit chamber associated with the former helicopter wash pad. The primary functions of SWMU 318 were to collect water, soap, oil, grease, and dirt from the wash pad; separate the solids from the liquids; and then segregate the oil and grease from the remaining liquids. The OWS was removed in 2005. The area surrounding the SWMUs is currently covered with grass. An open drainage ditch that collects stormwater runoff from the surrounding area is located east of the OWS.

Several hangars are located along the edge of the flight line within Site 86 to service the aircraft. Hangar AS504, located furthest to the east, was the original hangar and included a carburetor shop, battery shop, paint shop, and engine build-up shop. AS504 continues to house aircraft maintenance activities. Hangars AS515 and AS518 have been used for aircraft maintenance activities. Hangar AS3900, located on the northwest corner of the flight line, is specially designed for aircraft maintenance requiring rapid air circulation. Adjacent to Hangar AS3900 to the south is Hangar AS3905. Similar to AS515, AS3905 is used for light aircraft maintenance.

Site Investigations (SIs) at Site 86 are ongoing. The findings of the most recent field investigation which took place during 2007-2008 showed that the primary site contaminant is TCE, with sizeable plumes in both the shallow and intermediate aquifers, as shown on Figure 2-45 (CH2M HILL, 2008h).

The geology at Site 86 consists of loose to medium dense sands and soft to medium stiff clay (Figure 2-46 to Figure 2-49). Shallow groundwater flows to the east and northeast in the vicinity of Site 86 (Figure 2-50). Depth to groundwater, measured during the 2007–2008 sampling events, ranged from approximately 5 to 10 ft bgs (Table 2-16).

SWMU 299

SWMU 299 was an AST that stored used oil generated from a Hobby Shop located near Building AS114. The Hobby Shop, where military personnel did maintenance on their personal vehicles, generated wastes such as used petroleum-based liquids, solvents, and paints, which were then stored in the AST. A concrete wash pad was adjacent to the AST.

Two CSIs were conducted at SWMU 299. The constituents exceeding screening criteria in soil included petroleum-based compounds and metals. Naphthalene was the only constituent detected in groundwater at concentrations exceeding screening criteria (CH2M HILL, 2006c).

Based on the results of the CSIs, an Interim Measure (IM) action was performed in 2006 (Shaw, 2006). The IM included the removal of approximately 700 yd^3 (1,160 tons) of contaminated soil. Following the IM actions, a Statement of Basis (SB) was prepared in

September 2006 (CH2M HILL, 2006c) discussing the proposed remedy of LTM and LUCs for groundwater.

The groundwater flow direction is to the northeast, toward the New River. Depth to groundwater, measured during the 2002 sampling event, ranged from approximately 0.9 to 2.2 ft bgs (Shaw, 2006).

SWMU 475

SWMU 475 is located within a site being developed for the expansion of a water treatment plant (WTP) facility. During construction activities, contaminated soils and buried perforated metal pans, which appeared to be oil drain pans, were identified within excavation areas for a new stormwater retention pond and a building structure. Soil samples were collected from the excavation area by the construction contractor in January and March 2006. VOCs, semivolatile organic compounds (SVOCs), and total petroleum hydrocarbon (TPH)-oil and grease were reported in the samples. Some of the impacted material was removed during this excavation effort.

In 2007 an RFI was initiated at SWMU 475. Soil samples revealed polycyclic aromatic hydrocarbon (PAH) contamination in some areas of the site, and groundwater samples contained benzene and lead in excess of screening criteria, as shown on Figure 2-51 (CH2M HILL, 2008f).

Within the vicinity of SWMU 475, the uppermost undifferentiated formation consists of mostly fine to medium grained sands with varying amounts of silts and clays (Figures 2-52 through 2-54). In general, groundwater flow direction within the shallow aquifer at SWMU 475 is to the northeast towards the New River (Figure 2-55). The static water level elevations at SWMU 475 ranged from approximately 5 to 9 ft bgs (Table 2-17).

USTAS-4141

Building AS-4141 is located at west of the airfield and consists of several parking lots and a helicopter hangar. An underground pipeline transports jet-propulsion fuel, grade 5 (JP-5) fuel from the Campbell Street Fuel Farm to four USTs at the rapid jet systems.

In the early 1980s, environmental investigations at the site identified leaks in the JP-5 fuel line. A CAP was developed in 1991 to address free product and groundwater contamination. In February 1994, a free phase product recovery system and a groundwater extraction and treatment system were installed. These systems operated through July 2000. Since then, AFVR events have been conducted periodically and passive product skimmers have been placed in wells to enhance the removal of free phase product (Shaw, 2007b).

The site is currently in the post-operational groundwater monitoring program phase of remediation. The results of the October 2006 and March 2007 sampling events indicate groundwater concentrations of petroleum compounds and lead are present above NCGWQS (Figures 2-56). Detectable free product was observed in multiple wells, with thickness ranging from 0.1 to 3.81 ft. Shallow groundwater generally flows southeast (Figure 2-57). The shallow depth to groundwater in the vicinity of Building AS-4141 ranges from approximately 3 ft to 11 ft bgs (Table 2-18).

USTAS-4158

Building AS-4158 is located on the west side of Perimeter Street and is used to provide fuel and maintenance to vehicles at the air station. Currently, two 10,000-gallon ASTs used for diesel fuel storage are located towards the southern end of the site. Fuel is transported by way of an underground pipeline from the ASTs to the dispensers located adjacent to Building AS-4158. One 1,000-gallon used oil AST is also in use on the northwest side of Building AS-4158.

The presence of petroleum hydrocarbons was identified during the removal of three USTs in 1992. A Site Assessment was conducted in 1993 to evaluate the impact to the groundwater and vadose zone soil caused by the release of petroleum hydrocarbons from the former USTs.

A CAP was prepared in September 1995, which selected a remedial approach consisting of the installation of an AS/SVE system to recover free phase product, coupled with groundwater monitoring to evaluate the migration and attenuation of the dissolved petroleum hydrocarbon constituents from the former UST basin. The system began operation in April 1998. In December 1999, dissolved-phase constituent concentrations had decreased and free phase product was no longer present; therefore, the system was shut down. The system was restarted in February 2001 due to increasing dissolved-phase constituent concentrations and remained in operation until January 2006 (Shaw, 2007d).

The site is currently in the post-operational groundwater monitoring program phase of remediation. The results of the March 2007 sampling event indicate groundwater concentrations of benzene are present above NCGWQS (Figure 2-58). No free product was detected. Groundwater generally flows east towards Building AS-4158. The shallow depth to groundwater in the vicinity of Building AS-4158 ranged from approximately 8 ft to 11 ft bgs (Table 2-19).

USTAS-843

Building AS-843 is located in the central portion of Air Station. Building AS-843 is utilized as the airfield operations building. One 550-gallon diesel UST and one 1,000-gallon diesel UST were removed the site in September 1992. During this removal, petroleum hydrocarbons and free product were detected (Sovereign, 2007e).

Between 1993 and 1995, SIs took place to define the extent of the soil and groundwater contamination. Since then, the site has been monitored annually. During the most recent monitoring event, conducted in July 2006, groundwater concentrations of benzene, 4-isopropyltoluene, and naphthalene were present above NCGWQS (Figure 2-59). No free product was detected. Groundwater generally flows northeast, away from Building AS-843 (Figure 2-60). The shallow depth to groundwater in the vicinity of Building AS-843 is approximately 2 to 4 ft bgs (Table 2-20).

USTCSFF

The Campbell Street Fuel Farm (CSFF) is near the intersection of Campbell and White Streets. The site is separated into two areas: one located at the fuel farm and Building AS-143 and the other approximately 500 ft south near Building AS-4151. The CSFF site consists of four 215,000-gallon ASTs, which contain JP-5 fuel that is pumped to the tarmac

helicopter refueling station via an underground delivery line. Building AS-143 is an active gasoline fueling station that supplies gasoline to government owned vehicles. The station stores unleaded gasoline in an AST. Building AS-4151 is a steam generation plant. Three 100,000 ASTs store No. 2 fuel oil, and one 1,000-gallon AST stores diesel fuel.

An SI conducted in the early to middle 1990s within the CSFF and Building AS4151 areas identified petroleum constituents in soil and groundwater, as well as the presence of free product. A CAP was prepared for each site in 1994. Subsequently, a groundwater pump and treat system was installed and put into operation in 1996 in the vicinity of Building AS-4151. In 1999, extraction wells were installed in the CSFF area and connected to the treatment system. The groundwater treatment system was shut down in July 2005 (Sovereign, 2007d).

Three surface releases occurred from an open fuel sample port within the fuel farm area between 2004 and 2006. As a result, a large scale soil excavation occurred in June 2006; however, residual contamination remains.

Free product was observed within the fuel farm area, with thicknesses ranging from 0.03 feet to 1.59 ft in 2006 and 2007. Groundwater flow in the vicinity of the CSFF is to the south, southwest, and southeast. In the vicinity of Building AS-4151, groundwater flows generally to the east (Figure 2-61). The shallow depth to groundwater in these areas is approximately 4 to 7 ft bgs (Table 2-21).

USTRR

The Rapid Refueler (RR) Tank System is located at the MCAS New River and is responsible for providing aviation fuels to the flight line. It is located northeast of Instrument Runway 5-23. Fuel is transferred to the RR Tank System from the CSFF.

Several releases have been recorded from the system requiring repair and contamination removals. In October 2005, a free phase product recovery trench was installed to collect and recover free phase product. AFVR events are also conducted on monitoring wells with measurable amounts of free product (Shaw, 2007e).

During the March 2007 sampling event, groundwater concentrations of benzene, 1,2-dichlorobenzene, bis(2-ethylhexyl)phthalate, 2-methylnaphthalene, naphthalene, and C11-C22 aromatics were present above NCGWQS (Figure 2-62). Free product was detected in 10 site monitoring wells, with thicknesses ranging from 0.02 ft to 3.21 ft. The shallow groundwater flow direction is to the northeast (Figure 2-63). The shallow depth to groundwater ranged from approximately 2 ft to 10 ft bgs (Table 2-22).

2.2.4 Courthouse Bay

One IR site (Site 73), one RCRA site (SWMU 474) and two UST sites (Building 190 and Building 293) within Courthouse Bay were retained for further evaluation of vapor intrusion pathways. A complete list of sites evaluated in the Courthouse Bay area is provided in Table 2-5.

Site 73

Site 73, encompasses the Amphibious Vehicle Maintenance Facility located in the Courthouse Bay Area of MCB Camp Lejeune. The Amphibious Vehicle Maintenance Facility

is an active facility and consists of numerous buildings, ASTs, USTs, vehicle wash racks, and OWSs. The Amphibious Vehicle Maintenance Facility began operations in 1946.

Numerous site investigations have identified two contaminant plumes within the shallow aquifer and two contaminant plumes within the deep aquifer. Benzene is present in the shallow aquifer in the vicinity of Building A47 and extends from approximately from the middle of the site toward Courthouse Bay. A former UST located near Building A47 was reported to be the suspected source of the benzene contamination. A deep aquifer benzene plume was identified during the Natural Attenuation Evaluation Study (NAES) and subsequent LTM sampling events which mirrored the size and concentration that was seen in the shallow aquifer.

Chlorinated solvents (TCE, DCE, and VC) are present in the shallow aquifer at concentrations below the applicable NCGWQS. The highest concentrations have historically been in the central portion of the site, within the deeper aquifer, with concentrations decreasing towards Courthouse Bay, as well as decreasing over time. Chlorinated solvents are also present in the deep aquifer, and the plume is oriented in a north-south direction through the center of the site.

Additional work at the site has included LTM (2000-2005), NAES (2000-2002), Horizontal Hydrogen Sparge Well Pilot Study (2003-2006), and Horizontal Air/Ozone Sparge Well Pilot Study (2007-Present).

Figures showing the most recent groundwater data from the August 2006 sampling event are provided as Figures 2-64 to 2-67. The surficial aquifer soils underlying this portion of the site predominantly consist of very fine to fine sands with varying amounts of silt. Thin, discontinuous silt and clay lenses are also present in the surficial aquifer (Figures 2-68 to 2-73). Groundwater generally flows southeast across the site towards Courthouse Bay (Figure 2-74). The depth to groundwater at Site 73 ranges from approximately 4 to 7 ft bgs (Table 2-23).

Building 190

Building 190 is located in the Courthouse Bay area off Marines Road. It is an active water treatment plant. A former 500-gallon UST was used to store diesel fuel for heat production and was abandoned in place in May 2004. During tank closure activities, the presence of TPH–gasoline rang organics (GRO) and diesel range organics (DRO) above state action levels were detected (Sovereign, 2007f).

As a result, a comprehensive site assessment was conducted in 1995 (Law Catlin, 1997). As a result of the CSA, a CAP was prepared to address contamination at the site. The CAP recommended biosparging to address groundwater contamination, using a combination of horizontal and vertical BS wells while a SVE system was recommended for collection of vapors from the BS well. The BS/SVE system was installed in October 1998 and operated until December 1999, when the system was shut down based on low contaminant concentrations (Sovereign, 2007f).

The site is currently in the post-operational groundwater monitoring program phase of remediation. The results of the February 2007 sampling event indicate groundwater concentrations of benzene and naphthalene are present above NCGWQS (Figure 2-75). No free product was detected. Groundwater flows generally towards the southwest across the

site (Figure 2-76).The shallow depth to groundwater in the vicinity is approximately 4 to 13 ft bgs (Table 2-24).

Building BB-293

Building BB-293 is located near Peach and Middle Streets and is the location of an active training facility for field purification of raw water, as well as operation of portable field laundry facilities. The former UST BB-293-1, which operated from 1983 to 1996, was utilized to store used oil. There were no product delivery lines associated with the tank. Upon closure by removal, contaminants were detected in the subsurface soil.

A comprehensive site assessment was performed which did not identify any free product during the assessment. The 1998 CSA recommended further investigation of the area near MW05, as well as the preparation of a CAP to address site soil and groundwater contamination. A request for NFA was denied in 2003 and a monitoring program was recommended.

VOCs bromoform, dibromochloroethane, and 4-isopropyltoluene were detected at the site during the November 2006 monitoring event above NCGWQS (Figure 2-77). These VOCs are typical byproducts of water purification using chlorination, which is a process used as part of the raw water purification training conducted at the site. Groundwater generally flows northwest across the site (Figure 2-78).The shallow depth to groundwater in the vicinity of Building 293 ranges from approximately 2 to 4 ft below total organic carbon (TOC) (Table 2-25).

SWMU 474

SWMU 474 is the site of Building BB52, known as the motor pool for the 2nd Combat Engineer Battalion and is located within a half mile of Courthouse Bay. SWMU 474 is located east of Clinton Street and approximately two and a half blocks southeast of SWMU 470. During recent installation activities of storm water utilities for Building BB329, discarded debris was uncovered in the utility corridor excavation. The debris encountered consisted of five-gallon motor oil and hydraulic fluid cans, spent vehicle oil filters, head light assemblies, and a vehicle tow bar. This area around the former utility corridor excavation and discarded debris has been identified as SWMU 474. The excavation and subsequent sampling of the contaminated soil identified TPH-DRO, TPH-GRO, SVOCs, VOCs, and RCRA Metals as COPCs.

1,4-Dichlorobenzene and PCE were detected in one temporary well, SWMU474-TW08, located at the center of the approximate area of previous excavation at SWMU 474 during the November 2006 CSI sampling event. Both these VOCs exceeded their respective NCGWQS (Figure 2-79). The extent of impact to groundwater by these contaminants has not yet been defined. No remedial actions have been implemented to date.

Fine to medium grained sands dominate the near surface soils in a zone which is generally 3 to 5 ft thick, it overlies a mottled sandy-clay to a depth of 14 ft bgs; fine to medium sands were observed below the mottled sandy-clay. Shallow groundwater flows to the south/ southeast toward the New River as shown on Figure 2-80. The depth to groundwater at SWMU 474 ranged from approximately 0 to 12 ft bgs (Table 2-26).

2.2.5 Camp Geiger

Three IR sites (Site 35, Site 89, and Site 93) located within Camp Geiger were retained for further evaluation of vapor intrusion pathways. A complete list of sites evaluated in the Camp Geiger area is provided in Table 2-4.

Site 35

Site 35, formerly the Camp Geiger Area Fuel Farm, is located within Camp Geiger, in the northwest portion of the Base. Site 35 primarily refers to five 15,000-gallon ASTs, underground fuel transmission lines, a pump house, a fuel unloading pad, an OWS, and a distribution island. The fuel farm was active until it was decommissioned in the spring of 1995 to make way for the construction of the US Highway 17 Bypass. During the active life of the fuel farm, several releases of fuel occurred. During 1957 and 1958 approximately 1,000-gallons of fuel were released. To control the release, interceptor trenches were dug and the fuel was ignited. There is also evidence of a fuel release from an abandoned underground distribution line that supplied No. 6 fuel oil to a UST that fueled a boiler at the Mess Hall Heating Plant, located adjacent to "D" Street between Third and Fourth Streets (JV 1, 2007).

From 1984 to 1987, a Confirmation Study was conducted, which included collecting soil, groundwater, surface water, and sediment samples. Groundwater analytical results identified widespread contamination of the shallow aquifer with VOCs, including benzene, trans-1,2-DCE, and TCE.

From 1994 to 2007, remedial investigations were completed, which included a soil gas survey and groundwater screening investigation, soil investigation, groundwater investigation, and surface water and sediment investigation. Soil analytical results identified low levels of VOCs (primarily PCE), possibly attributable to groundwater contamination beneath the site. Groundwater analytical results identified fuel-related (primarily benzene) and solvent-related (primarily TCE and cis-1,2-DCE) groundwater contamination in the surficial aquifer.

In January 2007, an EE/CA was completed and a Non-Time-Critical Removal Action (NTCRA) (JV 1, 2007) was approved to address the continuing presence of a dissolved-phase chlorinated VOC groundwater plume east of Building G533 at Site 35. An Action Memorandum was submitted in May 2007, documenting enhanced reductive dechlorination (ERD) via emulsified vegetable oil and lactate injection as the preferred remedial action. Injections associated with the NTCRA were completed in May and June 2007 and monitoring is ongoing.

The most recent groundwater data is shown on Figures 2-81 to 2-83. Groundwater generally flows northeast across the site (Figure 2-84). The shallow depth to groundwater at Site 35 ranges from approximately 2 to 12 ft bgs (Table 2-27) (CH2M HILL, 2008d).

Site 89

Site 89, the former Defense Reutilization and Marketing Office (DRMO), is located in the extreme northwest corner of the Base. Historical records for Site 89 indicate that the Base Motor Pool operated on site until approximately 1988, when it was relocated to its current location, an asphalt paved area immediately north of the DRMO facility.

The Base Motor Pool, located at Site 89, reportedly used solvents (acetone, TCE, and MEK) for parts cleaning. After 1988, the site was used as the DRMO by the Defense Logistics Agency (DLA) until 2000. The facility was used as a storage yard for items such as scrap and surplus metal, electronic equipment, vehicles, and rubber tires. In the early 1990s, fuel bladders were placed onsite. The bladders ranged in size from 600 to 20,000 gallons and were used in training exercises for helicopter refueling. Base personnel reported that the bladders were emptied on the ground, cleaned with solvents, re-emptied on the ground, and capped prior to storage at the DRMO. The bladders were stored for three to 4 years in a pile approximately 75 ft in diameter by 25 ft high. A shredder was then brought onsite and located immediately north of the bladder pile. The bladders were shredded into small cubes and placed into roll-off boxes. During shredding operations, liquids were observed escaping from the bladders. These liquids were not contained or removed. The site has not been used since the DRMO relocated in 2000.

Investigations at Site 89 have historically been focused on a small area within the DRMO that formerly contained a 550-gallon steel UST used to store waste oil. The initial UST investigation detected chlorinated VOCs in the groundwater, which led to the inclusion of the site into the Camp Lejeune IRP.

A Comprehensive RI was completed in 2007 (CH2M HILL, 2007b) to fully delineate the extent of contaminated groundwater at Site 89 (Figure 2-85). Groundwater analytical results identified solvent-related (primarily TCE and tetrachloroethane [PCA]) groundwater contamination in the aquifer at Site 89. TCE and PCA were detected in groundwater at concentrations as high as 440,000 µg/L and 250,000 µg/L, respectively, during the Comprehensive RI field activities Groundwater generally flows towards Edwards Creek and the New River (Figure 2-86). The shallow depth to groundwater at Site 89 is approximately 3 to 19 ft bgs (Table 2-28).

Site 93

Site 93, Building TC-942, is located within Camp Geiger in the extreme northwest corner of the Base. The buildings in this portion of Camp Geiger were constructed during the Korean War and currently function as classrooms, barracks, and supply rooms for the Marine Infantry School. Historical records indicate that a 550-gallon UST storing waste oil was previously located on Site 93, off the southwest corner of Building TC-942. The UST was permanently closed as part of a tank removal in December 1993, completed under the authority of the State of North Carolina's UST program. Upon removal of the UST, an investigation was conducted, which identified chlorinated VOCs in the groundwater. Over time, the investigations have expanded outward from TC-942.

Between 1995 and 1996, a geotechnical investigation and environmental screening were conducted near the barracks area. Chlorinated solvent contamination was not observed in any of the soil borings located around the barracks; however, trace levels of chlorinated VOCs were detected in groundwater samples collected from one temporary well. From 1996 to 1997, a RI was conducted to characterize the nature and extent of soil and groundwater contamination.

Groundwater analytical results for Site 93 identified chlorinated VOC contamination (primarily TCE) concentrated in the surficial aquifer (less than 15 ft bgs) within the immediate area of the former UST. VOCs were not detected in any groundwater samples

collected from the upgradient locations around the barracks. A chlorinated VOC groundwater plume was identified as generally extending from east of the barracks to "E" Street, between Ninth and Tenth streets (Figures 2-87 and 2-88).

The Final ROD for Site 93 was signed on October 2, 2006 (CH2M HILL, 2006b). The ROD identified *in situ* chemical oxidation (ISCO) via permanganate injection, monitored natural attenuation (MNA), and LUCs as the selected remedy. Groundwater generally flows east across the site towards Edwards Creek (Figure 2-89). The shallow depth to groundwater at Site 93 ranges from approximately 1 to 5 ft bgs (Table 2-29).

2.2.6 Tarawa Terrace

Two UST sites (TT-2477 and TT-2478) located within the Tarawa Terrace area were retained for further evaluation of vapor intrusion pathways. A complete list of sites evaluated in the Tarawa Terrace area is provided in Table 2-6.

Site TT-2477 and TT-2478

Building TT-2477 was built in 1950 as a full service gas station with vehicle maintenance capabilities. The building is now being utilized as a chapel. A 10,000 gallon gasoline tank, a 500 gallon hydraulic fluid tank, and a 500 gallon heating oil tank were located in the vicinity of the building. The USTs were removed in 1992 (Sovereign, 2006b). Building TT-2478 is currently a MCCS gas station with two pump islands. Three 10,000 gallon fiberglass USTs held gasoline and one 10,000 gallon UST held diesel fuel. In 1995, the three USTs which held gasoline were removed (Sovereign, 2006b).

Numerous site investigations were performed in the early 1990s. Assessment work focused on the USTs at Buildings TT-2477 and TT-2478, as well as USTS at TT-2453. TT-2453 was incorporated into TT-2477/78 site in 2002. During the investigations, shallow groundwater contamination, along with free product, was identified at the site. An AS/SVE remediation system was installed in October 1997 and operational until shut down in May 2004. The system was expanded in March 1998 and again in April 2001 to treat contamination in the vicinity of TT-2453. The system was deactivated in May 2004 when post operational monitoring began at the site (Sovereign, 2006b).

The field program for the buildings consist of quarterly gauging of approximately 44 wells and annual groundwater sampling of 17 monitoring wells. During the annual groundwater monitoring event in April 2006, benzene, ethylbenzene, total xylenes, bis(2-ethylhexyl) phthalate and naphthalene were detected in above NCGWQS (Sovereign, 2006b).

The most recent groundwater data from the April 2006 sampling event is provided as Figure 2-90. The geology at the site consists of predominantly sandy clay to clayey fine sand with fine sand and clay lenses to a depth of 6 to 8 ft bgs. Below this surficial material, the geology can be described as relatively clean, fine to medium sand to a depth of approximately 50 ft (Catlin, 2004a). Shallow groundwater at the site flows generally to the south (Figure 2-91) (Catlin, 2004a). Groundwater elevations, measured during the April 2006 sampling event, ranged from approximately 7 to 14 ft bgs (Table 2-30) (Sovereign, 2006b).

Table 2-1
Summary of Identified Sites - Mainside
MCB Camp Lejeune, North Carolina

Site No.	Site Description and Use	Primary Contaminants	Site Status	Current VOC Contamination above NCGWQS?	Contain Buildings with 100 ft of a well containing VOC concentrations above NCGWQS?	Retained for Further Evaluation?
IR Sites						
1	French Creek Disposal Area – used as vehicle and equipment maintenance/staging area since 1940s	POL and battery acid, minor detections of VOCs – TCE and vinyl chloride (Baker, 1995a)	Final ROD signed 1996: Selected GW Remedy - LTM and LUCs (Baker, 1996b). LTM discontinued in January 2001; Final Closeout Report submitted in 2002 (CH2M HILL, 2002)	NO (CH2M HILL, 2002)	NO	NO
2	Former Nursery/Day Care Center – onsite building used for storing, handling and dispensing pesticides from 1945 to 1958	Pesticides, low levels of ethylbenzene and toluene (Baker, 1994c and 1994d)	Final ROD signed 1995: Selected GW Remedy - LTM and LUCs (Baker, 1994d). TCRA completed in 1994, removal of 1,049 tons pesticide contaminated soil. LTM discontinued in 2007; Closeout report submitted in February 2008 (CH2M HILL, 2008a)	NO (CH2M HILL, 2008a)	NO	NO
3	Former Creosote Plant - supplied treated lumber during construction of the Camp Lejeune Railroad 1951-1952	PAHs - primarily naphthalene (Baker, 1996a)	Final ROD signed 1997; Amended 2000: Selected GW Remedy - LTM and LUCs; PAH contaminated soil excavated and disposed off-site. LTM ongoing.	YES (JV 2, 2008)	NO	NO
6	Storage Lots 201 and 203 - used from the 1940s to late 1980s for disposal and storage of wastes and supplies, including pesticides, transformers containing PCBs, solvents, electrolytes, and waste oils. Currently used to store military equipment, vehicles, hydraulic oils, and other non-hazardous supplies	PCBs, Pesticides, VOCs, SVOCs, and metals (Baker, 1993a)	Final ROD signed 1993: selected GW Remedy - LTM and LUCs (Baker, 1993b). TCRA completed in 1994, removal of 20 drums containing DDT and contaminated soil. Second TCRA completed 1995 and 1996, removal of >2,655 cubic yards of drums, batteries, and communications wires. LTM on-going, future investigations planned.	YES (CH2M HILL, 2008b)	NO	NO
9	Fire Training Area - Used as fire training area from 1960s to present.	None (Baker, 1993a)	Final ROD signed 1993: no remediation required (Baker, 1993b) POL contaminated soil voluntarily removed in 2000	NO (Baker, 1993a)	NO	NO
24	Industrial Area Fly Ash Dump - used for disposal of fly ash, cinders, solvents, used paint stripping compounds, sewage sludge, and water treatment sludge from the late 1940s to 1980	Pesticides and metals (Baker, 1994e)	Final ROD signed 1994 (Baker, 1994f) - selected GW remedy - LTM and LUCs. LTM discontinued in 1998 after no detections of pesticides for four consecutive quarters.	NO (Baker 1994e)	NO	NO

Table 2-1
Summary of Identified Sites - Mainside
MCB Camp Lejeune, North Carolina

Site No.	Site Description and Use	Primary Contaminants	Site Status	Current VOC Contamination above NCGWQS?	Contain Buildings with 100 ft of a well containing VOC concentrations above NCGWQS?	Retained for Further Evaluation?
28	Hadnot Point Burn Dump - Operated from 1946 to 1971 as a burn area for a variety of solids wastes generated on Base. Covered with soil, graded, and seeded in 1971. Currently used for recreation and physical training exercises	SVOCs (PAHs), metals, and pesticides. Low levels of VOCs - not related to site activities (Baker, 1995a)	Final ROD signed 1996: Selected GW Remedy - LTM (Baker, 1996b). Final Closeout Report submitted in 2002 (CH2M HILL, 2002)	NO (CH2M HILL , 2002)	NO	NO
74	Mess Hall Grease Dump Area. From early 1950s to early 1960s, grease from mess hall at Site 74 disposed in trenches. Reportedly, drums containing PCB and pesticide soaked bags also were buried near the grease pit.	Limited detection of VOCs, SVOCs, pesticides, metals, and PCBs (Baker, 1995b)	Final ROD signed 1995: Selected GW Remedy LTM and LUCs (Baker, 1995c). LTM discontinued in 1998 because detected metals concentrations deemed indicative of naturally occurring metals in the presence of acidic soil. Closeout report completed in 2006. (CH2M HILL, 2006a)	NO (CH2M HILL, 2006a)	NO	NO
80	Paradise Point Golf Maintenance Area - used for golf course maintenance operations	Low levels of pesticides, SVOCs, and metals (Baker, 1996c)	TCRA completed in 1996 - removed 988 tons of impacted soil. Final ROD signed 1997: No remedial actions required (Baker, 1997).	NO (Baker, 1997)	NO	NO
82	Piney Green VOC Area - used for storage, disposal, and handling of potentially hazardous waste and material until late 1980s.	PCBs, Pesticides, VOCs, SVOCs, and metals (Baker, 1993a)	Final ROD signed 1993 - Selected GW Remedy: GW extraction, LTM, aquifer restrictions, and LUCs. SVE selected as soil remedy (Baker, 1993b). GW extraction on-going.	YES	NO	NO
84	Building 45 - operated by Tidewater Electric from 1941 to 1965. Converted to maintenance facility for large machinery in 1965.	Benzene, pesticides, PCBs, and metals (Baker, 2002).	Three-phase NTCRA removed approximately 13,000 tons of contaminated soil. CAP submitted to address pesticide contamination in GW.	NO (Rhea, 2006)	NO	NO
88	Former Base Dry Cleaning Facility (former Building 25) - operated as a dry cleaning facility from the 1940s to 2004.	VOCs - PCE and degradation products (CH2M HILL, 2008b)	EE/CA completed 2004 - soil mixing with clay-ZVI completed 2005 under an NTCRA. PCE soil concentrations within the treatment area reduced >99% (JV 2, 2006). FS submitted February 2008 (CH2M HILL, 2008b).	YES (CH2M HILL, 2008b)	YES	YES
95	Dipping Vat Sites - used from 1906 to 1961 to submerge livestock in a pesticide solution of arsenic and synthetic pesticides. Consists of three locations: Jaybird Road, Lyman Road, and Magnolia Road.	Arsenic at Magnolia Road (CH2M HILL, 2007a)	NFA recommended for Jaybird and Lyman Roads and excavate 370 cubic yards of arsenic impacted soil (CH2M HILL, 2007a)	NO (CH2M HILL, 2007a)	NO	NO

Table 2-1
Summary of Identified Sites - Mainside
MCB Camp Lejeune, North Carolina

Site No.	Site Description and Use	Primary Contaminants	Site Status	Current VOC Contamination above NCGWQS?	Contain Buildings with 100 ft of a well containing VOC concentrations above NCGWQS?	Retained for Further Evaluation?
RCRA Sites						
SWMU 43	Former oil/water separator located at Parachute Road Pesticide/Herbicide Management Area	SVOCs, pesticides, and metals (Baker, 2001)	RFI recommended; COPCs are pesticides and metals (Baker, 2001)	NO (Baker, 2001)	NO	NO
SWMU 118	SWMU 118 is a former 1,000-gallon UST and fuel line at the Gottschalk Marina. The UST, historically used for storing and supplying fuels for the marina, was removed in July 2005 under UST guidelines.	BTEX,1,2-DCA, PAHs, and metals (CH2M HILL, 2007d)	RFI recommended	YES (CH2M HILL 2007d)	YES	YES
SWMU 473	SWMU 473 is an area of impacted soils associated with a former hydraulic lift within Building HP237	Arsenic and bis(2-Ethylhexyl)phthalate	NFA Recommended (CH2M HILL 2008g)	NO (CH2M HILL, 2008g)	NO	NO
SWMU 177	SWMU 177, previously known as SWMU 361, has been identified as the former 550-gallon UST "C" located near Building 333. UST-333C was historically used for storing kerosene for heating Building 333 and was removed in March 1993.	SVOCs and Pesticides (CH2M HILL, 2007f)	RFI Recommended LTM and LUCs (CH2M HILL, 2007f)	NO (CH2M HILL, 2007f)	NO	NO
SWMU 269	SWMU 269 was an OWS/vehicle wash rack located adjacent to Building 816. The OWS and wash rack were removed in 1995/1996. Building 816 was removed in 2007.	PCE, TCE, VC, benzene (Baker, 2005b)	RFI Recommended LTM (Baker, 2005b)	Yes (Baker 2005b)	NO	NO
SWMU 476	SWMU 476 has been identified as a septic tank and drain field system that supported former Building FC19 and a wash pad at the former sanitary landfill	PAHs, pesticides, and metals in soil. No groundwater contamination (CH2M HILL, 2008g)	Additional delineation recommended (CH2M HILL, 2008g)	NO (CH2M HILL, 2008g)	NO	NO
UST Sites						
Building 820	Active Marine Corps Exchange gas station	BTEX and MTBE; no free product (Shaw, 2007a)	Passive free-product recovery system in operation from 1994 to 1997. AS/SVE in operation from 1997 to present.	YES (Shaw, 2007a)	NO	YES[a]

Table 2-1
Summary of Identified Sites - Mainside
MCB Camp Lejeune, North Carolina

Site No.	Site Description and Use	Primary Contaminants	Site Status	Current VOC Contamination above NCGWQS?	Contain Buildings with 100 ft of a well containing VOC concentrations above NCGWQS?	Retained for Further Evaluation?
Building FC-201(E)	Heavy construction and vehicle maintenance facility	BTEX and PAHs (Catlin,1995)	CAP recommended natural attenuation (Catlin, 1995). Monthly status report submitted in November 2000 indicates BTEX and PAHs not detected above NCGWQS and indicates NFA request as future action.	NO	NO	NO
Building LCH-4015	Consists of community center building, former fueling and maintenance area, Marine Corps Exchange Convenience Store, and former fuel tank farm.	Petroleum hydrocarbons (Law, 1996a)	1996 CAP recommended AS/SVE (Law, 1996a).Biosparging/SVE system in operation from 1998 to present (Catlin, 2004b).	YES (Sovereign, 2007a)	NO	YES[a]
PT-5	Used to supply diesel fuel to adjacent Building PT-5 for heat production	Petroleum hydrocarbons (Law, 1996b)	1996 recommended recovery of LNAPL and natural attenuation for dissolved plume. LNAPL recovery activities conducted from 1997 to 2000. In February 2000, 600 cubic yards of soil excavated to remove LNAPL. In 2001, monitoring detected benzene in one well slightly above NCGWQS and NFA was requested (J.A. Jones, 2002b). No additional monitoring events have been conducted.	NO[b]	NO	NO
MMRP Sites						
UXO-06	Fortified Beach Assault Area - used as a practice range	PAHs, iron, and manganese (CH2M HILL, 2007g)	A PA/SI is scheduled for the entire UXO-06 site in 2008.	NO	NO	NO

Notes:
[a]Retained due to operation of AS system
[b]Low detection likely to have naturally attenuated over last seven years and data evaluation only includes data from 2003 to 2007.

Table 2-2
Summary of Identified Sites - Hadnot Point Industrial Area
MCB Camp Lejeune, North Carolina

Site No.	Site Description and Use	Primary Contaminants	Site Status	Current VOC Contamination above NCGWQS?	Contain Buildings within 100 ft of a well containing VOC concentrations above NCGWQS	Retained for Further Evaluation?
IR Sites						
21	Transformer Storage Lot 140 - part of OU1 - From 1950 to 1951, a pit located in the northern portion of the site was used as a drainage receptor for oil from transformers (CH2M HILL, 2007g)	PCBs/Pests (CH2M HILL, 2007g)	Final ROD signed 1994 (Baker, 1994): Removal action included excavation of 650 tons of pesticide-contaminated soil and 161 tons of PCB-contaminated soil (CH2M HILL, 2007g).	NO (CH2M HILL, 2007g)	NO (CH2M HILL, 2007g)	NO
78	Hadnot Point Industrial Area - part of OU1 - 590 acres comprised of maintenance shops, warehouses, painting shops, printing shops, auto body shops, and other small industrial facilities (CH2M HILL, 2007g)	TCE/PCE/BTEX (CH2M HILL, 2007g)	Product recovery/groundwater treatment system began operation in 1991 and was expanded in 1994 and is currently treating water from one extraction well. Final ROD signed 1994: Selected GW Remedy - LTM and Selected Soil Remedy- LUCs (Baker, 1994a). LTM began in 1995 and is ongoing (CH2M HILL, 2007g)	YES (CH2M HILL, 2007g)	YES (CH2M HILL, 2007g)	YES
RCRA Sites						
SWMU 360	Building 1817 UST - Former 300 gallon waste oil UST near Building 1817 located in the Mainside Hadnot Point Industrial Area (CH2M HILL, 2008c)	PCE (CH2M HILL, 2006d)	A CMS was conducted in 2007. The corrective measures alternatives developed include ERD, air sparging (which may increase VI potential), and ISCO (CH2M HILL, 2007e). No remedial actions are currently in place.	YES (Baker, 2005c)	YES (CH2M HILL, 2007e)	YES
SWMU 423	Michael Street Construction Site- Base vehicles and heavy equipment were staged at this facility. Building 970 was demolished in 2004. In 2005, Building 1023 was constructed in its place (CH2M HILL, 2006e) .	PAH (Shaw, 2007c)	PAH contamination of surface soil was excavated in 2007 (Shaw, 2007c). RFI scheduled for FY2008.	NO (CH2M HILL, 2006e)	NO	NO

Table 2-2
Summary of Identified Sites - Hadnot Point Industrial Area
MCB Camp Lejeune, North Carolina

Site No.	Site Description and Use	Primary Contaminants	Site Status	Current VOC Contamination above NCGWQS?	Contain Buildings within 100 ft of a well containing VOC concentrations above NCGWQS	Retained for Further Evaluation?
UST Sites						
Building 900	Building 900 is located in the HPIA and was used as an equipment and maintenance facility. A 5000 gal UST was on site which held diesel fuel and possibly gasoline (Sovereign, 2007c)	PAH and VOCs - benzene and naphthalene (Sovereign, 2007c)	AS/SVE system in operation from 1999 to 2004. Vinyl chloride, aliphatics, aromatics, and SVOCs above NCGWQS (Soveriegn, 2007c).	YES (Sovereign, 2007c)	YES (Sovereign, 2007c)	YES
Building 1101	Building 1101 is located in the Hadnot Point Industrial Area and was formerly known as the Hadnot Point Fuel Farm (HPFF). The HPFF operated as a fuel storage and dispensing site (CH2M HILL, 2001).	TPH (soil) and Benzene, Toluene, Ethylbenzene, Total Xylene, Naphthalene (GW) (CH2M HILL, 2001)	A Petroleum Recovery System (PRS) and other associated small-scale free-product recovery efforts from 1993 to 1997. AFVR system was put in place in 1997. In December 1999 Building 1101 was evacuated due to petroleum vapor concerns. In 2000, a new SVE system with a vapor intercepting trench was installed adjacent to Building 1101. In 2001, a Remediation Assessment Report (RAR) determined that the SVE trench is effective at reducing vapor concentrations to non-detectable levels inside the building (CH2M HILL, 2001). Free product assumed to remain beneath building 1101.	YES (CH2M HILL, 2001)	YES (CH2M HILL, 2001)	YES
Building 1613	Building 1613 consists of an active Marine Corps Community Service (MCCS) gas station. The building contains three concrete pump islands with two petroleum dispensers per pump island. The dispensers located on the outer islands were removed in the mid-1980s. Four gasoline USTs (9,000 to 30,000 gallons) were installed in the 1950s and removed in January 1995 (Sovereign, 2006a).	BTEX, Naphthalene, Aliphatics, and Aromatics (Sovereign, 2006a)	USTs were removed in 1995 along with 2,128 tons of petroleum contaminated soil. 1998 CAP recommended AFVR coupled with a AS/SVE (Law Catlin, 1996b). AS/SVE system was installed in 1998, expanded 2001. DENR classified as residential land use due to the existence of bordering vacant properties (NCDENR, 2004). No measureable free product detected during 2006 sampling event (Sovereign 2006a).	YES (Sovereign, 2006a)	YES (Sovereign, 2006a)	YES

Table 2-2
Summary of Identified Sites - Hadnot Point Industrial Area
MCB Camp Lejeune, North Carolina

Site No.	Site Description and Use	Primary Contaminants	Site Status	Current VOC Contamination above NCGWQS?	Contain Buildings within 100 ft of a well containing VOC concentrations above NCGWQS	Retained for Further Evaluation?
MMRP Sites						
UXO-08	Bazooka Range and Gas Chambers - part of Site 78. Areas of interest within UXO-08 include the D-7 Gas Chamber, the alternate location of the Base Chemical Smoke (CS) Chamber, the Base CS Chamber and Nuclear, Biological, and Chemical (NBC) Training Trail, and a suspected 2.36 inch Bazooka Range.	VOCs, SVOCs, explosives, and metals	VOCs are related to Site 78. A PA/SI is scheduled for the remainder of UXO-08 in 2008. (CH2M HILL 2007g)	YES	YES	NO (VOC detections related to Site 78)

Notes:
Buildings which have received No Further Action Status or where no groundwater data has been collected are not included.

TABLE 2-3
Summary of Identified Sites - Air Station
MCB Camp Lejeune, North Carolina

Site No.	Site Description and Use	Primary Contaminants	Site Status	Current VOC Contamination above NCGWQS?	Contain Buildings within 100 ft of a well containing VOC concentrations above NCGWQS	Retained for Further Evaluation?
IR Sites						
54	Site 54 is also known as the Crash Crew Fire Training Burn Pit. The site is located in OU6 and has served as the fire training burn pit since the mid-1950s (CH2M HILL, 2007g).	VOCs, SVOCs and lead (CH2M HILL, 2007g)	The removal action that took place in 2000/2001 included groundwater collection which determined that lead, SVOCs, and VOCs no longer posed an impact to groundwater (CH2M HILL, 2007a). Groundwater monitoring was discontinued in 2002 (CH2M HILL, 2007g).	NO (CH2M HILL, 2007g)	No (CH2M HILL, 2007g)	NO
86	Site 86 (OU 20) was previously known as the Tank Area AS419-AS421 and served as a storage area for petroleum products from 1954 to 1988 (CH2M HILL, 2007g).	VOCs - benzene, TCE and PCE (CH2M HILL, 2007g)	Three ASTs, which stored No. 6 fuel oil and waste fuel oil, were emptied in 1988 and removed in 1992. A TCE plume runs from the boundary of Site 86 onto SWMU 318 property. The two sites are now known as OU 20. According to the most recent tech memo, VOCs in exceedance of NCGWQS exist on site in two significant plumes; one in the shallow aquifer, one in the intermediate aquifer (CH2M HILL, 2008h)	YES (CH2M HILL, 2008h)	YES - (CH2M HILL, 2008h)	YES
63	Verona Loop Dump - reportedly received bivouac wastes generated during training exercises	SVOCs, pesticides, and metals (CH2M HILL, 2007g)	Final ROD signed April 1997. No additional remediation or monitoring required.	NO (CH2M HILL, 2007g)	NO	NO
RCRA Sites						
SWMU 299	SWMU 299 an above-ground storage tank (AST) that stored used oil generated from a Hobby Shop located near Building AS114. The Hobby Shop generated wastes such as used petroleum-based liquids, solvents, and paints, stored in the AST (CH2M HILL, 2008g).	Naphthalene (CH2M HILL, 2008g)	A LUCIP and LTM plan will be completed in FY 2008. Groundwater will be monitored until naphthalene concentrations reach clean up goals (CH2M HILL, 2008g).	YES (CH2M HILL, 2008g)	YES - (CH2M HILL, 2008g)	YES
SWMU 475	SWMU 475 is located within the White Street water treatment plant expansion property (CH2M HILL, 2008f)	VOCs (benzene) and lead (CH2M HILL, 2008f)	A 2007 RFI indicated the presence of benzene and lead above NCGWQS in groundwater at the site (CH2M HILL, 2008f).	YES (CH2M HILL, 2008f)	YES - (CH2M HILL, 2008f)	YES

TABLE 2-3
Summary of Identified Sites - Air Station
MCB Camp Lejeune, North Carolina

Site No.	Site Description and Use	Primary Contaminants	Site Status	Current VOC Contamination above NCGWQS?	Contain Buildings within 100 ft of a well containing VOC concentrations above NCGWQS	Retained for Further Evaluation?
UST Sites						
USTAS1	30,000-gal UST at Aqua Station	Petroleum hydrocarbons (Catlin, 2005)	CAP Recommended in 2005	YES (Catlin, 2005)	NO	NO
USTAS2	30,000-gal UST at Aqua Station	Petroleum hydrocarbons (Catlin, 2005)	CAP Recommended in 2005	YES (Catlin, 2005)	NO	NO
USTAS3	30,000-gal UST at Aqua Station	Petroleum hydrocarbons (Catlin, 2005)	CAP Recommended in 2005	YES (Catlin, 2005)	NO	NO
USTAS4141	Site consists of several parking lots and a helicopter hangar. The site is transected by a JP-5 pipeline. Pipeline was used to transport jet fuel. A leak in the pipeline is the source of contamination. (Shaw, 2007b)	VOCs and SVOCs (Shaw, 2007b)	Site currently contains free product. Free product recovery system operated from 1994 to 2000. AFVR events conducted periodically (Shaw, 2007b)	YES, LNAPL present (Shaw, 2007b)	YES (Shaw, 2007b)	YES
USTAS4151	Steam Generating Plant. Three 100,000 gallon ASTs containing No 6 fuel and one 1,000-gallon UST containing No. 2 fuel oil are present. Also located in the vicinity of the JP-5 pipeline (see CSFF).	VOCs (Catlin, 2008a and 2008b)	Tank Closure Reports for USTAS4151 (1) and USTAS4151(2) submitted in 2008. No GW impacts above NCGWQS (Catlin, 2008a and 2008b)	NO (Catlin, 2008a and 2008b)	NO (Catlin, 2008a and 2008b)	NO
USTAS4158	Used to provide fuel and maintenance to vehicles at the air station. Currently has two 10,000 gallon ASTs containing diesel fuel. (Shaw, 2007d)	BTEX, MTBE (Shaw, 2007d)	AS/SVE system operated periodically from 1998 to 2006, Currently monitored annually (Shaw, 2007d)	YES (Shaw, 2007d)	YES (Shaw, 2007d)	YES
USTAS428	Former 280-gallon diesel UST	VOCs and SVOCs (J.A. Jones, 2002a)	No Further Action Requested in 2002 (J.A. Jones, 2002a)	NO (J.A. Jones, 2002a)	NO (J.A. Jones, 2002a)	NO
USTAS511	Located along the JP-5 pipeline. Tracer testing indicated leak in JP-5. Considered part of the rapid refueling system	BTEX and SVOCs (Baker, 2007)	Soil sampling indicated presence of petroleum, no groundwater samples collected (Baker, 2007)	NO (Baker, 2007)	NO (Baker, 2007)	NO
USTAS527	Below-grade valve box associated with the JP-5 pipeline	VOCs (Baker ,1993c)	No data collected since 1993, only low levels of groundwater contamination observed in 1993 (Baker, 1993c)	NO	NO	NO
USTAS843	Air Field Operations Building - former 550-gallon diesel UST and 1,000-gallon diesel UST	Benzene, naphthalene, 4-isopropyltoluene (Sovereign, 2007e)	Semi-Annual Monitoring	YES (Sovereign, 2007e)	YES (Sovereign, 2007e)	YES

TABLE 2-3
Summary of Identified Sites - Air Station
MCB Camp Lejeune, North Carolina

Site No.	Site Description and Use	Primary Contaminants	Site Status	Current VOC Contamination above NCGWQS?	Contain Buildings within 100 ft of a well containing VOC concentrations above NCGWQS	Retained for Further Evaluation?
USTCSFF	Campbell Street Fuel Farm - system consisted of 8 USTs and Fuel Delivery Line along White Street. Broken into 2 Areas: 1) fuel farm and AS-143 and 2) around building AS-4151	Free Product - jet fuel (Sovereign, 2007d)	Free product historically present in USTCSFF-MW13; soil excavation conducted in February 2007 to remove free product	YES (Sovereign, 2007d)	YES (Sovereign, 2007d)	YES
USTRR	Rapid Refueler Tank System supplies jet fuel to the flight line and is broken into 2 sections: A-B (Building AS-498) and C-D (Building AS-511)	Free Product - jet fuel (Shaw, 2007e)	LNAPL Recovery Trench installed in 2005 and MMPE and AFVR Events (Shaw, 2007e)	YES (Shaw, 2007e)	YES (Shaw, 2007e)	YES
USTAS410S	AS-410S consists of two former USTs, (1) 285 gallon waste oil tank and (1) 550 gallon heating oil tank. These tanks were removed in 1992 (Catlin, 2002).	MADEP aromatics (Catlin, 2002)	A NFA requested by the MCB in 2000 was denied by NCDENR in 2001 due to the need to additional soil and groundwater sample results. In 2002, an addendum to the Site Assessment Characterization was performed and found that all groundwater contamination was below the NCGWQS (Catlin, 2002)	NO (Catlin, 2002)	NO (Catlin, 2002)	NO
USTAS410N	AS-410N consists of 4 USTs (JA Jones, 2001)	Petroleum hydrocarbons (JA Jones, 2001)	VOC groundwater contamination was below NCGWQS in 2000 Annual Monitoring Report (JA Jones, 2000). NFA submitted in 2000 was denied Site AS-410N by the NCDENR due to the lack of soil sample results as evidence that the site was below cleanup criteria (NCDENR, 2000b). In 2001, JA Jones submitted the addendum to the Annual Monitoring Report to support a second request for NFA status which reported soil results only (JA Jones, 2001).	NO (JA Jones, 2000)	NO (JA Jones, 2000)	NO

TABLE 2-4
Summary of Identified Sites - Camp Geiger
MCB Camp Lejeune, North Carolina

Site No.	Site Description and Use	Primary Contaminants	Site Status	Current VOC Contamination above NCGWQS?	Contain Buildings with 100 ft of a well containing VOC concentrations above NCGWQS	Retained for Further Evaluation?
IR Sites						
35	Camp Geiger Fuel Farm - solvent related compounds thought to be from nearby auto maintinence shop	VOCs - benzene, trans-1,2-DCE, TCE, PCE.	EE/CA completed in 2004 - sodium lactate and emulsified vegetable oil injection completed 2007 under an NTCRA (CH2M HILL, 2007g). Comprehensive groundwater sampling scheduled for 2008.	YES (CH2M HILL, 2007g)	YES (CH2M HILL, 2007g)	YES
36	Camp Geiger Dump Area Near Sewage Treatment Plant - disposal of municipal wastes and mixed industrial wastes	VOCs - 1,2-DCE, TCE, PCE, and 1,1,2,2-PCA	LTM implemented in 1998 and ongoing (CH2M HILL, 2005a). IRACR completed 2007 to document monitoring and LUCs restricting development on site.	YES (CH2M HILL, 2007g)	NO	NO
41	Camp Geiger Dump near Former Trailer Park	VOCs, metals, RDX	LTM implemented in 1997 and discontinued in 2004 when site-wide concentrations dropped below remedial goals. (CH2M HILL, 2007g)	NO (CH2M HILL, 2007g)	NO	NO
43	Agan Street Dump - received construction debris and trash	PAHs and metals (CH2M HILL, 2007g)	Final ROD signed July 2005 (Baker, 2005d). LUCs selected as remedial action	NO (CH2M HILL, 2007g)	NO	NO
44	Jones Street Dump - debris, cloth, lumber, and paint cans were reportedly disposed of at the site	VOCs in GW and SW - attributed to Site 89 upgradient of Site 44 (CH2M HILL, 2007g)	Final ROD signed 2005 - LUCs the preferred alternative in ROD (Baker, 2005d).	NO - attributed to Site 89	NO	NO
89	Former DRMO - solvents for parts cleaning, storage of fuel bladders for helicopter refueling	Chlorinated VOCs (CH2M HILL, 2007b)	Treatability Study completed - air sparge horizontal well, permeable reactive barrier, ZVI, sodium lactate and emulsified vegetable oil injections. Source area soil mixing NTCRA in progress.	YES (CH2M HILL, 2007b)	YES	YES
93	Classrooms, barracks, and supply rooms for Marine Infantry School	Chlorinated VOCs (CH2M HILL, 2007g)	Final ROD signed 2006 - ISCO injections, LUCs, and LTM (CH2M HILL, 2006b)	YES (CH2M HILL, 2007g)	YES	YES
AS116/AS119/SAS113	MCAS New River - formerly used for storage of chemicals consisent with automobile repair	SVOCs, pesticides, and metals (CH2M HILL, 2007g)	Future investigations planned.	NO (CH2M HILL, 2007g)	NO	NO
RCRA Sites						
SWMU 307	Wash rack with associated oil/water separator southwest of Building G650	Arsenic, Barium, Chromium, Mercury, Lead (CH2M HILL, 2008g)	Phase II CSI 2002-2003 (CH2M HILL, 2008g) - RFI recommneded, RFI analyizing VOCs, SVOCs, and RCRA metals 2007	NO (CH2M HILL, 2008g)	NO	NO
UST Sites						
Building TC-341	#6 Heating oil	Naphthalene, Fluorene, Phenanthrene, Cadmium, Lead (Law, 1996c)	NFA Recommended (J.A. Jones, 2002c)	NO (Law, 1996c)	NO	NO

TABLE 2-5
Summary of Identified Sites - Courthouse Bay
MCB Camp Lejeune, North Carolina

Site No.	Site Description and Use	Primary Contaminants	Site Status	Current VOC Contamination above NCGWQS?	Contain Buildings with 100 ft of a well containing VOC concentrations above NCGWQS	Retained for Further Evaluation?
IR Sites						
73	Amphibious Vehicle Maintenance Facility - disposal activities and vehicle maintenance	Chlorinated VOCs (TCE, daughter products) and benzene (CH2M HILL, 2007g)	LTM implemented between 2000-2005. Air Sparging Interim Measure (2002) treated concentrated VC near the bulkhead. Hydrogen Sparging pilot study (2003-2006) implemented to treat main TCE groundwater plume. Ozone enhanced air sparging implemented in 2007. (CH2M HILL, 2007g)	YES (CH2M HILL, 2007g)	YES	YES
RCRA Sites						
SWMU 474	BB52 - motor pool for the 2nd Combat Engineer Battalion. Location of newly built Joint Maritime Special Missions Maintenance Supply Building (BB329).	Arsenic, chromium, lead, PCE, and1,4-dichlorobenzene (CH2M HILL, 2008g)	Confirmatory Sampling Investigation was completed in 2006. An RFI is scheduled for FY 2008.	YES (CH2M HILL, 2008g)	YES	YES
UST Sites						
BB-293	Building BB-293 - location of former UST BB-293-1 which operated from 1983 to 1996 for used oil storage	VOCs, Naphthalene, metals (Sovereign, 2007b)	Comprehensive Site Assessment (1998) recommended further investigation. Second investigation completed in 2000. NCDENR denied request for NFA and recommended a monitoring program which is still on-going today.	YES (Sovereign, 2007b)	YES	YES
BB-190	Building BB-190 - location of former 500-gallon UST used to store diesel fuel and currently is an active water treatment plant	Benzene, TPH, GRO, DRO, and Naphthalene (Sovereign, 2007f)	Comprehensive Site Assessment (1995) recommended corrective action plan. Corrective Action Plan recommended biosparge and SVE for soil and groundwater remediation. Biosparge/SVE system installed in 1998 and shutdown in 1999. NFA request denied and recommended monitoring program which is still on-going today.	YES (Sovereign, 2007f)	YES	YES

TABLE 2-6
Summary of Identified Sites - Tarawa Terrace
MCB Camp Lejeune, North Carolina

Site No.	Site Description and Use	Primary Contaminants	Site Status	Current VOC Contamination above NCGWQS?	Contain Buildings within 100 ft of a well containing VOC concentrations above NCGWQS	Retained for Further Evaluation?
IR Sites						
ABC Cleaners	Dry cleaning service since 1955, which uses PCE as a dry cleaning solvent. PCE was historically reclaimed through a filtration-distillation process, and the still bottoms generated from the distillation process were disposed of in a nearby dirt drive as "pothole" filler. It is estimated that approximately one ton of still bottoms was placed on the driveway over a 30 year period.	PCE (CH2M HILL, 2007c)	Site investigation including soil sampling, soil gas sampling, and groundwater sampling was conducted in the vicinity of the Tarawa Terrace Elementary School and Tarawa Terrace 1 Housing Units to evaluate the impact and potential for vapor intrusion. With the exception of a single soil vapor sample, no VOCs were detected that could have been released from the dry cleaner. PCE was detected in a soil vapor sample at a concentration lower than conservative risk-based screening levels. Results of the investigation indicated that there is very little potential for a vapor intrusion pathway at the TT Primary School (CH2M HILL, 2007c)	YES (CH2M HILL, 2007c)	NO	NO
7	Tarawa Terrace Dump - part of OU11 along with Site 80 - used as a non-hazardous waste dump during construction of Tarawa Terrace housing. Dump closed in 1972 (CH2M HILL, 2007g)	SVOCs (PAHs) and Pesticides (CH2M HILL, 2007g)	Final ROD for OU 11 signed on August 21, 1997 (Baker, 1997). No remedial actions were required in the ROD for Site 7 due to the absence of contamination. Therefore, Site 7 was closed with NFA (CH2M HILL, 2007g)	NO (CH2M HILL, 2007g)	NO	NO
84	Building 45 is located one mile west of the Main Gate. Building 45 was constructed on the site in 1941, shortly after the land was purchased by the US government. The property was leased to Tidewater Electric through 1965. The Base then converted the building to a maintenance facility for large machinery. Employee interviews revealed that the site's activities included PCB transformer maintenance, recycling, and on0site disposal of spent transformer casings. The site also contained a 500-gallon UST used for storing heating oil (CH2M HILL, 2007g).	PCBs, Pesticides, and PAHs (CH2M HILL, 2007g)	During a UST investigation in 1992, low levels of PCBs were detected in a soil sample collected from the area where a transformer has been discovered on the site. Soil from around the lagoon and surface water and sediments from within the lagoon was adversely impacted by high levels of PCBs. Phase I (2002) removed 4,857 tons of non-hazardous PCB-contaminated soil, 142 tons of contaminated soil and the remaining building foundation. The Phase II NTCRA was conducted from December 2003 to August 2004, and included the removal of approximately 12,000 tons of contaminated soil/sediment. Phase III (2006) removed 680 tons of PCB-contaminated soil. Total excavation to achieve the PCB remediation goal of 10 parts per million (ppm) was deemed impractical, so a two-foot thick vegetative soil cover was placed over the remaining PCB-contaminated soil. A groundwater monitoring program for the site is being managed under the UST program as proposed in the CAP. A Draft Final Construction Closeout Report was submitted in May 2007 (CH2M HILL, 2007g).	NO (* GW monitoring under UST program)	NO	NO

TABLE 2-6
Summary of Identified Sites - Tarawa Terrace
MCB Camp Lejeune, North Carolina

Site No.	Site Description and Use	Primary Contaminants	Site Status	Current VOC Contamination above NCGWQS?	Contain Buildings within 100 ft of a well containing VOC concentrations above NCGWQS	Retained for Further Evaluation?
RCRA Sites						
SWMU 350	SWMU 350 is a former AST facility, which consisted of tanks STT-61 through STT-66, located approximately 400 ft east of Iwo Jima Boulevard, the entrance to Tarawa Terrace, and 100 ft south of NC Highway 24. The six ASTs (each with approximately 30,000 gallon capacity) at the facility held liquid propane until 1984. The piping system was then modified to store used oil. The ASTs have been taken out of service and removed, along with the associated piping (CH2M HILL, 2008g).	VOC, SVOCs, RCRA metals, and naphthalene (CH2M HILL, 2008g)	During the preliminary and addendum site assessments (O'Brien and Gere, 1993) at SWMU 350, VOCs (petroleum hydrocarbons and chlorinated organics) were identified in surficial and intermediate aquifer zones south and southwest of the AST facility (CH2M HILL, 2008c). In July 1996, naphthalene was reported in an intermediate depth monitoring well at a concentration that slightly exceeded the State water quality standard (Baker, 1998). A CSI field investigation was conducted in March, 2007. The CSI included soil and groundwater sampling for VOC, SVOC, and RCRA metals analysis. No VOCs or SVOCs were found to be exceeding screening criteria in either the surface or subsurface soils at SWMU 350. Naphthalene, lead, arsenic, and benzene concentrations exceeded the screening criteria in groundwater. In July 2007, groundwater sampling was conducted around the Tarawa Terrace II Elementary School (TT-84), located approximately 300 ft southeast of SWMU 350. No VOC contamination was identified in the groundwater surrounding the school, indicating that the SWMU 350 VOC contamination has been bounded in that direction (CH2M HILL	NO (CH2M HILL, 2008g)	NO (CH2M HILL, 2008g)	NO
UST Sites						
M-232-236	Buildings M-232 through 236 are located in the Camp Johnson area of the MCB along Hayes Street. The buildings are currently utilized as bachelor housing quarters. Five heating oil USTs (one UST at each of the associated buildings) were excavated and removed from the site in May 1990. Soil samples exhibited petroleum hydrocarbon contamination above the State standards (Sovereign, 2007g).	VOCs, SVOCs, VPHs (Sovereign, 2007g)	Results from Annual Groundwater Sampling 2006-2007 indicate that no VOCs are present in groundwater in exceedance of NCGWQS (Sovereign, 2007g)	NO (Sovereign, 2007g)	NO (Sovereign, 2007g)	NO

TABLE 2-6
Summary of Identified Sites - Tarawa Terrace
MCB Camp Lejeune, North Carolina

Site No.	Site Description and Use	Primary Contaminants	Site Status	Current VOC Contamination above NCGWQS?	Contain Buildings within 100 ft of a well containing VOC concentrations above NCGWQS	Retained for Further Evaluation?
STT - 39A	Building STT-39A was a former water treatment plant. A former 1,000-gallon fuel oil UST was located 40 feet west of Bldg STT-39A. The tank was removed in 1992 (Law Catlin, 2001).	VOCs, SVOCs, VPHs (Law Catlin, 2001)	VOCs were not detected above NCGWQS during the April 2001 monitoring period (Law, 2001). In 1997, The General Assembly of North Carolina passed legislation that allowed the temporary suspension of cleanups at some UST sites and assigned Site STT-39A the rank of 15E (NCDENR, 1997).	NO (Law Catlin, 2001)	NO (Law Catlin, 2001)	NO
TT-2453	Building TT-2453 was utilized as a gas station until 1987, when it was used as a MCCS recreational equipment issue. The building was demolished in 2001. There were seven USTs, one AST, two hydraulic lifts, and the former dispenser islands and associated UST piping on site. All components were removed from the site either in 1987 or by 2001 when the building was demolished (Sovereign, 2006d).	VOCs and naphthalene (Sovereign, 2006d)	Building TT-2453 was incorporated into TT-2477/78 site in 2002 (Sovereign, 2006a). An air sparging soil vapor extraction remediation system was installed and operated until May 2004. Post operational monitoring of the site areas indicated groundwater contaminants (benzene, ethylbenzene, and total xylenes) were detected at concentrations above the NCGWQS. Bis(2-ethylhexyl)phthalate and naphthalene were also detected above NCGWQS (Sovereign, 2006d). An NFA status was granted to Site TT-2453 by the NCDENR stating that any groundwater contamination that may have been associated with this incident has been cleaned up to the level of the standards or interim standards established (NCDENR, 2008)	NO (NCDENR, 2008)	NO (NCDENR, 2008)	NO
TT-2455	Building TT-2455 was previously used as a commissary for military personnel. The site contained (1) 1,000 gallon steel heating oil UST which was located adjacent to and west of the building (Law Catlin, 1998).	PAH (Law Catlin, 1998)	The NCDENR granted a NFA to Site TT-2455 in 1998 stating that contaminated groundwater does not exceed gross contamination levels that were established in 15A NCAC 2L.0115(g) (NCDENR, 2000a)	NO (NCDENR, 2000a)	NO (NCDENR, 2000a)	NO
TT-2463-2473	Buildings TT-2463 through TT-2473 make up part of the Tarawa Terrace shopping center located at the northwest corner of the intersection of Tarawa Boulevard and Iwo Jima Boulevard (Shaw, 2004). Buildings TT-2463 through 2473 contained (6) 500 gallon heating oil USTs (Catlin, 2007). The USTs were abandoned in place by filling with grout in the early 1990s (Shaw, 2004).	VOCs, SVOCs, and TPH (Shaw, 2004)	A BS/SVE remediation system was installed at the site and began operation in August 1996. The system operated at the site until shutdown in 2002. Subsequent to system shutdown, soil excavations were completed in 2003 and 2004 (Catlin, 2007). On November 7, 2005, the NCDENR agreed with the NFA request assuming the site has been re-asphalted/concreted and a land use restriction has been applied (Catlin, 2007).	NO (Catlin, 2007)	NO (Catlin, 2007)	NO

TABLE 2-6
Summary of Identified Sites - Tarawa Terrace
MCB Camp Lejeune, North Carolina

Site No.	Site Description and Use	Primary Contaminants	Site Status	Current VOC Contamination above NCGWQS?	Contain Buildings within 100 ft of a well containing VOC concentrations above NCGWQS	Retained for Further Evaluation?
TT-2477	Building TT-2477 was built in 1950 as a full service gas station with vehicle maintenance capabilities. The building is now being utilized as a chapel. A 10,000 gallon gasoline tank, a 500 gallon hydraulic fluid tank, and a 500 gallon heating oil tank were located in the vicinity of the building. The USTs were removed in 1992 (Sovereign, 2006b).	VOCs, SVOCs, and naphthalene (Sovereign, 2006b)	Building TT-2453 was incorporated into TT-2477/78 site in 2002. An AS/SVE remediation system was installed in October 1997 and operational until shut down in May 2004. The system was expanded in March 1998 and again in April 2001 to treat contamination in the vicinity of TT-2453. During the April 2006 groundwater monitoring event, benzene, ethylbenzene, and total xylenes were detected in MWs: 2477-MWOB01, 2477-MWOB10, 2477-MWPVC101, and 2478-MW18 above NCGWQS. Bis(2-ethylhexyl)phthalate and naphthalene were also detected above NCGWQS in wells 2477-MWOB01, 2477-MWPVC101, 2477-MW01, and 2477-MW02 (Sovereign, 2006b).	YES (Sovereign, 2006b) - 2477-MWOB01, 2477-MWOB10, 2477-MWPVC101, 2478-MW18, 2477-MWPVC101, 2477-MW01, and 2477-MW02	YES (Sovereign, 2006b) - Buildings STT-2464, STT-2466, and TT-2477	YES
TT-2478	Building TT-2478 is currently a Marine Corps Community Services gas station with two pump islands. Three 10,000 gallon fiberglass USTs held gasoline and one 10,000 gallon UST held diesel fuel. In 1995, the 3 USTs which held gasoline were removed (Sovereign, 2006b).					
TT-3548	TT-3548 is a single-family residence in the Tarawa Terrace II Housing Area. The building was scheduled to be demolished in the summer of 2006. The former leaking UST system on site was a 500 gallon heating oil UST and associated piping used to heat the single family residence. The UST was removed in August 2001 (Sovereign, 2006c).	MADEP VPH/EPH (Sovereign, 2006c)	During the removal of the UST, TPH impacted soil was removed and soil samples were taken to reveal VOC, SVOC, and MADEP constituents contamination above soil action limits. A Phase I Limited Site Assessment (LSA) was conducted in 2002-2003 which identified soil contamination above the STGW and MSCCs. A Soil Assessment Report (SAR) was conducted in 2004 and confirmed the presence of MADEP constituents of the UST excavation site. During the SAR, groundwater contamination of aromatic petroleum hydrocarbons that exceeded NCGWQS and it was recommended that the groundwater be monitored on an annual basis until soil excavation is performed in 2009 or 2010. During the January 2006 annual groundwater monitoring, no VOCs were found exceeding the NCGWQS (Sovereign, 2006c).	NO (Sovereign, 2006c)	NO (Sovereign, 2006c)	NO

TABLE 2-6
Summary of Identified Sites - Tarawa Terrace
MCB Camp Lejeune, North Carolina

Site No.	Site Description and Use	Primary Contaminants	Site Status	Current VOC Contamination above NCGWQS?	Contain Buildings within 100 ft of a well containing VOC concentrations above NCGWQS	Retained for Further Evaluation?
MMRP Sites						
UXO-04	Knox Trailer Park encompasses approximately 134 acres in the northern portion of the Base. The Knox Trailer Park area began as a Civilian Conservation Corps Camp in 1941. Diesel oil was sprayed on water surfaces as a larvicide against malaria carrying insects. Between 1942 and the early 1950s, the Park was used for training and research activities involving explosives and live ammunition. From the early 1950s to 2006, the Park has been used for residential housing (CH2M HILL, 2007g)	PCBs, Pesticides, and Metals	UOX-04 is currently being considered for a public-private venture (PPV) development of the land. As a result in 2006, an Expanded SI (ESI) was conducted at UXO-04 to evaluate the nature, number, and density of anomalies that could potentially represent subsurface munitions of explosive concern (MEC) and to identify the presence and nature of any hazardous or toxic waste contamination that may exist. The HHRS and ERS concluded that a more comprehensive surface soil sampling program would need to be completed in order to define discrete areas of surface soil contamination. A second phase of sampling in support of the ESI was conducted in September 2007. Field activities included soil, groundwater, surface water, and sediment sampling and the results will be presented in a final ESI report (CH2M HILL, 2007g).	NO (CH2M HILL, 2007g)	NO	NO

TABLE 2-7
Summary of NFA Sites
MCB Camp Lejeune, North Carolina

CERCLA Sites	RCRA Sites	UST Sites
IR-4	1	UST-1
IR-5	2	UST-1106
IR-8	3	UST-1205/S1213
IR-10	4	UST-1310
IR-12	5	UST-1323
IR-13	6	UST-1401
IR-14	10	UST-1450-1,2,5,
IR-16	11	UST-1450-3,4
IR-17	12	UST-1502-1
IR-18	13	UST-1604/S1616
IR-19	14	UST-1607
IR-20	15	UST-1612
IR-23	16	UST-1736
IR-25	17	UST-1775-2,3
IR-27	20	UST-1775-4
IR-30	21	UST-1775-5
IR-31	22	UST-1780-1
IR-32	23	UST-1780-1A
IR-33	24	UST-1780-1B
IR-34	25	UST-1804/S1856
IR-37	30	UST-1815/S1813
IR-38	32	UST-1829-3
IR-39	35	UST-1841
IR-40	37	UST-1854-1
IR-42	38	UST-1854-2,3
IR-46	39	UST-1854-4
IR-47	41	UST-1860
IR-48	53	UST-1860
IR-49	89	UST-1880-1
IR-50	90	UST-1880-2
IR-51	91	UST-1880-3
IR-52	92	UST-1919-1
IR-53	94	UST-1919-2
IR-55	95	UST-1919-3
IR-56	196	UST-1932
IR-57	207	UST-20
IR-58	209	UST-21
IR-59	253	UST-24
IR-60	254	UST-311
IR-61	255	UST-32
IR-62	256	UST-33
IR-64	257	UST-331
IR-65	258	UST-333B
IR-66	259	UST-40
IR-67	260	UST-5400
IR-68	261	UST-575
IR-75	262	UST-575-4
IR-76	263	UST-575-6

TABLE 2-7
Summary of NFA Sites
MCB Camp Lejeune, North Carolina

CERCLA Sites	RCRA Sites	UST Sites
IR-85	264	UST-600
IR-87	265	UST-61
IR-90	266	UST-738
IR-91	267	UST-903 (901)
IR-92	268	UST-A47-2
IR-94	270	UST-A47-4
	271	UST-A47-5
	272	UST-AS1011
	273	UST-AS109/SAS15
	274	UST-AS114
	275	UST-AS114
	276	UST-AS118
	277	UST-AS118
	278	UST-AS146
	279	UST-AS2094
	280	UST-AS2804
	281	UST-AS2804
	282	UST-AS3000
	283	UST-AS3504
	284	UST-AS4146
	285	UST-AS4146-3
	286	UST-AS522
	287	UST-AS605
	289	UST-AS804
	290	UST-AS822
	291	UST-AS840
	292	UST-AS849
	293	UST-AS872
	294	UST-BA130
	295	UST-BA130/SBA131
	296	UST-BB177
	297	UST-BB30
	298	UST-BB-46
	300	UST-BB51
	301	UST-BB52/SBB70
	302	UST-BB71
	304	UST-BB9
	305	UST-CG1
	306	UST-FC102
	308	UST-FC120
	310	UST-FC190
	311	UST-FC200
	312	UST-FC201(W)
	313	UST-FC230-2
	314	UST-FC230-3
	315	UST-FC241
	316	UST-FC251
	317	UST-FC263

TABLE 2-7
Summary of NFA Sites
MCB Camp Lejeune, North Carolina

CERCLA Sites	RCRA Sites	UST Sites
	319	UST-FC270-1
	320	UST-FC270-2
	321	UST-FC280
	324	UST-FC281
	325	UST-FC-40-2
	326	UST-FC45
	327	UST-H18
	329	UST-H19
	330	UST-H31
	331	UST-HELO REL
	332	UST-HP100
	333	UST-HP100-3
	334	UST-HP250
	335	UST-LCH4022
	336	UST-M101
	337	UST-M167
	338	UST-M171
	339	UST-M178
	358	UST-M230-1
	359	UST-M230-2
	362	UST-M90
	363	UST-MRFF
	468	UST-NH-118
	469	UST-PP3311
	471	UST-PP3322
	482	UST-PP3340
		UST-PP3343
		UST-PP3358
		UST-PP3363
		UST-PT37
		UST-PT39
		UST-RR72
		UST-RR80
		UST-S688
		UST-S947
		UST-SBB161
		UST-SBB94
		UST-SLCH4019
		UST-STT39A
		UST-STT69
		UST-TC1251
		UST-TC1255
		UST-TC307
		UST-TC501
		UST-TC-647
		UST-TC755
		UST-TC774
		UST-TT2254

TABLE 2-7
Summary of NFA Sites
MCB Camp Lejeune, North Carolina

CERCLA Sites	RCRA Sites	UST Sites
		UST-TT2258
		UST-TT2634
		UST-TT3140
		UST-TT3165
		UST-TT3233
		UST-TT3524
		UST-TT3548
		UST-TT44
		UST-TT48
		UST-TT60
		UST-TT779

TABLE 2-8
Summary of Groundwater Elevations
Site 88 - August 2007
MCB Camp Lejeune, North Carolina

Monitoring Well ID	Gauge Date	DTW (ft bTOC)	TOC Elev. (ft MSL)	Well Depth (ft bgs)	Water Elevation (ft MSL)	Depth interval (S/I/D/D2)
88-EX07IW	08/06/07	NM	24.18	55.0	NM	I
88-EX08DW	08/06/07	NM	26.50	85.0	NM	D
88-MW01	08/06/07	6.75	26.07	22.0	19.32	S
88-MW01IW	08/06/07	16.90	26.16	50.0	9.26	I
88-MW02 repl.	08/06/07	9.50	24.94	18.0	15.44	S
88-MW02DW repl.	08/06/07	15.71	25.30	97.0	9.59	D
88-MW02IW repl.	08/06/07	15.81	25.18	50.0	9.37	I
88-MW03	08/13/07	7.61	25.38	15.0	17.77	S
88-MW03DW	08/13/07	16.42	25.32	85.0	8.90	D
88-MW03IW	08/13/07	16.10	25.62	50.0	9.52	I
88-MW04	08/06/07	14.91	24.54	25.0	9.63	S
88-MW04DW	08/06/07	15.13	24.61	85.0	9.48	D
88-MW04IW	08/06/07	15.11	24.60	50.0	9.49	I
88-MW05	08/06/07	8.42	23.97	23.0	15.55	S
88-MW05DW	08/06/07	15.22	24.33	85.0	9.11	D
88-MW05DW2	08/06/07	15.15	24.26	150.0	9.11	D2
88-MW05IW	08/06/07	15.11	24.33	50.0	9.22	I
88-MW06	08/06/07	NM	23.13	23.0	NM	S
88-MW06DW	08/06/07	NM	24.21	89.0	NM	D
88-MW06IW repl.	08/06/07	14.88	24.30	50.0	9.42	I
88-MW07	08/06/07	9.75	23.37	22.0	13.62	S
88-MW07DW	08/06/07	14.51	22.97	85.0	8.46	D
88-MW07IW	08/06/07	14.74	23.38	50.0	8.64	I
88-MW08	08/06/07	9.30	22.98	20.0	13.68	S
88-MW08IW	08/06/07	13.94	22.91	50.0	8.97	I
88-MW09	08/06/07	9.28	21.83	21.0	12.55	S
88-MW09IW	08/06/07	12.52	21.74	50.0	9.22	I
88-MW11	08/06/07	14.20	23.91	14.5	9.71	S
88-MW11DW	08/06/07	14.90	23.72	85.0	8.82	D
88-MW11IW	08/06/07	13.65	23.6	50.0	9.97	I
88-MW12	08/07/07	6.40	26.16	15.0	19.76	S
88-MW12DW	08/06/07	17.00	25.75	85.0	8.75	D
88-MW12IW	08/06/07	17.14	25.9	50.0	8.77	I
88-MW13	08/06/07	16.10	26.47	20.0	10.37	S
88-MW13IW	08/06/07	16.70	26.9	50.0	10.19	I
88-MW14	08/06/07	10.05	21.40	20.0	11.35	S
88-MW14DW	08/06/07	13.17	21.40	85.0	8.23	D
88-MW14IW	08/06/07	13.31	21.6	50.0	8.24	I

TABLE 2-8
Summary of Groundwater Elevations
Site 88 - August 2007
MCB Camp Lejeune, North Carolina

Monitoring Well ID	Gauge Date	DTW (ft bTOC)	TOC Elev. (ft MSL)	Well Depth (ft bgs)	Water Elevation (ft MSL)	Depth interval (S/I/D/D2)
88-MW15	08/06/07	6.53	21.17	18.0	14.64	S
88-MW15DW	08/06/07	13.06	21.05	85.0	7.99	D
88-MW15IW	08/06/07	13.48	21.5	50.0	8.02	I
88-MW16	08/08/07	9.90	22.48	15.0	12.58	S
88-MW16DW2	08/08/07	14.20	23.24	85.0	9.04	D
88-MW16DW	08/08/07	13.60	22.92	150.0	9.32	D2
88-MW16IW	08/08/07	13.42	22.64	50.0	9.22	I
88-MW17	08/06/07	10.34	26.36	15.0	16.02	S
88-MW17DW	08/06/07	16.86	26.50	85.0	9.64	D
88-MW17IW	08/06/07	17.45	26.2	50.0	8.74	I
88-MW18DW	08/06/07	13.43	22.59	85.0	9.16	D
88-MW18DW2	08/06/07	13.78	22.71	150.0	8.93	D2
88-MW18IW	08/06/07	13.42	22.64	50.0	9.22	I
88-MW19DW	08/06/07	16.96	24.06	85.0	7.10	D
88-MW19IW	08/06/07	16.98	24.11	50.0	7.13	I
88-MW20DW	08/06/07	17.15	23.54	84.0	6.39	D
88-MW20IW	08/06/07	17.35	23.70	50.0	6.35	I
88-MW21DW	08/06/07	18.86	25.67	85.0	6.81	D
88-MW21IW	08/06/07	18.66	25.45	50.0	6.79	I
88-MW22DW	08/06/07	18.12	24.99	85.0	6.87	D
88-MW22IW	08/06/07	18.28	25.17	55.0	6.89	I
88-MW23DW	08/06/07	13.96	22.45	85.0	8.49	D
88-MW23IW	08/06/07	13.96	22.71	50.0	8.75	I
88-MW24DW	08/06/07	15.98	24.64	85.0	8.66	D
88-MW24IW	08/06/07	15.48	24.33	50.0	8.85	I
88-MW25	08/06/07	7.80	24.71	20.0	16.91	S
88-MW-26	08/06/07	8.08	25.23	20.0	17.15	S
88-MW-27	08/06/07	11.75	24.65	20.0	12.90	S
88-MW-28	08/06/07	10.30	24.01	20.0	13.71	S
88-MW-29 **	08/06/07	NM		20.0	NM	S
88-MW-30	08/06/07	9.59	25.36	18.0	15.77	S
88-MW30IW	08/06/07	16.03	24.95	40.0	8.92	I
88-MW-31	08/09/07	7.94	24.95	18.0	17.01	S
88-MW31IW	08/06/07	16.28	25.15	40.0	8.87	I
88-MW32DW	08/06/07	17.14	24.79	85.0	7.65	D
88-MW32IW	08/06/07	17.09	24.73	50.0	7.64	I
88-MW33DW	08/06/07	13.40	22.13	83.0	8.73	D
88-MW33IW	08/06/07	13.35	22.29	50.5	8.94	I

TABLE 2-8
Summary of Groundwater Elevations
Site 88 - August 2007
MCB Camp Lejeune, North Carolina

Monitoring Well ID	Gauge Date	DTW (ft bTOC)	TOC Elev. (ft MSL)	Well Depth (ft bgs)	Water Elevation (ft MSL)	Depth interval (S/I/D/D2)
88-MW34DW	08/06/07	17.22	25.02	85.0	7.80	D
88-MW34IW	08/06/07	17.31	25.13	50.0	7.82	I
88-MW35DW	08/06/07	14.15	21.95	85.0	7.80	D
88-MW35IW	08/06/07	14.11	22.24	50.0	8.13	I
88-MW36DW	08/06/07	13.57	22.72	85.0	9.15	D
88-MW36IW	08/06/07	13.42	22.66	50.0	9.24	I
88-MW37DW	08/06/07	15.96	25.25	85.0	9.29	D
88-MW37IW	08/06/07	15.89	25.22	50.0	9.33	I
88-MW38DW	08/06/07	13.17	22.06	85.0	8.89	D
88-MW38IW	08/06/07	13.40	22.39	50.0	8.99	I

** MW-29 was destroyed

Table 2-9
Groundwater Elevation Table
Building 820
Camp LeJeune, North Carolina

		Revised			Revised			Revised			Revised
Well No.	Well Type (depth)	Top of Casing	Date Measured	Depth (BTC)	Elev. (NGVD)	Date Measured	Depth (BTC)	Elev. (NGVD)	Date Measured	Depth (BTC)	Elev. (NGVD)
UST820-MW02	shallow	32.27	Aug-05	14.45	**17.82**	Feb-06	11.10	**21.17**	Oct-06	11.83	**20.44**
UST820-MW03	shallow	32.42	Aug-05	14.63	**17.79**	Feb-06	11.18	**21.24**	Oct-06	12.02	**20.40**
UST820-MW04	shallow	32.87	Aug-05	14.62	**18.25**	Feb-06	11.20	**21.67**	Oct-06	12.15	**20.72**
UST820-MW05	shallow	29.93	Aug-05	11.38	**18.55**	Feb-06	7.71	**22.22**	Oct-06	8.57	**21.36**
UST820-MW06	shallow	31.75	Aug-05	15.20	**16.55**	Feb-06	11.62	**20.13**	Oct-06	12.56	**19.19**
UST820-MW08	shallow	26.80	Aug-05	13.62	**13.18**	Feb-06	10.61	**16.19**	Oct-06	11.41	**15.39**
UST820-MW10	shallow	31.38	Aug-05	NM	---	Feb-06	8.86	**22.52**	Oct-06	9.57	**21.81**
UST820-MW11	shallow	29.12	Aug-05	10.58	**18.54**	Feb-06	7.16	**21.96**	Oct-06	7.92	**21.20**
UST820-MW12	shallow	31.50	Aug-05	14.21	**17.29**	Feb-06	11.64	**19.86**	Oct-06	11.63	**19.87**
UST820-MW13	shallow	28.80	Aug-05	13.35	**15.45**	Feb-06	9.01	**19.79**	Oct-06	9.87	**18.93**
UST820-MW14	shallow	31.65	Aug-05	13.75	**17.90**	Feb-06	11.80	**19.85**	Oct-06	12.56	**19.09**
UST820-MW15	shallow	29.89	Aug-05	10.36	**19.53**	Feb-06	7.10	**22.79**	Oct-06	14.28	**15.61**
UST820-MW16	shallow	31.86	Aug-05	13.29	**18.57**	Feb-06	9.08	**22.78**	Oct-06	10.06	**21.80**
UST820-MW18	shallow	31.31	Aug-05	13.69	**17.62**	Feb-06	9.68	**21.63**	Oct-06	10.81	**20.50**
UST820-MW20	shallow	31.18	Aug-05	15.55	**15.63**	Feb-06	11.62	**19.56**	Oct-06	12.56	**18.62**
UST820-MW22	shallow	31.53	Aug-05	13.69	**17.84**	Feb-06	14.42	**17.11**	Oct-06	15.31	**16.22**
UST820-MW24	shallow	29.35	Aug-05	16.19	**13.16**	Feb-06	13.20	**16.15**	Oct-06	13.82	**15.53**
UST820-MW26	shallow	28.49	Aug-05	12.00	**16.49**	Feb-06	9.19	**19.30**	Oct-06	10.09	**18.40**
UST820-MW27	shallow	29.91	Aug-05	11.30	**18.61**	Feb-06	7.81	**22.10**	Oct-06	8.65	**21.26**
UST820-MW7	deep	26.86	Aug-05	12.72	**14.14**	Feb-06	9.68	**17.18**	Oct-06	10.46	**16.40**
UST820-MW9	deep	31.21	Aug-05	18.81	**12.40**	Feb-06	11.40	**19.81**	Oct-06	NM	**NM**
UST820-MW9D	deep	32.53	Aug-05	20.90	**11.63**	Feb-06	16.24	**16.29**	Oct-06	17.42	**15.11**
UST820-MW17	deep	32.16	Aug-05	19.81	**12.35**	Feb-06	16.46	**15.70**	Oct-06	17.32	**14.84**
UST820-MW19	deep	31.35	Aug-05	18.95	**12.40**	Feb-06	NM	---	Oct-06	16.62	**14.73**
UST820-MW21	deep	31.49	Aug-05	18.80	**12.69**	Feb-06	14.86	**16.63**	Oct-06	13.33	**18.16**
UST820-MW23	deep	30.86	Aug-05	17.83	**13.03**	Feb-06	14.84	**16.02**	Oct-06	15.63	**15.23**
UST820-MW25	deep	28.18	Aug-05	15.51	**12.67**	Feb-06	12.35	**15.83**	Oct-06	13.13	**15.05**
UST820-MW28	deep	28.85	Aug-05	16.21	**12.64**	Feb-06	15.05	**13.80**	Oct-06	13.67	**15.18**
UST820-MW29	deep	27.37	Aug-05	13.75	**13.62**	Feb-06	10.60	**16.77**	Oct-06	11.28	**16.09**
UST820-MW30	deep	29.29							Oct-06	17.29	**12.00**
UST820-MW31	deep	29.97							Oct-06	17.81	**12.16**
UST820-MW32	deep	29.17							Oct-06	11.97	**17.20**
UST820-MW33	deep	31.30							Oct-06	14.06	**17.24**
UST820-MW34	deep	30.19							Oct-06	13.72	**16.47**

** NGVD = National Geodetic Vertical Datum
# Measurement not used due to suspected

TABLE 2 -10
GROUNDWATER ELEVATION DATA
REPORTING PERIOD: JUNE 2006 – MAY 2007
Incident Number and Name: 85352 – Building LCH 4015

Monitoring Well	Top of Casing Elevation (feet)	Groundwater Elevation (feet)	
		10/11/2006	2/7/2007
LCH4015-MW01	32.53	29.72	30.45
LCH4015-MW02	31.69	30.30	30.82
LCH4015-MW03	34.70	29.90	30.44
LCH4015-MW04	35.29	30.28	30.84
LCH4015-MW05	20.56	18.36	18.58
LCH4015-MW06	31.80	29.27	29.50
LCH4015-MW07	32.38	30.28	31.98
LCH4015-MW08	31.38	30.18	30.03
LCH4015-MW09	30.91	29.98	29.77
LCH4015-MW10	30.89	30.02	30.10
LCH4015-MW11	31.77	28.45	28.78
LCH4015-MW12	31.87	27.62	28.40
LCH4015-MW13	31.97	9.87	11.89
LCH4015-MW14	32.04	27.63	28.37
LCH4015-MW15	31.90	28.75	28.91
LCH4015-MW16	32.26	31.29	Not Calculated
LCH4015-MW17	Well Lost	Not Calculated	Not Calculated
LCH4015-MW18	32.60	31.72	30.90
LCH4015-MW19	32.62	9.82	11.92
LCH4015-MW20	31.83	10.03	11.96
LCH4015-MW21	32.64	10.04	12.14
LCH4015-MW22	31.72	9.74	11.91
LCH4015-MW23	32.55	9.83	12.00
LCH4015-MW24	31.24	29.68	30.43

Not Calculated = Elevation not calculated due to insufficient data; MW-17 LOST.

TABLE 2-11
SWMU 118 Groundwater Elevations
MCB Camp Lejeune, North Carolina

Temporary Well Identification	Top of Casing Elevation (ft msl)	Well Diameter (inches)	Well Depth (ft bgs)	Screened Interval (ft bgs)	Depth-to-Water (ft bTOC)	Groundwater Elevation (ft msl)
SWMU118-TW01	9.97	1	12.0	7 - 12	7.9	2.06
SWMU118-TW02	13.46	1	10.5	5.5 - 10.5	10.83	2.63
SWMU118-TW03	14.06	1	19.0	14 - 19	11.20	2.86
SWMU118-TW04	14.29	1	18.5	13.5 - 18.5	12.85	1.44

ft msl	Feet above mean sea level.
ft bgs	Feet below ground surface.
ft bTOC	Feet below top of casing.
N/A	Not Available

TABLE 2-12
Site 78 Groundwater Elevations
MCB Camp Lejeune, North Carolina

Sample ID	Sample Method [1]	Date of Water Level Measurement	Top of Casing Elevation (feet above msl)[2]	Total Well Depth (feet BTOC)[3]	Top of Screened Interval (feet BTOC)[3]	Bottom of Screened Interval (feet BTOC)[3]	Depth to Water (feet BTOC)[3]	Groundwater Elevation (feet above msl)[2]
GW01	PDB	8/22/2007	32.92	25.0	5.0	25.0	20.10	12.82
GW02	NS	8/22/2007	32.15	-- [4]	-- [4]	-- [4]	8.15	24.00
GW03	NS	8/22/2007	31.85	-- [4]	-- [4]	-- [4]	8.41	23.44
GW04-1	PDB	8/22/2007	31.63	24.5	4.5	24.5	Dry	<24.50
GW04-2	NS	8/22/2007	31.01	-- [4]	-- [4]	-- [4]	19.30	11.71
GW05	PDB	8/22/2007	28.63	27.0	5.0	25.0	11.42	17.21
GW06	NS	8/22/2007	27.94	-- [4]	-- [4]	-- [4]	15.10	12.84
GW07	NS	8/22/2007	27.83	-- [4]	-- [4]	-- [4]	14.22	13.61
GW08	PDB	8/22/2007	28.72	25.0	5.0	25.0	13.35	15.37
GW09-1	PDB	8/22/2007	28.13	25.0	5.0	25.0	11.41	16.72
GW09-3	PDB	8/22/2007	23.42	120.0	115.0	120.0	11.44	11.98
GW10	PDB	8/22/2007	28.13	25.0	5.0	25.0	12.75	15.38
GW11	PDB	8/22/2007	28.22	25.0	5.0	25.0	13.66	14.56
GW12	NS	8/22/2007	30.08	-- [4]	-- [4]	-- [4]	11.97	18.11
GW13	NS	8/22/2007	26.20	-- [4]	-- [4]	-- [4]	12.45	13.75
GW14	NS	8/22/2007	27.32	25.0	5.0	25.0	9.70	17.62
GW15	NS	8/22/2007	27.03	25.0	5.0	25.0	NM [5]	NM [5]
GW16	NS	8/22/2007	32.40	-- [4]	-- [4]	-- [4]	11.78	20.62
GW17-1	NS	8/22/2007	30.00	25.0	5.0	25.0	11.12	18.88
GW19	NS	8/22/2007	29.07	-- [4]	-- [4]	-- [4]	NM [5]	NM [5]
GW20	NS	8/22/2007	25.33	-- [4]	-- [4]	-- [4]	NM [5]	NM [5]
GW21	NS	8/22/2007	33.51	25.0	5.0	25.0	10.28	23.23
GW22	PDB	8/22/2007	32.36	25.0	5.0	25.0	8.32	24.04
GW23	PDB	8/22/2007	32.08	25.0	5.0	25.0	11.48	20.60
GW24-1	PDB	8/22/2007	32.84	25.0	5.0	25.0	8.73	24.11

TABLE 2-12
Site 78 Groundwater Elevations
MCB Camp Lejeune, North Carolina

Sample ID	Sample Method [1]	Date of Water Level Measurement	Top of Casing Elevation (feet above msl)[2]	Total Well Depth (feet BTOC)[3]	Top of Screened Interval (feet BTOC)[3]	Bottom of Screened Interval (feet BTOC)[3]	Depth to Water (feet BTOC)[3]	Groundwater Elevation (feet above msl)[2]
GW24-2	PDB	8/22/2007	33.73	76.6	56.6	76.6	13.98	19.75
GW24-3	PDB	8/22/2007	32.32	148.0	128.0	148.0	13.32	19.00
GW25	PDB	8/22/2007	32.58	25.0	5.0	25.0	10.32	22.26
GW29	NS	8/22/2007	NA	-- [4]	-- [4]	-- [4]	21.31	NM [5]
GW33	NS	8/22/2007	29.84	14.0	4.0	13.1	NM [5]	NM [5]
GW34	NS	8/22/2007	32.66	13.0	3.0	12.0	8.49	24.17
GW35	NS	8/22/2007	32.08	20.0	9.8	18.9	13.90	18.18
GW36	NS	8/22/2007	29.86	18.0	8.1	17.2	13.21	16.65
GW37	NS	8/22/2007	20.02	14.0	3.8	13.1	9.83	10.19
GW39	PDB	8/22/2007	19.44	20.0	10.0	20.0	15.51	3.93
GW40	PDB	8/22/2007	31.34	24.6	4.4	24.0	11.91	19.43
GW41	PDB	8/22/2007	29.54	24.0	4.5	23.8	6.82	22.72
GW42	PDB	8/22/2007	28.52	23.0	3.9	23.2	18.20	10.32
GW43	NS	8/22/2007	29.94	-- [4]	-- [4]	-- [4]	10.82	19.12
GW44	Low-Flow	8/22/2007	30.25	31.2	27.5	31.2	11.25	19.00
GW45	Low-Flow	8/22/2007	28.67	25.0	20.0	25.0	8.68	19.99
GW46	Low-Flow	8/22/2007	30.51	23.0	18.0	23.0	10.85	19.66
GW47	Low-Flow	8/22/2007	29.76	30.0	25.0	30.0	10.78	18.98
GW48	NS	8/22/2007	29.21	23.0	4.0	23.0	8.45	20.76
GW49	Low-Flow	8/22/2007	25.55	30.5	25.5	30.5	11.77	13.78
GW50	Low-Flow	8/22/2007	29.32	23.0	18.0	23.0	18.34	10.98
GW53	PDB	8/22/2007	26.38	25.0	15.0	25.0	16.44	9.94
GW54	PDB	8/22/2007	28.50	25.0	15.0	25.0	18.92	9.58
GW55	NS	8/22/2007	29.13	23.5	18.5	23.5	18.60	10.53
GW56	NS	8/22/2007	29.21	29.6	24.6	29.6	18.53	10.68

TABLE 2-12
Site 78 Groundwater Elevations
MCB Camp Lejeune, North Carolina

Sample ID	Sample Method [1]	Date of Water Level Measurement	Top of Casing Elevation (feet above msl)[2]	Total Well Depth (feet BTOC)[3]	Top of Screened Interval (feet BTOC)[3]	Bottom of Screened Interval (feet BTOC)[3]	Depth to Water (feet BTOC)[3]	Groundwater Elevation (feet above msl)[2]
GW57	NS	8/22/2007	29.33	28.0	23.0	28.0	18.50	10.83
GW58	Low-Flow	8/22/2007	-- [4]	28.0	23.0	28.0	15.46	-- [4]
GW59	Low-Flow	8/22/2007	28.11	25.0	20.0	25.0	17.7	10.46
GW60	Low-Flow	8/22/2007	26.84	31.0	25.0	31.0	13.0	13.84
GW61	Low-Flow	8/22/2007	24.19	29.0	24.0	29.0	14.49	9.70
GW62	Low-Flow	8/22/2007	25.62	30.0	25.0	30.0	NM [5]	NM [5]
GW63	Low-Flow	8/22/2007	27.97	29.0	24.0	29.0	19.05	8.92
GW64	Low-Flow	8/22/2007	26.90	28.0	23.0	28.0	18.11	8.79
GW65	Low-Flow	8/22/2007	27.91	32.0	27.0	32.0	18.52	9.39
GW66	NS	8/22/2007	27.28	29.5	24.5	29.5	17.50	9.78
GW67	NS	8/22/2007	29.28	32.5	27.0	32.5	NM [5]	NM [5]
GW68	NS	8/22/2007	28.03	28.0	23.0	28.0	18.07	9.96
GW69	NS	8/22/2007	29.76	38.0	33.0	38.0	NM [5]	NM [5]
GW70	NS	8/22/2007	29.95	38.0	33.0	38.0	NM [5]	NM [5]
GW71	NS	8/22/2007	29.82	38.0	33.0	38.0	10.85	18.97
GW72	NS	8/22/2007	29.68	38.0	33.0	38.0	NM [5]	NM [5]
GW73	Low-Flow	8/22/2007	25.35	30.0	25.0	30.0	12.30	13.05
GW74	Low-Flow	8/22/2007	25.29	43.0	38.0	43.0	NM [5]	NM [5]
GW76	NS	8/22/2007	25.55	23.0	18.0	23.0	11.65	13.90
GW77	NS	8/22/2007	26.51	43.0	38.0	43.0	13.90	12.61
GW78	Low-Flow	8/22/2007	26.05	32.0	27.0	32.0	13.05	13.00
RW05	PDB	8/22/2007	-- [4]	35.0	15.0	35.0	NM [5]	NM [5]
RW08	Sample Port	8/22/2007	-- [4]	35.0	15.0	35.0	NM [5]	NM [5]
RW10	Sample Port	8/22/2007	-- [4]	35.0	15.0	35.0	NM [5]	NM [5]
RW11	Sample Port	8/22/2007	-- [4]	35.0	15.0	35.0	NM [5]	NM [5]

TABLE 2-12
Site 78 Groundwater Elevations
MCB Camp Lejeune, North Carolina

Sample ID	Sample Method [1]	Date of Water Level Measurement	Top of Casing Elevation (feet above msl)[2]	Total Well Depth (feet BTOC)[3]	Top of Screened Interval (feet BTOC)[3]	Bottom of Screened Interval (feet BTOC)[3]	Depth to Water (feet BTOC)[3]	Groundwater Elevation (feet above msl)[2]
RW12	Sample Port	8/22/2007	-- [4]	35.0	15.0	35.0	NM [5]	NM [5]
RW14	Sample Port	8/22/2007	-- [4]	35.0	15.0	35.0	NM [5]	NM [5]

Notes:

1. NS = Not Sampled, not in LTM Program; PDB - Passive Diffusion Bag
2. msl - mean sea level
3. BTOC - below top of casing
4. "--" - Well construction details are unknown
5. NM = Not Measured

TABLE 2-13
SWMU 360 Groundwater Elevations
MCB Camp Lejeuene

Well Identification	Date Installed	Top of PVC Casing Elevation (feet above msl)	Ground Surface Elevation (feet above msl)	Well Depth (feet bgs)	Screen Interval (feet bgs)	Depth to Sand/Slough (feet bgs)	Depth to Bentonite (feet bgs)	Static Water Level (feet below TOC)	Static Water Elevation (feet above msl)
SWMU360-MW01	7/13/2003	27.25	27.51	28	18 - 28	16	13.1	21.19	6.06
SWMU360-MW01IW	7/12/2003	27.41	27.55	45	40 - 45	38	34.6	21.35	6.06
SWMU360-MW02	7/12/2003	26.24	26.38	28	18 - 28	16	14	19.90	6.34
SWMU360-MW02IW	7/11/2003	26.17	26.42	45	40 - 45	37.4	34.9	21.90	4.27
SWMU360-MW03	7/14/2003	24.26	24.62	28	18 - 28	16	14	18.98	5.28
SWMU360-MW03IW	7/13/2003	24.3	24.66	45	40 - 45	39	38	19.02	5.28
SWMU360-MW04	7/13/2003	25.71	26.04	28	18 - 28	16	14	20.10	5.61
SWMU360-MW05	7/15/2003	22.92	23.31	25	15 - 25	13	11	16.64	6.28
SWMU360-MW06	7/14/2003	24.54	24.85	27	17 - 27	15	13	17.45	7.09
SWMU360-MW07	7/10/2003	25.25	25.35	25	15 - 25	13	11.2	18.99	6.26
SWMU360-MW08	7/13/2003	26.32	26.68	26.9	16.9 - 26.9	14.8	12	18.85	7.47
1817-MW01	8/14/1997	26.13	26.8	25	15 - 25	13	11	19.40	6.73
IR78-GW39	Information not available								
SWMU360-MW09	**1/10/2006**	**19.5**	**19.87**	**25**	**15 - 25**	**13**	**11**	**14.82**	**4.68**
SWMU360-MW09IW	**1/13/2006**	**19.44**	**19.88**	**45**	**40 - 45**	**38**	**31**	**14.80**	**4.64**
SWMU360-MW10	**1/10/2006**	**23.58**	**23.82**	**25**	**15 - 25**	**13**	**11**	**19.32**	**4.26**
SWMU360-MW10IW	**1/12/2006**	**23.46**	**24**	**45**	**40 - 45**	**38**	**34**	**19.18**	**4.28**
SWMU360-MW11	**1/11/2006**	**23.86**	**24.42**	**27**	**17 - 27**	**15**	**13**	**19.23**	**4.63**
SWMU360-MW12	**1/11/2006**	**20.64**	**21.15**	**25**	**15 - 25**	**13**	**11**	**16.50**	**4.14**

NOTES:
1) Groundwater levels were measured on January 18, 2006
2) Bold denotes newly installed wells

TABLE 2-14
GROUNDWATER ELEVATION DATA
2006-2007
Incident Number and Name: 32126 - Building 900

Monitoring Well	Top of Casing Elevation (feet)	Groundwater Elevation (feet)			
		7/17/2006	10/16/2006	1/15/2007	3/13/2007
UST900-MW01	29.74	20.26	21.14	22.99	22.35
UST900-MW02	29.72	24.81	24.77	25.92	25.53
UST900-MW03	29.5	20.10	21.03	22.99	22.25
UST900-MW04	29.42	24.34	24.56	25.62	25.15
UST900-MW05	29.57	24.61	24.59	25.60	25.40
UST900-MW06	30.28	24.83	Not Calcluated	25.88	25.42
UST900-MW07	28.93	Well lost during construction		25.33	25.03
UST900-MW08	29.34	22.17	22.62	24.25	23.66
UST900-MW09	29.82	23.62	23.82	25.10	24.45
UST900-MW10	28.86	23.76	23.75	24.85	24.51
IR78-GW22	31.93	24.70	24.61	25.43	25.05
IR78-GW23	31.23	21.12	21.78	23.76	22.61
UST900-RW10	25.85	18.93	21.05	20.56	16.80

NM = Well not measured; either not accessible or not designated as part of gauging program.
Not Calculated due to insufficient data or well not measured.
TOC Elevations taken from Sovereign Well Survey Database January 2007; MW07 relocated.

TABLE 2-15
GROUNDWATER ELEVATION DATA
APRIL 2006
Incident Number and Name: 20660 - Building 1613

Monitoring Well	Top of Casing Elevation (feet)	Groundwater Elevation (feet)
		04/06/06
UST1613-MW06	27.77	14.20
UST1613-MW10	28.67	14.04
UST1613-MW11	25.24	14.76
UST1613-MW16	27.03	13.67
UST1613-MW20	25.72	14.01
UST1613-MW21	26.24	14.53
UST1613-MW22	25.52	14.16
UST1613-HPGW06	28.10	14.25

TABLE 2- 16
Site 86 Grounwater Elevations
MCB Camp Lejeune

Well Identification	Date (mm/dd/yyyy)	Depth to Water (feet BTOC)	TOC Elevation (ft msl)	Well Depth (ft)	Water Elevation (ft msl)	Well Type (S/I/D)
IR86-AS428-GW06	12/3/2007	9.24	21.00	49.82	11.76	intermediate
IR86-GW15IW	12/3/2007	7.60	16.49	54.51	8.89	intermediate
IR86-MW15DW	12/3/2007	7.82	16.56	95.33	8.74	deep
IR86-GW16IW	12/3/2007	8.24	16.82	55.17	8.58	intermediate
IR86-MW16DW	12/3/2007	8.57	16.71	91.75	8.14	deep
IR86-MW17DW	12/3/2007	8.00	17.24	105.81	9.24	deep
IR86-MW18DW	12/3/2007	8.85	17.89	107.56	9.04	deep
IR86-MW19DW	12/3/2007	9.90	18.67	103.90	8.77	deep
IR86-MW20IW	12/3/2007	8.55	17.87	57.95	9.32	intermediate
IR86-MW22IW	12/3/2007	8.83	17.78	64.84	8.95	intermediate
IR86-MW23IW	12/3/2007	8.99	17.36	62.80	8.37	intermediate
IR86-MW24IW	12/3/2007	5.34	15.15	64.35	9.81	intermediate
IR86-GW25IW	12/3/2007	5.48	15.32	29.80	9.84	shallow
IR86-MW26IW	12/3/2007	6.00	15.85	55.38	9.85	intermediate
IR86-MW27IW	12/3/2007	6.02	15.91	29.90	9.89	shallow
IR86-GW29IW	12/3/2007	8.97	16.97	59.80	8.00	intermediate
IR86-MW30IW	12/3/2007	7.76	17.57	59.95	9.81	intermediate
IR86-MW31IW	12/3/2007	8.81	15.76	53.07	6.95	intermediate
IR86-MW31DW	12/3/2007	8.90	15.73	88.75	6.83	deep
IR86-MW34IW	12/3/2007	8.01	11.97	45.20	3.96	intermediate
IR86-MW39	12/3/2007	6.85	18.72	30.00	11.87	shallow
IR86-MW40	12/3/2007	8.57	20.28	30.00	11.71	shallow
IR86-MW41	12/3/2007	6.50	17.67	29.30	11.17	shallow
IR86-MW42IW	2/5/2008	4.60	17.44	49.94	12.84	intermediate
IR86-MW42DW	12/3/2007	5.75	17.39	94.86	11.64	deep
IR86-MW43IW	12/3/2007	6.73	17.78	49.30	11.05	intermediate
IR86-MW44IW	2/5/2008	5.89	18.21	50.61	12.32	intermediate
IR86-MW44DW	12/3/2007	6.85	18.09	94.80	11.24	deep
IR86-MW45DW	12/3/2007	6.94	18.22	94.83	11.28	deep
IR86-MW46IW	12/3/2007	7.24	17.69	49.86	10.45	intermediate
IR86-MW47	2/5/2008	7.66	18.10	30.20	10.44	shallow
IR86-MW47IW	12/3/2007	8.74	18.14	48.65	9.40	intermediate
IR86-MW48	12/3/2007	9.33	17.62	29.00	8.29	shallow
IR86-MW48IW	12/3/2007	9.79	18.44	29.36	8.65	intermediate
IR86-MW49DW	12/3/2007	9.31	17.17	49.24	7.86	deep
IR86-MW50IW	12/3/2007	9.06	17.07	95.59	8.01	intermediate
IR86-MW51DW	12/3/2007	8.96	15.87	50.51	6.91	deep
SWMU318-MW01	12/3/2007	6.03	17.53	29.85	11.50	shallow
SWMU318-MW03	2/5/2008	5.62	17.57	29.45	11.95	shallow
SWMU318-MW05	12/3/2007	6.13	17.18	30.25	11.05	shallow
SWMU318-MW06	12/3/2007	6.70	19.39	29.63	12.69	shallow
SWMU318-MW08	12/3/2007	6.76	17.32	30.00	10.56	shallow
USTCSFF-MW06	12/3/2007	7.00	17.79	18.38	10.79	shallow

Note:

BTOC - below top of casing

ft msl - feet mean sea level

TABLE 2-17
SWMU 475 Groundwater Elevations
MCB Camp Lejeune, North Carolina

Well Identification	Top of Casing Elevation *	May 8 & 14, 2007		July 18, 2007		November 14, 2007		December 11, 2007	
		Depth to Water	Static Water Elevation *	Depth to Water	Static Water Elevation *	Depth to Water	Static Water Elevation *	Depth to Water	Static Water Elevation *
	(ft msl)	(ft bTOC)	(ft above msl)	(ft bTOC)	(ft above msl)	(ft bTOC)	(ft above msl)	(ft bTOC)	(ft above msl)
SWMU475-TW01	19.34	9.15	10.19	NA	NA	NA	NA	NA	NA
SWMU475-TW02	20.56	8.82	11.74	NA	NA	NA	NA	NA	NA
SWMU475-MW01	17.6	4.00	13.60	7.70	9.90	5.50	12.10	6.11	11.49
SWMU475-MW02	17.84	5.59	12.25	6.23	11.61	5.42	12.42	7.10	10.74
SWMU475-MW03	19.34	5.71	13.63	6.85	12.49	7.82	11.52	8.40	10.94
SWMU475-MW04	18.07	5.33	12.74	4.69	13.38	6.71	11.36	5.79	12.28

NOTES:

*	Survey elevations reported using NAVD 88 datum.
ft msl	Feet above mean sea level.
ft bgs	Feet below ground surface.
ft bTOC	Feet below top of casing.
Top of PVC Casing is flush with ground.	
NA	Not Available

Table 2.18
Building AS4141 (JP-5 Area)
Groundwater Elevations

	Date		10/19/2006					3/13/2007				
Well ID	DTB	TOC Elevation	DTW	DTP	Product Thickness	Groundwater Elevation	Total Fluids Recovery (gal)	DTW	DTP	Product Thickness	Groundwater Elevation	Total Fluids Recovery (gal)
MW02	18.92	23.48	6.50	0	0	16.98		6.80	0	0	16.68	
MW07	15.54	NM	NM	0	0	NM		3.10	0	0	NM	
MW08	16.58	25.62	NM	0	0	NM		10.93	0	0	14.69	
MW10	14.88	21.56	NM	0	0	NM		4.67	0	0	16.89	
MW13	15.56	18.87	NM	0	0	NM		5.12	0	0	13.75	
MW14	24.81	19.56	5.78	0	0	13.78		5.70	0	0	13.86	
MW15	12.79	18.62	3.47	0	0	15.15		2.20	0	0	16.42	
MW16	14.47	NM	NM	0	0	NM		6.35	0	0	NM	
MW17	14.45	19.78	5.80	0	0	13.98		5.82	0	0	13.96	
MW18	15.07	NM	NM	0	0	NM		6.70	0	0	NM	
MW19	14.57	19.76	6.10	0	0	13.66		5.82	0	0	13.94	
MW20	12.93	NM	5.90	0	0	NM		7.45	5.71	1.74	NM	
MW21	12.23	NM	7.40	0	0	NM		7.74	5.70	2.04	NM	
RW01	23.93	NM	5.29	5.19	0.10	NM		5.38	5.13	0.25	NM	
RW02	21.00	NM	NM	0	0	NM		8.62	0	0	NM	
OBG02	12.57	23.85	NM	0	0	NM		5.69	0	0	18.16	
OBG03R	12.70	20.64	7.22	0	0	13.42		7.10	6.46	0.64	13.54	
OBG04	17.14	20.28	NM	0	0	NM		6.35	0	0	13.93	
OBG05	14.15	19.55	NM	0	0	NM		5.13	0	0	14.42	
OBG06	17.30	20.88	5.70	0	0	15.18		5.21	0	0	15.67	
TP-1	12.62	20.40	6.71	6.45	0.26	13.69		6.68	6.42	0.26	13.72	
TP-2	12.73	20.24	6.35	0	0	13.89		5.79	0	0	14.45	
TP-3	12.60	20.37	7.29	6.24	1.05	13.08		9.58	5.77	3.81	10.79	
TP-4	12.62	20.17	5.91	5.50	0.41	14.26		6.48	6.15	0.33	13.69	
TP-5	12.56	20.26	7.75	6.3	1.45	12.51		7.66	5.21	2.45	12.60	

NM = Not Measured
DTB = Depth to bottom of well (feet)
DTP = Depth to product (feet)

Table 2-19
Building AS 4158
Camp Lejeune, North Carolina
Water Level Measurement Summary

		3/8/2007			1/11/2007			12/15/2006			11/15/2006		
Sample Point	Top of Casing Elevation (ft., msl)	Depth to Hydrocarbon Product (ft. below toc)	Depth to Groundwater (ft. below toc)	Groundwater Elevation (ft., msl)	Depth to Hydrocarbon Product (ft. below toc)	Depth to Groundwater (ft. below toc)	Groundwater Elevation (ft., msl)	Depth to Hydrocarbon Product (ft. below toc)	Depth to Groundwater (ft. below toc)	Groundwater Elevation (ft., msl)	Depth to Hydrocarbon Product (ft. below toc)	Depth to Groundwater (ft. below toc)	Groundwater Elevation (ft., msl)
MW-1	20.54		6.70	13.84		Not Measured			Not Measured			Not Measured	
MW-2	21.31		dry			Not Measured			Not Measured			Not Measured	
MW-3	20.87		6.50	14.37		Not Measured			Not Measured			Not Measured	
MW-4	21.55		7.47	14.08		6.85	14.70		8.27	13.28		8.70	12.85
MW-5	21.87		7.42	14.45		6.67	15.20		8.20	13.67		8.79	13.08
MW-6	22.04		7.48	14.56		6.29	15.75		8.45	13.59		8.86	13.18
MW-7	21.37		8.10	13.27		8.41	12.96		8.60	12.77		9.23	12.14
MW-8	22.18		8.17	14.01		Not Measured			Not Measured			Not Measured	
MW-9 (Prod. Recovery Well)	22.02		8.53	13.49		8.72	13.30		9.89	12.13		9.51	12.51
MW-10	22.43		9.48	12.95		8.96	13.47		9.40	13.03		10.51	11.92
MW-11	23.10		10.00	13.10		9.83	13.27		9.72	13.38		10.90	12.20
MW-12	22.03		covered			Not Measured			Not Measured			Not Measured	
MW-13	23.23		10.40	12.83		10.27	12.96		10.74	12.49		11.25	11.98
MW-14	22.53		9.21	13.32		9.38	13.15		9.56	12.97		9.74	12.79
MW-15	23.25		9.68	13.57		Not Measured			Not Measured			Not Measured	
MW-16	21.34		8.12	13.22		7.69	13.65		8.63	12.71		9.51	11.83
MW-17	22.67		9.40	13.27		Not Measured			Not Measured			Not Measured	
MW-18	23.15		10.49	12.66		Not Measured			Not Measured			Not Measured	
PW-1	22.80		Not Measured			Not Measured			Not Measured			Not Measured	

Notes:

[1] wells (TOC) resurveyed in August 2006
[2] System not operational during water level survey
ft = feet
toc = top of casing elevation
msl = mean sea level
* Indicates that the depth to hydrocarbon product could not be measured. The product-water interface probe was being repaired.

TABLE 2-20
AS843 Groundwater Elevations
MCB Camp Lejeune

Well ID	TOC Elevation (feet)	Groundwater Elevation (feet)		
		7/5/2006	10/3/2006	1/4/2007
USTAS843-MW01 (Shallow)	12.73	8.48	7.53	9.03
USTAS843-MW02 (SHallow)	13.20	9.10	8.70	9.30
USTAS843-MW03 (Shallow)	13.23	9.22	9.41	9.02
USTAS843-MW04 (Shallow)	13.03	11.05	10.61	11.23
USTAS843-MW05 (Deep)	12.96	7.85	7.06	8.26

TABLE 2-21
GROUNDWATER ELEVATION DATA – JUNE 2006 TO MAY 2007
CAMPBELL STREET FUEL FARM - INCIDENT # 23297

Monitoring Well	Top of Casing Elevation (feet)	Groundwater Elevation (feet)											
		6/5/2006	7/13/2006	8/4/2006	9/12/2006	10/4/2006	11/1/2006	12/5/2006	1/4/2007	2/2/2007	3/2/2007	4/2/2007	5/7/2007
USTCSFF-MW03	21.07	14.34	14.75	15.77	15.62	14.62	15.55	15.32	15.81	15.50	16.61	14.35	14.12
USTCSFF-MW04	21.90	13.42	13.79	14.45	14.89	13.79	13.99	14.18	14.32	14.41	14.42	13.89	13.50
USTCSFF-MW05	23.05	14.41	14.89	16.06	15.89	14.63	15.06	14.96	15.15	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-MW06	19.55	13.05	13.00	13.55	13.49	13.04	13.32	13.23	13.33	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-MW07	20.43	13.53	13.76	16.02	15.55	13.83	15.66	15.86	16.07	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-MW08	19.56	14.10	14.26	15.51	15.35	14.26	15.53	15.45	15.71	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-MW09	19.49	13.52	13.89	14.52	14.95	13.92	14.12	14.34	14.52	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-MW10	20.22	14.01	14.32	15.98	15.62	14.35	15.39	15.30	15.60	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-MW11	21.11	13.66	14.04	14.71	15.18	14.03	14.34	14.55	14.84	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-MW12	20.64	13.77	13.89	14.57	14.53	13.89	14.12	14.04	14.22	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-MW13	21.61	13.85	14.24	14.42	14.60	13.86	13.81	14.06	14.24	14.43	Not Calculated	Not Calculated	Not Calculated
USTCSFF-MW14	19.14	13.39	13.52	14.12	14.14	13.44	13.94	13.83	14.19	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-MW15	20.72	13.24	13.61	14.25	14.66	13.70	13.85	14.02	14.29	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-MW16	20.55	13.91	13.82	14.00	13.95	13.65	13.68	13.98	14.10	14.18	14.12	13.65	13.69
USTCSFF-MW17	21.70	16.01	16.25	17.50	17.25	15.80	16.79	16.95	17.45	17.69	17.75	16.30	15.64
USTAS142-MW01	17.35	15.17	15.47	17.24	16.55	15.17	16.04	15.75	16.25	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-MW20	18.64	15.93	15.94	16.92	17.61	15.52	18.43	15.74	15.91	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-MW21	20.95	13.66	14.02	14.86	15.05	13.97	14.53	14.50	14.75	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-MW22	20.15	13.26	13.43	13.93	13.92	13.38	13.60	13.45	13.70	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-MW24	20.62	13.35	13.46	14.22	14.21	13.39	13.80	13.77	14.02	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-MW25	19.07	Not Calculated	Not Calculated	Not Calculated	Not Calculated	13.97	14.17	14.32	14.62	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS143-MW26	16.98	Not Calculated	Not Calculated	Not Calculated	Not Calculated	12.91	13.03	13.27	13.31	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-DW01	19.92	13.16	13.57	14.20	14.67	13.60	13.77	13.92	14.10	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-DW02	22.06	13.39	13.80	14.46	14.96	13.84	14.04	14.24	14.61	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-DW04	20.12	13.47	13.87	14.51	15.01	13.92	14.09	14.32	14.50	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-DW05	21.78	13.15	13.57	14.20	14.70	13.61	13.78	13.96	14.13	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTCSFF-DW06	20.94	13.11	13.52	14.12	14.39	13.54	13.68	13.83	13.99	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS4151-DW01	21.28	18.14	13.76	14.27	14.71	13.77	13.86	14.12	14.26	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS4151-DW01A	17.90	13.22	13.72	14.22	14.63	13.73	13.83	14.00	14.18	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS4151-DW02	21.87	13.50	13.92	14.46	14.91	13.96	14.05	14.32	14.42	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS4151-MW01	21.88	15.99	16.22	15.37	16.72	15.56	15.86	NM	16.08	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS4151-MW02	21.67	15.63	15.86	16.40	16.03	15.05	15.07	15.85	16.24	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS4151-MW02A	21.11	14.60	14.65	14.65	14.69	14.56	14.66	14.70	14.75	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS4151-MW03	21.31	14.73	15.04	16.00	16.26	14.47	15.15	15.76	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS4151-MW04	18.82	16.85	15.88	16.54	16.37	15.68	16.10	15.92	17.24	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS4151-MW05	17.77	13.89	13.77	14.22	14.25	13.70	14.12	14.14	14.37	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS4151-MW07	17.52	14.06	14.27	14.98	14.82	14.05	14.49	14.34	14.75	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS4151-MW08	20.34	13.69	13.82	14.14	15.07	13.62	13.88	13.74	13.94	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS4151-MW09	18.04	13.51	13.47	13.87	13.77	13.44	13.56	13.32	13.19	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS4151-MW10	20.80	14.80	14.80	15.58	15.29	14.38	15.08	15.02	15.36	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS4151-MW11	20.56	14.77	14.55	15.13	14.89	14.38	14.91	14.58	14.93	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS4151-MW12	20.00	14.26	14.48	15.13	14.98	14.28	14.59	14.52	14.88	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS4151-MW13	19.72	14.10	14.32	15.01	14.87	14.11	14.51	14.44	14.89	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS4151-MW13A	21.09	14.97	15.32	15.76	15.64	15.19	15.44	15.28	15.49	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS4151-MW14	22.57	16.22	16.45	16.94	16.35	15.40	15.46	16.36	16.72	Not Calculated	Not Calculated	Not Calculated	Not Calculated
USTAS4151-RW01	18.00	14.03	14.20	14.55	14.42	13.89	14.14	13.80	13.70	Not Calculated	Not Calculated	Not Calculated	Not Calculated

Not Calculated = Well DTW not measured; either not accessible or not designated as part of gauging program; groundwater elevation not calculated.
Wells above double line are associated with the CSFF/AS143 area; wells below the double line are associated with the AS4151 area.

Table 2-22

Rapid Refueler Area Air Station, New River
Well Gauging (Groundwater and Free Product)
March 2007

				3/19/2007			
Well ID	Well Diameter	DTB	TOC Elevation	DTW	DTP	Product Thickness	Groundwater elevation
RR-1	Not Located						
RR-2	2	14.07	NM	4.42			NM
RR-3	2	13.95	NM	4.85			NM
RR-4	Not Located						
RR-5	2	14.46	17.81	7.02			10.79
RR-6	2	13.08	15.55	4.00			11.55
RR-7	2	14.7	17.59	6.40			11.19
RR-8	Not Located						
RR-9	2	14.99	20.81	8.38			12.43
RR-10	2	14.93	17.39	6.33			11.06
RR-11	2	14.7	17.11	6.20			10.91
RR-12	2	14.95	16.86	4.96	4.92	0.04	11.9
RR-13	Not Located						
RR-14	2	48.1	17.21	5.32			11.89
RR-15	6	30.83	17.17	6.25			10.92
RR-16	4	14.1	20.01	8.28	8.20	0.08	11.73
RR-17	2	9.9	16.8	2.40			NM
RR-18	4	14.55	20.9	10.92	7.71	3.21	9.98
RR-19	2	15	21.08	7.79	6.82	0.97	NM
RR-20	2	15	21.71	7.30	7.25	0.05	14.41
RR-21	2	13.85	20.93	4.23			16.70
RR-22	4	14.5	21.13	7.47			13.66
RR-23	2	13.58	19.6	6.55			13.05
RR-1G	6	16.88	18.23	5.91	5.80	0.09	12.32
RR-2G	6	24.3	17.65	5.13	5.11	0.02	12.52
RR-3G	6	21.62	17.41	6.50			10.91
RR-4G	6	20.45	17.94	5.67			12.27
RR-5G	6	23	19.33	7.51	6.97	0.54	11.82
RR-6G	6	21.85	18.17	6.45			11.72
AS511-1	2	14.13	20.76	6.22			14.54
AS511-2	2	14.9	21.02	6.55			14.47
AS511-3	2	15.1	21.72	6.97			14.75
AS511-4	2	13.6	21.79	6.08			15.71
AS511-5	2	49.35	21.29	7.22			14.07
AS511-6	2	49.13	21	6.94			14.06
AS511-7	2	49.25	21.7	7.45			14.25
AS511-8	2	14.17	21.63	6.58			15.05
AS527-MW3	2	15.25	21.73	9.57			12.16
AS527-MW4	2	14.47	22.86	10.28			12.58
AS527-MW8	Not Located						
AS527-MW9	Not Located						
AS527-MW10	2	14	21.78	8.11			13.67
AS527-MW11	Not Located						
AS527-MW12	2	13.9	21.45	7.50			13.95
AS527-MW13	Not Located						
AS527-DW2	2	28.7	21.46	3.6			17.86
AS527-DW5	Not Located						
AS527-DW6	2	46.75	20.34	4.12			16.22
AS512-MW15	2	12	21.87	7.30	6.70	0.60	NM
AS512-MW16	2	12	20.15	5.86			14.29
AS497-MW01	2	13.95	18.35	5.55			12.80
AS497-MW02	2	14.45	20.71	7.65			13.06
AS497-MW03	2	13.9	18.54	5.97			12.57
AS497-MW04	2	14	NM	6.09			NM
AS497-MW05	2	14	17.05	5.72	5.53	0.19	11.33
AS497-MW06	2	49.3	18.1	6.13	0		11.97

M

NM = Not Measured
DTB = Depth to bottom of well (feet)
DTP = Depth to product (feet)
Monitoring Wells were Resurveyed in August 2006

TABLE 2-23
Site 73 Groundwater Elevation
MCB Camp Lejeune

Well ID	Date (dd/mm/yy)	DTW (ft bTOC)	TOC (ft msl)	Well Depth (ft)	Water Elevation (ft msl)
Site 73					
73-A47/3-12	04/08/06	5.49	8.1	17	2.61
73-A47/3-13	04/08/06	NM	8.54	15	NM
73-A47/3-15	04/08/06	5.96	n.a.	n.a.	n.a.
73-A47/3-16	04/08/06	5.05	7.75	15.5	2.70
73-A47/3-19	04/08/06	6.11	7.27	19.18	1.16
73-A47/3-22	04/08/06	7.45	10.45	18.5	3.00
73-A47/3-8	04/08/06	4.15	6.87	17	2.72
73-A47/3-9	04/08/06	3.60	7.15	17	3.55
73-MW01	04/08/06	9.95	15.35	18	5.40
73-MW01DW	04/08/06	10.24	15.92	57	5.68
73-MW01IW	04/08/06	10.10	15.86	38	5.76
73-MW02	04/08/06	6.74	14.66	18	7.92
73-MW02IW	04/08/06	17	14.39	32	-2.61
73-MW03	04/08/06	7.5	13.7	18	6.20
73-MW04	04/08/06	NM	12.86	11.5	NM
73-MW05	04/08/06	NM	15.78	18	NM
73-MW06	04/08/06	5.22	7.32	10	2.10
73-MW06IW	04/08/06	4.74	6.86	43	2.12
73-MW07	04/08/06	NM	13.94	17	NM
73-MW08	04/08/06	5.13	10.98	11.5	5.85
73-MW09	04/08/06	3.3	18.47	11	15.17
73-MW09DW	04/08/06	NM	6.69	150	NM
73-MW09IW	04/08/06	NM	6.74	62	NM
73-MW10	04/08/06	2.84	6.54	11	3.70
73-MW11	04/08/06	5.8	13.14	18	7.34
73-MW11DW	04/08/06	12.6	12.95	90	0.35
73-MW11IW	04/08/06	9.89	13.00	38	3.11
73-MW12	04/08/06	4.38	9.76	15	5.38
73-MW13	04/08/06	3.4	8.43	18	5.03
73-MW13DW	04/08/06	5.51	8.28	70	2.77
73-MW14	04/08/06	3.74	8.48	18	4.74
73-MW15	04/08/06	3.7	5	10	1.30
73-MW15IW	04/08/06	2.22	4.68	46	2.46
73-MW15N	04/08/06	7.65	n.a.	14.5	n.a.
73-MW16	04/08/06	3.6	11.13	15	7.53
73-MW17	04/08/06	5.71	10.69	18	4.98
73-MW17DW	04/08/06	10.21	9.76	86	-0.45
73-MW18	04/08/06	6.4	12.19	17	5.79
73-MW19	04/08/06	6.81	12.73	18	5.92
73-MW20	04/08/06	2.67	7.70	18	5.03
73-MW20DW	04/08/06	4.34	7.32	53	2.98
73-MW21	04/08/06	3.72	7.26	20	3.54
73-MW22	04/08/06	NM	10.11	10.5	NM
73-MW23	04/08/06	4.76	11.67	18	6.91
73-MW24	04/08/06	NM	6.59	18	NM

TABLE 2-23
Site 73 Groundwater Elevation
MCB Camp Lejeune

Well ID	Date (dd/mm/yy)	DTW (ft bTOC)	TOC (ft msl)	Well Depth (ft)	Water Elevation (ft msl)
Site 73					
73-MW25	04/08/06	4.63	11.09	9	6.46
73-MW26	04/08/06	DRY	16.04	16	DRY
73-MW26DW	04/08/06	13.00	15.83	150	2.83
73-MW26IW	04/08/06	DRY	16.15	55	DRY
73-MW27	04/08/06	3.25	9.52	18	6.27
73-MW27DW	04/08/06	6.66	8.66	75	2.00
73-MW28	04/08/06	6.33	11.45	11	5.12
73-MW29	04/08/06	3.4	8.76	18	5.36
73-MW30	04/08/06	1.08	9.13	18	8.05
73-MW31	04/08/06	8.93	12.06	12	3.13
73-MW31DW	04/08/06	9.00	11.85	70	2.85
73-MW32	04/08/06	NM	6.73	9	NM
73-MW32DW	04/08/06	NM	6.85	51	NM
73-MW33	04/08/06	NM	14.32	12	NM
73-MW33DW	04/08/06	10.60	14.33	56	3.73
73-MW34	04/08/06	7.44	12.9	17	5.46
73-MW34DW	04/08/06	9.55	12.57	61	3.02
73-MW35	04/08/06	8.3	12.89	18	4.59
73-MW35DW	04/08/06	10.06	13.29	61	3.23
73-MW36	04/08/06	NM	8.4	11	NM
73-MW36DW	04/08/06	NM	8.67	45	NM
73-MW37	04/08/06	5.7	11.12	18	5.42
73-MW38DW	04/08/06	5.36	8.22	110	2.86
73-MW39DW	04/08/06	5.3	8.06	70	2.76
73-MW40DW	04/08/06	2.92	5.98	70	3.06
73-MW41DW	04/08/06	3.3	5.83	110	2.53
73-MW42DW	04/08/06	2.86	5.64	110	2.78
73-MW43DW	04/08/06	4.55	7.52	70	2.97
73-MW44DW	04/08/06	5.65	8.56	70	2.91
73-MW45DW	04/08/06	0.92	3.33	70	2.41
73-MW46DW	04/08/06	6.95	10.12	75	3.17
73-MW47DW	04/08/06	6.19	9.17	75	2.98
73-MW48DW	04/08/06	5.22	8.09	75	2.87
73-MW49DW	04/08/06	6.32	9.67	75	3.35
73-MW49DWA	04/08/06	6.47	8.23	126	1.76
73-MW49IW	04/08/06	6.52	8.46	55	1.94
73-MW50DW	04/08/06	4.8	7.93	75	3.13
73-MW51	04/08/06	3.33	6.55	150	3.22
73-MW51DW	04/08/06	4.00	6.94	74	2.94
73-MW52	04/08/06	2.94	5.75	150	2.81
73-MW52DW	04/08/06	2.20	4.68	60	2.48
73-MW53	04/08/06	4.81	8.4	150	3.59
73-MW54	04/08/06	6.70	12.98	15	6.28
73-MW55	04/08/06	5.95	12.15	11.5	6.20
73-MW56	04/08/06	7.39	14.18	14	6.79
73-MW57	04/08/06	5.12	12.37	12	7.25
73-MW58	04/08/06	6.45	14.92	14	8.47

TABLE 2-23
Site 73 Groundwater Elevation
MCB Camp Lejeune

Well ID	Date (dd/mm/yy)	DTW (ft bTOC)	TOC (ft msl)	Well Depth (ft)	Water Elevation (ft msl)
Site 73					
73-MW60	04/08/06	NM	13.13	22.5	NM
73-MW61	04/08/06	6.41	11.04	21.5	4.63
73-MW62DW	04/08/06	12.18	18	30	5.82
73-MW63DW	04/08/06	6.12	7.91	76	1.79

Notes:
NM - not measured
n.a. - not available.
ft bTOC - feet below top of casing
ft msl - feet above mean sea level
DTW - Depth to Water
TOC - Top of Well Casing

TABLE 2-24
GROUNDWATER ELEVATION AND PRODUCT THICKNESS DATA
FEBRUARY 2007
Incident Number and Name: 22793 - Building BB-190

Monitoring Well	Top of Casing Elevation (feet)	Depth to Water (DTW)	Groundwater Elevation (feet)	Product Thickness (feet)
		02/05/07	02/05/07	02/05/07
USTBB190-MW01	12.92	NM	Not Calculated	NM
USTBB190-MW02	11.46	3.65	7.81	--
USTBB190-MW03	13.65	7.00	6.65	--
USTBB190-MW04	13.58	5.50	8.08	--
USTBB190-MW05	11.61	5.92	5.69	--
USTBB190-MW06	9.86	4.46	5.40	--
USTBB190-MW07	10.88	4.17	6.71	--
USTBB190-MW08	13.63	6.18	7.45	--
USTBB190-MW09	13.48	5.25	8.23	--
USTBB190-MW10	10.00	4.70	5.30	--
USTBB190-MW11	12.84	7.55	5.29	--
USTBB190-MW12	12.18	3.68	8.50	--
USTBB190-MW13	13.40	13.20	0.20	--
USTBB190-MW14	9.88	8.10	1.78	--
USTBB190-MW15	11.13	9.25	1.88	--
USTBB190-MW16	10.94	4.95	5.99	--
USTBB190-MW17	10.83	4.55	6.28	--
PSWBB47	Unknown	NM	Not Calculated	--

- NM = Well not measured; well not accessible during the event.
- Not Calculated due to insufficient data or well not measured.
- Top of Casing elevations taken from Sovereign Consulting Well Survey January 2007
- "--"= free product not present during gauging event.

TABLE 2-25
GROUNDWATER ELEVATION AND PRODUCT THICKNESS DATA
NOVEMBER 2006

Incident Number and Name: 32049 - Building BB-293

Monitoring Well	Top of Casing Elevation (feet)	Depth to Water (DTW) (feet)	Groundwater Elevation (feet)	Product Thickness (feet)
		11/27/06	11/27/06	11/27/06
USTBB293-MW01 (Type III)	9.52	4.22	5.30	--
USTBB293-MW02 (Type II)	8.87	1.92	6.95	--
USTBB293-MW03 (Type II)	9.44	2.53	6.91	--
USTBB293-MW04 (Type II)	9.28	2.20	7.08	--
USTBB293-MW05A (Type II)	10.69	3.75	6.94	--
USTBB293-MW06 (Type II)	9.53	2.58	6.95	--
Pond Well (SBB313)	Unknown	NM	Not Calculated	NM

Note: " --" = free product not present during gauging event.

Table 2-26
Temporary Well Construction and Groundwater Elevations at SWMU 470 & 474, November 2006
MCB Camp Lejeune, North Carolina

Temporary Well Identification	**Top of Casing Elevation** (ft msl)	**Well Diameter** (inches)	**Well Depth** (ft bgs)	**Screened Interval** (ft bgs)	**Depth-to-Water** (ft bTOC)	**Groundwater Elevation** (ft msl)
SWMU470-TW01	20.01	0.75	9.0	4-9	0.0	20.01
SWMU470-TW03	22.33	0.75	11.0	6-11	2.25	20.08
SWMU470-TW05	21.60	0.75	12.0	7-12	2.13	19.47
SWMU474-TW02	26.93	0.75	16.0	11-16	12.40	14.53
SWMU474-TW06	24.72	0.75	16.0	11-16	10.15	14.57
SWMU474-TW08	26.81	0.75	16.0	11-16	12.15	14.66

ft msl Feet above mean sea level.
ft bgs Feet below ground surface.
ft bTOC Feet below top of casing.

TABLE 2-27
Site 35 Groundwater Elevations
MCB Camp Lejeune

Well Identification	Date (mm/dd/yyyy)	Depth to Water (feet BTOC)	TOC Elevation (ft msl)	Well Depth (ft)	Water Elevation (ft msl)	Well Type (S/I/D)
IR35-MW01DW	6/19/2006	8.30	19.95	61	11.65	Deep
IR35-MW02*	6/19/2006	5.07	16.21	20	11.14	Shallow
IR35-MW03DW	6/19/2006	8.65	19.03	65	10.38	Deep
IR35-MW04	6/19/2006	7.58	20.52	14	12.94	Shallow
IR35-MW06*	6/19/2006	6.56	18.14	13	11.58	Shallow
IR35-MW06DW	6/19/2006	5.99	17.57	69	11.58	Deep
IR35-MW07DW	6/21/2006	6.56	9.41	62	2.85	Deep
IR35-MW09	6/19/2006	8.10	18.92	13	10.82	Shallow
IR35-MW09IW	6/19/2006	8.13	18.88	30	10.75	Intermediate
IR35-MW10	6/19/2006	7.70	18.99	14	11.29	Shallow
IR35-MW10IW	6/19/2006	7.76	19.01	30	11.25	Intermediate
IR35-MW14	6/19/2006	10.70	17.78	13	7.08	Shallow
IR35-MW14IW	6/19/2006	10.70	17.73	29	7.03	Intermediate
IR35-MW29	6/19/2006	8.35	20.62	16	12.27	Shallow
IR35-MW29IW	6/19/2006	7.69	20.28	47	12.59	Intermediate
IR35-MW30	6/19/2006	6.30	18.38	16	12.08	Shallow
IR35-MW30IW	6/19/2006	6.20	18.38	42	12.18	Intermediate
IR35-MW30DW*	6/19/2006	6.25	16.94	65	10.69	Deep
IR35-MW31	6/19/2006	10.18	18.32	13	8.14	Shallow
IR35-MW31IW	6/19/2006	10.36	18.46	24	8.10	Intermediate
IR35-MW32	6/19/2006	8.11	18.23	14	10.12	Shallow
IR35-MW32IW	6/19/2006	8.90	18.75	42	9.85	Intermediate
IR35-MW34	6/19/2006	6.56	16.77	14	10.21	Shallow
IR35-MW34IW	6/19/2006	7.82	16.76	41	8.94	Intermediate
IR35-MW37	6/19/2006	7.13	20.30	15	13.17	Shallow
IR35-MW37IW	6/19/2006	7.34	20.33	45	12.99	Intermediate
IR35-MW38	6/19/2006	6.53	19.74	15	13.21	Shallow
IR35-MW38IW*	6/19/2006	6.74	18.90	44	12.16	Intermediate
IR35-MW39IW	6/19/2006	4.85	18.83	47	13.98	Intermediate
IR35-MW40IW	6/19/2006	5.80	17.59	47	11.79	Intermediate
IR35-MW47	6/19/2006	2.80	5.49	13	2.69	Shallow
IR35-MW47IW	6/19/2006	2.30	5.77	32	3.47	Intermediate
IR35-MW49	6/19/2006	3.20	4.99	13	1.79	Shallow
IR35-MW49IW	6/19/2006	1.60	4.98	32	3.38	Intermediate
IR35-MW55	6/19/2006	2.29	6.25	12	3.96	Shallow
IR35-MW55IW	6/19/2006	3.28	6.09	32	2.81	Intermediate
IR35-MW60	6/21/2006	8.06	10.08	20	2.02	Shallow
IR35-MW60IW	6/21/2006	7.55	9.59	36	2.04	Intermediate
IR35-MW62	6/19/2006	4.51	4.49	13	-0.02	Shallow
IR35-MW63IW	6/19/2006	2.30	5.39	30	3.09	Intermediate

TABLE 2-27
Site 35 Groundwater Elevations
MCB Camp Lejeune

Well Identification	Date (mm/dd/yyyy)	Depth to Water (feet BTOC)	TOC Elevation (ft msl)	Well Depth (ft)	Water Elevation (ft msl)	Well Type (S/I/D)
IR35-MW64IW	6/19/2006	2.55	4.77	30	2.22	Intermediate
IR35-MW66	6/19/2006	6.89	15.66	16	8.77	Shallow
IR35-MW67	6/19/2006	-- [1]	15.28	15	-- [1]	Shallow
IR35-MW68IW	6/19/2006	13.59	15.86	43	2.27	Intermediate
IR35-MW69IW	6/19/2006	10.25	19.83	43	9.58	Intermediate
IR35-MW70IW	6/19/2006	5.72	19.26	46	13.54	Intermediate
IR35-MW71IW	6/19/2006	1.76	12.70	43	10.94	Intermediate
IR35-MW72	6/19/2006	9.80	17.42	19	7.62	Shallow
IR35-MW72IW	6/19/2006	10.64	17.19	46	6.55	Intermediate
IR35-MW73	6/19/2006	11.65	17.71	21	6.06	Shallow
IR35-MW73IW	6/19/2006	11.68	17.77	48	6.09	Intermediate
IR35-MW74	6/19/2006	9.95	17.06	21	7.11	Shallow
IR35-MW74IW	6/19/2006	10.22	17.32	48	7.10	Intermediate
IR35-MW80IW*	6/19/2006	7.60	14.62	50	7.02	Intermediate
IR35-MW80DW*	6/19/2006	8.05	14.82	77	6.77	Deep

Note:
1. Water level not collected due to the presence of LNAPL
Wells IR35-MW72DW, IR35-MW81 and IR35-MW81IW not installed at the time water levels were collected.
* New TOC elevation from survey conducted in October 2006
BTOC - below top of casing
ft msl - feet mean sea level

TABLE 2-28
Site 89 Groundwater Elevations
MCB Camp Lejeune

Well Identification	Date	Top of Casing Elevation (ft msl)	Depth to Water (ft BTOC)	Well Depth (ft bgs)	Screened Interval (ft bgs)	Water Elevation (ft msl)	Well Type (S/I/D)
89-MW01	11/29/2005	13.32	2.95	13.3	3.3 to 13.3	10.4	Shallow
89-MW02	11/29/2005	14.81	4.56	14.0	4.0-14.0	10.3	Shallow
89-MW02IW	11/29/2005	NS	2.90	40	NA	NA	Intermediate
89-MW02DW	11/29/2005	12.28	2.39	70.0	65.0-70.0	9.9	Deep
89-MW03	11/29/2005	15.38	4.84	14.0	4.0-14.0	10.5	Shallow
89-MW03IW	11/29/2005	13.48	3.04	41.5	36.5-41.5	10.4	Intermediate
89-MW03DW	11/29/2005	13.47	3.32	70.0	65.0-70.0	10.2	Deep
89-MW04	11/29/2005	11.91	2.53	14.0	4.0-14.0	9.4	Shallow
89-MW04IW	11/29/2005	11.16	2.49	37.5	32.5-37.5	8.7	Intermediate
89-MW04DW	11/29/2005	10.91	2.20	70.0	65.0-70.0	8.7	Deep
89-MW05	11/29/2005	12.37	4.1	14.0	4.0-14.0	8.3	Shallow
89-MW05IW	11/29/2005	12.41	2.12	40.0	35.0-40.0	10.3	Intermediate
89-MW05DW	11/29/2005	12.86	1.49	70.0	65.0-70.0	11.4	Deep
89-MW06	12/4/2005	12.25	6.30	15.0	5.0-15.0	6.0	Shallow
89-MW06IW	11/29/2005	11.71	5.84	37.0	32.0-37.0	5.9	Intermediate
89-MW06DW	11/29/2005	11.44	5.57	70.0	65.0-70.0	5.9	Deep
89-MW07	12/4/2005	19.72	10.41	15.0	5.0-15.0	9.3	Shallow
89-MW07IW	11/29/2005	19.30	11.18	40.0	35.0-40.0	8.1	Intermediate
89-MW07DW	11/29/2005	18.99	12.16	80.0	75.0-80.0	6.8	Deep
89-MW08SH	11/29/2005	13.19	4.20	15.0	5.0-15.0	9.0	Shallow
89-MW08IW	12/5/2005	13.26	8.77	37.0	32.0-37.0	4.5	Intermediate
89-MW08DW	11/29/2005	13.38	7.57	90.0	85.0-90.0	5.8	Deep
89-MW09	11/29/2005	11.22	2.27	15.0	5.0-15.0	9.0	Shallow
89-MW09IW	11/29/2005	11.18	1.23	NA	NA	10.0	Intermediate
89-MW10	11/29/2005	15.40	4.72	15.0	5.0-15.0	10.7	Shallow
89-MW11	11/29/2005	12.21	1.18	15.0	5 to 15.0	11.0	Shallow
89-MW11IW	11/29/2005	11.46	1.25	NA	NA	10.2	Intermediate
89-MW12	11/29/2005	13.42	3.21	NA	NA	10.2	Shallow
89-MW13	11/29/2005	12.71	2.29	NA	NA	10.4	Shallow
89-MW14	11/29/2005	8.91	1.58	NA	NA	7.3	Shallow
89-MW14IW	11/29/2005	10.24	0.00	NA	NA	10.2	Intermediate

TABLE 2-28
Site 89 Groundwater Elevations
MCB Camp Lejeune

Well Identification	Date	Top of Casing Elevation (ft msl)	Depth to Water (ft BTOC)	Well Depth (ft bgs)	Screened Interval (ft bgs)	Water Elevation (ft msl)	Well Type (S/I/D)
89-MW15	11/29/2005	9.23	0.50	15.0	5 to 15	8.7	Shallow
89-MW15IW	11/29/2005	10.27	0.50	NA	NA	9.8	Intermediate
89-MW16	11/29/2005	9.28	2.5	13.0	3 to 13	6.8	Shallow
89-MW16IW	11/29/2005	9.49	3.05	35.5	30.5 to 35.5	6.4	Intermediate
89-MW17	11/29/2005	12.64	5.73	15.0	5 to 15	6.9	Shallow
89-MW17IW	11/29/2005	12.88	5.8	39.0	33.5 to 38.5	7.1	Intermediate
89-MW18	11/30/2005	14.96	6.75	15	5 to 15	8.2	Shallow
89-MW19	12/1/2005	14.69	6.40	15	5 to 15	8.3	Shallow
89-MW20	12/2/2005	14.27	5.95	15	5 to 15	8.3	Shallow
89-MW22	12/3/2005	12.69	4.60	15	5 to 15	8.1	Shallow
89-MW22IW	12/4/2005	NS	4.69	25	20 to 25	NA	Intermediate
89-MW26	12/5/2005	12.20	4.50	15	5 to 15	7.7	Shallow
89-MW27	12/6/2005	11.81	3.65	15	5 to 15	8.2	Shallow
89-MW29	12/7/2005	10.30	2.29	15	5 to 15	8.0	Shallow
89-MW29IW	12/8/2005	NS	2.45	25	20 to 25	NA	Intermediate
89-MW30	12/9/2005	9.74	1.09	15	5 to 15	8.7	Shallow
89-MW31	12/10/2005	13.87	5.60	15	5 to 15	8.3	Shallow
89-MW31IW	12/11/2005	NS	5.80	25	20 to 25	NA	Intermediate
89-MW32	11/29/2005	14.97	4.71	14.0	4.0-14.0	10.3	Shallow
89-MW32IW	11/29/2005	15.98	5.59	40.0	35.0-40.0	10.4	Intermediate
89-MW32DW	11/29/2005	16.20	5.69	70.0	65.0-70.0	10.5	Deep
89-MW33	11/29/2005	16.31	4.4	14.0	4.0-14.0	11.9	Shallow
89-MW33IW	11/29/2005	15.84	4.8	37.0	32.0-37.0	11.0	Intermediate
89-MW33DW	11/29/2005	15.32	4.73	70.0	65.0-70.0	10.6	Deep
89-MW34	11/29/2005	16.30	4.2	14.0	4.0-14.0	12.1	Shallow
89-MW34IW	11/29/2005	15.06	4.95	38.0	33.0-38.0	10.1	Intermediate
89-MW34DW	11/29/2005	15.15	5.59	70.0	65.0-70.0	9.6	Deep
89-MW35	11/30/2005	19.05	8.18	15.0	5.0-15.0	10.9	Shallow
89-MW35IW	11/29/2005	19.17	10.41	39.0	34.0-39.0	8.8	Intermediate
89-MW35DW	11/29/2005	19.08	11.21	75.0	70.0-75.0	7.9	Deep
89-MW36	11/30/2005	11.98	4.86	13.0	3.0-13.0	7.1	Shallow

TABLE 2-28
Site 89 Groundwater Elevations
MCB Camp Lejeune

Well Identification	Date	Top of Casing Elevation (ft msl)	Depth to Water (ft BTOC)	Well Depth (ft bgs)	Screened Interval (ft bgs)	Water Elevation (ft msl)	Well Type (S/I/D)
89-MW36IW	11/29/2005	12.10	4.70	45.0	40.0-45.0	7.4	Intermediate
89-MW36DW	11/29/2005	12.67	5.44	75.0	70.0-75.0	7.2	Deep
89-MW37	12/1/2005	8.57	0.98	13.0	3.0-13.0	7.6	Shallow
89-MW37IW	11/29/2005	8.43	0.00	35.0	30.0-35.0	8.4	Intermediate
89-MW37DW	11/29/2005	8.49	0.00	65.0	60.0-65.0	8.5	Deep
89-MW38	11/29/2005	16.61	9.93	15.0	5.0-15.0	6.7	Shallow
89-MW38IW	12/5/2005	17.65	9.73	45.0	40.0-45.0	7.9	Intermediate
89-MW38DW	11/30/2005	17.64	9.46	75.0	70.0-75.0	8.2	Deep
89-MW39	11/29/2005	12.17	6.42	14.0	4.0-14.0	5.8	Shallow
89-MW39IW	11/29/2005	12.26	5.58	40.0	35.0-40.0	6.7	Intermediate
89-MW39DW	11/29/2005	12.04	5.25	75.0	70.0-75.0	6.8	Deep
89-MW40	11/29/2005	11.78	1.91	20.0	15.0-20.0	9.9	Shallow
89-MW41	11/29/2005	11.22	1.54	23.0	18-23	9.7	Shallow
89-MW41IW	11/29/2005	11.53	1.55	40.0	35-40	10.0	Intermediate
89-MW42	11/29/2005	11.33	1.42	23.0	18-23	9.9	Shallow
89-MW43	11/29/2005	14.93	5.49	23.0	18-23	9.4	Shallow
89-MW44	11/29/2005	13.92	5.1	23.0	18-23	8.8	Shallow
89-MW45	11/29/2005	13.34	4.89	23.0	18-23	8.5	Shallow
89-MW46	11/29/2005	16.97	8.84	23.0	18-23	8.1	Shallow
89-MW47IW	11/29/2005	14.52	4.63	40.0	35-40	9.9	Intermediate

NS - Not Surveyed
NA - Not Available

TABLE 2-29
Site 93 Groundwater Elevations
MCB Camp Lejeune

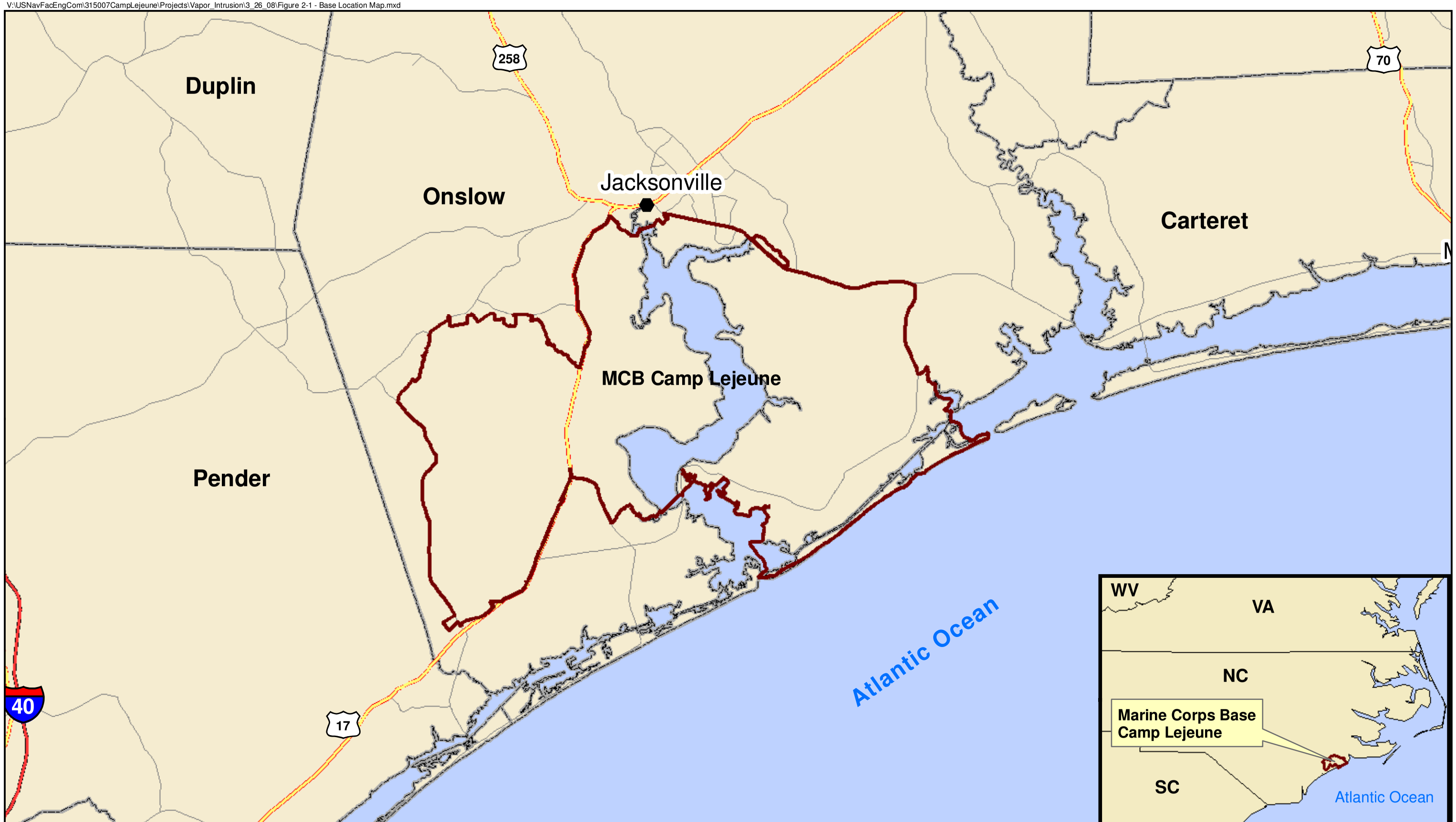
WATER LEVEL MEASUREMENTS JANUARY 4, 2005 SITE 93			
	TOC Elevation (ft above msl)	**GW Elevation (ft below TOC)**	**GW Elevation (ft above msl)**
MW-01	14.98	4.19	10.79
MW-02	12.76	2.14	10.62
MW-04	15.42	4.46	10.96
MW-05	13.64	4.45	9.19
MW-06	13.47	2.78	10.69
MW-07	15.95	2.98	12.97
MW-08	11.32	0.81	10.51
MW-09	12.72	2.11	10.61
MW-10	16.44	4.64	11.8
MW-11	14.3	3.28	11.02
MW-12	9.27	1.34	7.93

TABLE 2-30
GROUNDWATER ELEVATION DATA
SEPTEMBER 2005 - APRIL 2006
Incident Number and Name: 7176 - Buildings TT2477 and TT2478

Monitoring Well	Top of Casing Elevation (feet)	Groundwater Elevation (feet)		
		11/07/05	01/18/06	04/13/06
UST TT2477-MW01	25.18	13.12	11.85	12.42
UST TT2477-MW02	25.09	12.41	Not Calculated	Not Calculated
UST TT2477-MW03	Unknown	Not Calculated	Not Calculated	Not Calculated
UST TT2477-MW04	Unknown	Not Calculated	Not Calculated	Not Calculated
UST TT2477-MW05	Unknown	Not Calculated	Not Calculated	Not Calculated
UST TT2477-MW06	24.52	12.14	11.57	12.19
UST TT2477-MW07	24.83	11.63	12.10	12.35
UST TT2477-MW08	24.57	12.31	11.25	12.44
UST TT2477-MW09	25.44	11.54	10.96	12.02
UST TT2477-MW10	26.28	10.73	10.16	10.96
UST TT2477-MW11	26.32	10.74	10.18	4.42
UST TT2477-MW12	26.23	9.78	9.53	Not Calculated
UST TT2477-MW13	26.25	10.08	9.51	Not Calculated
UST TT2477-MW14	22.93	9.61	9.07	Not Calculated
UST TT2478-PW01	24.15	14.30	13.90	14.79
UST TT2478-MW01	23.96	14.39	Not Calculated	14.58
UST TT2478-MW02	24.04	Not Calculated	Not Calculated	Not Calculated
UST TT2478-MW03	24.03	14.11	13.57	14.24
UST TT2478-MW04	24.42	Not Calculated	14.44	Not Calculated
UST TT2478-MW05	24.2	14.09	13.62	Not Calculated
UST TT2478-MW06	24.33	14.01	13.43	14.14
UST TT2478-MW07	Unknown	Not Calculated	Not Calculated	Not Calculated
UST TT2478-MW08	23.90	Not Calculated	Not Calculated	Not Calculated
UST TT2478-MW09	21.48	12.90	12.33	12.90
UST TT2478-MW10	21.27	11.05	10.42	11.06
UST TT2478-MW11	21.43	Not Calculated	Not Calculated	Not Calculated
UST TT2478-MW11D	21.51	Not Calculated	Not Calculated	Not Calculated
UST TT2478-MW12	22.07	12.04	11.44	Not Calculated
UST TT2478-MW13	24.38	13.31	12.68	13.98
UST TT2478-MW14	23.68	13.47	Not Calculated	13.63
UST TT2478-MW14D	23.75	13.48	Not Calculated	14.10
UST TT2478-MW15	24.11	14.26	13.61	14.30
UST TT2478-MW16	22.72	11.17	10.78	11.97
UST TT2478-MW17	25.07	10.77	10.31	11.06
UST TT2478-MW17D	25.23	11.08	10.38	11.41
UST TT2478-MW18	25.6	11.33	Not Calculated	11.84
UST TT2478-MW19	24.92	12.11	11.48	12.39
UST TT2478-MW20	26.05	8.30	7.84	Not Calculated
UST TT2478-MW21D	26.74	8.73	8.26	8.99
UST TT2478-MW22	23.03	7.25	6.89	Not Calculated
UST TT2478-MW23	21.81	6.26	6.00	Not Calculated
UST TT2478-MW24	23.06	6.78	Not Calculated	6.83
UST TT2478-MW25	25.34	8.43	8.01	8.43
UST TT2477-MW-OB-01	27.96	8.81	8.33	Not Calculated
UST TT2477-MW-OB-10	24.66	5.76	5.35	8.73
UST TT2478-MW-SS-100	26.73	8.38	7.95	8.34
UST TT2477-MW-PVC-101	26.89	7.64	7.26	7.70

NM = Well not measured; either not accessible or not designated as part of gauging program.
Not Calculated due to insufficient data or well not measured.
Unknown Top of Casing Elevation

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\Figure 2-1 - Base Location Map.mxd



Legend
- Installation Area
- Limited Access Higwhay
- Highway
- Local Roads
- Cities

N

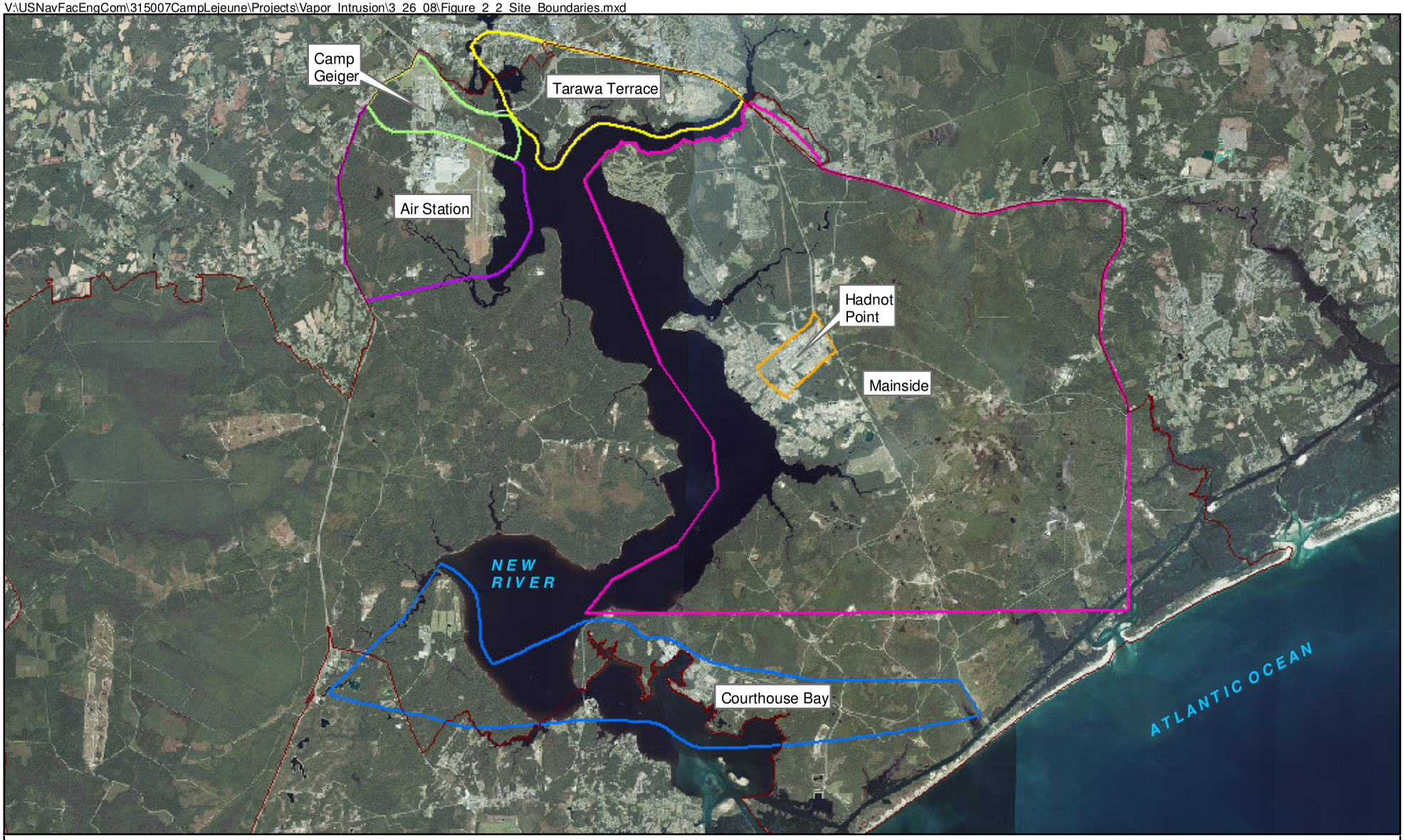
0 10,000 20,000 40,000 Feet

1 inch equals 20,000 feet

Figure 2-1
Base Location Map
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\Figure_2_2_Site_Boundaries.mxd



Legend

- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace
- Installation Area

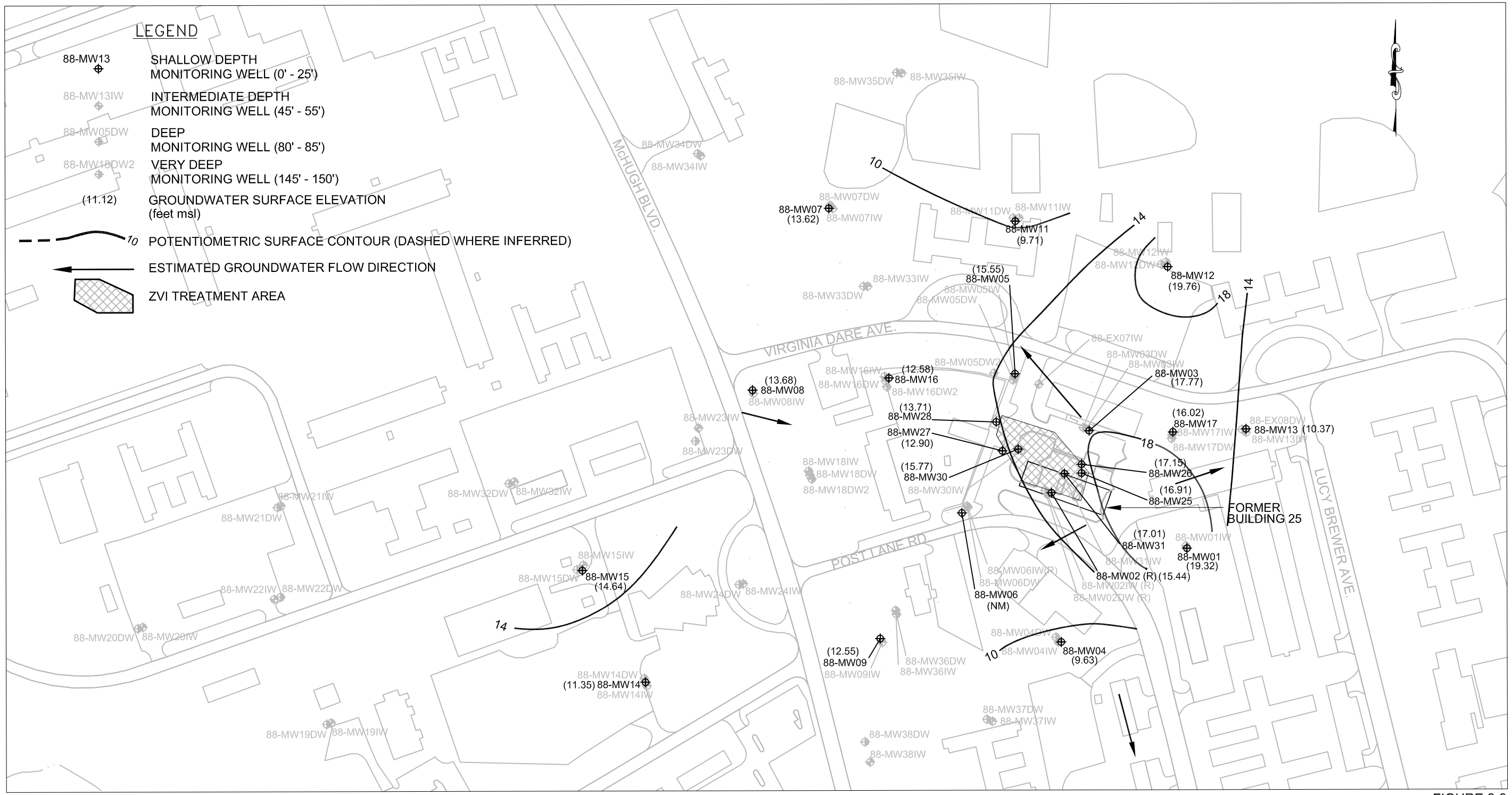
N

0 6,500 13,000 26,000 Feet

1 inch equals 13,000 feet

Figure 2-2
Site Boundaries
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL



NOTE:

1. POTENTIOMETRIC SURFACE CONTOURS HAVE BEEN INTERPOLATED BETWEEN MONITORING WELL LOCATIONS. ACTUAL CONDITIONS MAY DIFFER FROM THOSE SHOWN HERE.

2. (NM) INDICATES NO MEASUREMENT

0 200 400 600

1"=200'

FIGURE 2-8
POTENTIOMETRIC SURFACE
OF THE SHALLOW ZONE
AUGUST, 2007
O.U.15, SITE 88, MCB Camp Lejeune

CH2MHILL

SOURCE: MCB, CAMP LEJEUNE MARCH 2000

EBL\NAVYCLEAN\OU 15(SITE 88)\FS\Figures\CADD\D_SITE 88_FS_FIG2-8.dwg

Figure 2-3

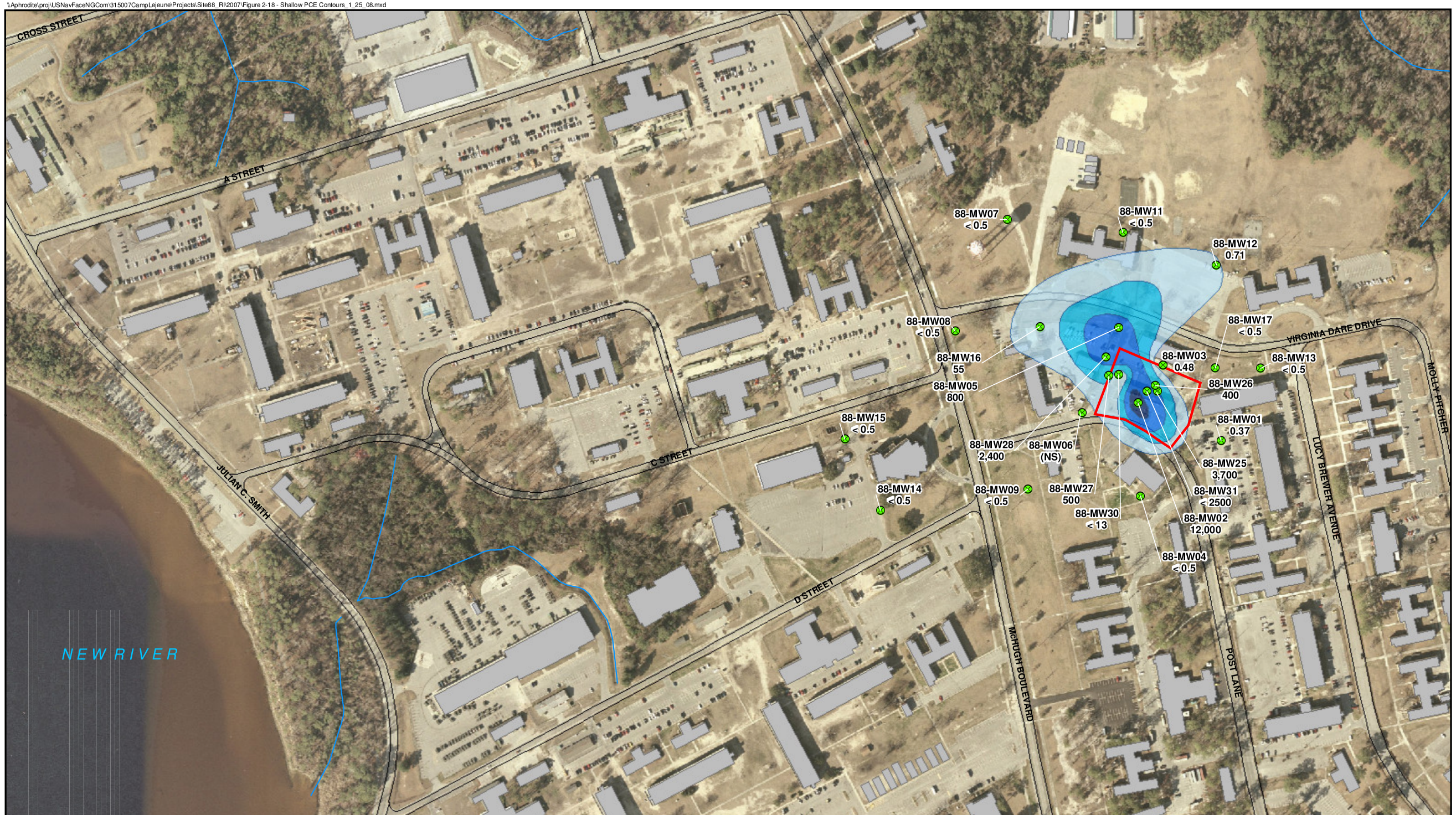
Site 88 - Potentiometric Surface of the Shallow Zone

\\Ariadne\groups\GIS\USNavFaceNGCom\315007CampLejeune\Projects\Site88_RI\2007\Figure 2-14 - Shallow MW VOC Exceedances.mxd

Figure 2-4

Site 88 - VOC Exceedances in Shallow Monitoring Wells

\\Aphrodite\proj\USNavFaceNGCom\315007CampLejeune\Projects\Site88_RI\2007\Figure 2-18 - Shallow PCE Contours_1_25_08.mxd



Legend
- Shallow Monitoring Well Location
- Surface Water Course Centerline
- Site 88 Boundary
- Buildings
- Road

Shallow PCE Contours
NC2L Standard : 0.7 µg/L
- > 0.7 µg/L
- > 70 µg/L
- > 700 µg/L
- > 7,000 µg/L

Note: Concentration contours have been interpolated between monitoring well locations. Actual concentrations may differ from those shown on this figure.

N W E S

0 300 600 Feet

1 inch equals 300 feet

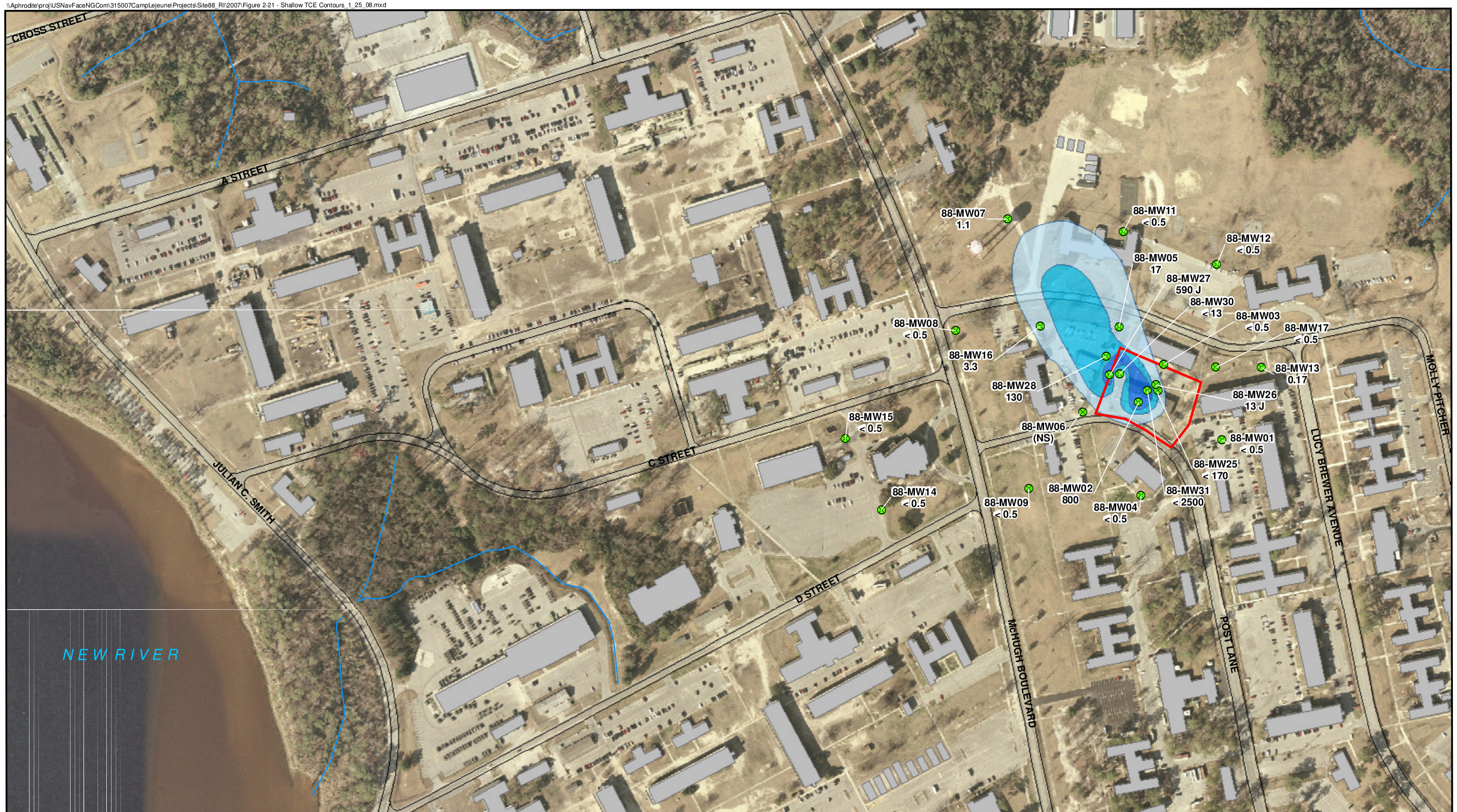
Figure 2-18
Tetrachloroethene
Shallow Well Concentrations
O.U. 15, Site 88, MCB Camp Lejeune

CH2MHILL

Figure 2-5

Site 88 - Tetrachloroethene Shallow Well Concentrations

\\Aphrodite\proj\USNavFaceNGCom\315007CampLejeune\Projects\Site88_RI\2007\Figure 2-21 - Shallow TCE Contours_1_25_08.mxd



Legend

- Shallow Monitoring Well Location
- Surface Water Course Centerline
- Site 88 Boundary
- Buildings
- Road

Shallow TCE Contours
NC2L Standard : 2.8 µg/L

- > 2.8 µg/L
- > 280 µg/L
- > 28 µg/L

Note: Concentration contours have been interpolated between monitoring well locations. Actual concentrations may differ from those shown on this figure.

N W E S

0 300 600 Feet

1 inch equals 300 feet

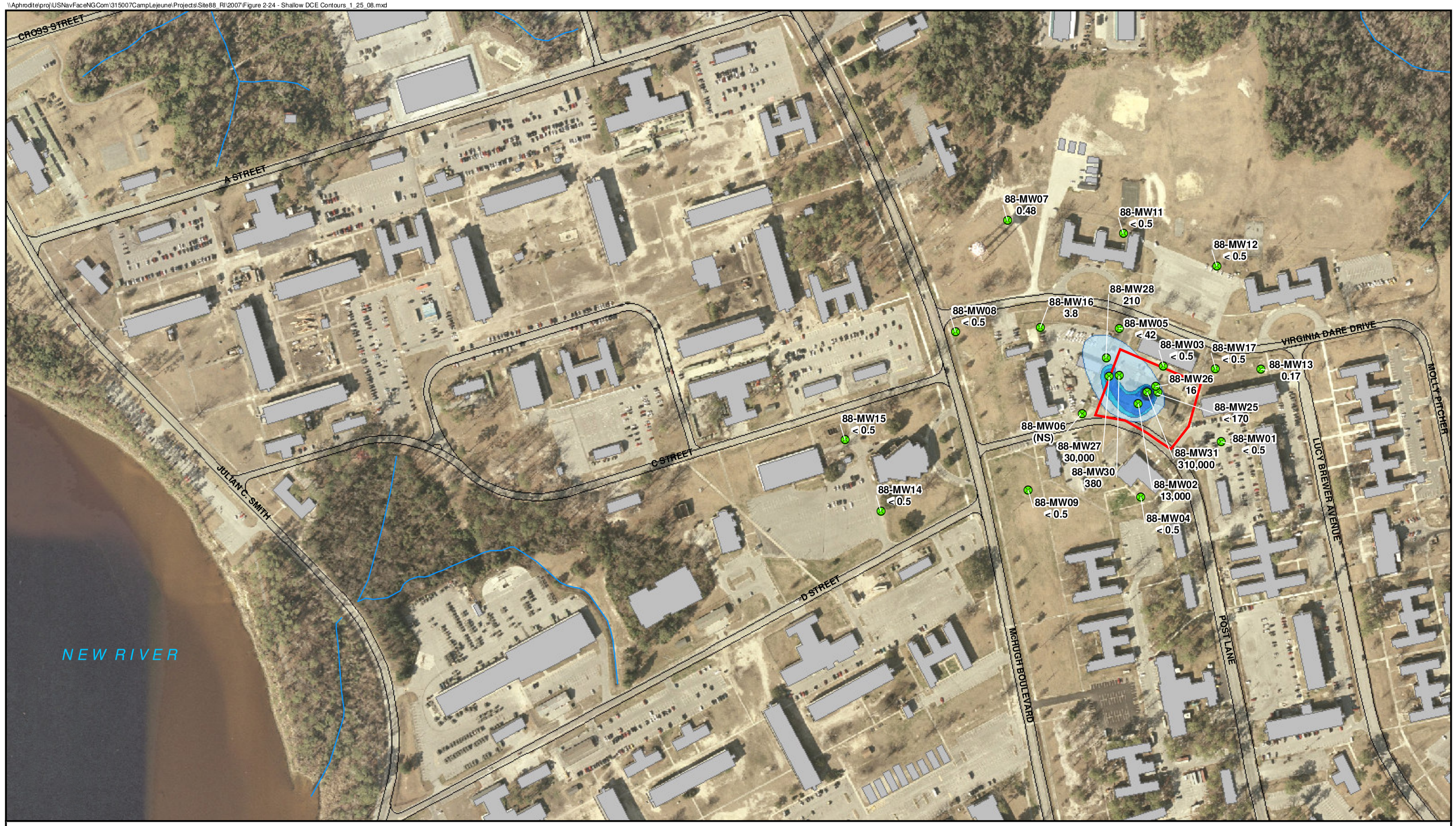
Figure 2-21
Trichloroethene
Shallow Well Concentrations
O.U. 15, Site 88, MCB Camp Lejeune

CH2MHILL

Figure 2-6

Site 88 - Trichloroethene Shallow Well Concentrations

\\Aphrodite\proj\USNavFaceNGCom\315007CampLejeune\Projects\Site88_RI\2007\Figure 2-24 - Shallow DCE Contours_1_25_08.mxd



Legend

- Shallow Monitoring Well Location
- Surface Water Course Centerline
- Site 88 Boundary
- Buildings
- Road

Shallow DCE Contours
NC2L Standard : 70 µg/L

- > 70 µg/L
- > 7,000 µg/L
- > 700 µg/L
- > 70,000 µg/L

Note: Concentration contours have been interpolated between monitoring well locations. Actual concentrations may differ from those shown on this figure.

N W E S

0 300 600 Feet

1 inch equals 300 feet

Figure 2-24
cis-1,2-Dichloroethene
Shallow Well Concentrations
O.U. 15, Site 88, MCB Camp Lejeune

CH2MHILL

Figure 2-7

Site 88 - Site 88 cis-1,2-Dichloroethene Shallow Well Concentrations

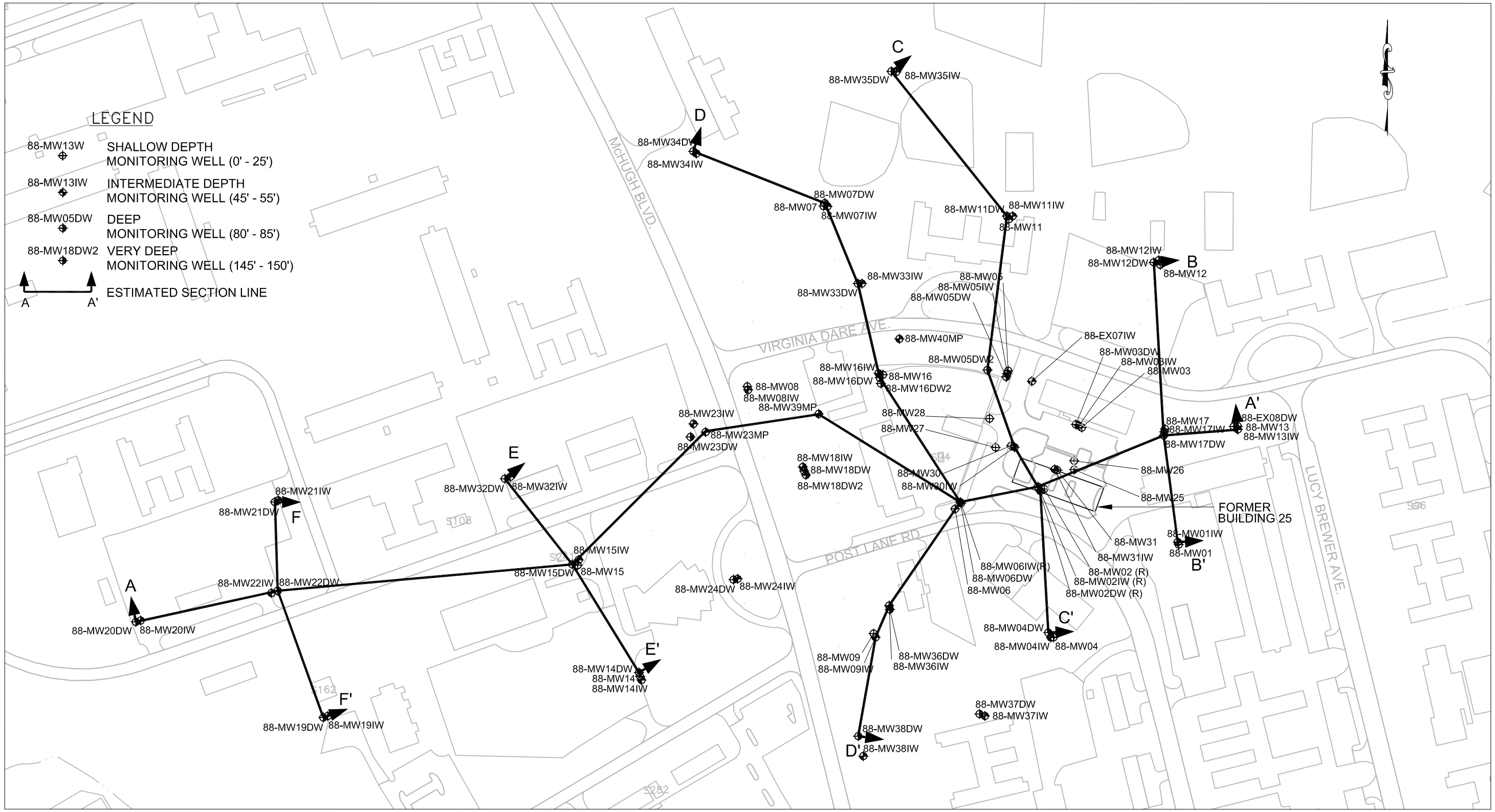


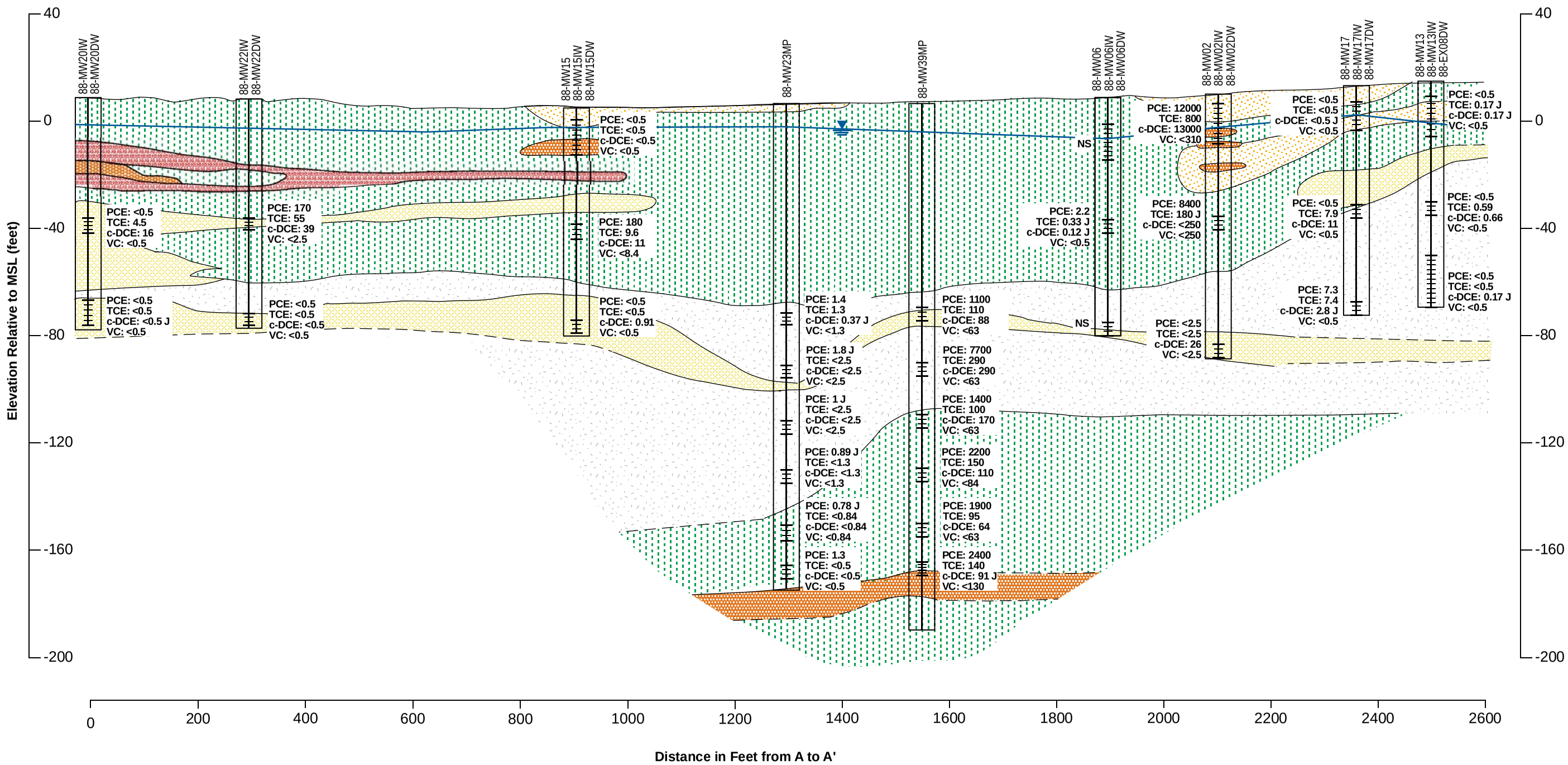
FIGURE 2-1
CROSS SECTION LOCATION MAP
O.U.15, SITE 88, MCB Camp Lejeune

SOURCE: MCB, CAMP LEJEUNE MARCH 2000

EBL\NAVYCLEAN\OU 15(SITE 88)\FS\Figures\CADD\D_SITE 88_FS_FIG2-1dwg

Figure 2-8

Site 88 - Cross Section Locations



Legend

- Clay
- Silt
- Fossiliferous Sand
- Silt/Clay
- Cemented Sand
- Screened Interval
- Sand
- Water Table Elevation

Horizontal : 1" = 200'
Vertical: 1" = 40'
V.E. = 10x

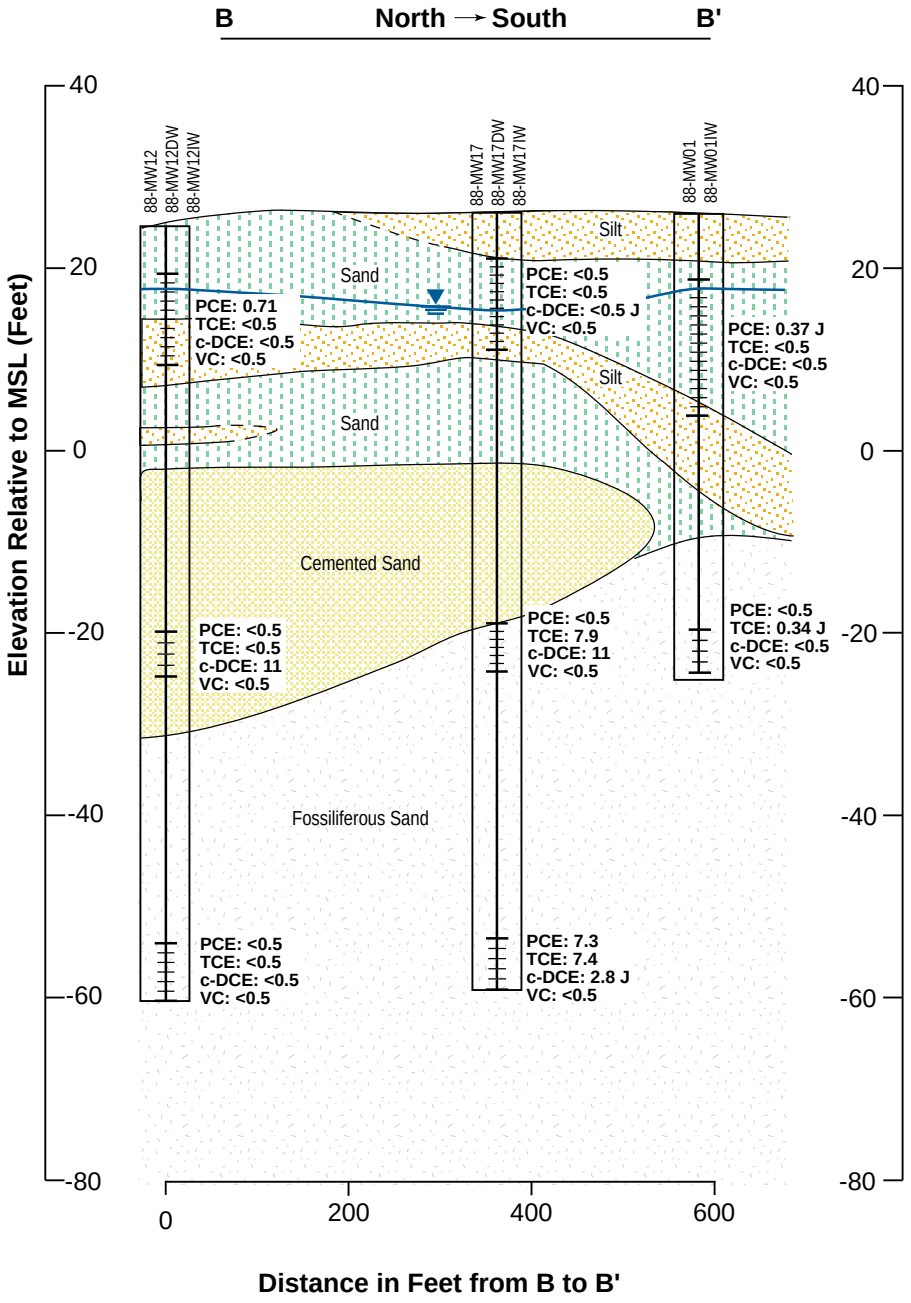
Notes:
1. The depth and thickness of the subsurface strata indicated on this section (profile) were generalized from and interpolated between test locations. Information on actual subsurface conditions applies only to the specific locations and dates indicated. Subsurface conditions and water levels at other locations may differ from conditions occurring at the indicated location.
2. Analytical results are from the August 2007 remedial investigation.
3. Constituent concentrations are presented in ug/L.
4. J - Reported value is estimated.

FIGURE 2-2
GEOLOGIC CROSS SECTION A-A'
O.U. 15, Site 88, MCB Camp Lejeune

CH2MHILL

ES012008004MKE_xSec-A_v11.ai 02.14.08 sls

Figure 2-9
Site 88 - Geologic Cross Section A - A'



Notes:
1. The depth and thickness of the subsurface strata indicated on this section (profile) were generalized from and interpolated between test locations. Information on actual subsurface conditions applies only to the specific locations and dates indicated. Subsurface conditions and water levels at other locations may differ from conditions occurring at the indicated location.

2. Analytical results are from the August 2007 remedial investigation.

3. Constituent concentrations are presented in ug/L.

4. J - Reported value is estimated.

Horizontal : 1" = 200'
Vertical: 1" = 20'
V.E. = 10x

Legend

- Sand
- Cement Sand
- Screened Interval
- Water Table Elevation
- Silt
- Fossiliferous Sand

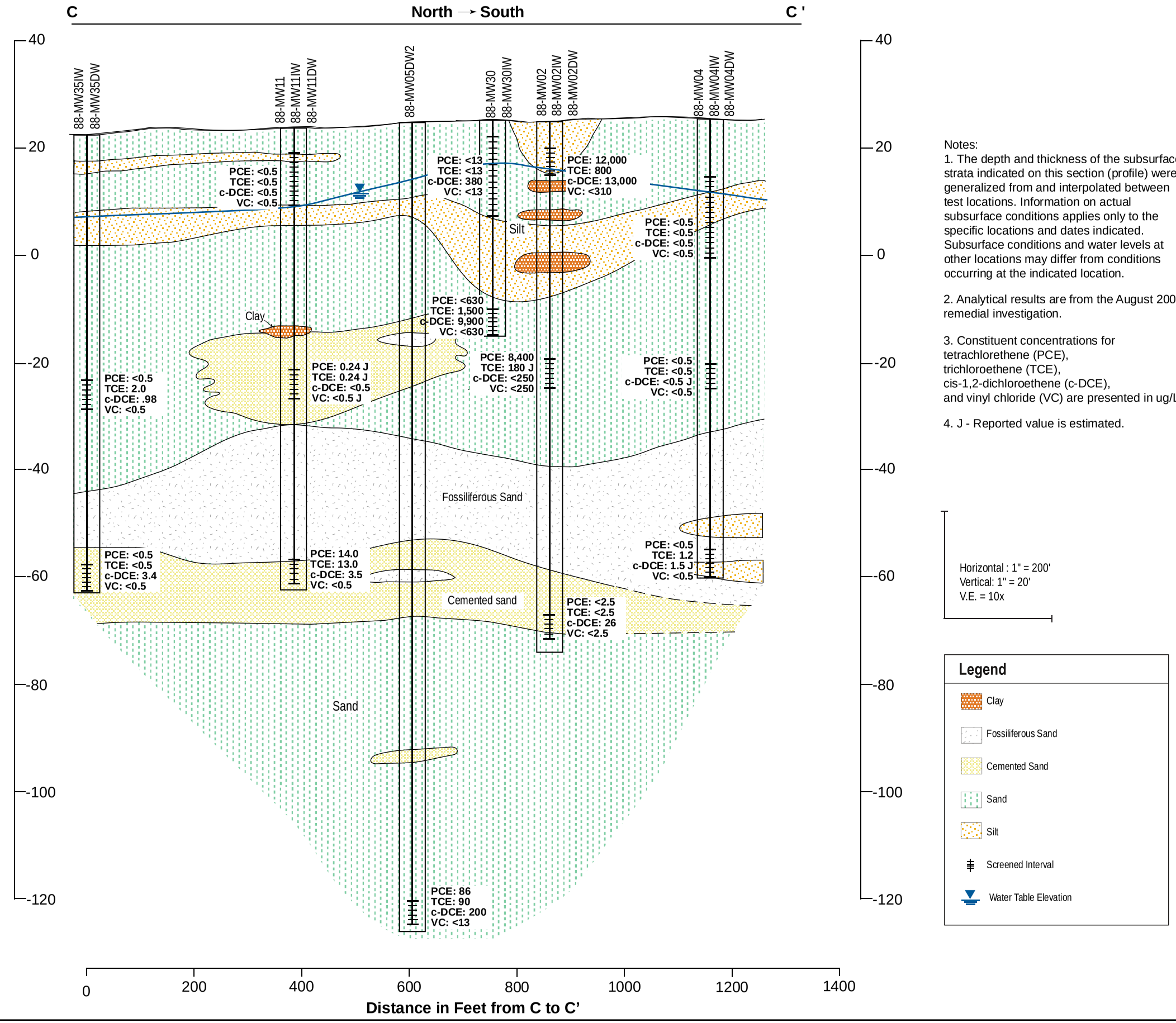
FIGURE 2-3
GEOLOGIC CROSS SECTION B-B'
O.U. 15, Site 88, MCB Camp Lejeune

CH2MHILL

ES012008004MKE_xSec-B-3_v16.ai 02.12.08 sls

Figure 2-10

Site 88 - Geologic Cross-Section B - B'



Notes:
1. The depth and thickness of the subsurface strata indicated on this section (profile) were generalized from and interpolated between test locations. Information on actual subsurface conditions applies only to the specific locations and dates indicated. Subsurface conditions and water levels at other locations may differ from conditions occurring at the indicated location.

2. Analytical results are from the August 2007 remedial investigation.

3. Constituent concentrations for tetrachlorethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (c-DCE), and vinyl chloride (VC) are presented in ug/L.

4. J - Reported value is estimated.

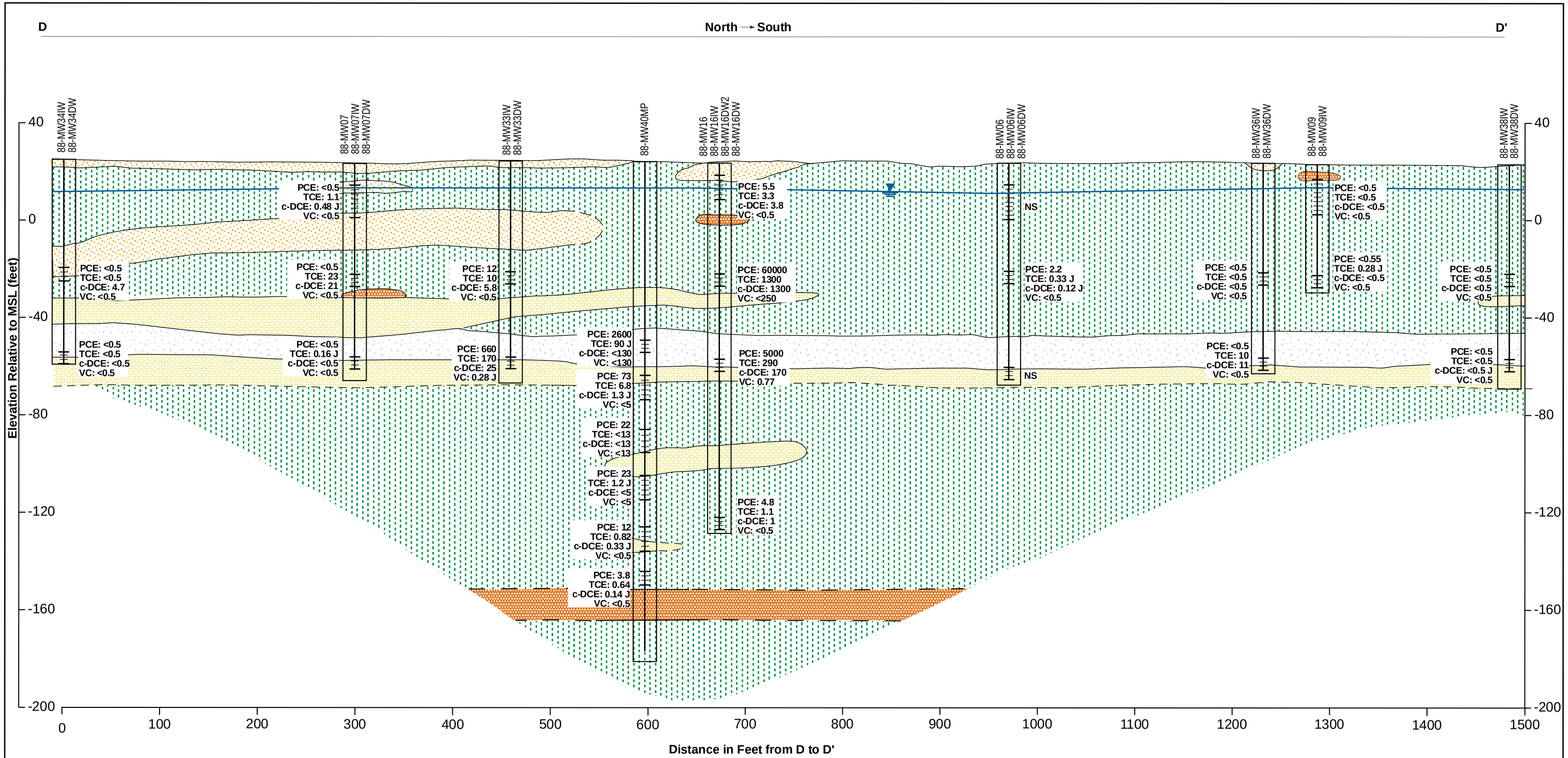
FIGURE 2-4
GEOLOGIC CROSS SECTION C-C'
O.U. 15, Site 88, MCB Camp Lejeune

CH2MHILL

ES012008004MKE_xSec-C_v17.ai 02.14.08 sls

Figure 2-11

Site 88 - Geologic Cross Section C - C'



Notes:
1. The depth and thickness of the subsurface strata indicated on this section (profile) were generalized from and interpolated between test locations. Information on actual subsurface conditions applies only to the specific locations and dates indicated. Subsurface conditions and water levels at other locations may differ from conditions occurring at the indicated location.

2. Analytical results are from the August 2007 remedial investigation.

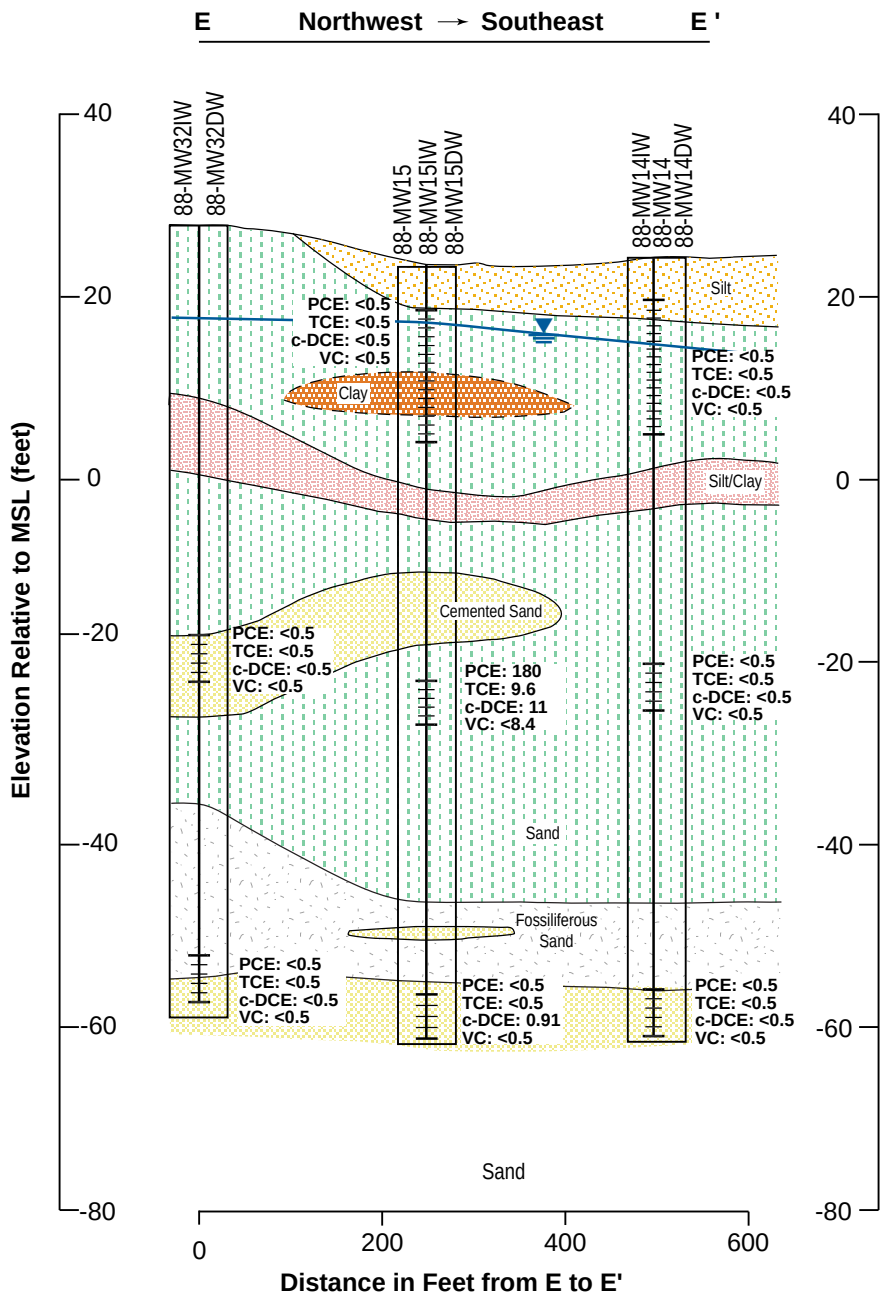
3. J - Reported Value is estimated.

FIGURE 2-5
GEOLOGIC CROSS SECTION D-D'
O.U. 15, Site 88, MCB Camp Lejeune

CH2MHILL

ES012008004MKE_xSec-D_v14.ai 02.14.08 sls

Figure 2-12
Site 88 - Geologic Cross Section D - D'



Notes:

1. The depth and thickness of the subsurface strata indicated on this section (profile) were generalized from and interpolated between test locations. Information on actual subsurface conditions applies only to the specific locations and dates indicated. Subsurface conditions and water levels at other locations may differ from conditions occurring at the indicated location.

2. Analytical results are from the August 2007 remedial investigation.

3. Constituent concentrations are presented in ug/L.

4. J - Reported value is estimated.

Horizontal : 1" = 200'
Vertical: 1" = 20'
V.E. = 10x

Legend

- Clay
- Silt
- Fossiliferous Sand
- Silt/Clay
- Cemented Sand
- Screened Interval
- Sand
- Water Table Elevation

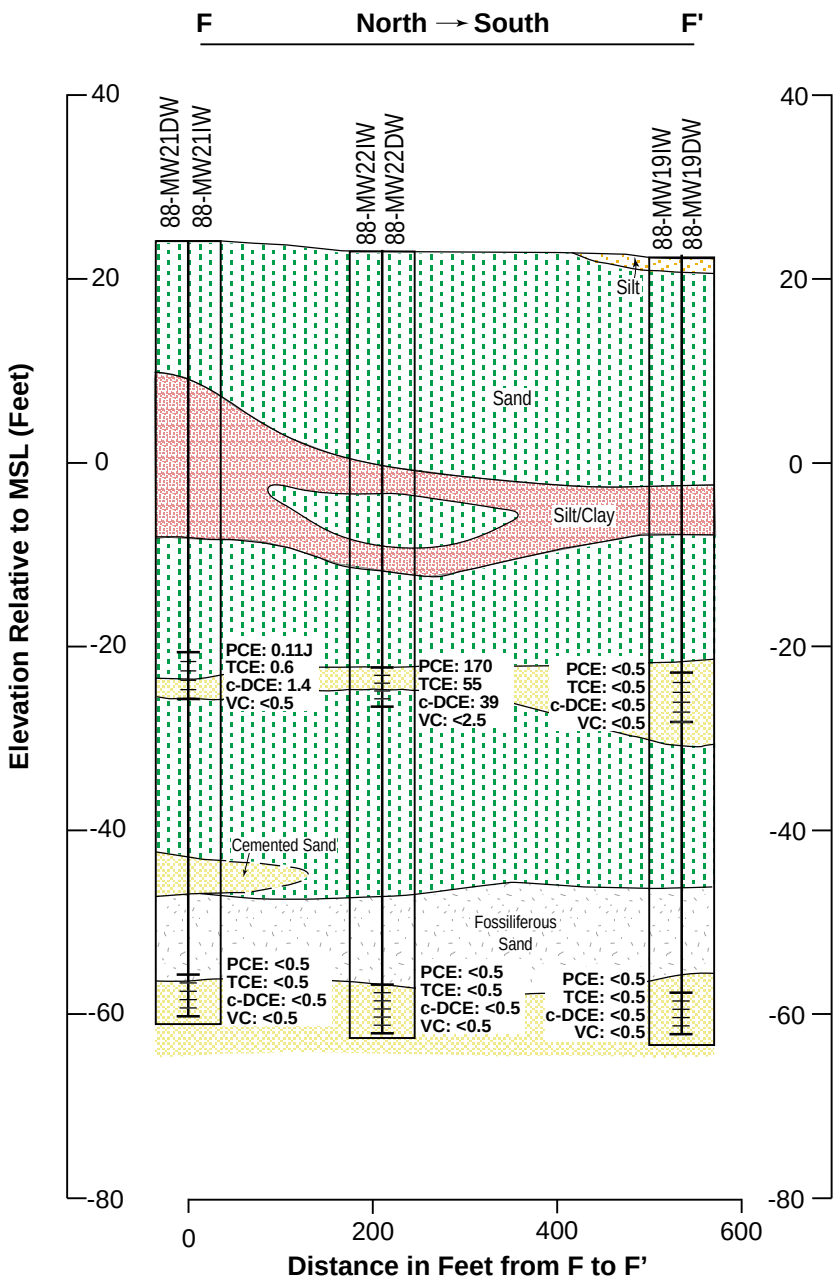
FIGURE 2-6
GEOLOGIC CROSS SECTION E-E'
O.U. 15, Site 88, MCB Camp Lejeune

CH2MHILL

ES012008004MKE_xSec-E.ai_v11 02.11.08 sls

Figure 2-13

Site 88 - Geologic Cross Section E - E'



Notes:
1. The depth and thickness of the subsurface strata indicated on this section (profile) were generalized from and interpolated between test locations. Information on actual subsurface conditions applies only to the specific locations and dates indicated. Subsurface conditions and water levels at other locations may differ from conditions occurring at the indicated location.

2. Analytical results are from the August 2007 remedial investigation.

3. Constituent concentrations are presented in ug/L.

4. J - Reported value is estimated.

Horizontal : 1" = 200'
Vertical: 1" = 20'
V.E. = 10x

Legend

- Clay
- Fossiliferous Sand
- Cemented Sand
- Sand
- Silt
- Silt/Clay
- Screened Interval
- Water Table Elevation

FIGURE 2-7
GEOLOGIC CROSS SECTION F-F'
O.U. 15, Site 88, MCB Camp Lejeune

CH2MHILL

ES012008004MKE_xSec-F.ai_v14 02.13.08 sls

Figure 2-14
Site 88 - Geologic Cross Section F - F'

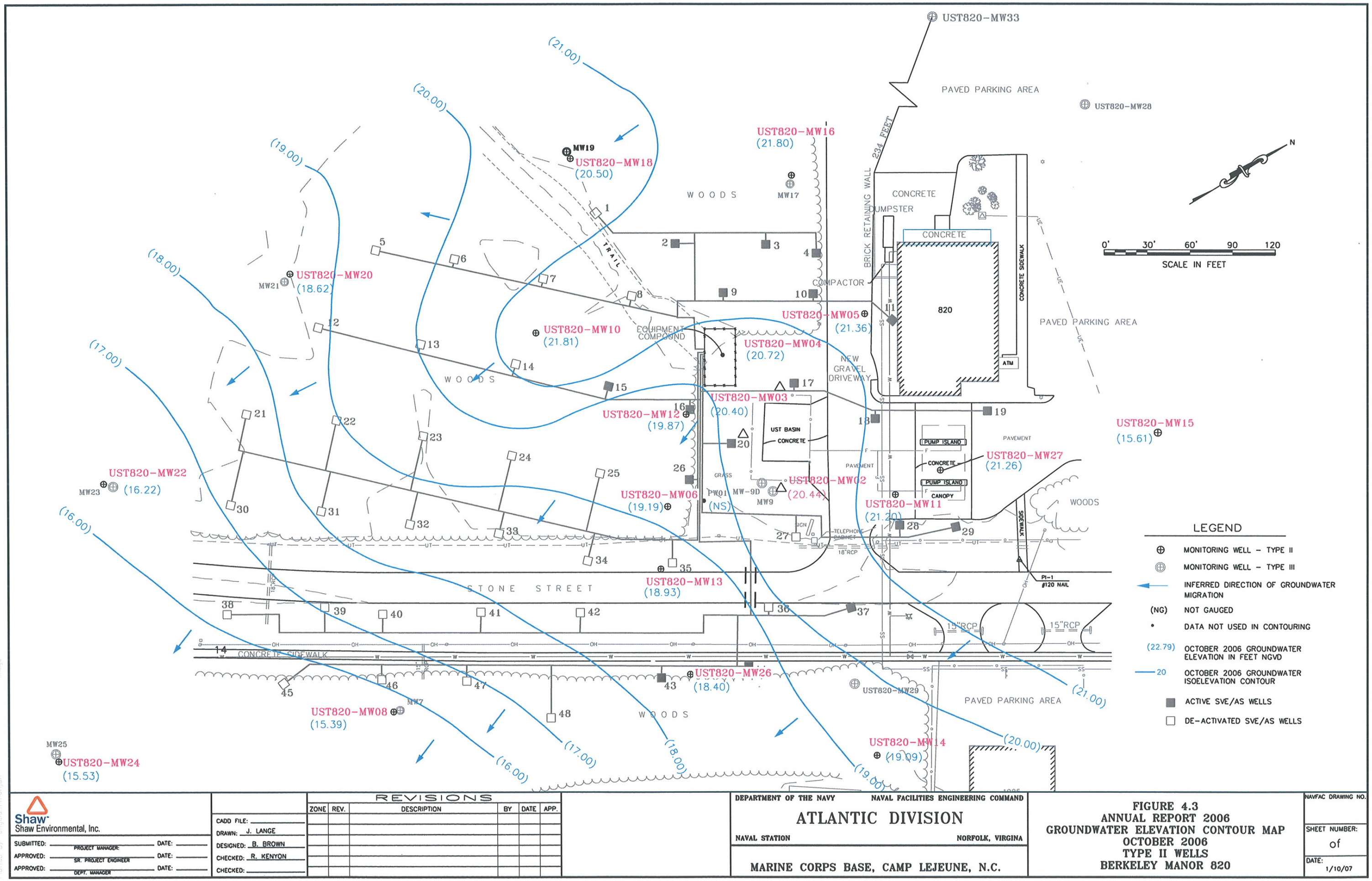
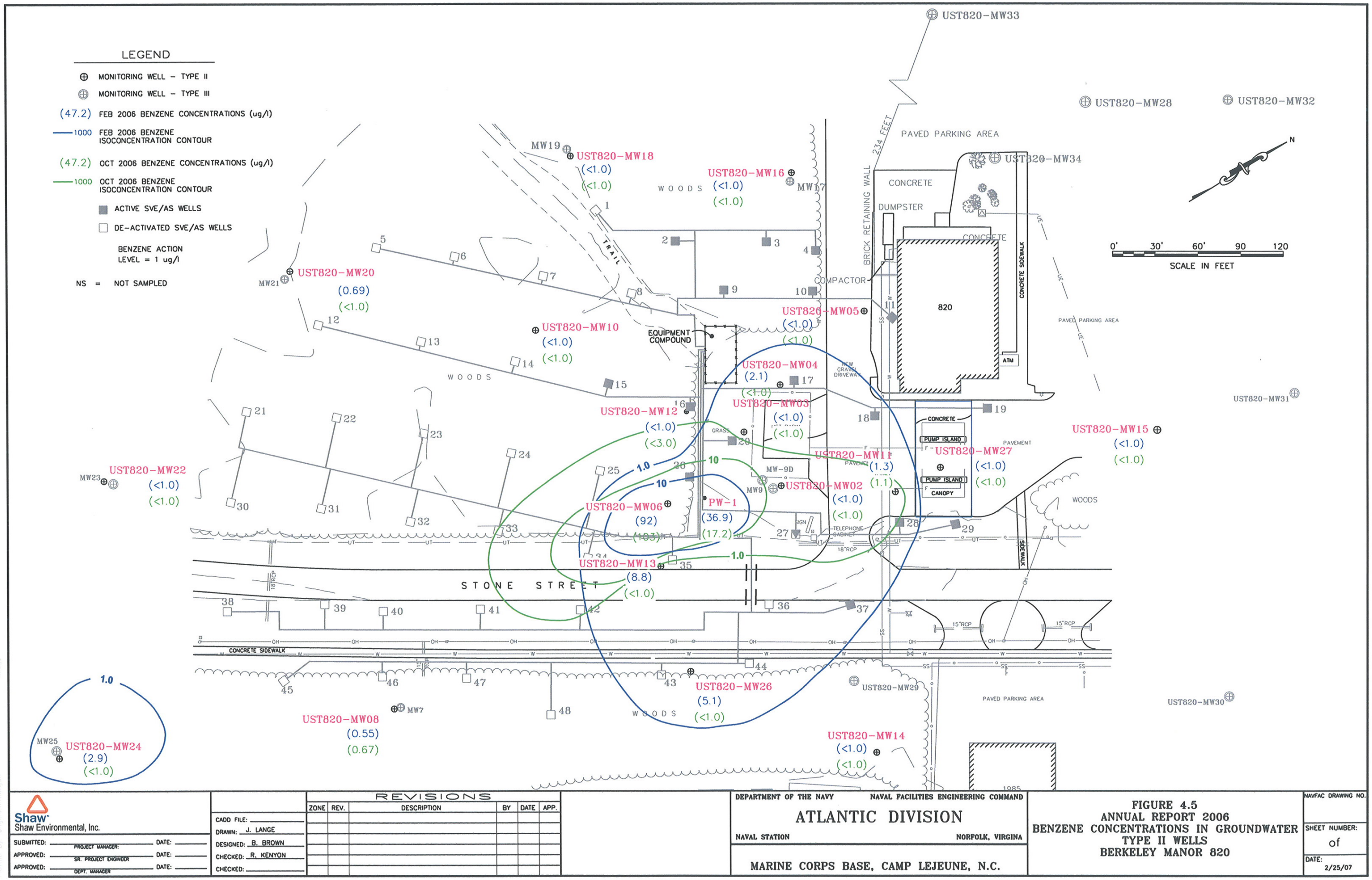


Figure 2-15

Building 820 - Groundwater Elevation Contours



Shaw Environmental, Inc.

SUBMITTED: PROJECT MANAGER DATE:
APPROVED: SR. PROJECT ENGINEER DATE:
APPROVED: DEPT. MANAGER DATE:

CADD FILE:
DRAWN: J. LANGE
DESIGNED: B. BROWN
CHECKED: R. KENYON
CHECKED:

REVISIONS

ZONE	REV.	DESCRIPTION	BY	DATE	APP.

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND
ATLANTIC DIVISION
NAVAL STATION — NORFOLK, VIRGINIA
MARINE CORPS BASE, CAMP LEJEUNE, N.C.

FIGURE 4.5
ANNUAL REPORT 2006
BENZENE CONCENTRATIONS IN GROUNDWATER
TYPE II WELLS
BERKELEY MANOR 820

NAVFAC DRAWING NO.
SHEET NUMBER: of
DATE: 2/25/07

Figure 2-16
Building 820 - Shallow Benzene Concentrations

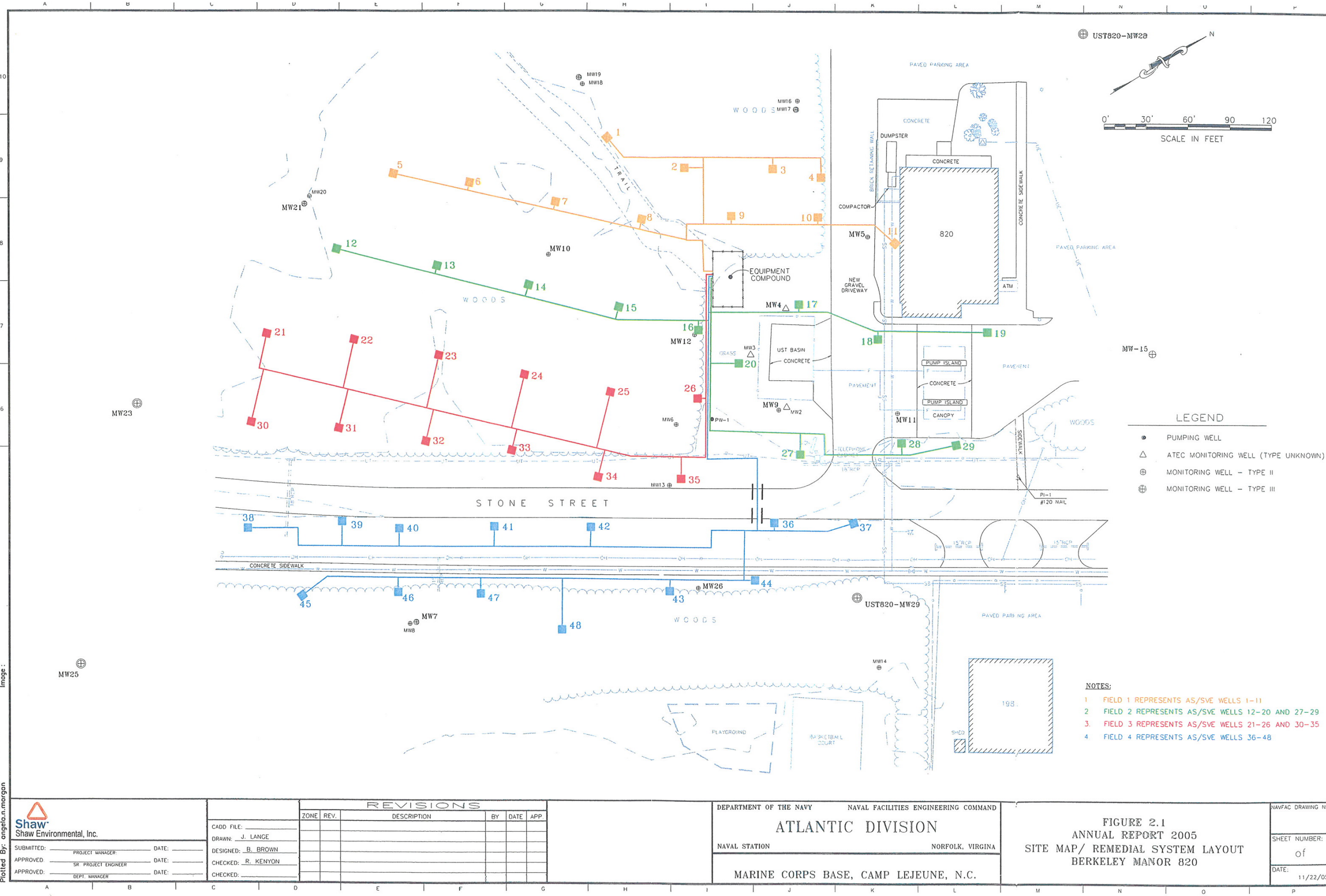


Figure 2-17
Building 820 - Remedial System Layout

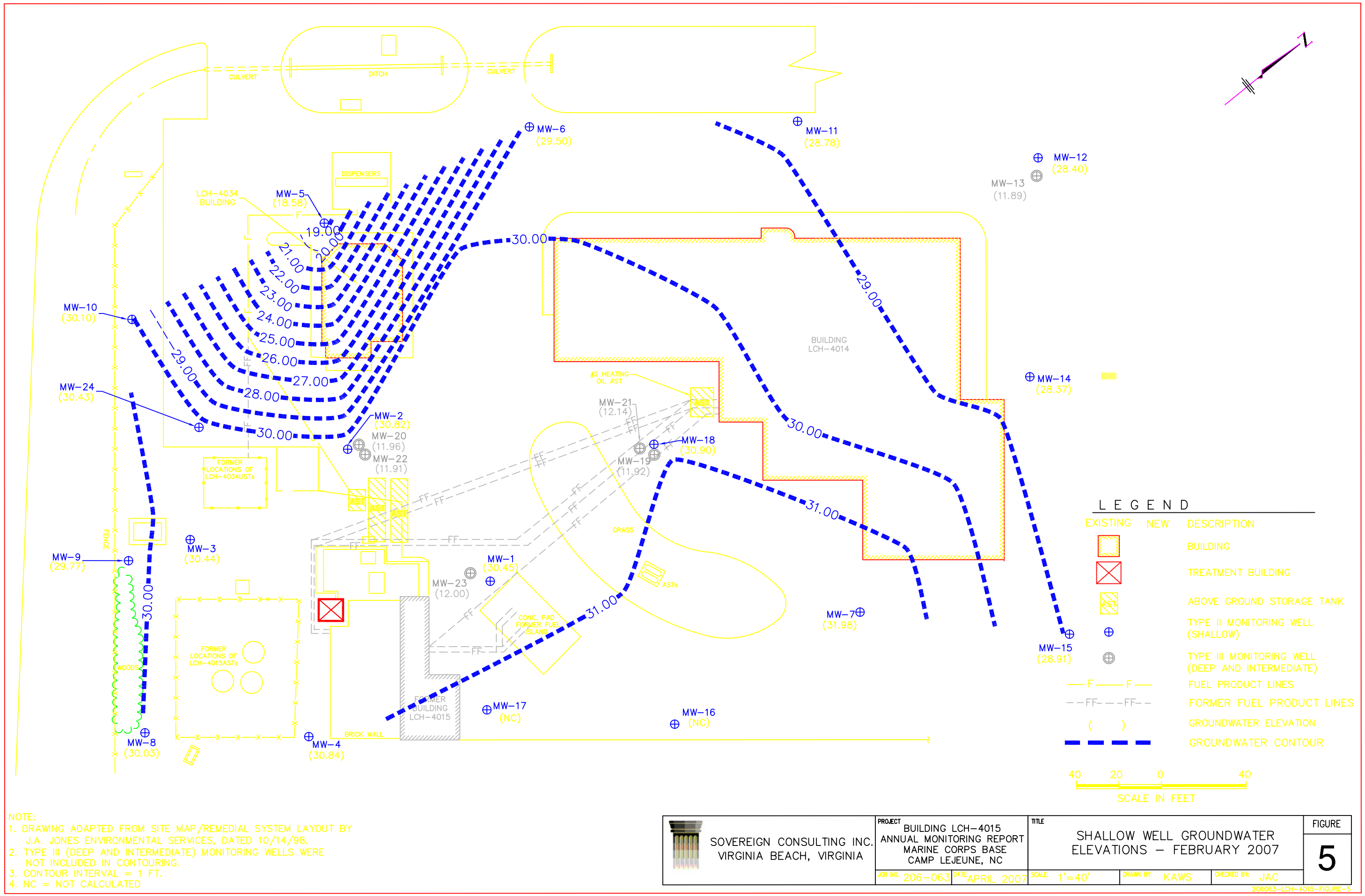
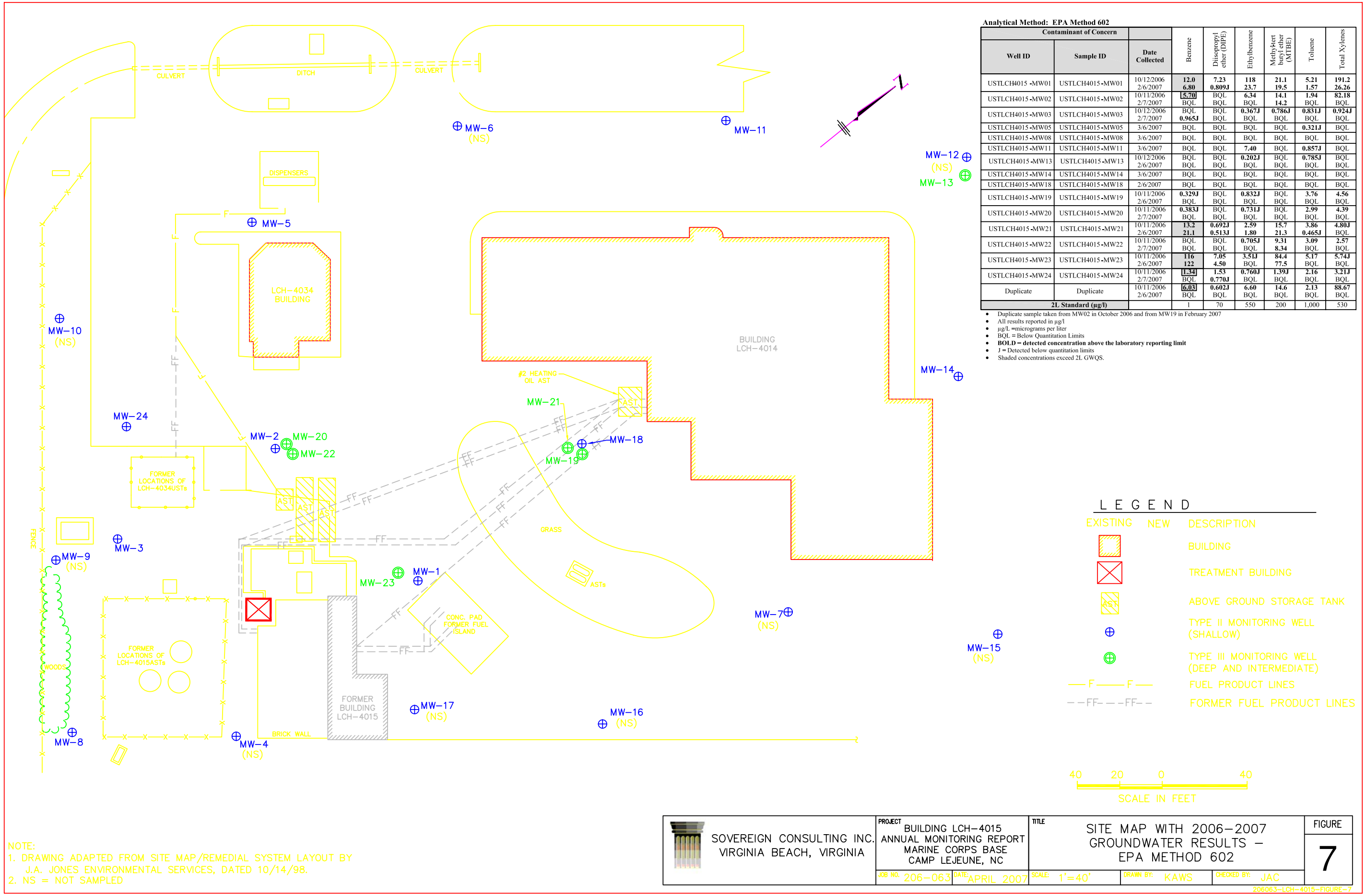


Figure 2-18

LCH-4015 - Shallow Groundwater Contours



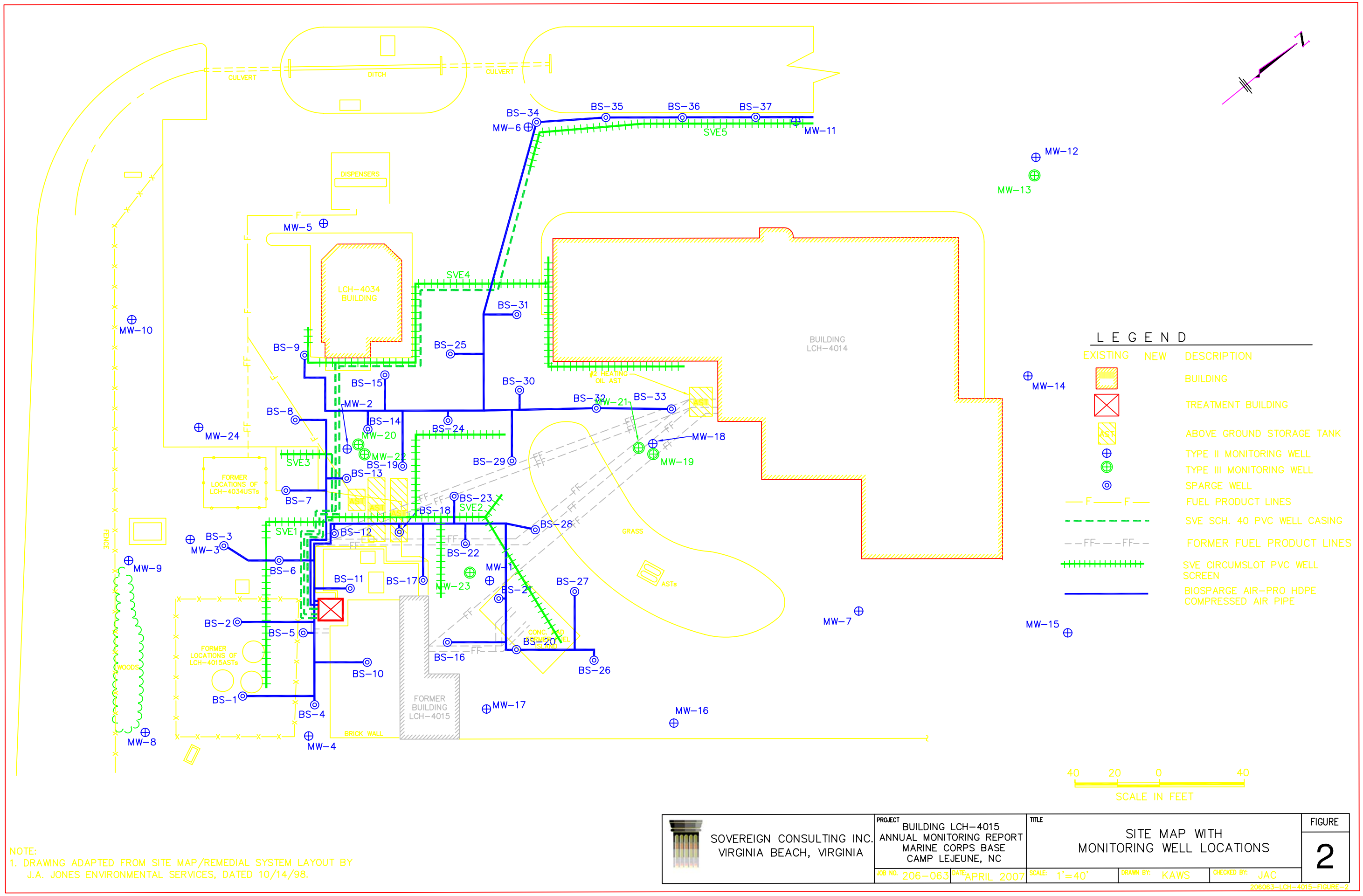
Analytical Method: EPA Method 602

Contaminant of Concern								
Well ID	Sample ID	Date Collected	Benzene	Diisopropyl ether (DIPE)	Ethylbenzene	Methyl-tert butyl ether (MTBE)	Toluene	Total Xylenes
USTLCH4015 -MW01	USTLCH4015-MW01	10/12/2006	**12.0**	**7.23**	**118**	**21.1**	**5.21**	**191.2**
		2/6/2007	**6.80**	**0.809J**	**23.7**	**19.5**	**1.57**	**26.26**
USTLCH4015-MW02	USTLCH4015-MW02	10/11/2006	**5.70**	BQL	**6.34**	**14.1**	**1.94**	**82.18**
		2/7/2007	BQL	BQL	BQL	**14.2**	BQL	BQL
USTLCH4015-MW03	USTLCH4015-MW03	10/12/2006	BQL	BQL	**0.367J**	**0.786J**	**0.831J**	**0.924J**
		2/7/2007	**0.965J**	BQL	BQL	BQL	BQL	BQL
USTLCH4015-MW05	USTLCH4015-MW05	3/6/2007	BQL	BQL	BQL	BQL	**0.321J**	BQL
USTLCH4015-MW08	USTLCH4015-MW08	3/6/2007	BQL	BQL	BQL	BQL	BQL	BQL
USTLCH4015-MW11	USTLCH4015-MW11	3/6/2007	BQL	BQL	**7.40**	BQL	**0.857J**	BQL
USTLCH4015-MW13	USTLCH4015-MW13	10/12/2006	BQL	BQL	**0.202J**	BQL	**0.785J**	BQL
		2/6/2007	BQL	BQL	BQL	BQL	BQL	BQL
USTLCH4015-MW14	USTLCH4015-MW14	3/6/2007	BQL	BQL	BQL	BQL	BQL	BQL
USTLCH4015-MW18	USTLCH4015-MW18	2/6/2007	BQL	BQL	BQL	BQL	BQL	BQL
USTLCH4015-MW19	USTLCH4015-MW19	10/11/2006	**0.329J**	BQL	**0.832J**	BQL	**3.76**	**4.56**
		2/6/2007	BQL	BQL	BQL	BQL	BQL	BQL
USTLCH4015-MW20	USTLCH4015-MW20	10/11/2006	**0.383J**	BQL	**0.731J**	BQL	**2.99**	**4.39**
		2/7/2007	BQL	BQL	BQL	BQL	BQL	BQL
USTLCH4015-MW21	USTLCH4015-MW21	10/11/2006	**13.2**	**0.692J**	**2.59**	**15.7**	**3.86**	**4.80J**
		2/6/2007	**21.1**	**0.513J**	**1.80**	**21.3**	**0.465J**	BQL
USTLCH4015-MW22	USTLCH4015-MW22	10/11/2006	BQL	BQL	**0.705J**	**9.31**	**3.09**	**2.57**
		2/7/2007	BQL	BQL	BQL	**8.34**	BQL	BQL
USTLCH4015-MW23	USTLCH4015-MW23	10/11/2006	**116**	**7.05**	**3.51J**	**84.4**	**5.17**	**5.74J**
		2/6/2007	**122**	**4.50**	BQL	**77.5**	BQL	BQL
USTLCH4015-MW24	USTLCH4015-MW24	10/11/2006	**1.34**	**1.53**	**0.760J**	**1.39J**	**2.16**	**3.21J**
		2/7/2007	BQL	**0.770J**	BQL	BQL	BQL	BQL
Duplicate	Duplicate	10/11/2006	**6.03**	**0.602J**	**6.60**	**14.6**	**2.13**	**88.67**
		2/6/2007	BQL	BQL	BQL	BQL	BQL	BQL
2L Standard (µg/l)			1	70	550	200	1,000	530

- Duplicate sample taken from MW02 in October 2006 and from MW19 in February 2007
- All results reported in µg/l
- µg/L =micrograms per liter
- BQL = Below Quantitation Limits
- **BOLD = detected concentration above the laboratory reporting limit**
- J = Detected below quantitation limits
- Shaded concentrations exceed 2L GWQS.

Figure 2-19

LCH-4015 - Groundwater Concentrations

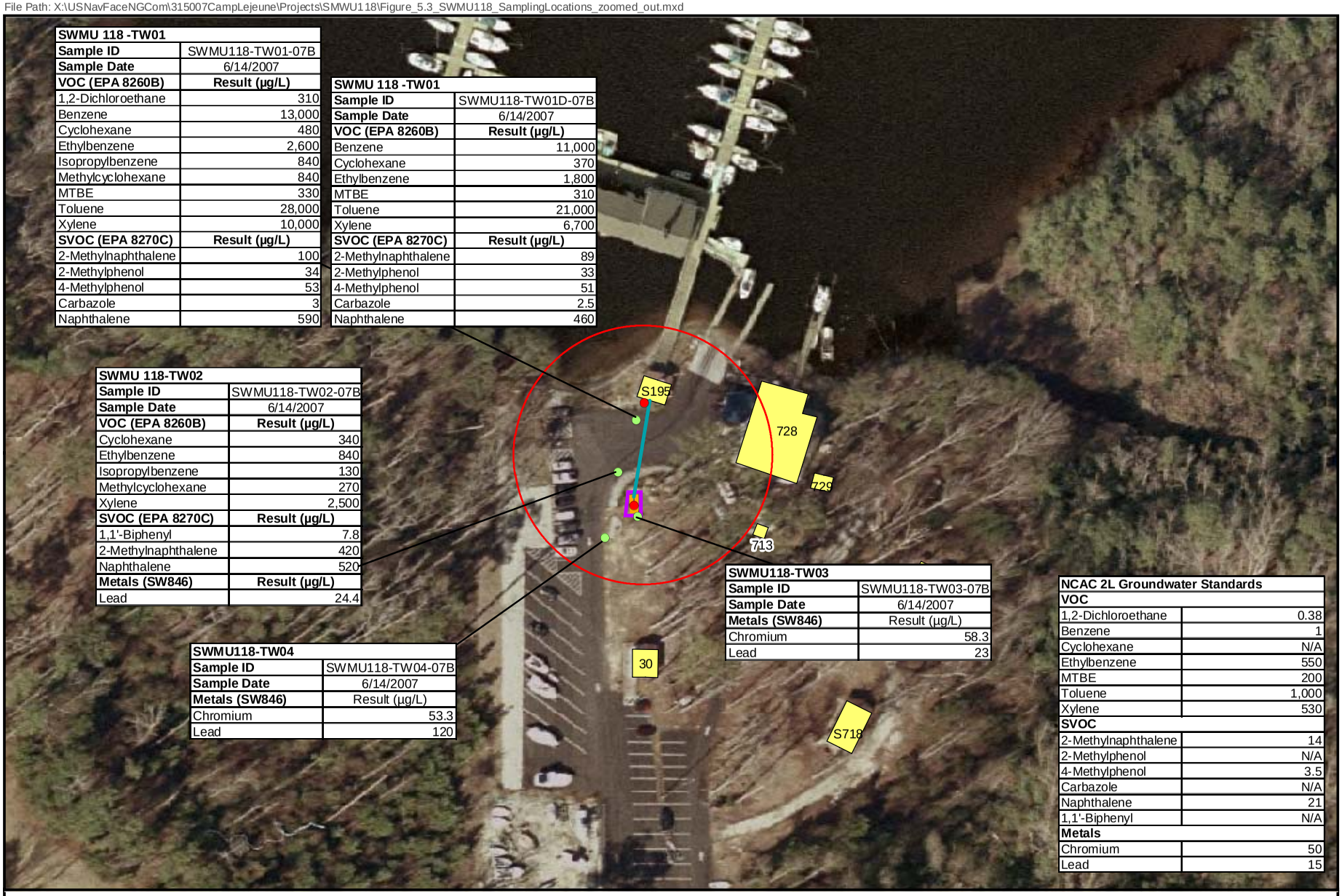


NOTE:
1. DRAWING ADAPTED FROM SITE MAP/REMEDIAL SYSTEM LAYOUT BY J.A. JONES ENVIRONMENTAL SERVICES, DATED 10/14/98.

Figure 2-20

LCH-4015 - Remediation System Layout

File Path: X:\USNavFaceNGCom\315007CampLejeune\Projects\SMWU118\Figure_5.3_SWMU118_SamplingLocations_zoomed_out.mxd



SWMU 118 -TW01	
Sample ID	SWMU118-TW01-07B
Sample Date	6/14/2007
VOC (EPA 8260B)	**Result (µg/L)**
1,2-Dichloroethane	310
Benzene	13,000
Cyclohexane	480
Ethylbenzene	2,600
Isopropylbenzene	840
Methylcyclohexane	840
MTBE	330
Toluene	28,000
Xylene	10,000
SVOC (EPA 8270C)	**Result (µg/L)**
2-Methylnaphthalene	100
2-Methylphenol	34
4-Methylphenol	53
Carbazole	3
Naphthalene	590

SWMU 118 -TW01	
Sample ID	SWMU118-TW01D-07B
Sample Date	6/14/2007
VOC (EPA 8260B)	**Result (µg/L)**
Benzene	11,000
Cyclohexane	370
Ethylbenzene	1,800
MTBE	310
Toluene	21,000
Xylene	6,700
SVOC (EPA 8270C)	**Result (µg/L)**
2-Methylnaphthalene	89
2-Methylphenol	33
4-Methylphenol	51
Carbazole	2.5
Naphthalene	460

SWMU 118-TW02	
Sample ID	SWMU118-TW02-07B
Sample Date	6/14/2007
VOC (EPA 8260B)	**Result (µg/L)**
Cyclohexane	340
Ethylbenzene	840
Isopropylbenzene	130
Methylcyclohexane	270
Xylene	2,500
SVOC (EPA 8270C)	**Result (µg/L)**
1,1'-Biphenyl	7.8
2-Methylnaphthalene	420
Naphthalene	520
Metals (SW846)	**Result (µg/L)**
Lead	24.4

SWMU118-TW03	
Sample ID	SWMU118-TW03-07B
Sample Date	6/14/2007
Metals (SW846)	Result (µg/L)
Chromium	58.3
Lead	23

SWMU118-TW04	
Sample ID	SWMU118-TW04-07B
Sample Date	6/14/2007
Metals (SW846)	Result (µg/L)
Chromium	53.3
Lead	120

NCAC 2L Groundwater Standards	
VOC	
1,2-Dichloroethane	0.38
Benzene	1
Cyclohexane	N/A
Ethylbenzene	550
MTBE	200
Toluene	1,000
Xylene	530
SVOC	
2-Methylnaphthalene	14
2-Methylphenol	N/A
4-Methylphenol	3.5
Carbazole	N/A
Naphthalene	21
1,1'-Biphenyl	N/A
Metals	
Chromium	50
Lead	15

Legend

- Groundwater Sampling Locations
- Sampling Location from Previous Investigation
- Approximate CPVC Fueling Line Casing
- Approximate Former 1,000 Gallon UST
- Approximate Area of Excavation
- Buildings

N

0 100 Feet

Figure 5.3
SWMU 118 Groundwater Sample Locations
Confirmatory Sampling Investigation
MCB Camp Lejeune, North Carolina

CH2MHILL

Figure 2-21

SWMU 118 - Groundwater Concentrations

File Path: X:\USNavFaceNGCom\315007CampLejeune\Projects\SMWU118\Figure_5_1_SWMU118_Potentiometric_Surface_Map.mxd

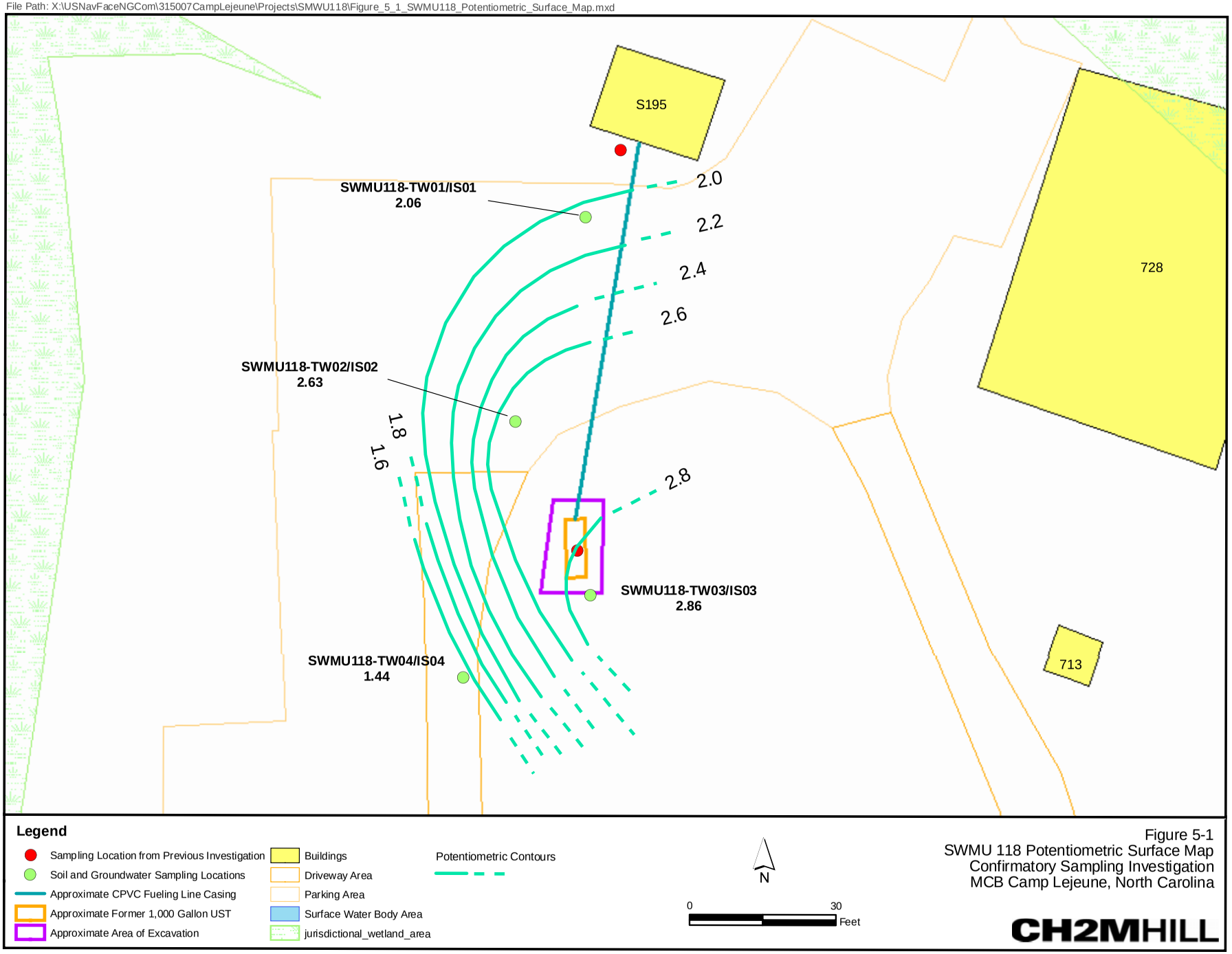
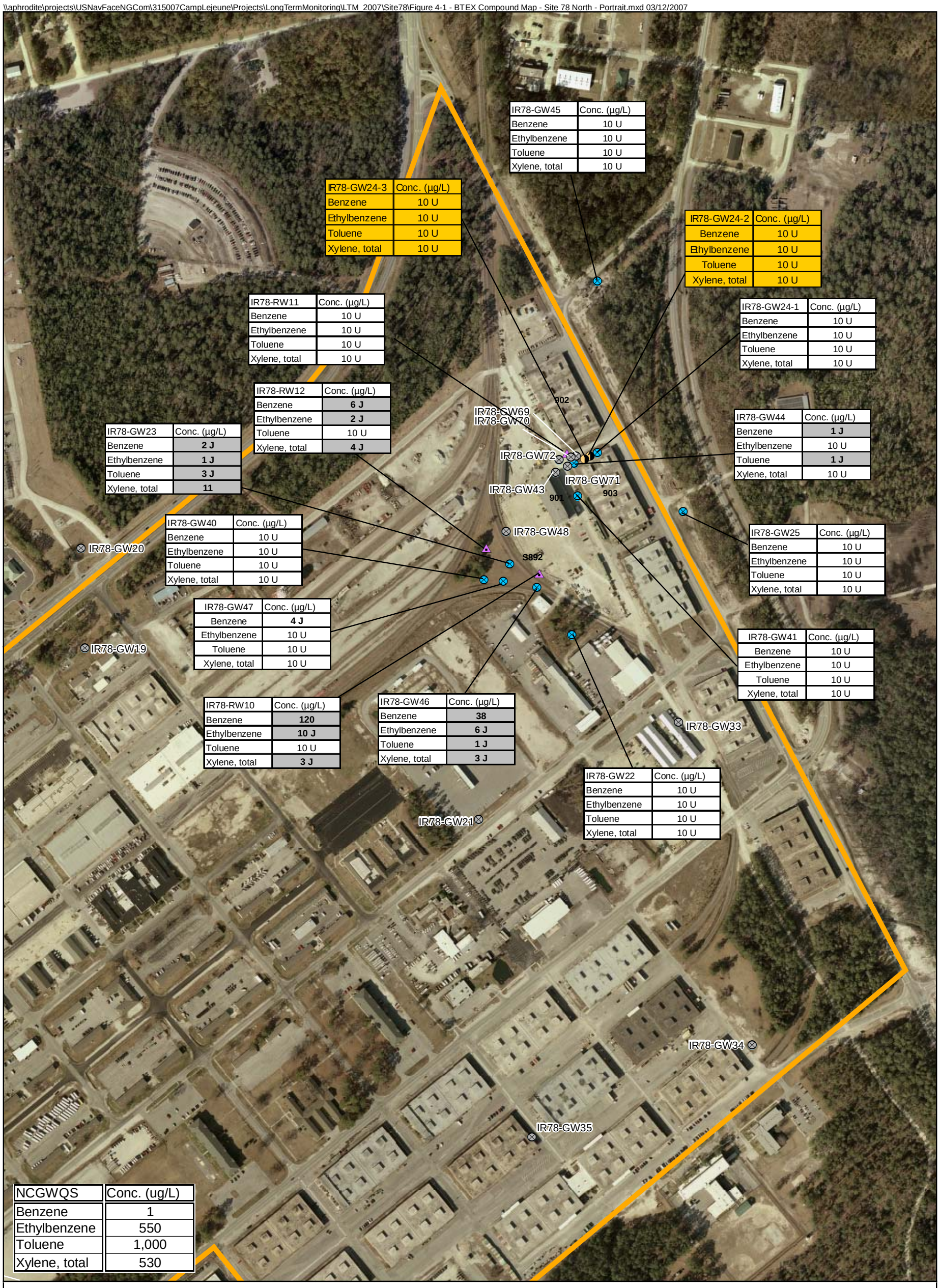


Figure 2-22

SWMU 118 - Shallow Groundwater Contours

\\aphrodite\projects\USNavFaceNGCom\315007CampLejeune\Projects\LongTermMonitoring\LTM_2007\Site78\Figure 4-1 - BTEX Compound Map - Site 78 North - Portrait.mxd 03/12/2007



Legend

- Deep Monitoring Well Locations
- Shallow Monitoring Well Locations
- Recovery Wells
- Shallow Monitoring Well Locations - Not in the LTM program
- Site 78 Boundary

Shallow Well
Deep Well

N W E S

0 200 400 800 Feet

1" = 400'

Notes:
U - Not Detected
J - Value is estimated
Shaded values denote exceedance of NCGWQS

Figure 4-1
BTEX Concentrations in Groundwater
August 2007
Operable Unit 1 - Site 78 North
2006 Long-Term Monitoring Report
Marine Corps Base, Camp Lejeune
North Carolina

AGVIQ CH2M HILL

Figure 2-23
Site 78 - North BTEX Groundwater Concentrations

\\ariadne\groups\gis\USNavFaceNGCom\315007CampLejeune\Projects\LongTermMonitoring\LTM_2007\Site78\Figure 4-2 - Chlorinated Solvents Map - Site 78 North - Portrait.mxd

Legend

- Deep Monitoring Well Locations
- Shallow Monitoring Well Locations
- Recovery Wells
- Shallow Monitoring Well Locations - Not in the LTM program
- Site 78 Boundary

Shallow Well
Deep Well

N W E S

0 200 400 800 Feet

1" = 400'

Notes:
U - Not Detected
J - Value is estimated
Shaded values denote exceedance of NCGWQS

Figure 4-2
Chlorinated VOC Concentrations in Groundwater
August 2007
Operable Unit 1 - Site 78 North
2007 Long-Term Monitoring Report
Marine Corps Base, Camp Lejeune
North Carolina

AGVIQ CH2M HILL

Figure 2-24
Site 78 - North CVOC Concentrations

\\ariadne\groups\gis\USNavFaceNGCom\315007CampLejeune\Projects\LongTermMonitoring\LTM_2007\Site78\Figure 4-3 - BTEX Compound Map - Site 78 South.mxd

IR78-GW73	Conc. (µg/L)
Benzene	2,000
Ethylbenzene	1,700
Toluene	11,000
Xylene, total	3,600

IR78-GW60	Conc. (µg/L)
Benzene	20 U
Ethylbenzene	1,400
Toluene	270
Xylene, total	3,700

IR78-GW09-1	Conc. (µg/L)
Benzene	10 U
Ethylbenzene	10 U
Toluene	10 U
Xylene, total	10 U

IR78-GW49	Conc. (µg/L)
Benzene	10 U
Ethylbenzene	10 U
Toluene	10 U
Xylene, total	5 J

IR78-GW78	Conc. (µg/L)
Benzene	83
Ethylbenzene	1,500
Toluene	4,500 J
Xylene, total	3,600

IR78-GW08	Conc. (µg/L)
Benzene	10 U
Ethylbenzene	10 U
Toluene	10 U
Xylene, total	10 U

IR78-GW05	Conc. (µg/L)
Benzene	10 U
Ethylbenzene	10 U
Toluene	10 U
Xylene, total	10 U

IR78-GW53	Conc. (µg/L)
Benzene	80
Ethylbenzene	6 J
Toluene	12
Xylene, total	4 J

IR78-GW42	Conc. (µg/L)
Benzene	4 J
Ethylbenzene	10 U
Toluene	3 J
Xylene, total	2 J

IR78-GW10	Conc. (µg/L)
Benzene	10 U
Ethylbenzene	10 U
Toluene	10 U
Xylene, total	10 U

IR78-GW09-3	Conc. (µg/L)
Benzene	10 U
Ethylbenzene	10 U
Toluene	1 J
Xylene, total	10 U

IR78-GW50	Conc. (µg/L)
Benzene	10 U
Ethylbenzene	10 U
Toluene	10 U
Xylene, total	10 U

IR78-RW08	Conc. (µg/L)
Benzene	10 U
Ethylbenzene	10 U
Toluene	10 U
Xylene, total	10 U

IR78-GW11	Conc. (µg/L)
Benzene	10 U
Ethylbenzene	10 U
Toluene	10 U
Xylene, total	10 U

IR78-GW54	Conc. (µg/L)
Benzene	10 U
Ethylbenzene	10 U
Toluene	10 U
Xylene, total	10 U

IR78-GW74	Conc. (µg/L)
Benzene	1,100
Ethylbenzene	720
Toluene	2,700
Xylene, total	620

IR78-GW01	Conc. (µg/L)
Benzene	10 U
Ethylbenzene	10 U
Toluene	10 U
Xylene, total	10 U

IR78-RW14	Conc. (µg/L)
Benzene	1 J
Ethylbenzene	10 U
Toluene	10 U
Xylene, total	8 J

IR78-GW58	Conc. (µg/L)
Benzene	150 J
Ethylbenzene	830
Toluene	3,600
Xylene, total	2,400

IR78-GW04	Conc. (ug/L)
Benzene	0.27 J
Ethylbenzene	0.5 U
Toluene	0.5 U
Xylene, total	0.5 U

IR78-GW64	Conc. (µg/L)
Benzene	10 U
Ethylbenzene	10 U
Toluene	2 J
Xylene, total	10 U

IR78-GW63	Conc. (µg/L)
Benzene	10 U
Ethylbenzene	10 U
Toluene	10 U
Xylene, total	10 U

IR78-RW05	Conc. (µg/L)
Benzene	10 U
Ethylbenzene	10 U
Toluene	10 U
Xylene, total	10 U

IR78-GW61	Conc. (µg/L)
Benzene	10 U
Ethylbenzene	10 U
Toluene	10 U
Xylene, total	10 U

IR78-GW59	Conc. (µg/L)
Benzene	10 U
Ethylbenzene	10 U
Toluene	5 J
Xylene, total	10 U

IR78-GW65	Conc. (µg/L)
Benzene	10 U
Ethylbenzene	10 U
Toluene	1 J
Xylene, total	10 U

IR78-GW62	Conc. (µg/L)
Benzene	10 U
Ethylbenzene	10 U
Toluene	10 U
Xylene, total	10 U

IR78-GW39	Conc. (µg/L)
Benzene	10 U
Ethylbenzene	10 U
Toluene	10 U
Xylene, total	10 U

NCGWQS	Conc. (ug/L)
Benzene	1
Ethylbenzene	550
Toluene	1,000
Xylene, total	530

Legend

- Deep Monitoring Well Locations
- Shallow Monitoring Well Locations
- Recovery Wells
- Deep Monitoring Well Locations - Not in the LTM program
- Shallow Monitoring Well Locations - Not in the LTM program
- Site 78 Boundary

Shallow Well
Deep Well

Notes:
U - Not Detected
NS - Not sampled
J - Value is estimated
Shaded values denote exceedance of NCGWQS

N W E S

0 225 450 900 Feet

1" = 450'

Figure 4-3
BTEX Concentrations in Groundwater
August 2007
Operable Unit 1 - Site 78 South
2007 Long-Term Monitoring Report
Marine Corps Base, Camp Lejeune
North Carolina

AGVIQ CH2M HILL

Figure 2-25

Site 78 - South BTEX Concentrations

\\aphrodite\projects\USNavFaceNGCom\315007CampLejeune\Projects\LongTermMonitoring\LTM_2007\Site78\Figure 4-4 - Chlorinated Solvents Map - Site 78 South.mxd

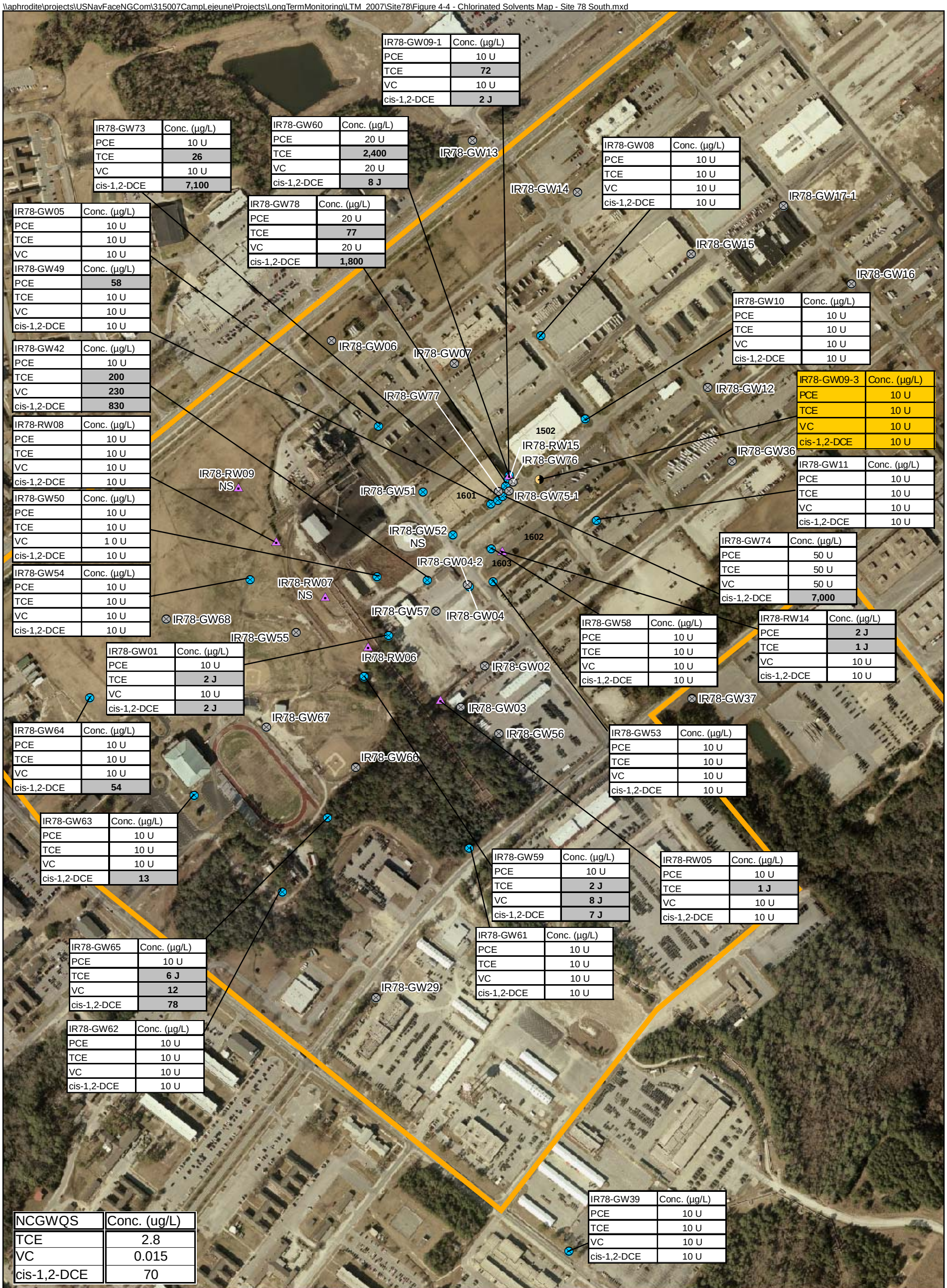
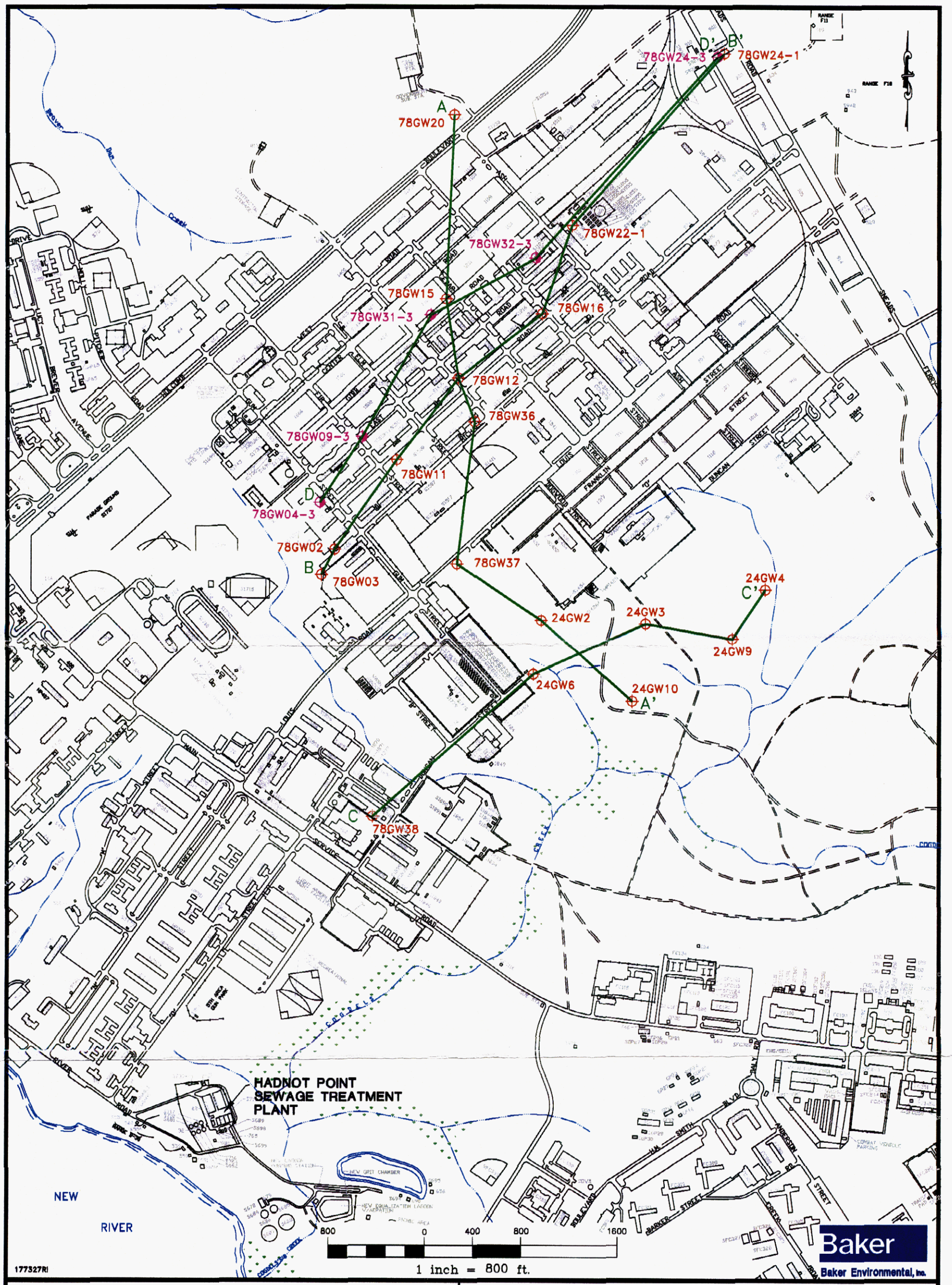


Figure 2-26

Site 78 South CVOC Concentrations



LEGEND

78GW02 — NEW OR EXISTING SHALLOW MONITORING WELL

78GW04-3 — EXISTING DEEP MONITORING WELL

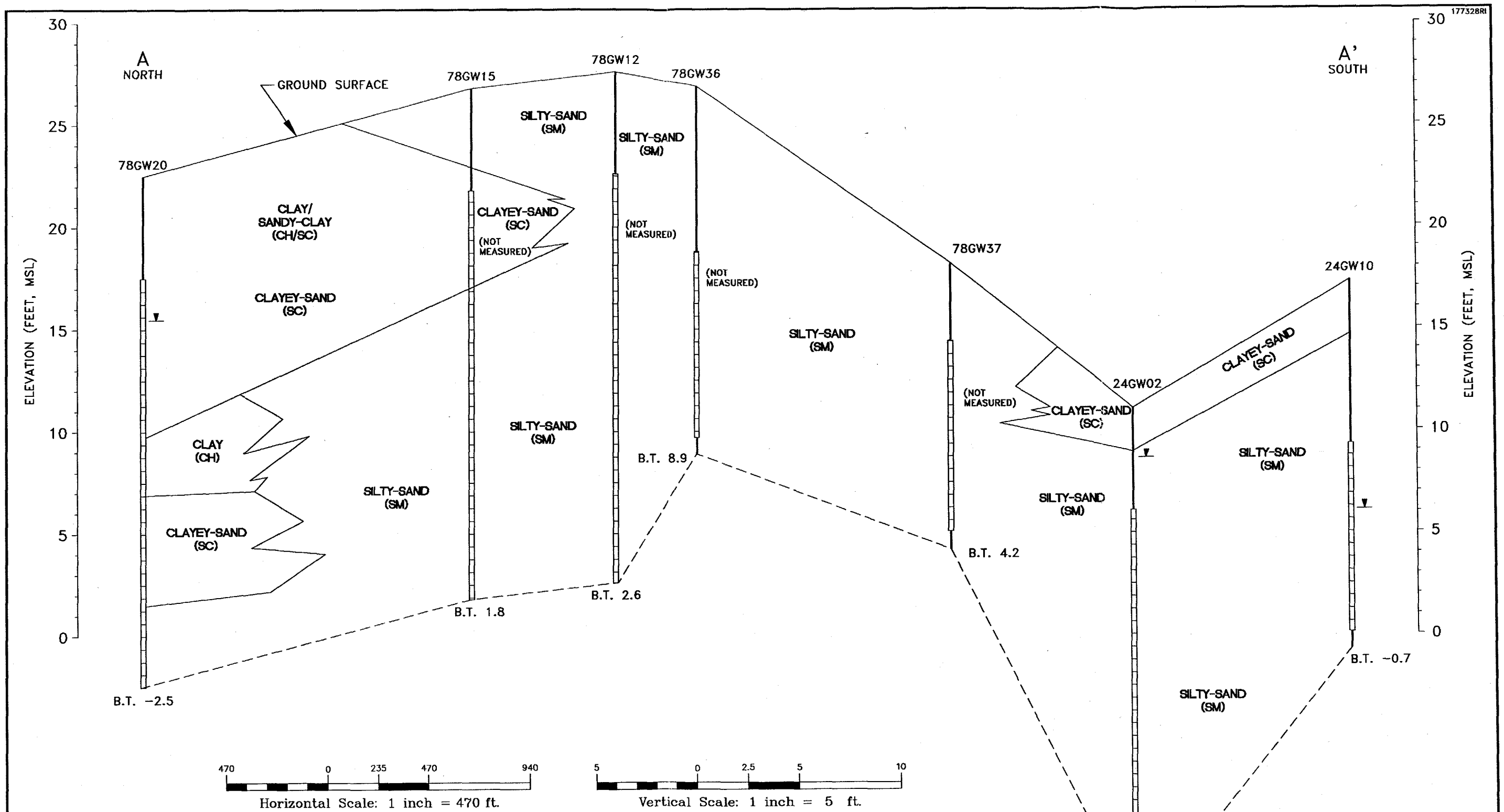
A—A' — GEOLOGIC CROSS-SECTION TRAVERSE

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 3-3
GEOLOGIC CROSS-SECTION
LOCATION MAP
OPERABLE UNIT No. 1
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

0127LV19Y

Figure 2-27
Site 78 - Cross Section Location Map



LEGEND

- GROUNDWATER ELEVATION, FEET ABOVE MSL (AUG. 1, 1993)
- B.T. -2.5 BORING TERMINATED, ELEVATION MSL
- WELL SCREEN INTERVAL
- ESTIMATED
- PROJECTED

NOTES:
-SOIL DESCRIPTIONS FOR BORINGS 78GW20, 78GW15, 78GW12, 78GW36, 78GW37, 24GW1, AND 24GW2 WERE OBTAINED FROM ESE, 1992.
-GROUNDWATER LEVELS WERE NOT MEASURED FOR WELLS 78GW15, 78GW12, 78GW36, AND 78GW37 ON AUGUST 1, 1993.

FIGURE 3-4
GEOLOGIC CROSS-SECTION A-A'
DEPICTING SHALLOW SOIL CONDITIONS
OPERABLE UNIT No. 1
REMEDIAL INVESTIGATION CTO-0177

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

Baker
Baker Environmental, Inc.

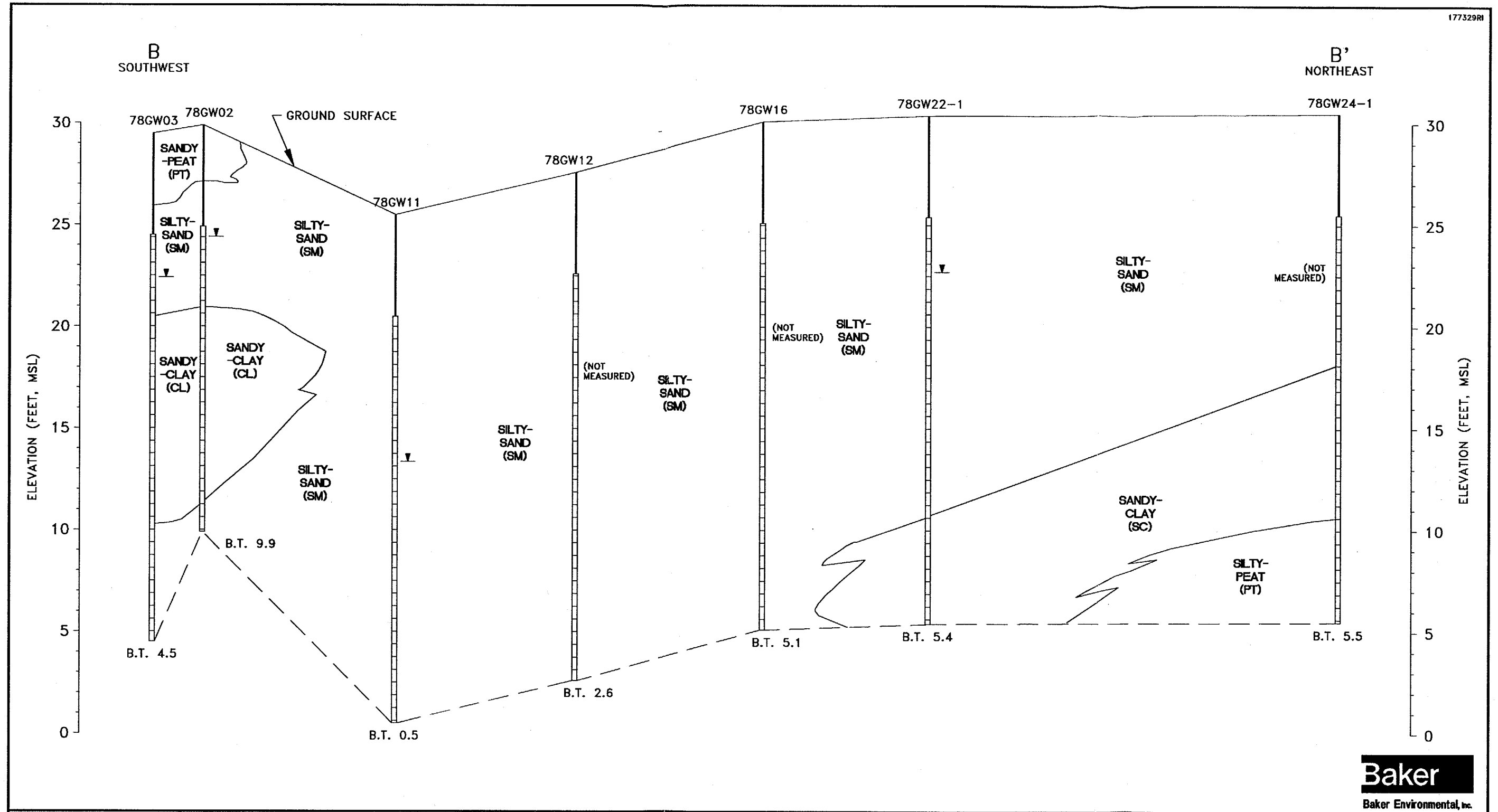
THE SOIL BORING INFORMATION IS CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS. SUBSURFACE CONDITIONS INTERPOLATED BETWEEN BORINGS ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND GEOLOGIC JUDGEMENT.

3-11

01271V20Z

Figure 2-28

Site 78 - Geologic Cross-Section A - A'



LEGEND

- GROUNDWATER ELEVATION, FEET ABOVE MSL (AUG. 2, 1993)
- B.T. 4.5' BORING TERMINATED, ELEVATION MSL
- WELL SCREEN INTERVAL
- ESTIMATED
- PROJECTED

NOTES:
-SOIL DESCRIPTIONS FOR ALL BORINGS WERE OBTAINED FROM ESE, 1992.
-GROUNDWATER LEVELS WERE NOT MEASURED FOR WELLS 78GW12, 78GW16, AND 78GW24-1 ON AUGUST 2, 1993.

470 0 235 470 940
Horizontal Scale: 1 inch = 470 ft.

5 0 2.5 5 10
Vertical Scale: 1 inch = 5 ft.

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

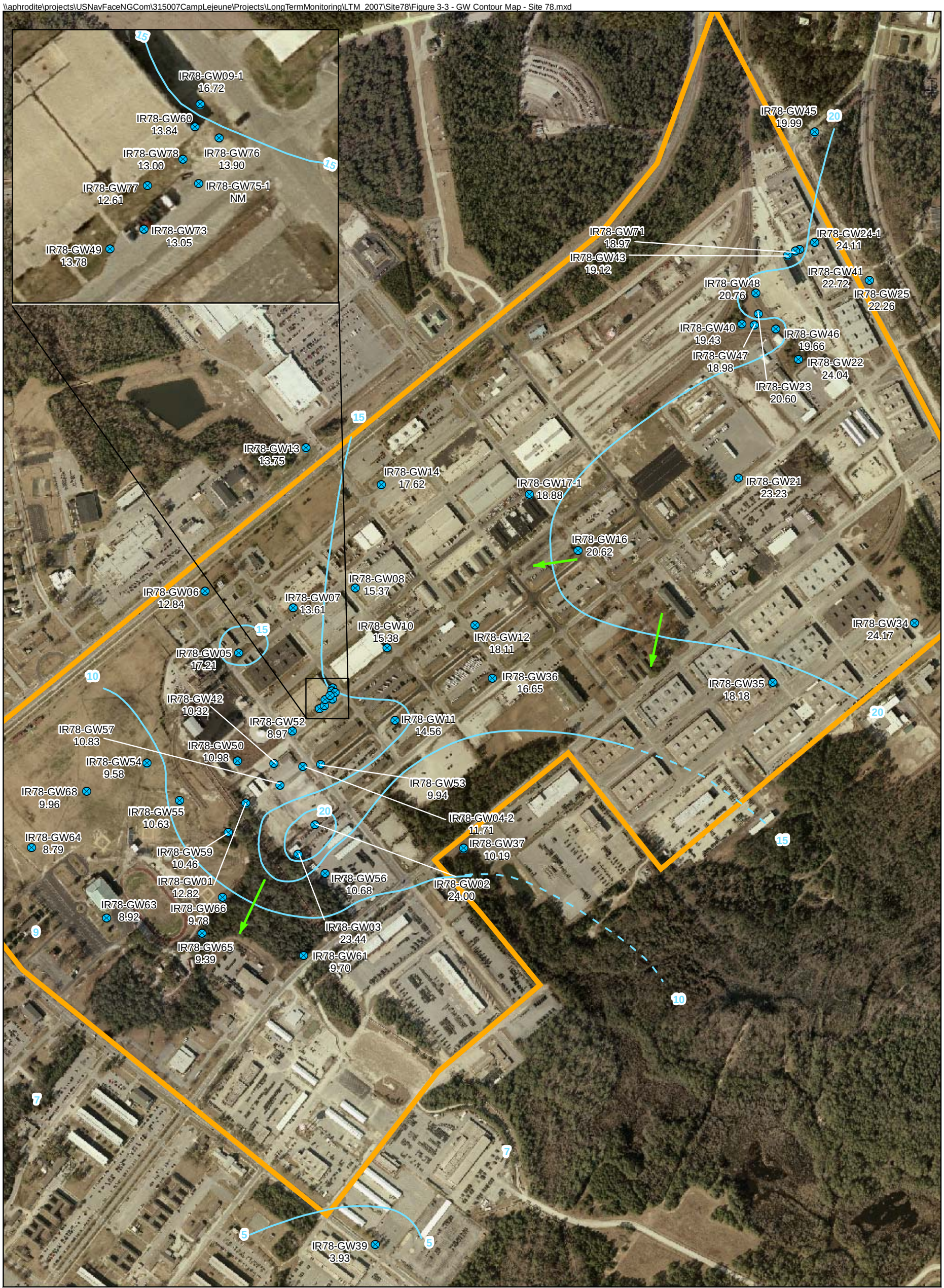
FIGURE 3-5
GEOLOGIC CROSS-SECTION B-B'
DEPICTING SHALLOW SOIL CONDITIONS
OPERABLE UNIT No. 1
REMEDIAL INVESTIGATION CTO-0177

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

01271V212

Figure 2-29
Site 78 - Geologic Cross-Section B - B'

\\aphrodite\projects\USNavFaceNGCom\315007CampLejeune\Projects\LongTermMonitoring\LTM_2007\Site78\Figure 3-3 - GW Contour Map - Site 78.mxd



Legend

- Shallow Monitoring Well Locations
- Site 78 Boundary
- 7—7 Groundwater Contours (feet above sea level - dashed where inferred)
- Direction of Groundwater Flow

N
W E
S

0 312.5 625 1,250 Feet

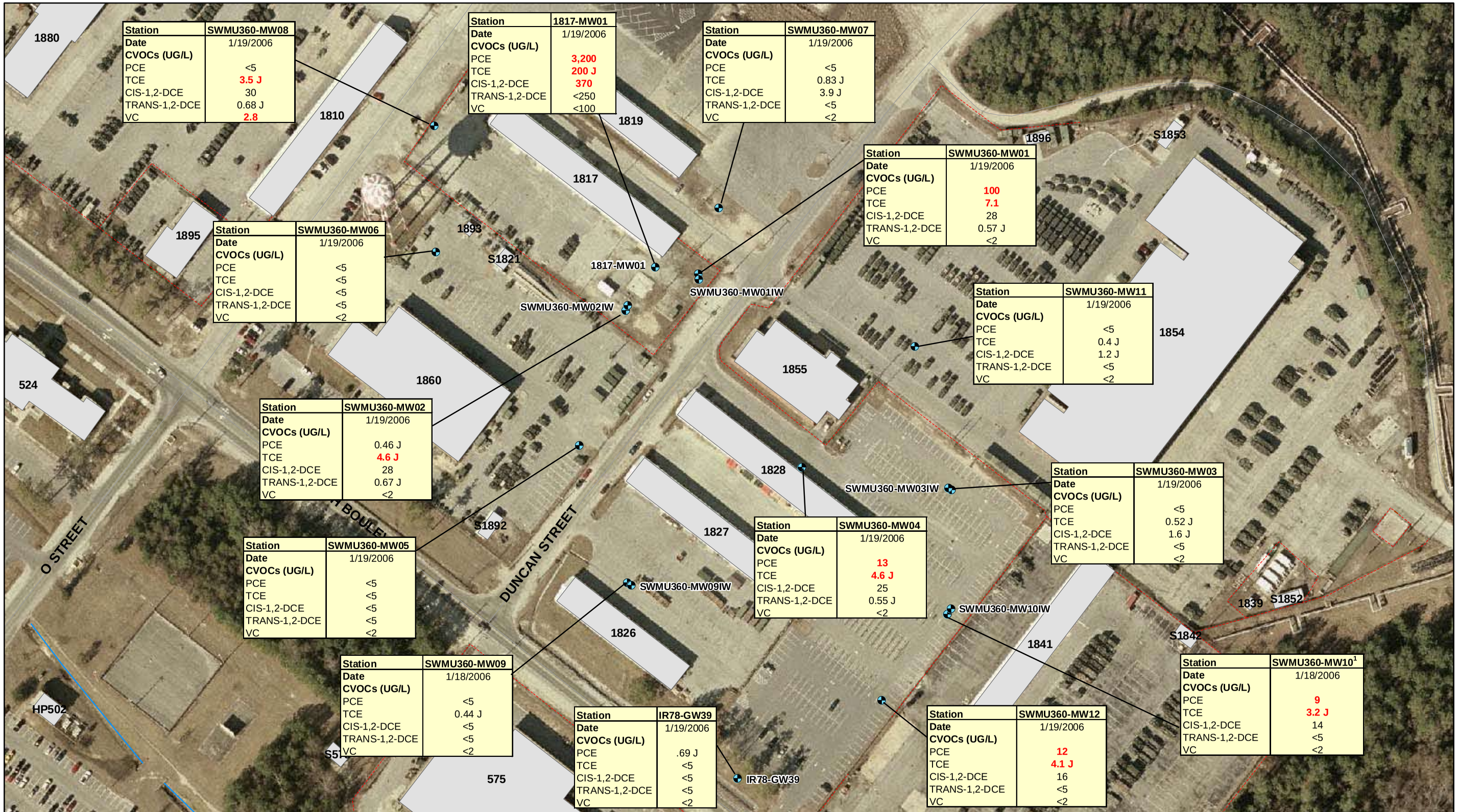
1" = 625'

Figure 3-3
Groundwater Contour Map - Shallow Aquifer
August 2007
Operable Unit 1 - Site 78
2007 Long-Term Monitoring Report
Marine Corps Base, Camp Lejeune
North Carolina

AGVIO
CH2M HILL

NM - Not measured
10.53 - Groundwater Elevations are feet above mean sea level
Note: Water level measurements were collected from deep monitoring locations but are not included on this map

Figure 2-30
Site 78 - Shallow Groundwater Contours



Legend

- Monitoring Well Location
- Fence
- Gate
- Wall

J- Reported value is estimated
PCE- Tetrachloroethene
TCE- Trichloroethene
cis 1,2-DCE- Cis 1,2-Dichloroethene
TRANS-1,2-DCE- Trans-1,2-Dichloroethene
VC- Vinyl Chloride
CVOCs- Chlorinated Volatile Organic Compounds
Bold Red indicates exceedance of NC2LGW screening criteria

N

0 125 250 Feet

Figure 4-6
CVOC Concentrations in Groundwater in the Shallow Aquifer
SWMU 360
Amended RFI Report
Marine Corps Base, Camp Lejeune, North Carolina

CH2MHILL

File Path: X:\USNavFaceNGCom\315007CampLejeune\Projects\SWMU360\Shallow_Aquifer_CVOCs.mxd

Figure 2-31
SWMU 360 Shallow CVOC Concentrations

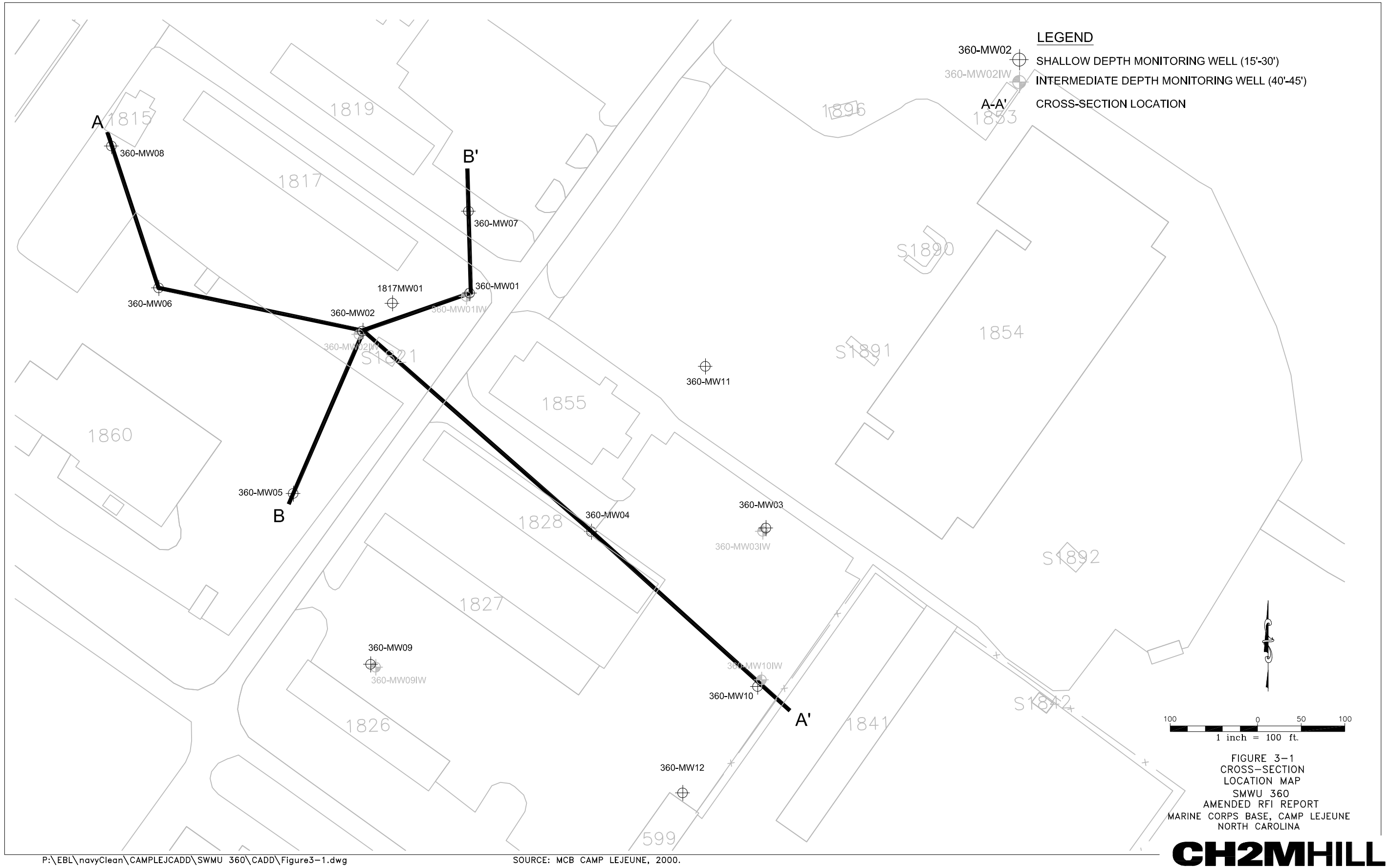
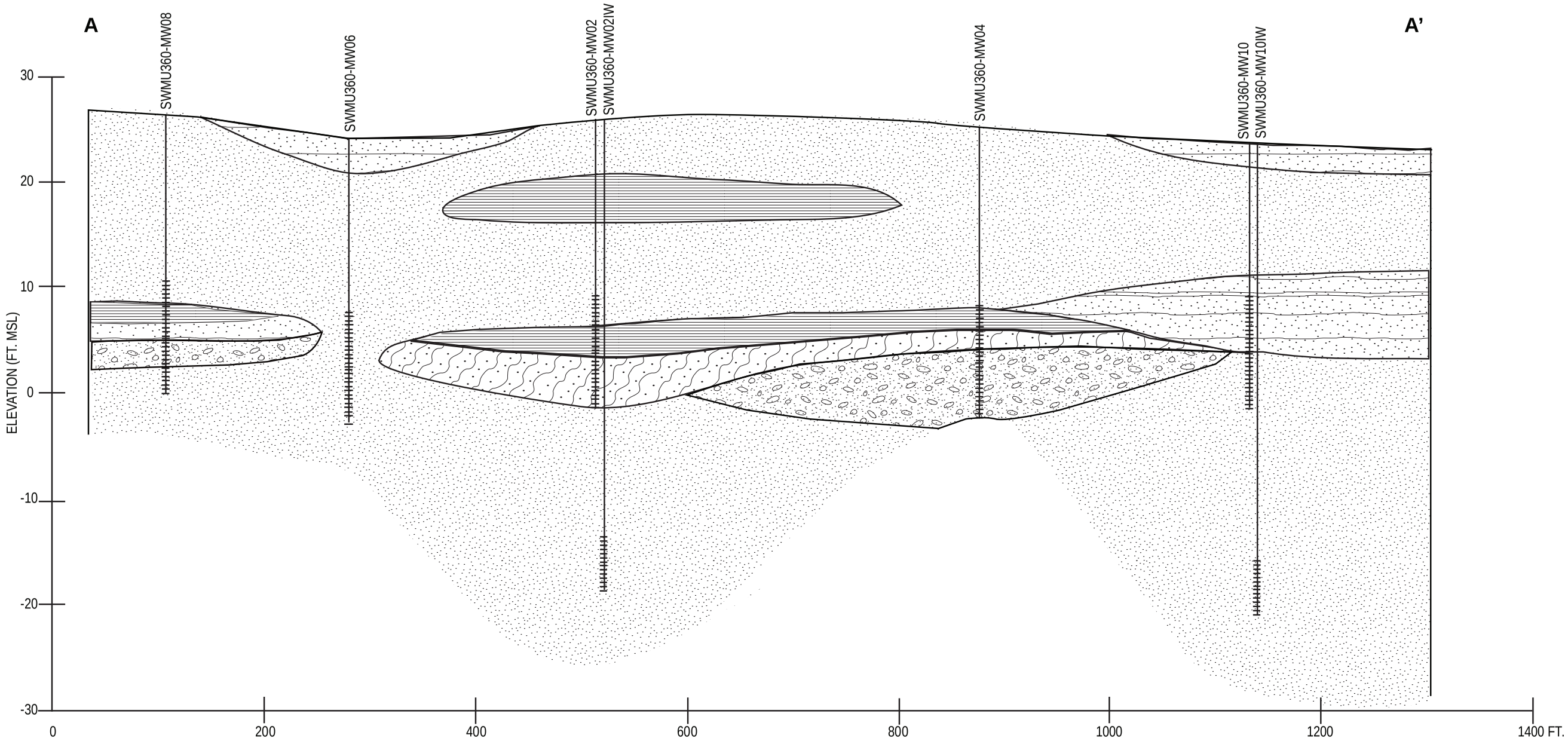


Figure 2-32
SWMU 360 - Cross Section Location Map



LEGEND:

- Silty Sand (SM)
- Fine Sand with some Silt (SP-SM)
- Inorganic Clay (CL)
- Monitoring Well
- Clayey Sand (SC)
- Fine Sand (SP) w/ Shell Fragments

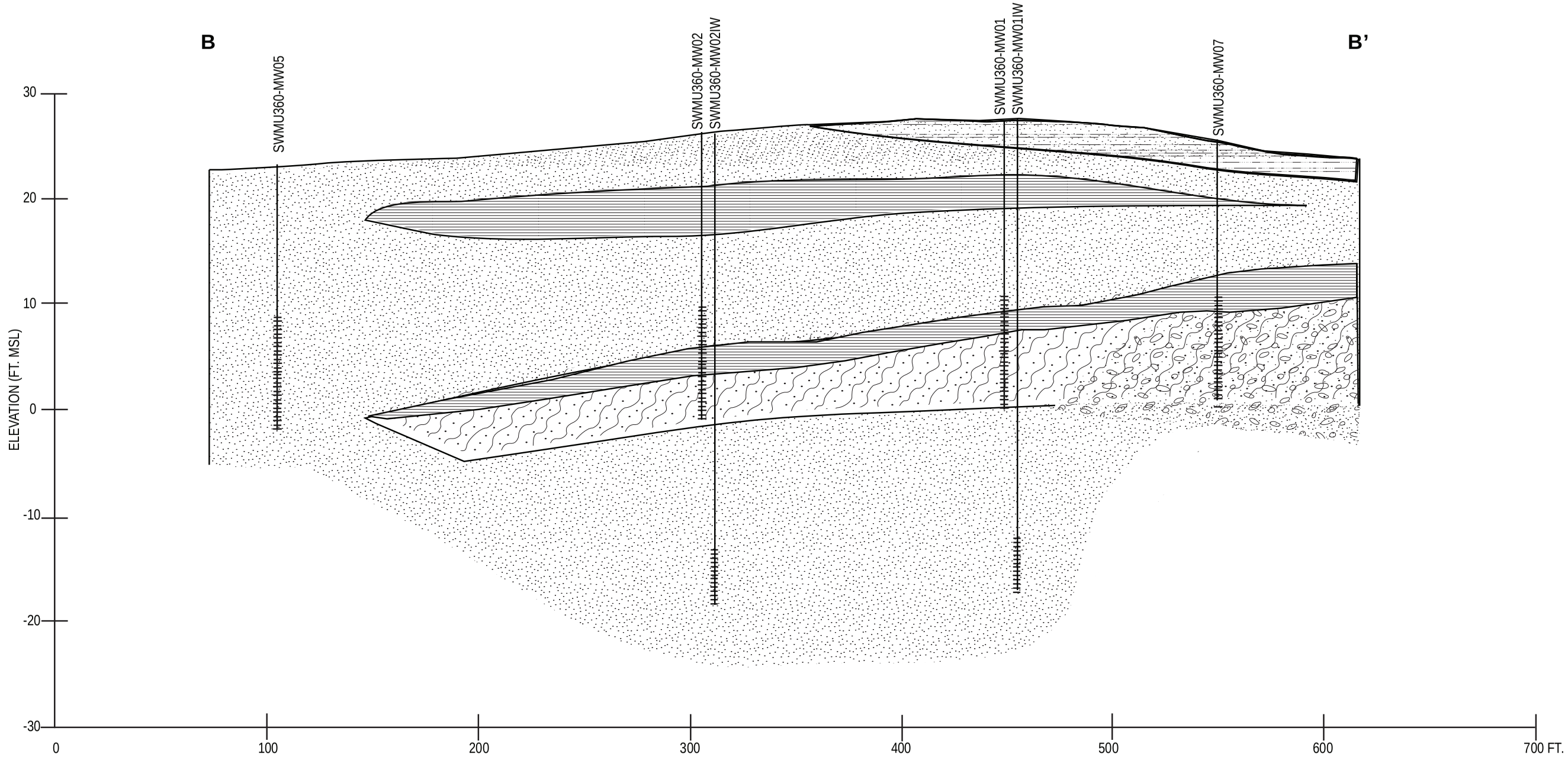
HORIZONTAL SCALE: 1'=100'
VERTICAL SCALE: 1'=10'

Notes:
The depth and thickness of the subsurface strata indicated on this section (profile) were generalized from and interpolated between test locations. Information on actual subsurface conditions applies only to the specific locations and dates indicated. Subsurface conditions and water levels at other locations may differ from conditions occurring at the indicated locations.

FIGURE 3-2
GENERALIZED GEOLOGIC CROSS-SECTION A-A'
SWMU 360
AMENDED RFI REPORT
MCB CAMP LEJEUNE, NORTH CAROLINA

CH2MHILL

Figure 2-33
SWMU 360 - Generalized Geologic Cross-Section A - A'



LEGEND:

- Inorganic Silt (ML)
- Fine Sand with some Silt (SP-SM)
- Inorganic Clay (CL)
- Monitoring Well
- Clayey Sand (SC)
- Fine to Coarse Sand (SW) with Shell Fragments

HORIZONTAL SCALE: 1'=50'
VERTICAL SCALE: 1'=10'

Notes:
The depth and thickness of the subsurface strata indicated on this section (profile) were generalized from and interpolated between test locations. Information on actual subsurface conditions applies only to the specific locations and dates indicated. Subsurface conditions and water levels at other locations may differ from conditions occurring at the indicated locations.

FIGURE 3-3
GENERALIZED GEOLOGIC CROSS-SECTION B-B'
SWMU 360
AMENDED RFI REPORT
MCB CAMP LEJEUNE, NORTH CAROLINA

CH2MHILL

Figure 2-34
SWMU 360 - Generalized Geologic Cross-Section B - B'

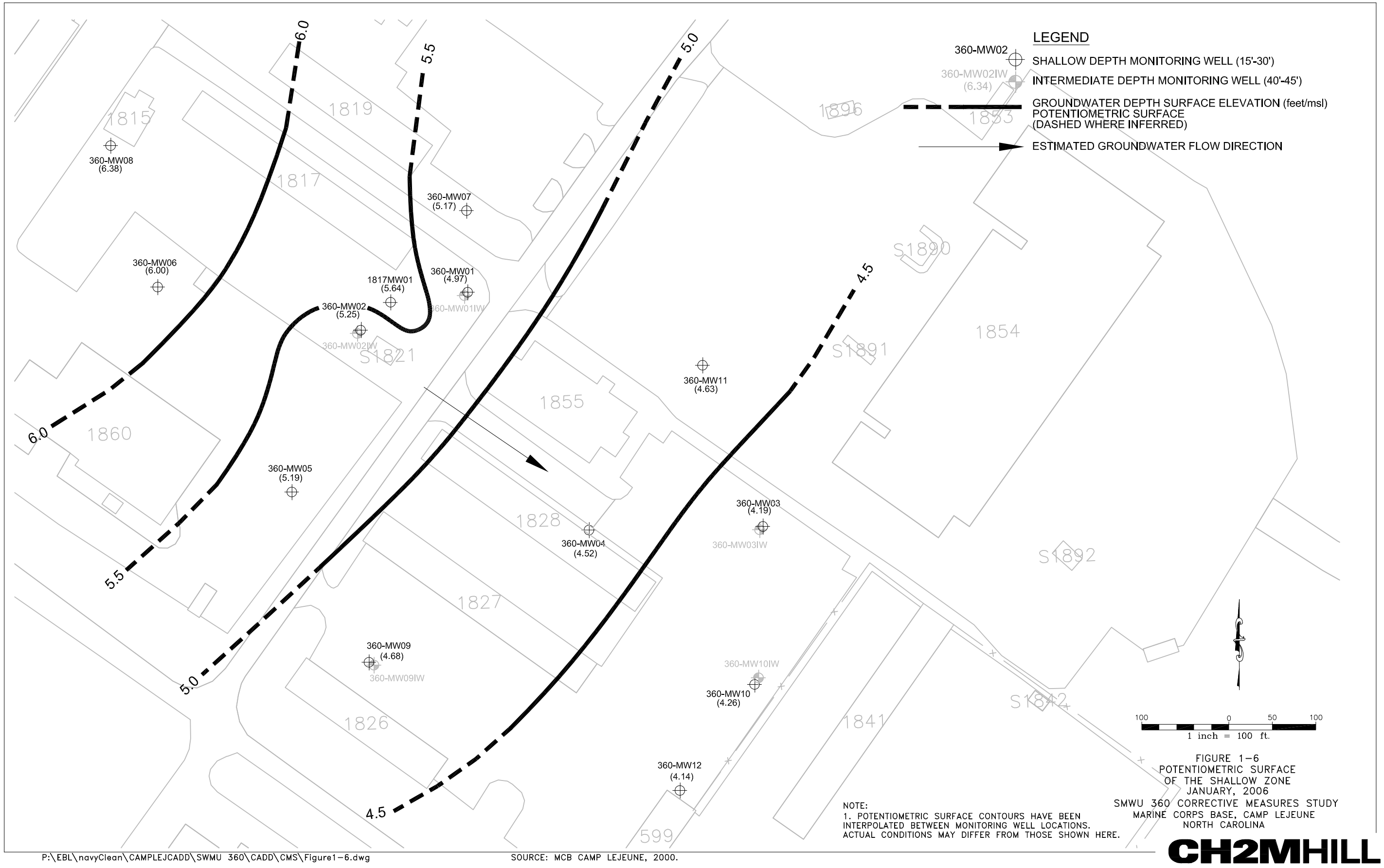
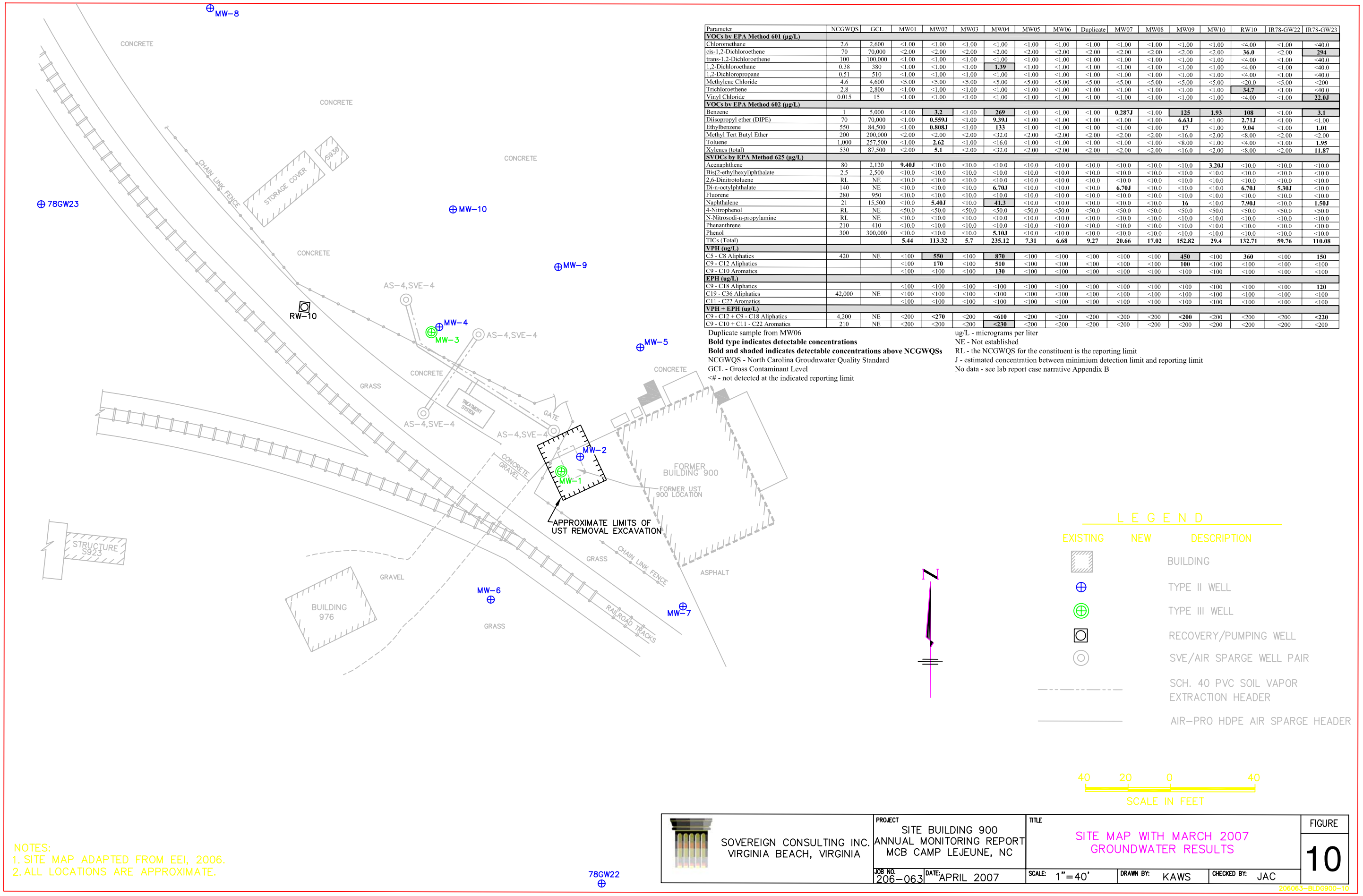


Figure 2-35
SWMU 360 - Shallow Groundwater Contours



Parameter	NCGWQS	GCL	MW01	MW02	MW03	MW04	MW05	MW06	Duplicate	MW07	MW08	MW09	MW10	RW10	IR78-GW22	IR78-GW23
VOCs by EPA Method 601 (µg/L)																
Chloromethane	2.6	2,600	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<4.00	<1.00	<40.0
cis-1,2-Dichloroethene	70	70,000	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	**36.0**	<2.00	**294**
trans-1,2-Dichloroethene	100	100,000	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<4.00	<1.00	<40.0
1,2-Dichloroethane	0.38	380	<1.00	<1.00	<1.00	**1.39**	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<4.00	<1.00	<40.0
1,2-Dichloropropane	0.51	510	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<4.00	<1.00	<40.0
Methylene Chloride	4.6	4,600	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<20.0	<5.00	<200
Trichloroethene	2.8	2,800	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	**34.7**	<1.00	<40.0
Vinyl Chloride	0.015	15	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<4.00	<1.00	**22.0J**
VOCs by EPA Method 602 (µg/L)																
Benzene	1	5,000	<1.00	**3.2**	<1.00	**269**	<1.00	<1.00	<1.00	**0.287J**	<1.00	**125**	**1.93**	**108**	<1.00	**3.1**
Diisopropyl ether (DIPE)	70	70,000	<1.00	**0.559J**	<1.00	**9.39J**	<1.00	<1.00	<1.00	<1.00	<1.00	**6.63J**	<1.00	**2.71J**	<1.00	<1.00
Ethylbenzene	550	84,500	<1.00	**0.808J**	<1.00	**133**	<1.00	<1.00	<1.00	<1.00	<1.00	**17**	<1.00	**9.04**	<1.00	**1.01**
Methyl Tert Butyl Ether	200	200,000	<2.00	<2.00	<2.00	<32.0	<2.00	<2.00	<2.00	<2.00	<2.00	<16.0	<2.00	<8.00	<2.00	<2.00
Toluene	1,000	257,500	<1.00	**2.62**	<1.00	<16.0	<1.00	<1.00	<1.00	<1.00	<1.00	<8.00	<1.00	<4.00	<1.00	**1.95**
Xylenes (total)	530	87,500	<2.00	**5.1**	<2.00	<32.0	<2.00	<2.00	<2.00	<2.00	<2.00	<16.0	<2.00	<8.00	<2.00	**11.87**
SVOCs by EPA Method 625 (µg/L)																
Acenaphthene	80	2,120	**9.40J**	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	**3.20J**	<10.0	<10.0	<10.0
Bis(2-ethylhexyl)phthalate	2.5	2,500	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
2,6-Dinitrotoluene	RL	NE	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Di-n-octylphthalate	140	NE	<10.0	<10.0	<10.0	**6.70J**	<10.0	<10.0	<10.0	**6.70J**	<10.0	<10.0	<10.0	**6.70J**	**5.30J**	<10.0
Fluorene	280	950	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Naphthalene	21	15,500	<10.0	**5.40J**	<10.0	**41.3**	<10.0	<10.0	<10.0	<10.0	<10.0	**16**	<10.0	**7.90J**	<10.0	**1.50J**
4-Nitrophenol	RL	NE	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0
N-Nitrosodi-n-propylamine	RL	NE	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Phenanthrene	210	410	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Phenol	300	300,000	<10.0	<10.0	<10.0	**5.10J**	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
TICs (Total)			**5.44**	**113.32**	**5.7**	**235.12**	**7.31**	**6.68**	**9.27**	**20.66**	**17.02**	**152.82**	**29.4**	**132.71**	**59.76**	**110.08**
VPH (ug/L)																
C5 - C8 Aliphatics	420	NE	<100	**550**	<100	**870**	<100	<100	<100	<100	<100	**450**	<100	**360**	<100	**150**
C9 - C12 Aliphatics			<100	**170**	<100	**510**	<100	<100	<100	<100	<100	**100**	<100	<100	<100	<100
C9 - C10 Aromatics			<100	<100	<100	**130**	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
EPH (ug/L)																
C9 - C18 Aliphatics			<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	**120**
C19 - C36 Aliphatics	42,000	NE	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
C11 - C22 Aromatics			<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
VPH + EPH (ug/L)																
C9 - C12 + C9 - C18 Aliphatics	4,200	NE	<200	**<270**	<200	**<610**	<200	<200	<200	<200	<200	**<200**	<200	<200	<200	**<220**
C9 - C10 + C11 - C22 Aromatics	210	NE	<200	<200	<200	**<230**	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200

Duplicate sample from MW06
Bold type indicates detectable concentrations
Bold and shaded indicates detectable concentrations above NCGWQSs
NCGWQS - North Carolina Groundwater Quality Standard
GCL - Gross Contaminant Level
<# - not detected at the indicated reporting limit

ug/L - micrograms per liter
NE - Not established
RL - the NCGWQS for the constituent is the reporting limit
J - estimated concentration between minimium detection limit and reporting limit
No data - see lab report case narrative Appendix B

Figure 2-36
Building 900 - Groundwater Concentrations

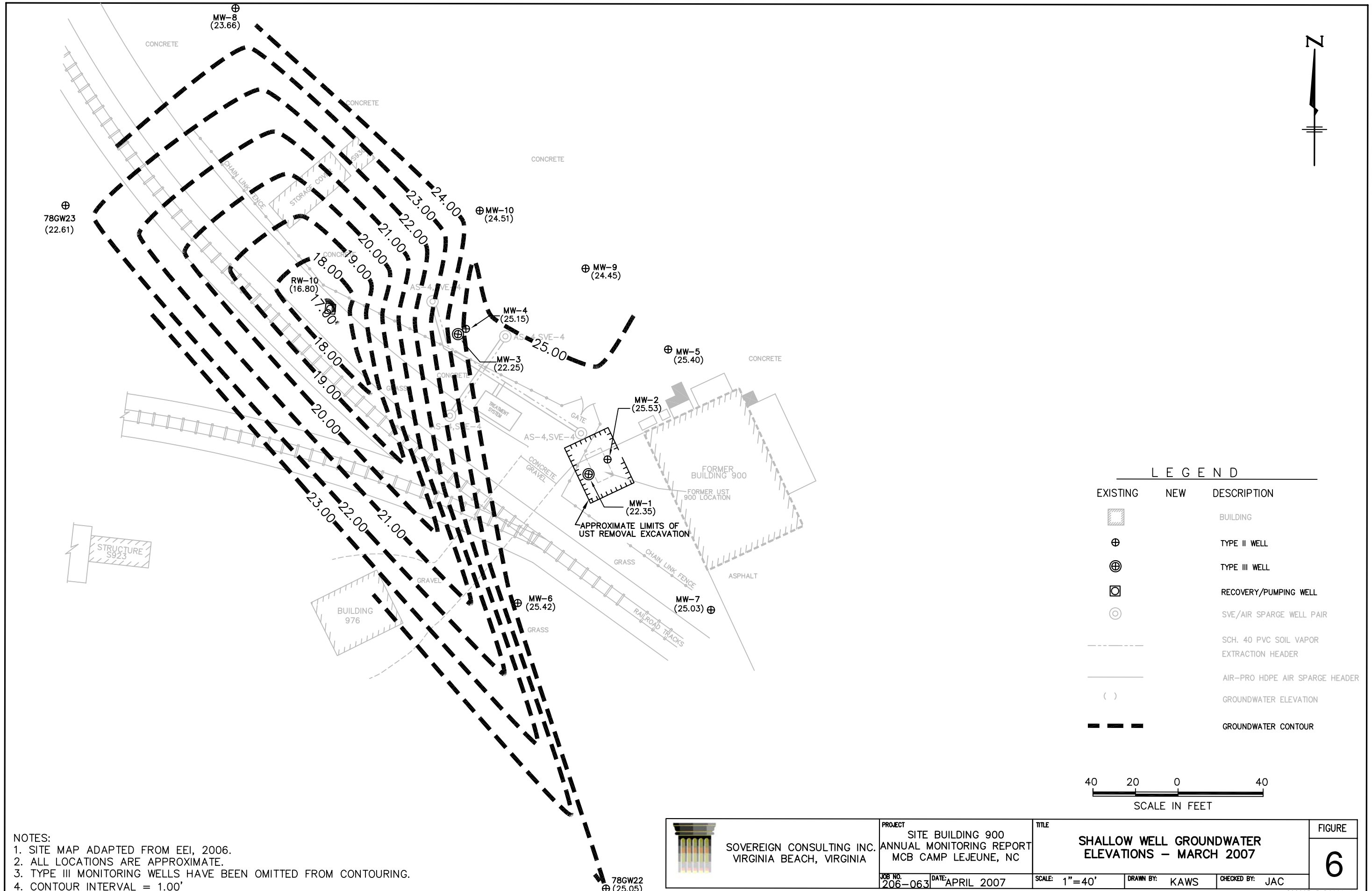


Figure 2-37

Building 900 - Shallow Groundwater Contours

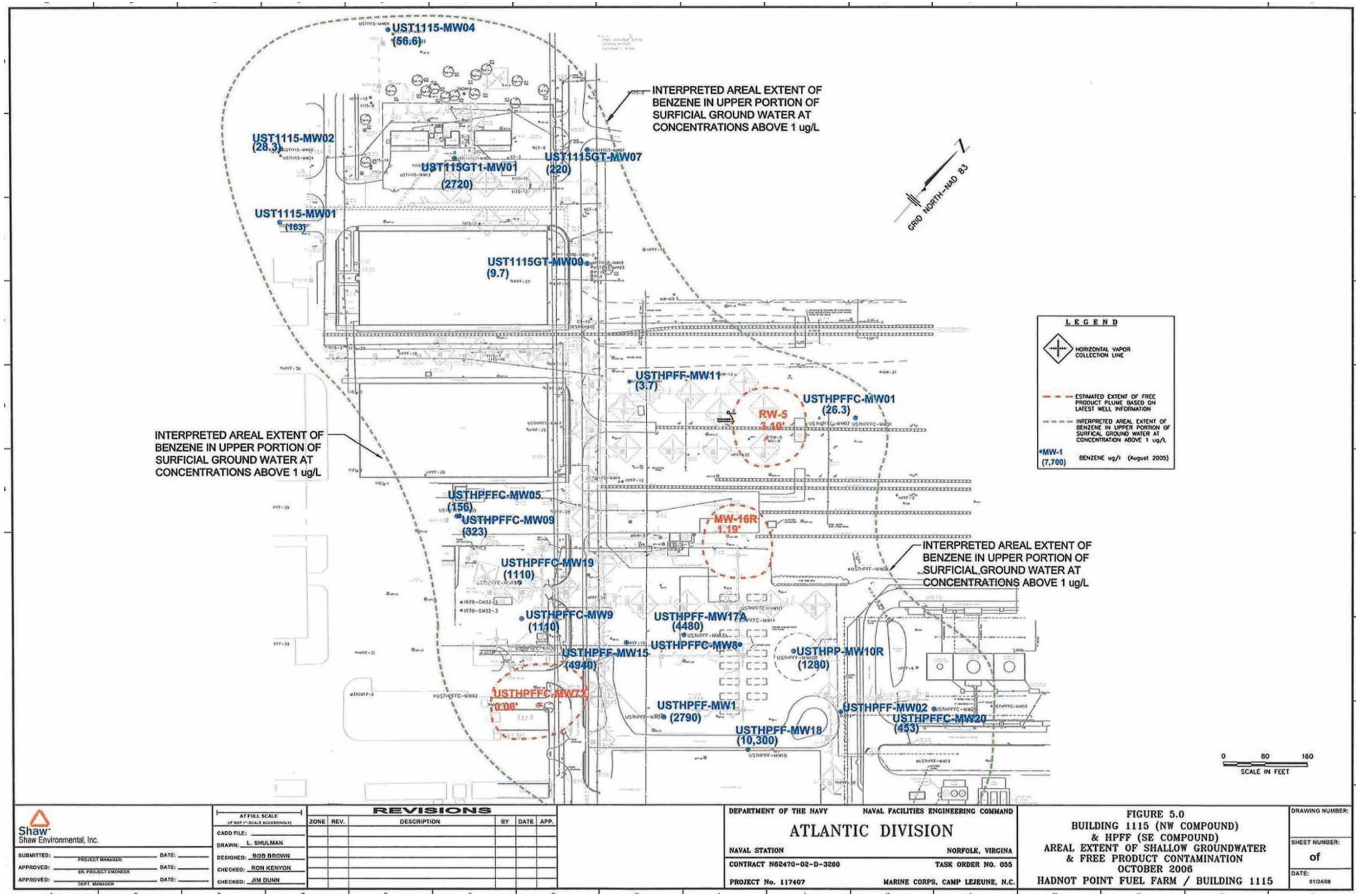


Figure 2-38

HPFF - October 2006 Free Product and Shallow Benzene Isopleths

\APHRODITE\PROJ\USNAVFACENGCOM\315007CAMPLEJEUNE\PROJECTS\VAPOR_INTRUSION\Figure_X_HadnotPointFuelFarm_SiteMap.mxd

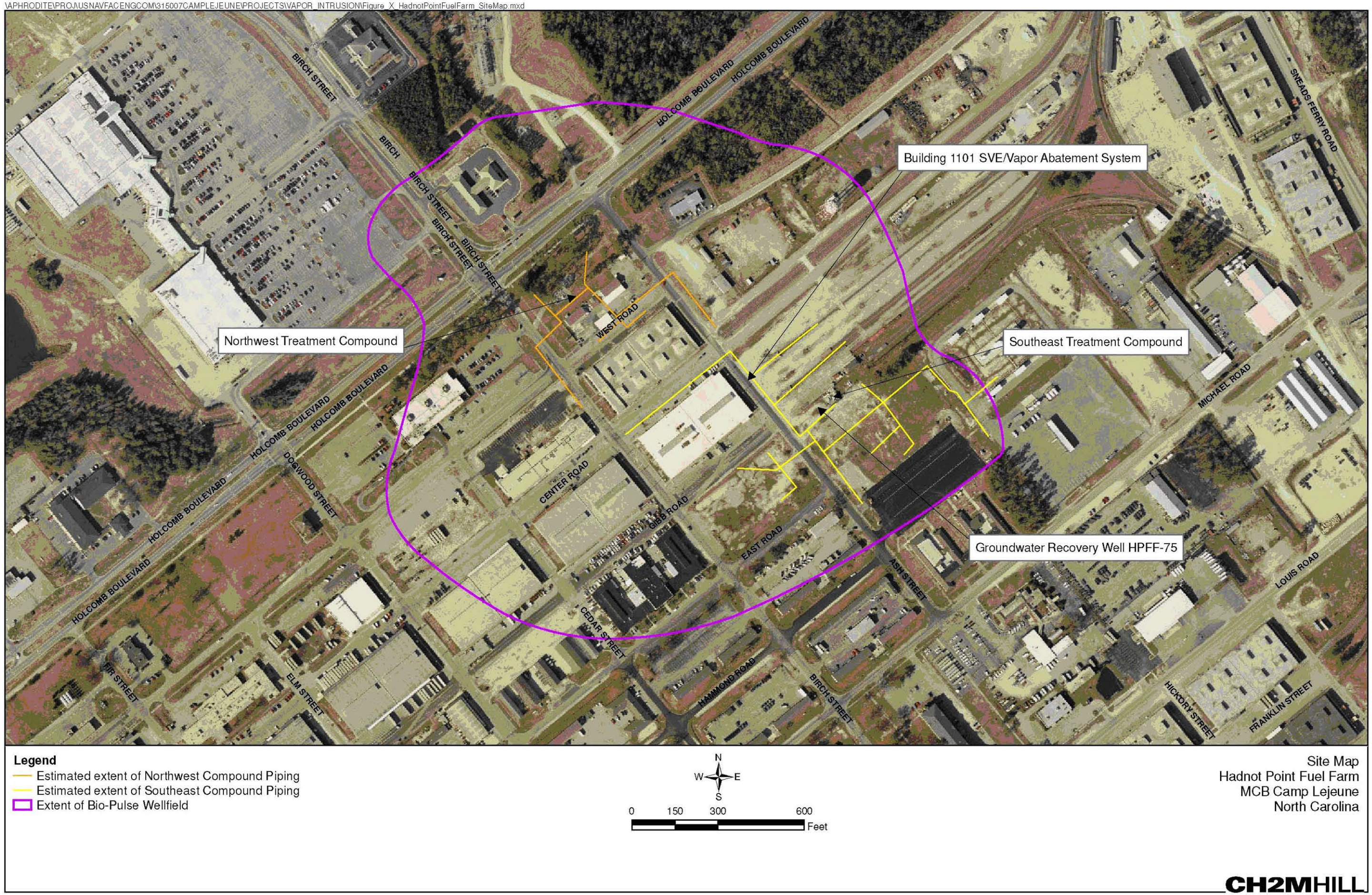


Figure 2-39
HPFF - Extent of Remediation Systems

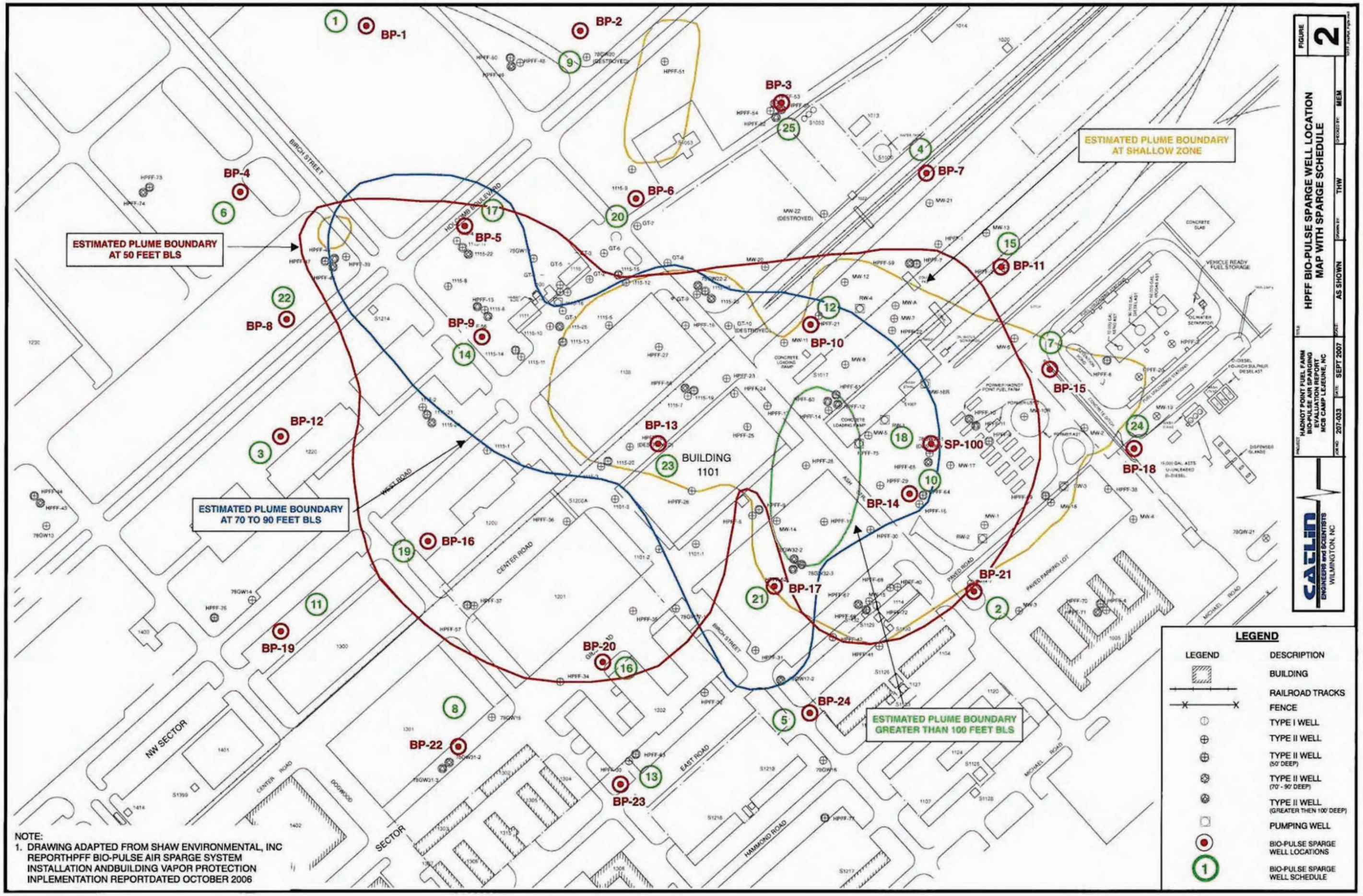


Figure 2-40
HPFF - Biopulse Well Configuration

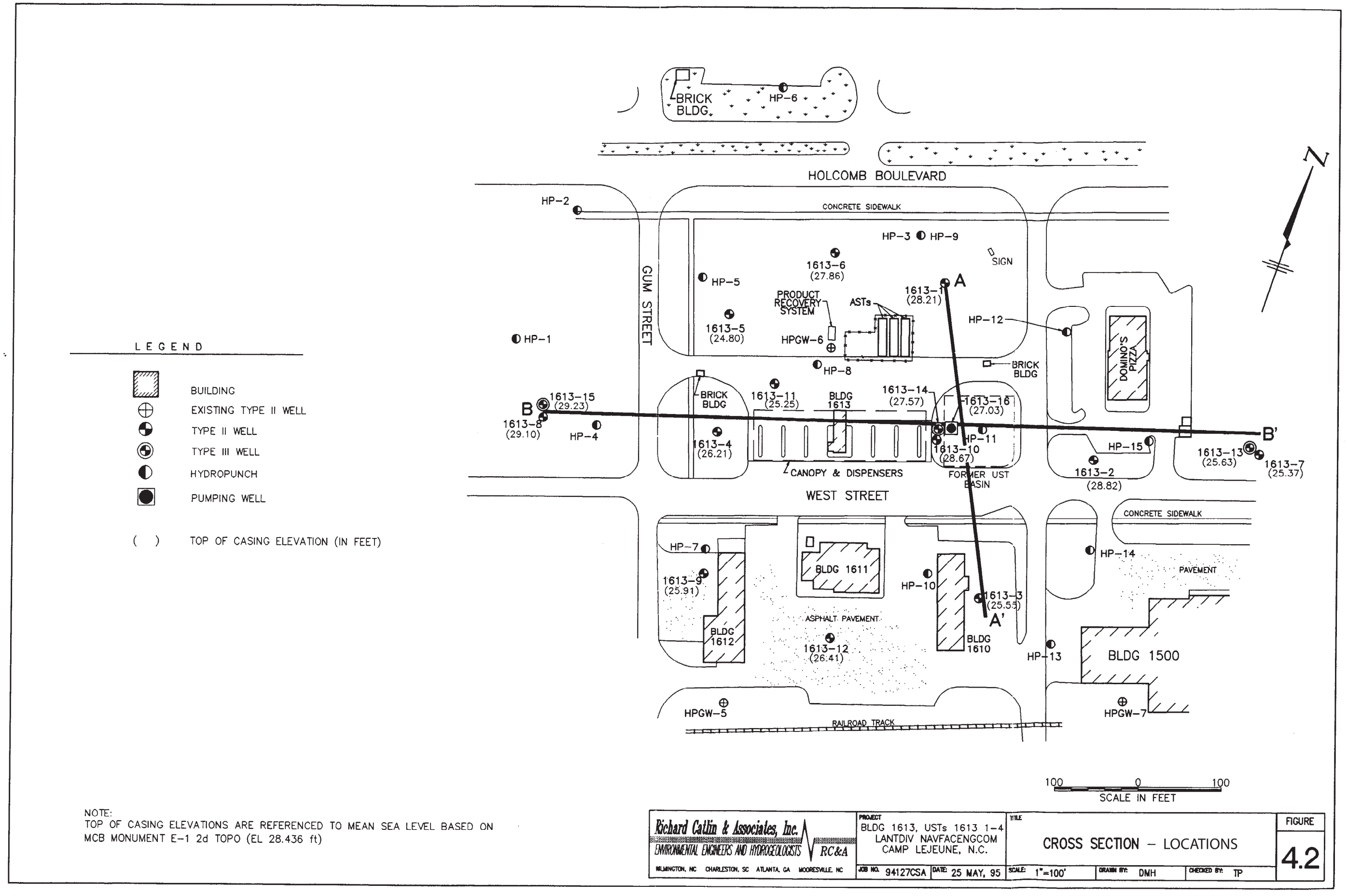
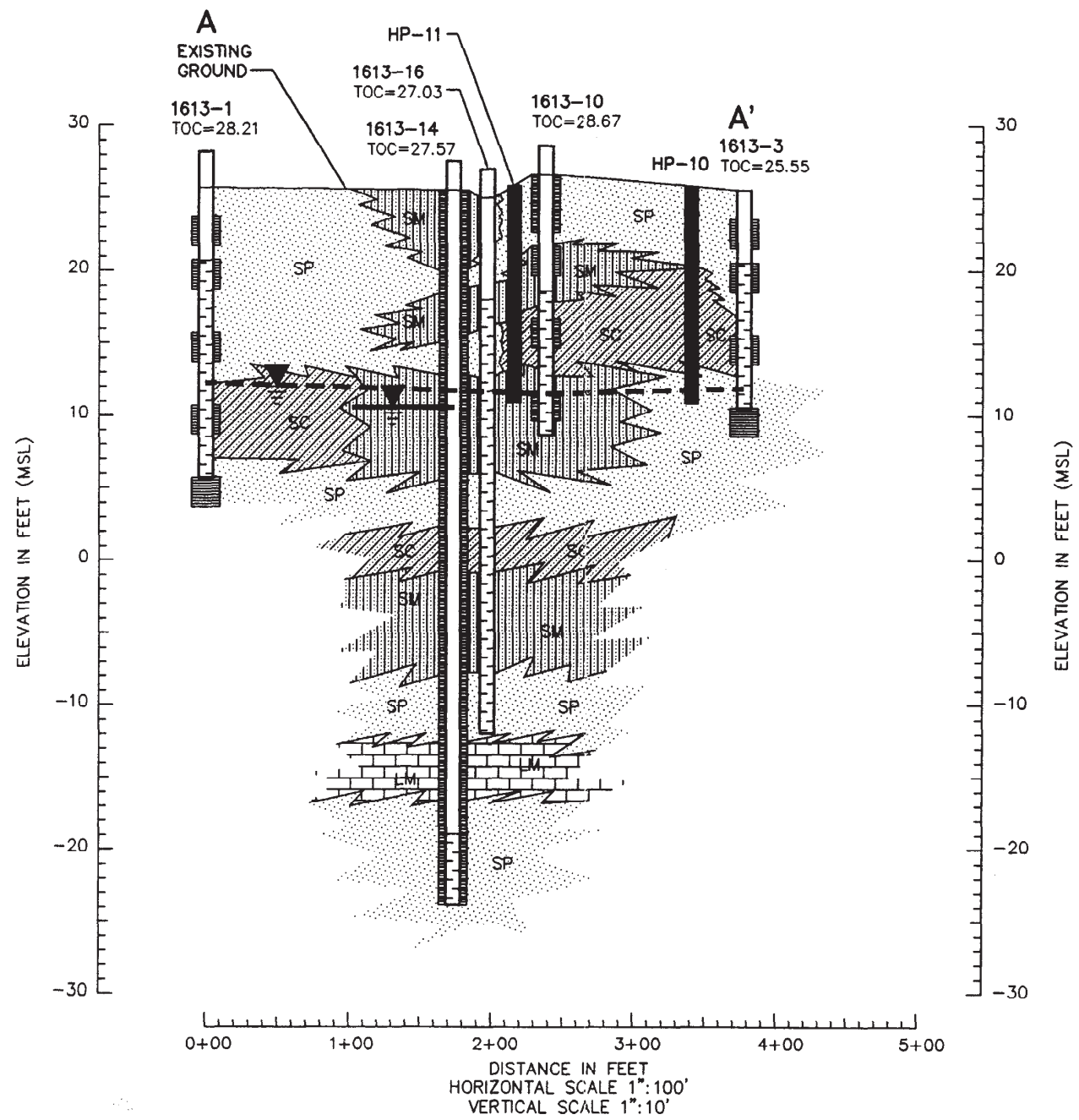


Figure 2-41

Building 1613 - Cross Section - Locations



NOTE: CONTACTS REPRESENT GRADATIONAL CHANGES BETWEEN UNITS AND ARE APPROXIMATED

LEGEND

- SP POORLY GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES
- SM SILTY SANDS, SAND-CLAY MIXTURES
- SC CLAYEY SANDS, SAND-CLAY MIXTURES
- CL INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
- GP POORLY GRADED SANDS OR GRAVEL-SANDS MIXTURES, LITTLE OR NO FINES
- LM WEATHERED LIMESTONE
- TOC TOP OF CASING ELEVATION ELEVATION BASED ON MEAN SEA LEVEL
- SCREEN INTERVAL
- SOIL SAMPLE INTERVAL
- WATER TABLE ELEVATION AS OF 5/17/95

Richard Catlin & Associates, Inc.
ENVIRONMENTAL ENGINEERS AND HYDROGEOLOGISTS
RC&A
WILMINGTON, NC CHARLESTON, SC ATLANTA, GA MOORESVILLE, NC

PROJECT: BLDG 1613, USTs 1613 1-4
LANTDIV NAVFACENGCOM
CAMP LEJEUNE, N.C.

TITLE: CROSS SECTION A – A'

FIGURE 4.3

JOB NO. 94127CSA | DATE: 25 MAY, 95 | SCALE: 1"=100' | DRAWN BY: DMH | CHECKED BY: TP

Figure 2-42

Building 1613 - Cross Section A - A'

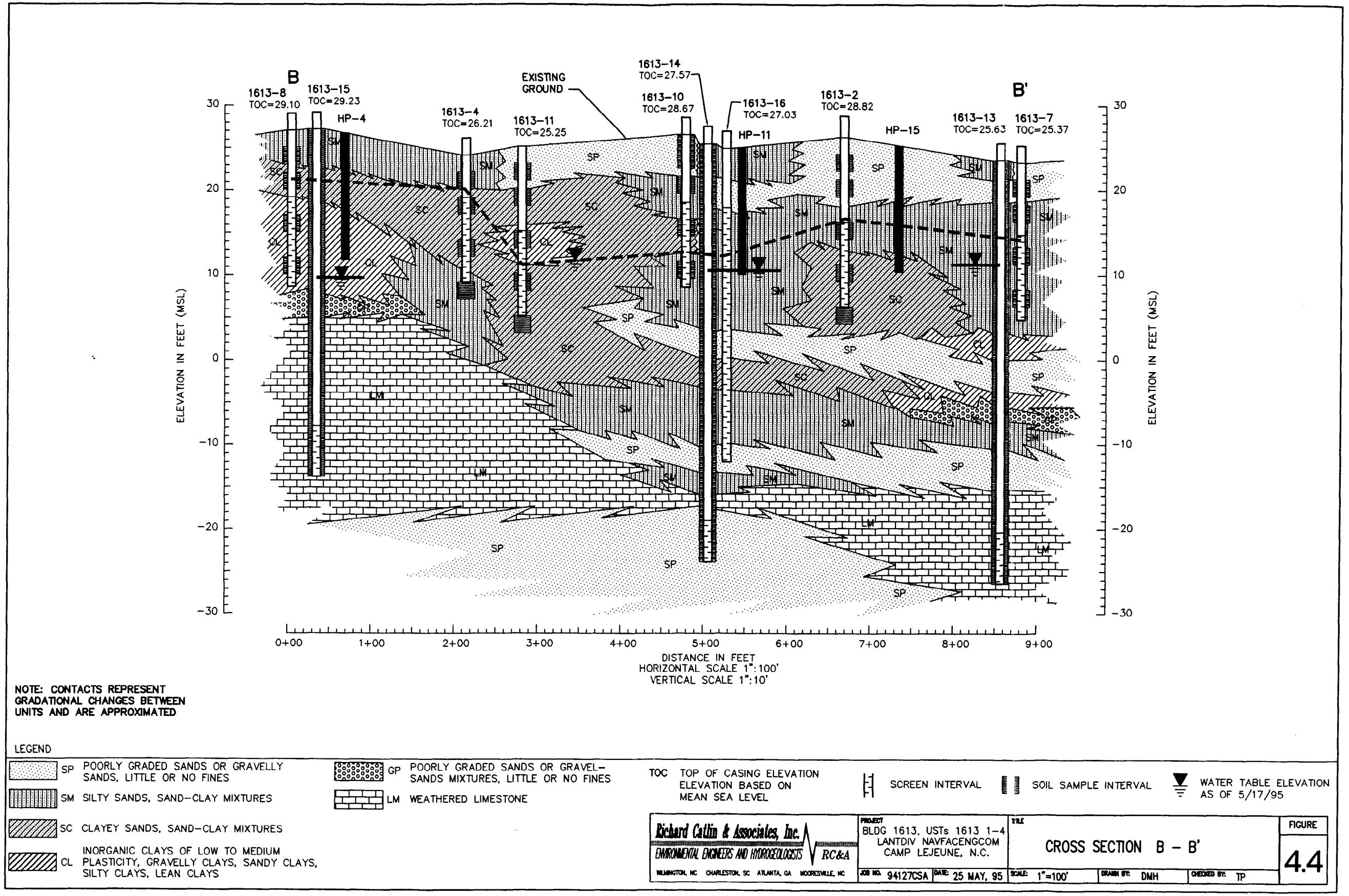


Figure 2-43

Building 1613 - Cross Section B - B'

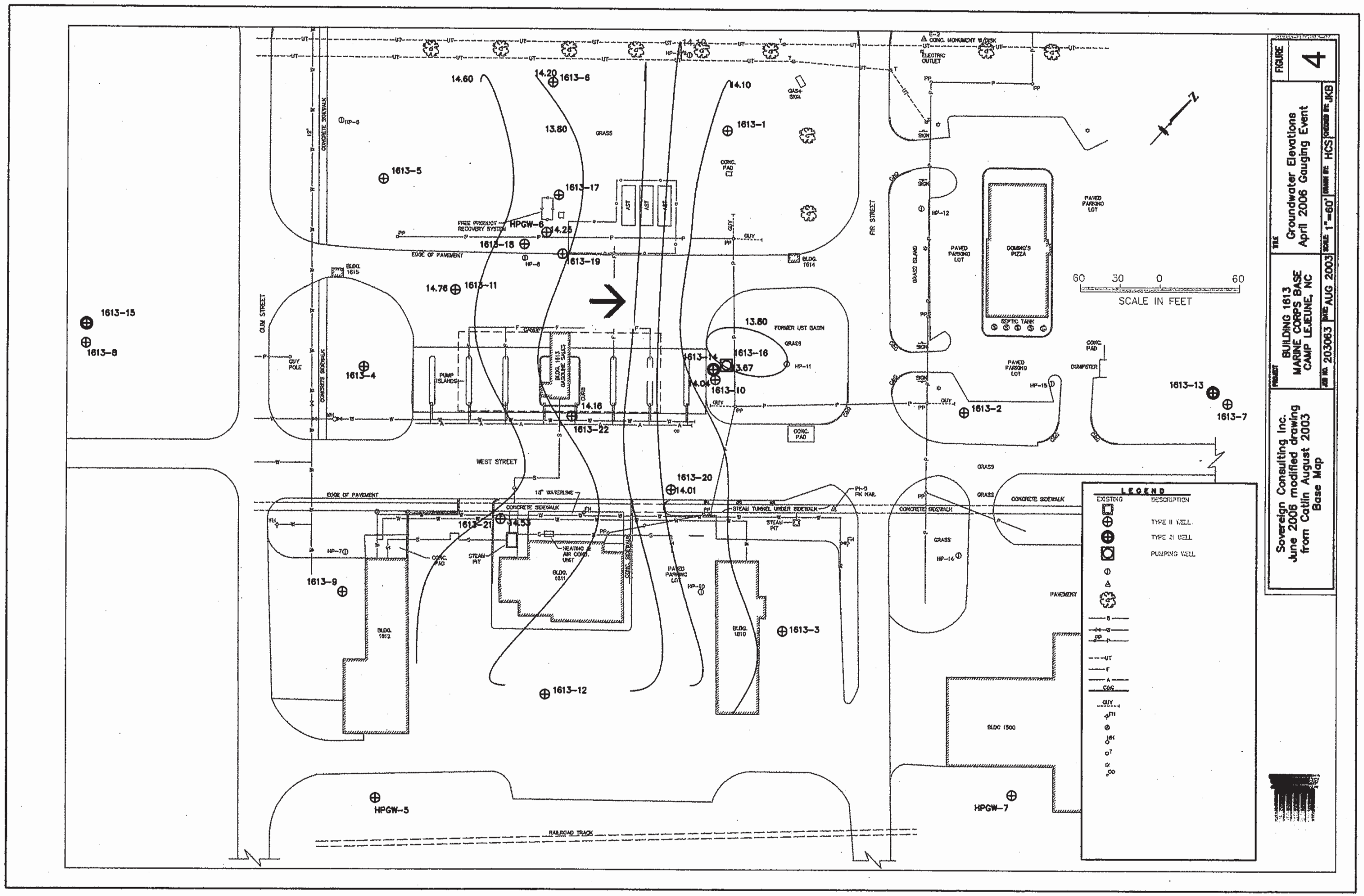
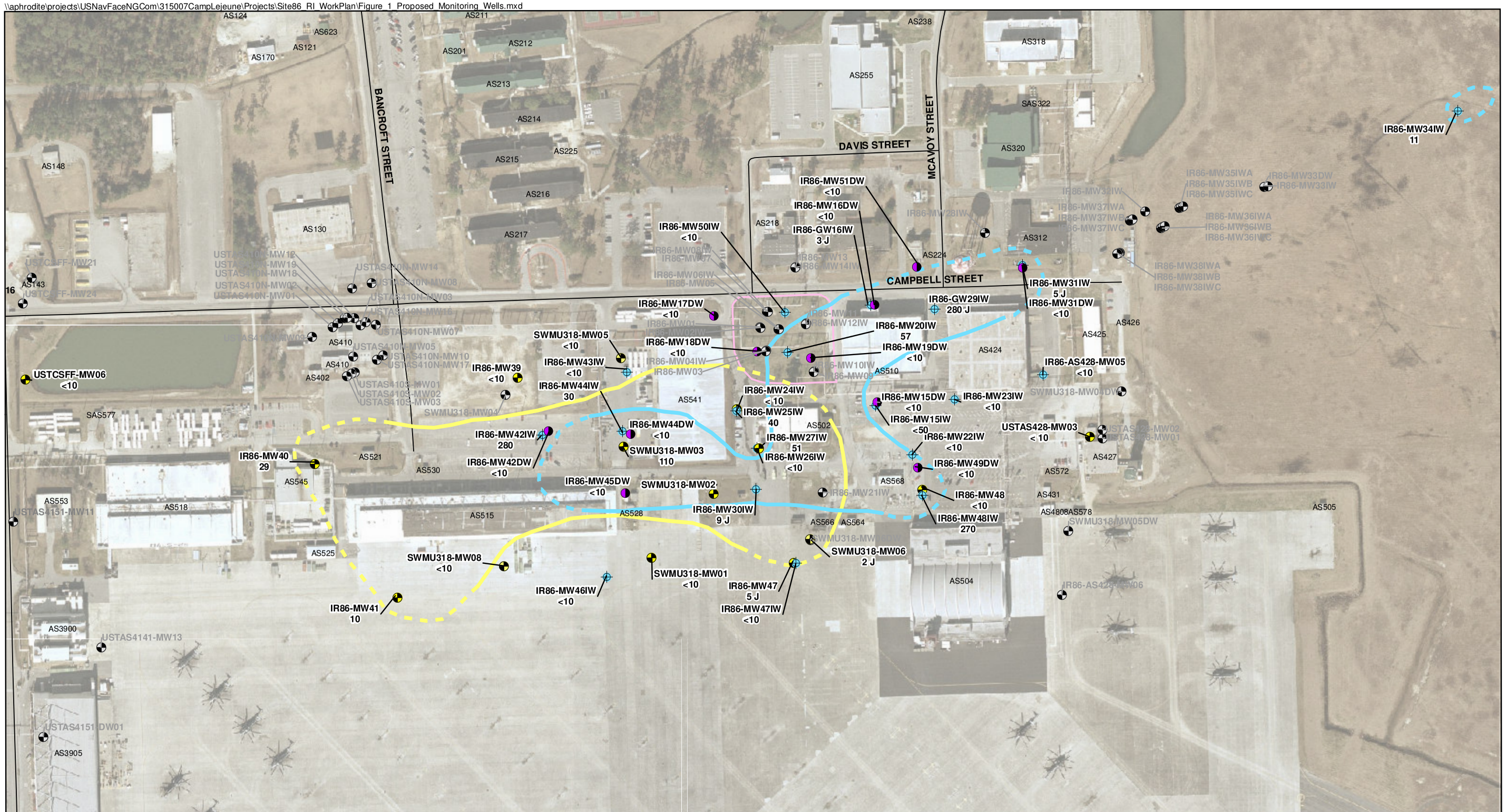


Figure 2-44
Building 1613 - Groundwater Contours

\\aphrodite\projects\USNavFaceNGCom\315007CampLejeune\Projects\Site86_RI_WorkPlan\Figure_1_Proposed_Monitoring_Wells.mxd



Legend

- Monitoring Wells - not sampled
- Shallow Monitoring Wells
- Intermediate Monitoring Wells
- Deep Monitoring Wells
- Original Site 86 Boundary
- Estimate of NCGWQS Exceedance for TCE- Intermediate
- Estimate of NCGWQS Exceedance for TCE- Shallow
- Note: Dashed where inferred

Notes:
TCE data collected in December 2007.
Monitoring wells IR86-MW42IW, IR86-MW44IW, IR86-MW47, and SWMU318-MW03 were resampled in February 2008.
All results are reported in µg/L.
J - Analytical result is estimated.
NCGWQS - North Carolina Groundwater Quality Standard

N

0 125 250 500 Feet

1 inch equals 250 feet

Figure 1
TCE Analytical Results
December 2007 and February 2008
Technical Memorandum - Site 86
Marine Corps Base, Camp Lejeune
North Carolina

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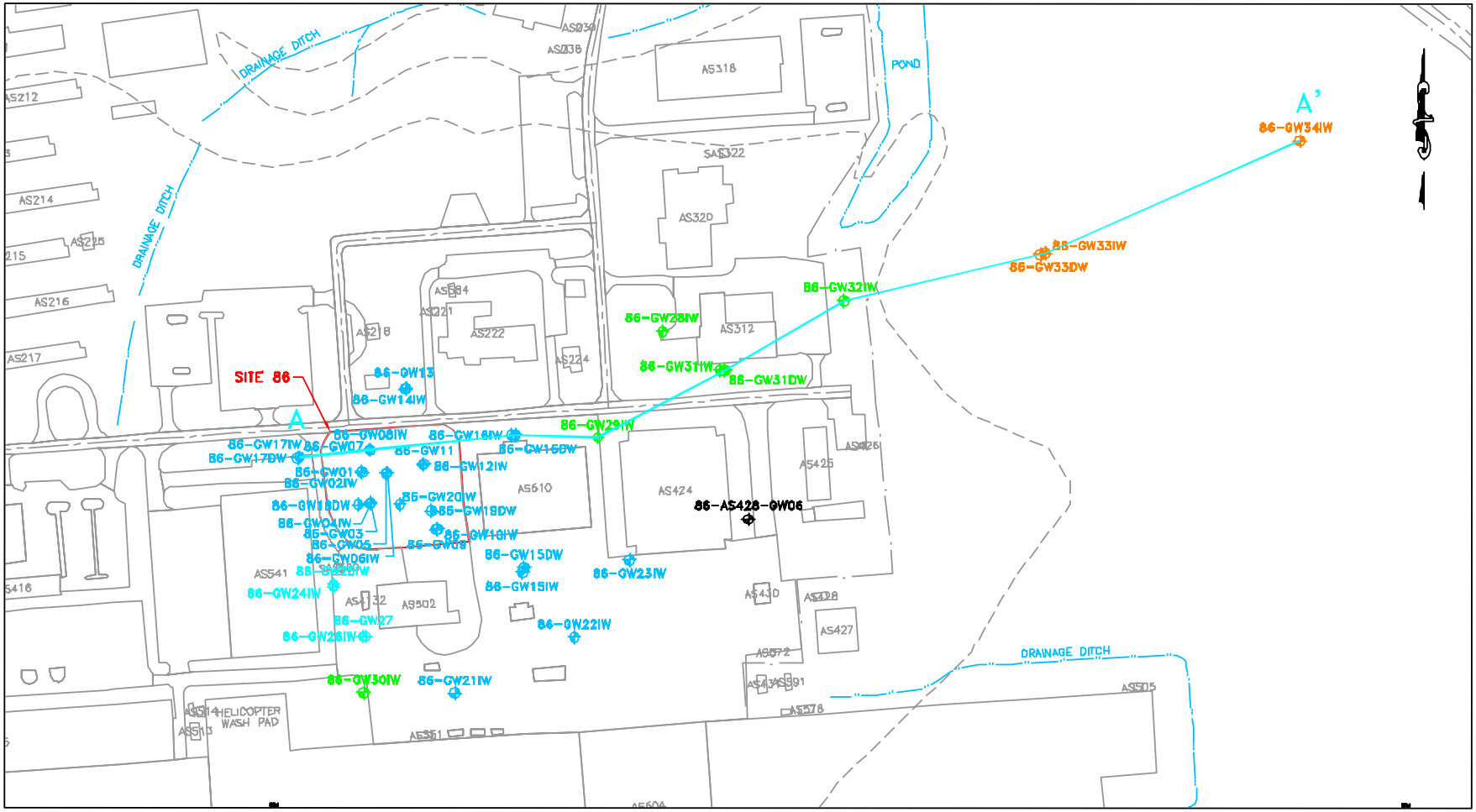
Figure 2-45
Site 86 - TCE Analytical Results



300 0 150 300
1 inch = 300 ft.

Baker
Baker Environmental, Inc.

SOURCE: MCB CAMP LEJEUNE, 2000.

LEGEND

- SHALLOW MONITORING WELL (RI – 1995)
- INTERMEDIATE MONITORING WELL (UST PROGRAM)
- INTERMEDIATE MONITORING WELL (RI – 1995)
- INTERMEDIATE MONITORING WELL (POST RI – 1997)
- INTERMEDIATE MONITORING WELL (AMENDED RI – 2002)
- DEEP MONITORING WELL (RI – 1995)
- DEEP MONITORING WELL (POST RI – 1995)
- DEEP MONITORING WELL (POST RI – 1997)
- DEEP MONITORING WELL (AMENDED RI – 2002)

FIGURE 2–3b
REVISED CROSS SECTION A–A'
OPERABLE UNIT No. 20 – SITE 86
AMENDED RI REPORT
CTO – 0191
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

2191424D

Figure 2-46

Site 86 - Cross Section - Location A - A'

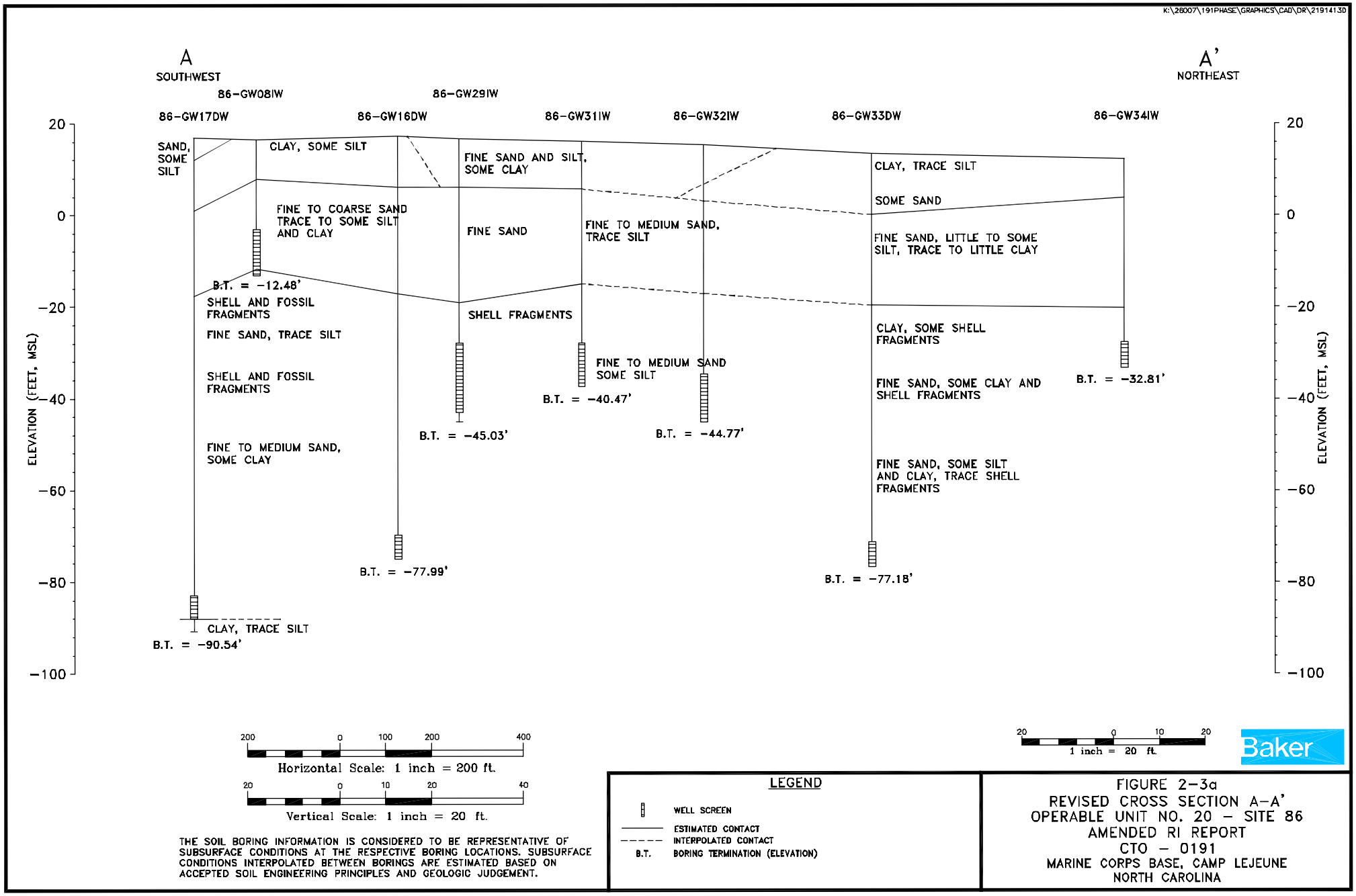


Figure 2-47

Site 86 - Cross Section A - A'

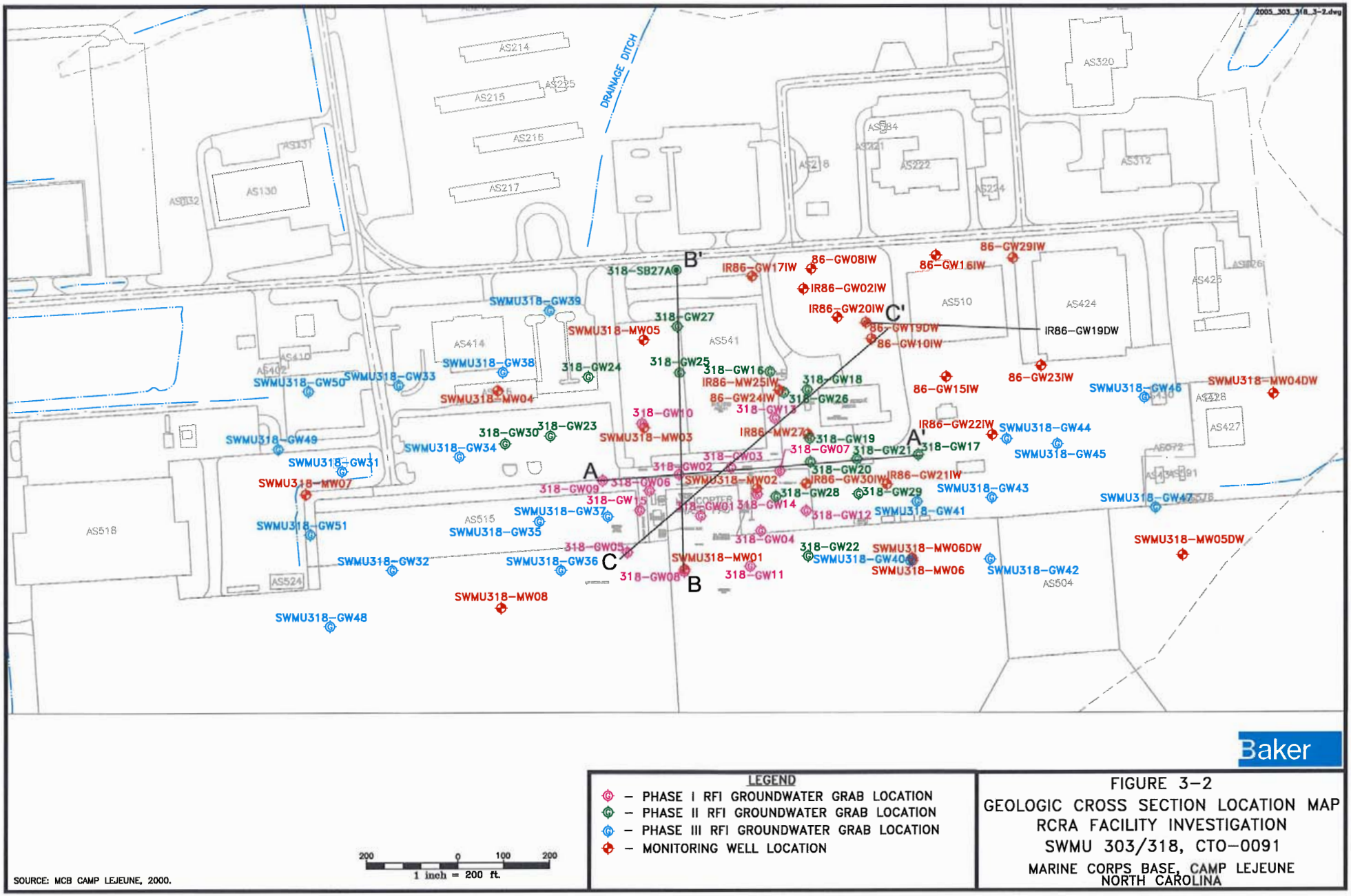


Figure 2-48

Site 86 - Cross Section - Location C - C'

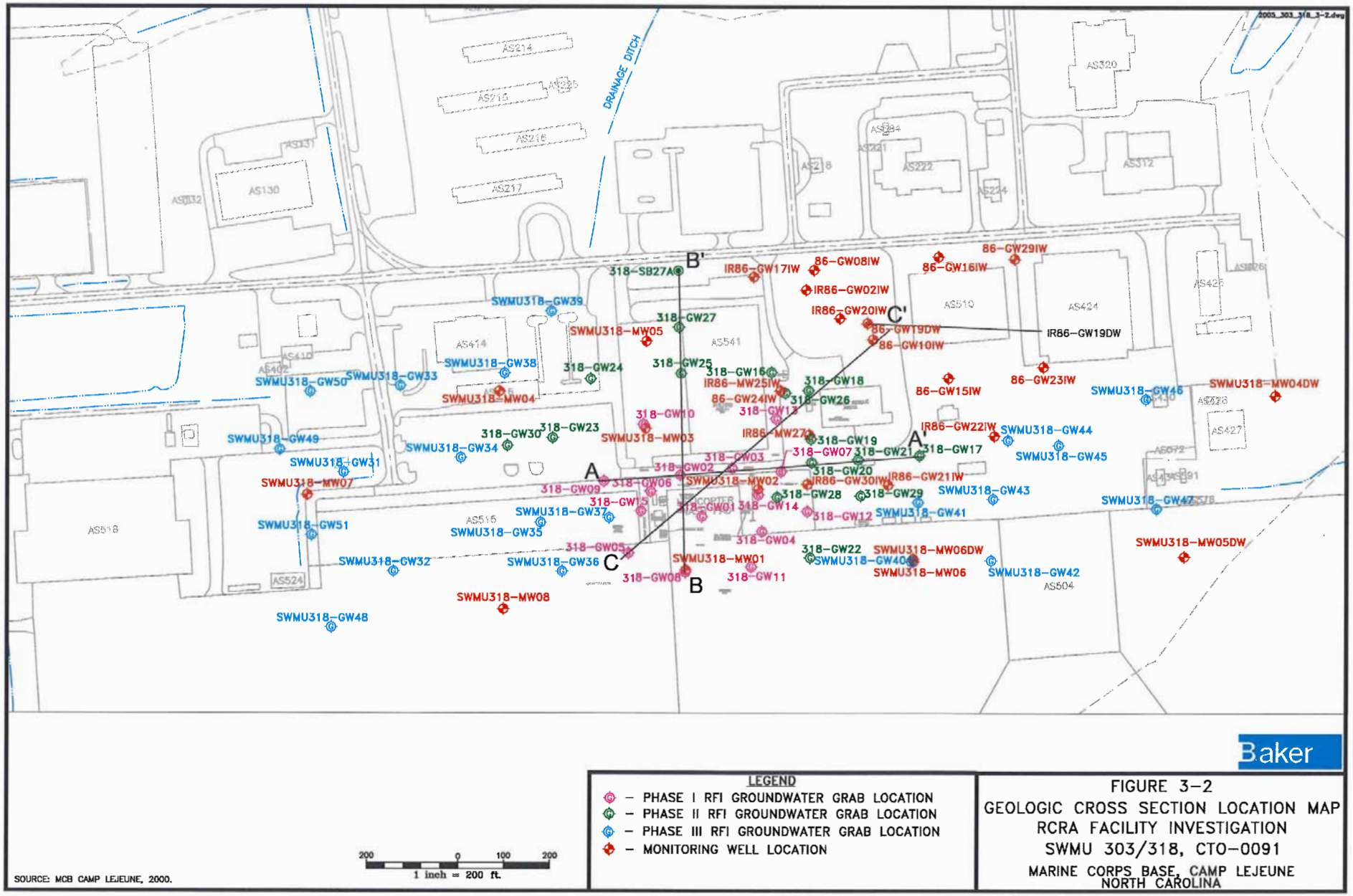


Figure 2-49

Site 86 - Cross Section C - C'

\\aphrodite\projects\USNavFaceNGCom\315007CampLejeune\Projects\Site86_RI_WorkPlan\Figure_1_Site_86_GW_Flow_Map.mxd

Legend

- Monitoring Well (screen interval not available)
- Shallow Monitoring Wells
- Intermediate Monitoring Wells
- Deep Monitoring Wells
- Public Water Supply Well
- Potentiometric Surface Contours
- Original Site 86 Boundary

N

0 125 250 500 Feet

1 inch equals 250 feet

Figure 1
Potentiometric Surface of the Surficial Aquifer
Operable Unit No. 20 (Site 86)
Supplemental Remedial Investigation
Marine Corps Base, Camp Lejeune
North Carolina

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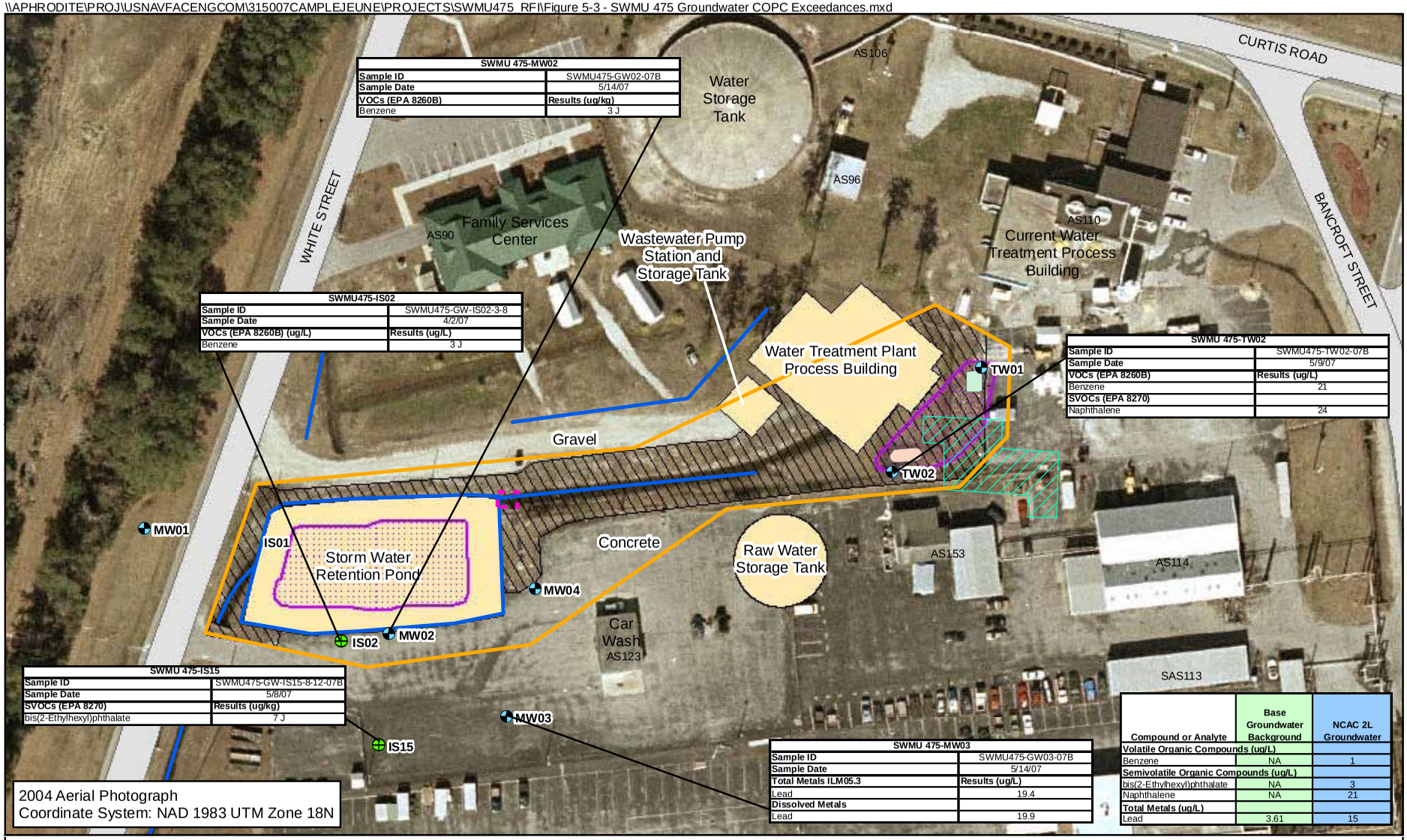
Figure 2-50

Site 86 - Potentiometric Surface of the Surficial Aquifer

\\APHRODITE\PROJ\USNAVFACENGCOM\315007CAMPLEJEUNE\PROJECTS\SWMU475_RFI\Figure 5-3 - SWMU 475 Groundwater COPC Exceedances.mxd



SWMU 475-MW02	
Sample ID	SWMU475-GW02-07B
Sample Date	5/14/07
VOCs (EPA 8260B)	Results (ug/kg)
Benzene	3 J

SWMU475-IS02	
Sample ID	SWMU475-GW-IS02-3-8
Sample Date	4/2/07
VOCs (EPA 8260B) (ug/L)	Results (ug/L)
Benzene	3 J

SWMU 475-TW02	
Sample ID	SWMU475-TW02-07B
Sample Date	5/9/07
VOCs (EPA 8260B)	Results (ug/L)
Benzene	21
SVOCs (EPA 8270)	
Naphthalene	24

SWMU 475-IS15	
Sample ID	SWMU475-GW-IS15-8-12-07B
Sample Date	5/8/07
SVOCs (EPA 8270)	Results (ug/kg)
bis(2-Ethylhexyl)phthalate	7 J

SWMU 475-MW03	
Sample ID	SWMU475-GW03-07B
Sample Date	5/14/07
Total Metals ILM05.3	Results (ug/L)
Lead	19.4
Dissolved Metals	
Lead	19.9

Compound or Analyte	Base Groundwater Background	NCAC 2L Groundwater
Volatile Organic Compounds (ug/L)		
Benzene	NA	1
Semivolatile Organic Compounds (ug/L)		
bis(2-Ethylhexyl)phthalate	NA	3
Naphthalene	NA	21
Total Metals (ug/L)		
Lead	3.61	15

Legend

- Monitoring Well Locations
- Soil Sample Locations
- Current Ditch Configuration
- New Construction
- Oil Drain Pans
- Buried Debris/Metal Shelf
- Roads
- Maintained Grass
- SWMU 475 Boundary
- Approximate Wetland Boundary
- Approximate 2006 Soil Removal Areas
- SWMU 299 Interim Soil Removal Area

N W E S

0 50 100 Feet

Figure 5-3
Groundwater COPC Exceedances
SWMU 475 RFI
MCB Camp Lejeune, North Carolina

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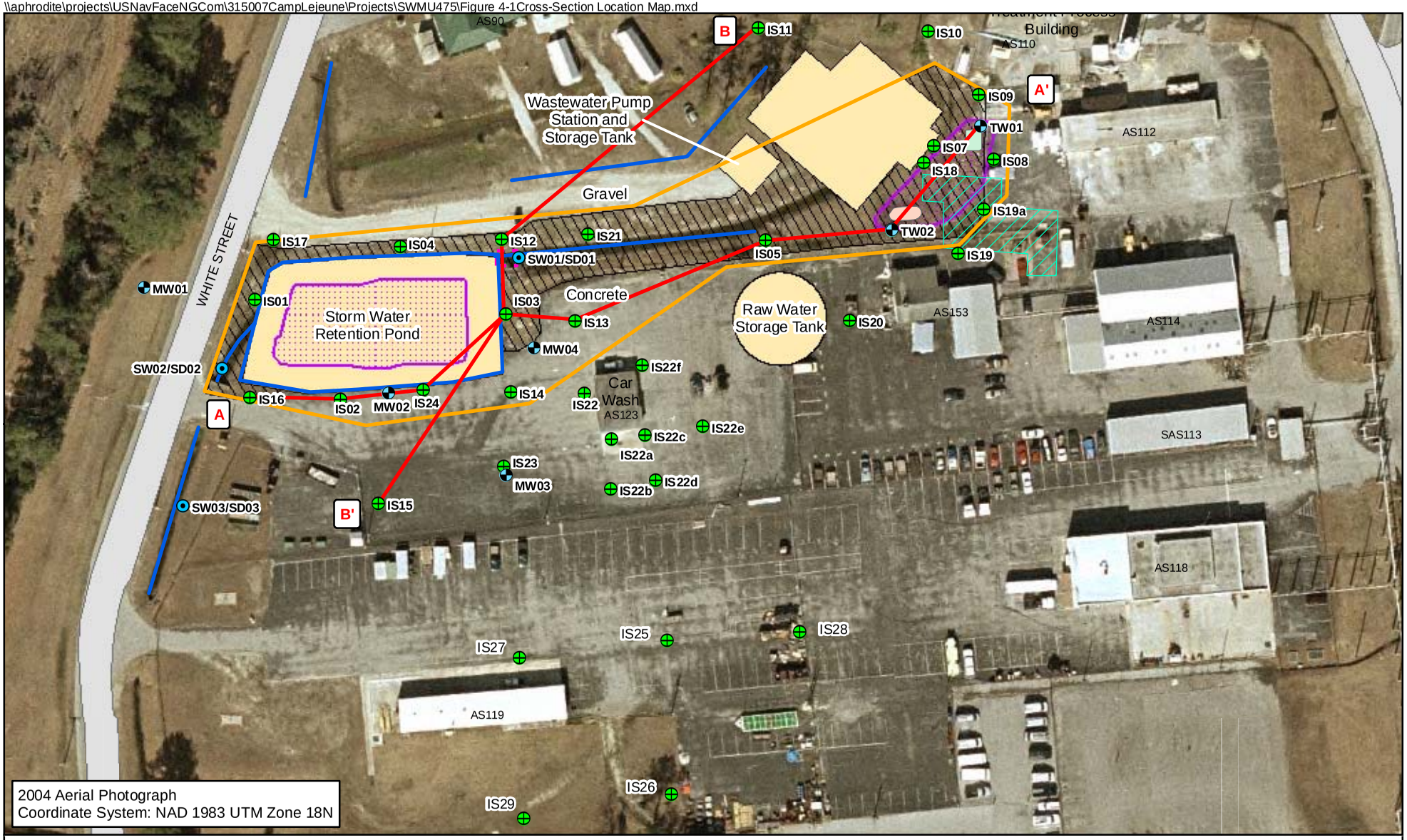
Figure 2-51

SWMU 475 - Groundwater Exceedances

\\aphrodite\projects\USNavFaceNGCom\315007CampLejeune\Projects\SWMU475\Figure 4-1Cross-Section Location Map.mxd



Legend

- Monitoring Well Locations
- 2007 Surface Water/Sediment Location
- 2007 Soil Sample Location used for Ecological Evaluation
- Cross Section Location
- Current Ditch Configuration
- New Construction
- Oil Drain Pans
- Buried Debris/Metal Shelf
- Roads
- Maintained Grass
- SWMU 475 Boundary
- Approximate Wetland Boundary
- Approximate 2006 Soil Removal Areas
- SWMU 299 Interim Soil Removal Area

N W E S

0 50 100 Feet

Figure 4-1
Cross-Section Location Map
SWMU 475 RFI
MCB Camp Lejeune, North Carolina

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Figure 2-52

SWMU 475 - Cross Section - Locations

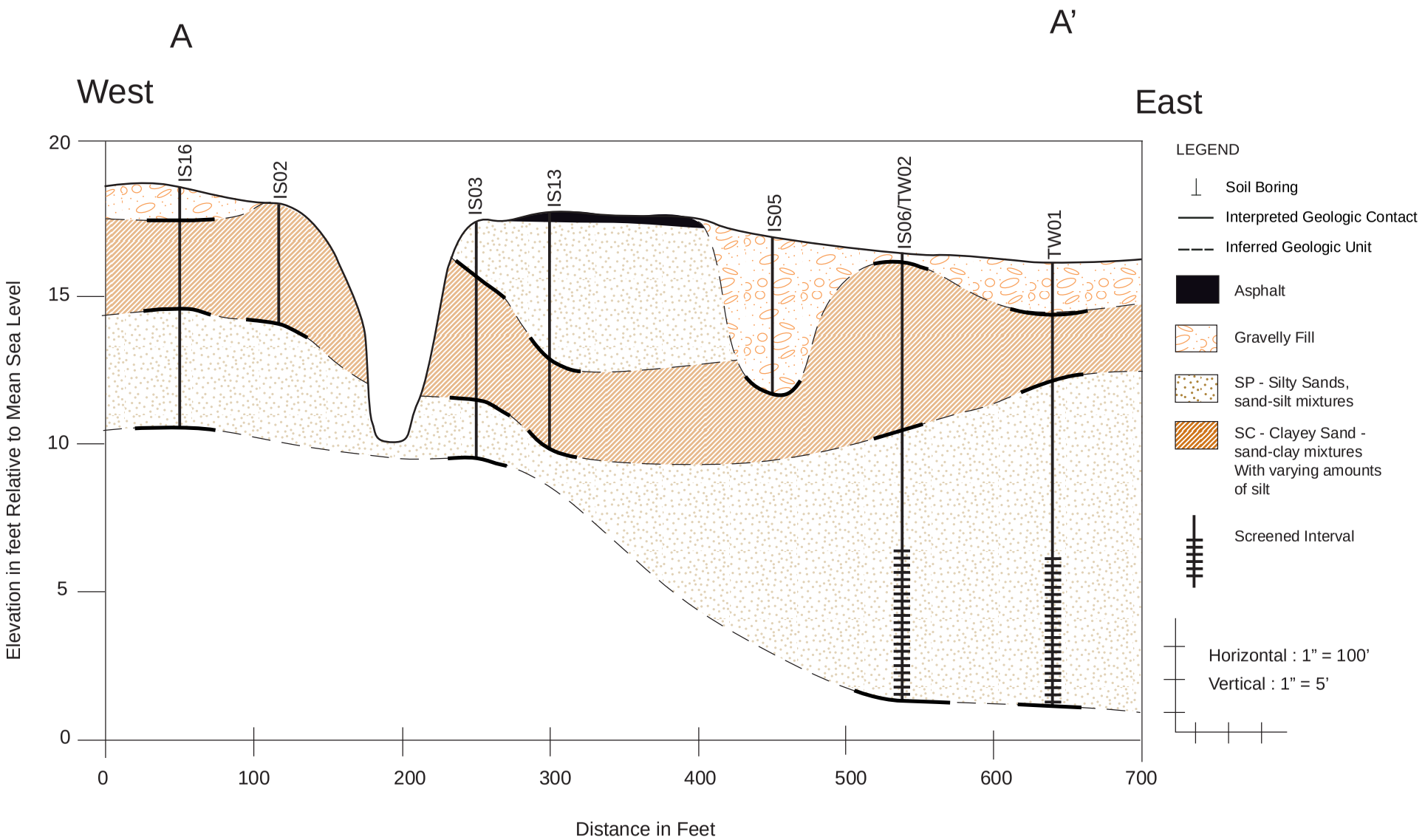

FIGURE 4-2
Geologic Cross-Section A-A' "
Marine Corps Base, Camp Lejeune
North Carolina

ES102007022WDC

CH2MHILL

Figure 2-53
SWMU 475 Cross Section A - A'

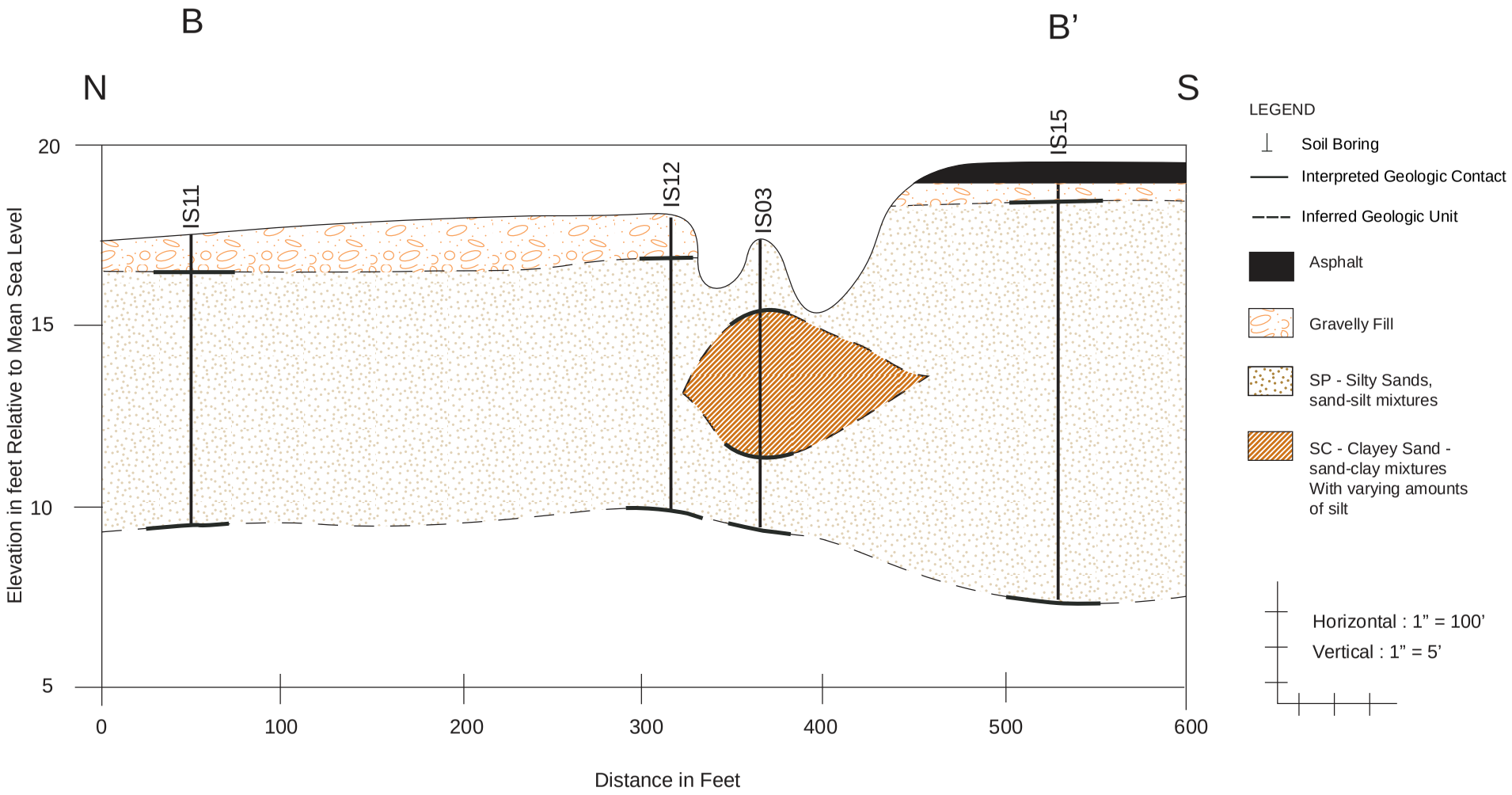

FIGURE 4-3
Geologic Cross-Section B-B' "
Marine Corps Base, Camp Lejeune
North Carolina

ES102007022WDC

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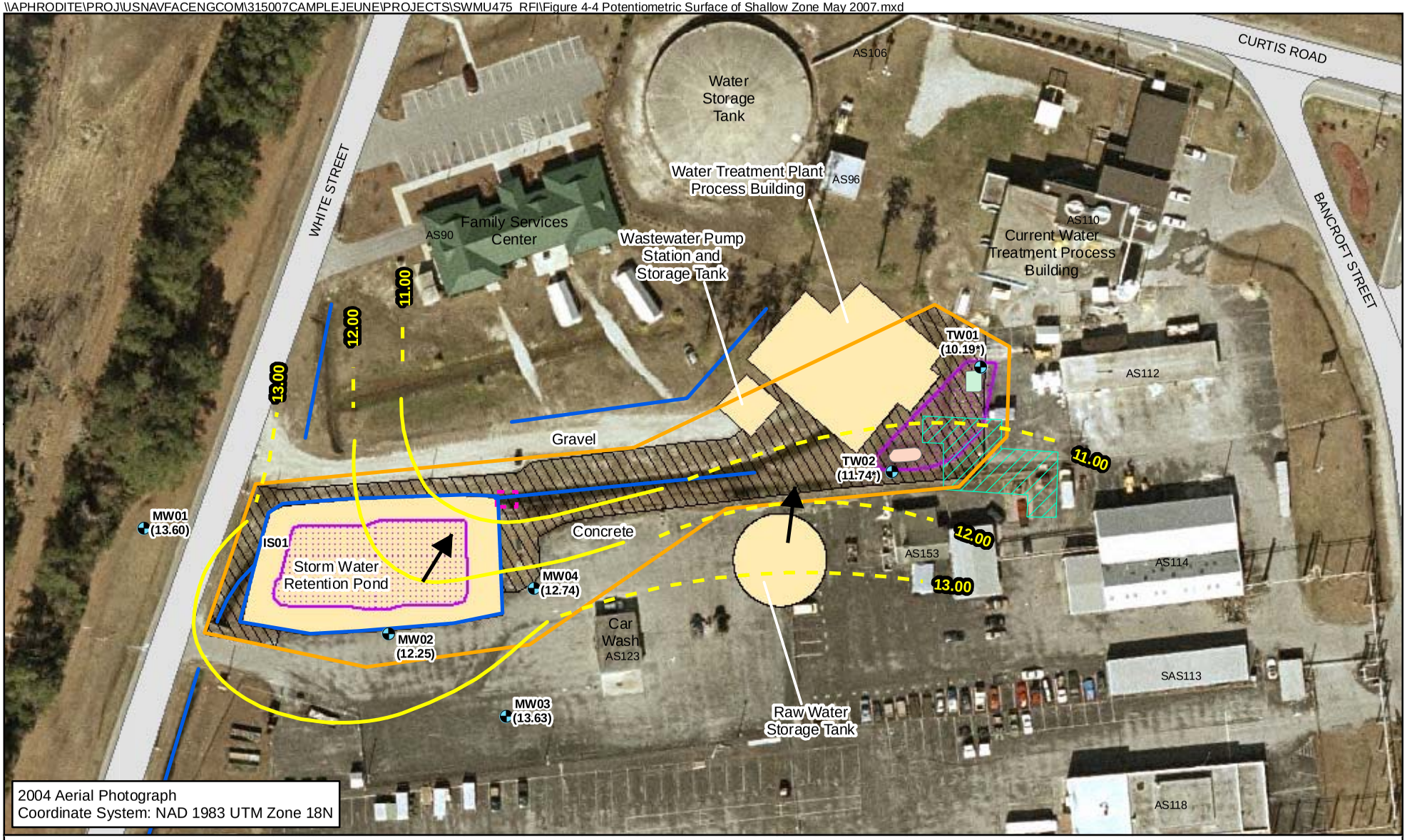
Figure 2-54
SWMU 475 - Cross Section B - B'

\\APHRODITE\PROJ\USNAVFACENGCOM\315007CAMPLEJEUNE\PROJECTS\SWMU475_RFI\Figure 4-4 Potentiometric Surface of Shallow Zone May 2007.mxd



Legend

- Monitoring Well Locations
- Current Ditch Configuration
- Potentiometric Surface of Shallow Zone
- Inferred Potentiometric Surface of Shallow Zone
- New Construction
- Oil Drain Pans
- Buried Debris/Metal Shelf
- Roads
- Maintained Grass
- SWMU 475 Boundary
- Approximate Wetland Boundary
- Approximate 2006 Soil Removal Areas
- SWMU 299 Interim Soil Removal Area

N W E S

0 50 100 Feet

Figure 4-4
Potentiometric Surface of Shallow Zone May 2007
SWMU 475 RFI
MCB Camp Lejeune, North Carolina

CH2MHILL

Figure 2-55

SWMU 475 - Potentiometric Surface of Shallow Zone May 2007

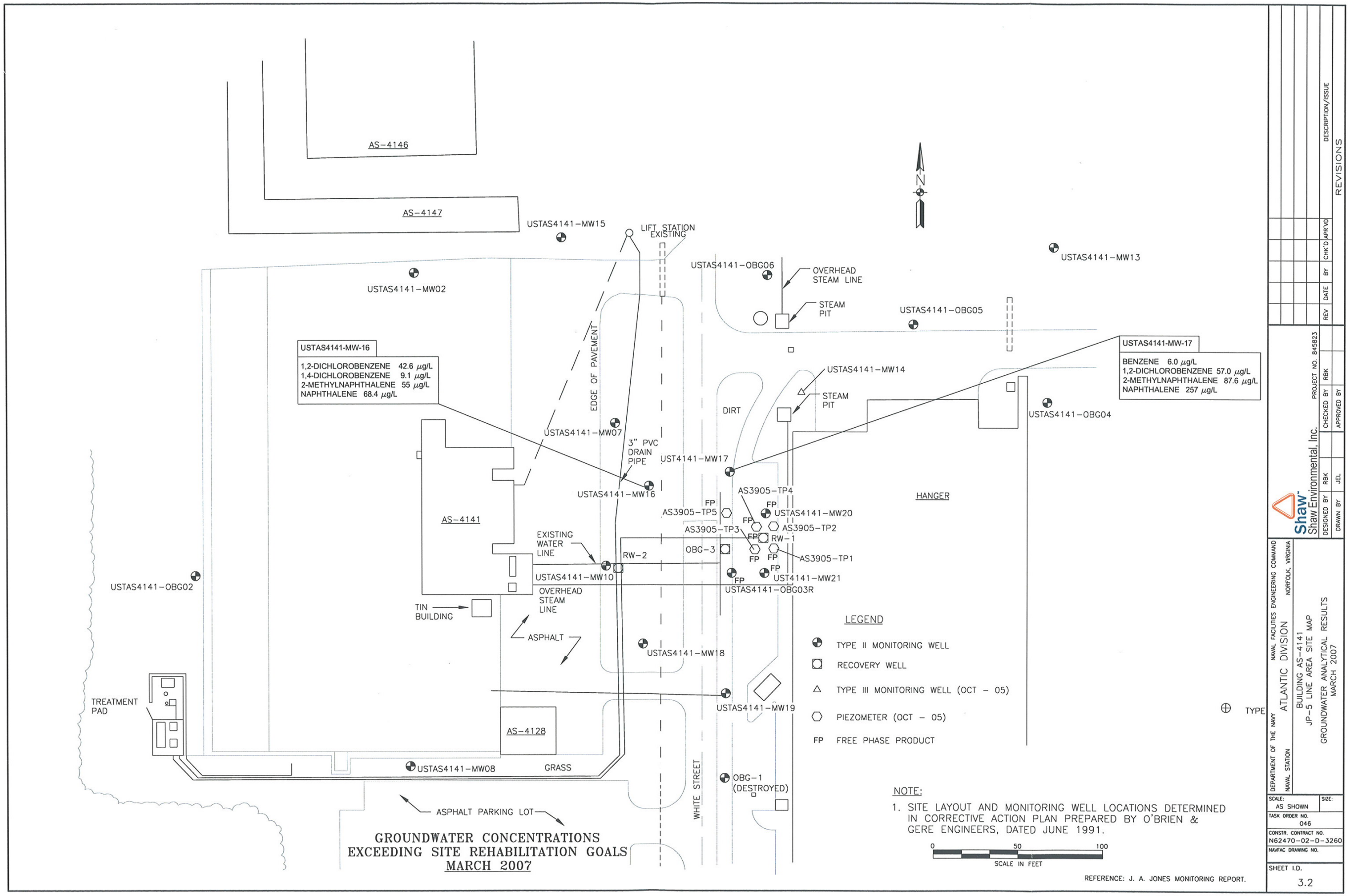


Figure 2-56

UST AS-4141 - JP-5 Line Area Site Map, Groundwater Analytical Results

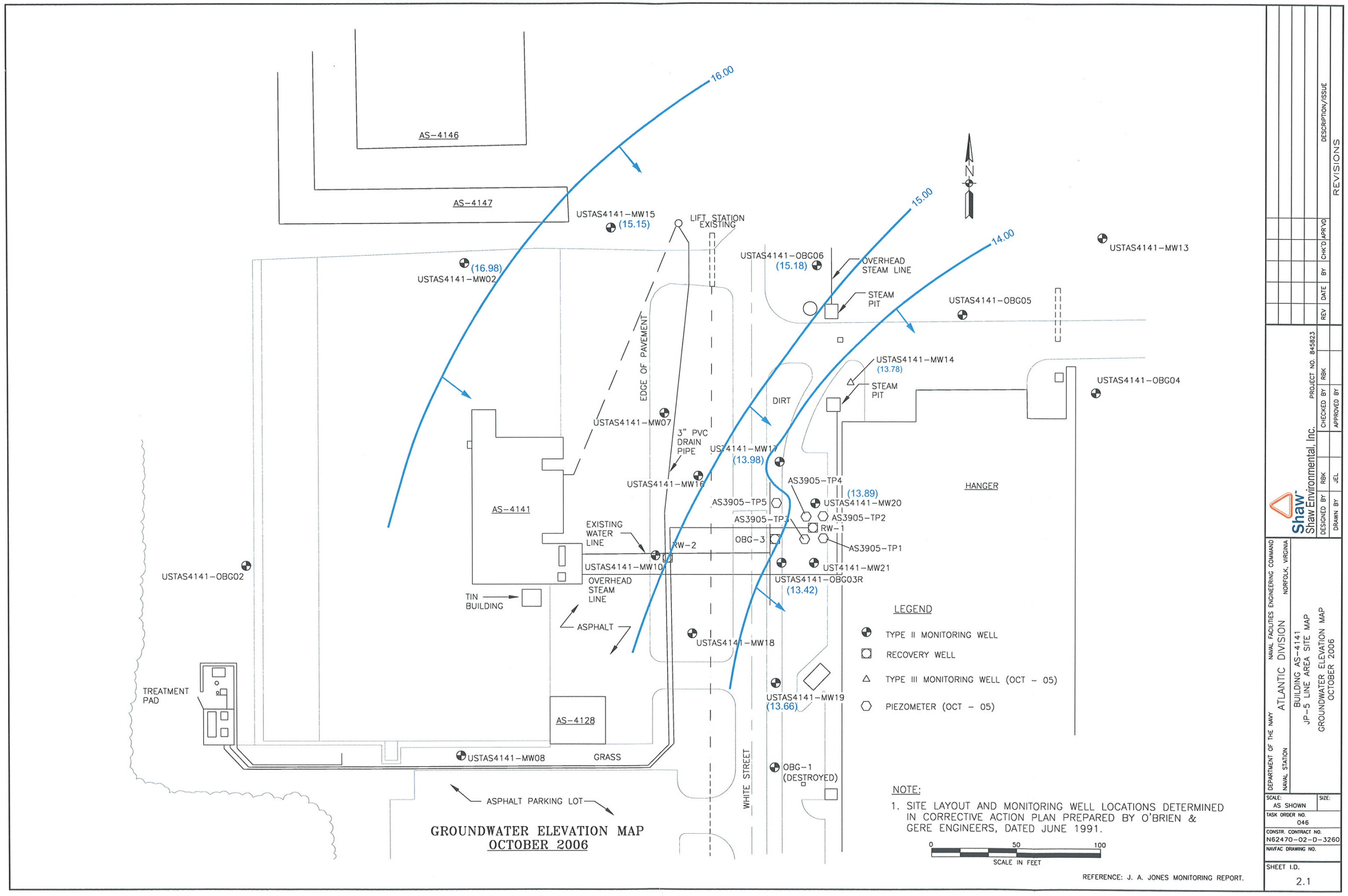


Figure 2-57

UST AS-4141 - JP-5 Line Item Site Map, Groundwater Elevation Map

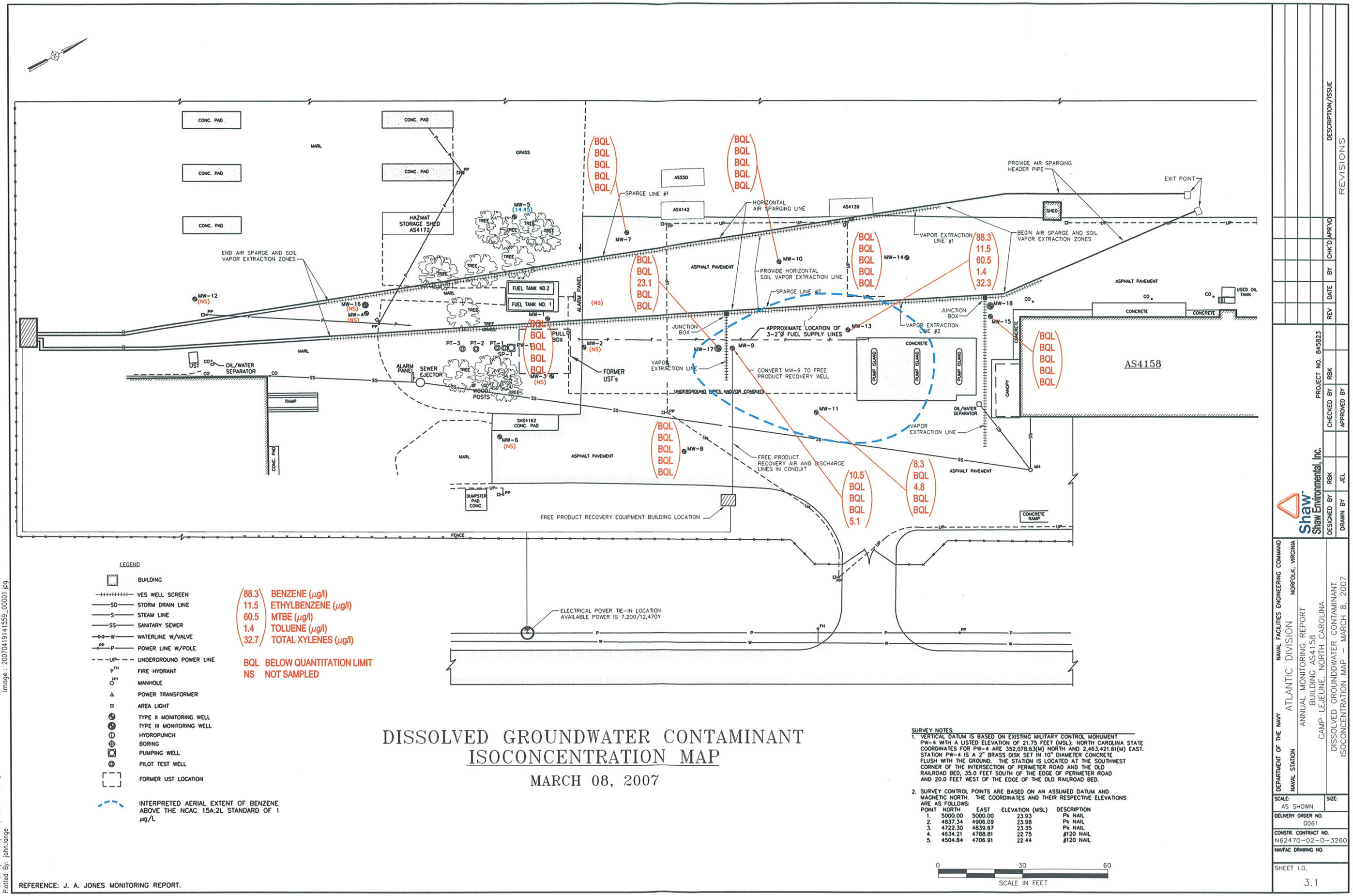
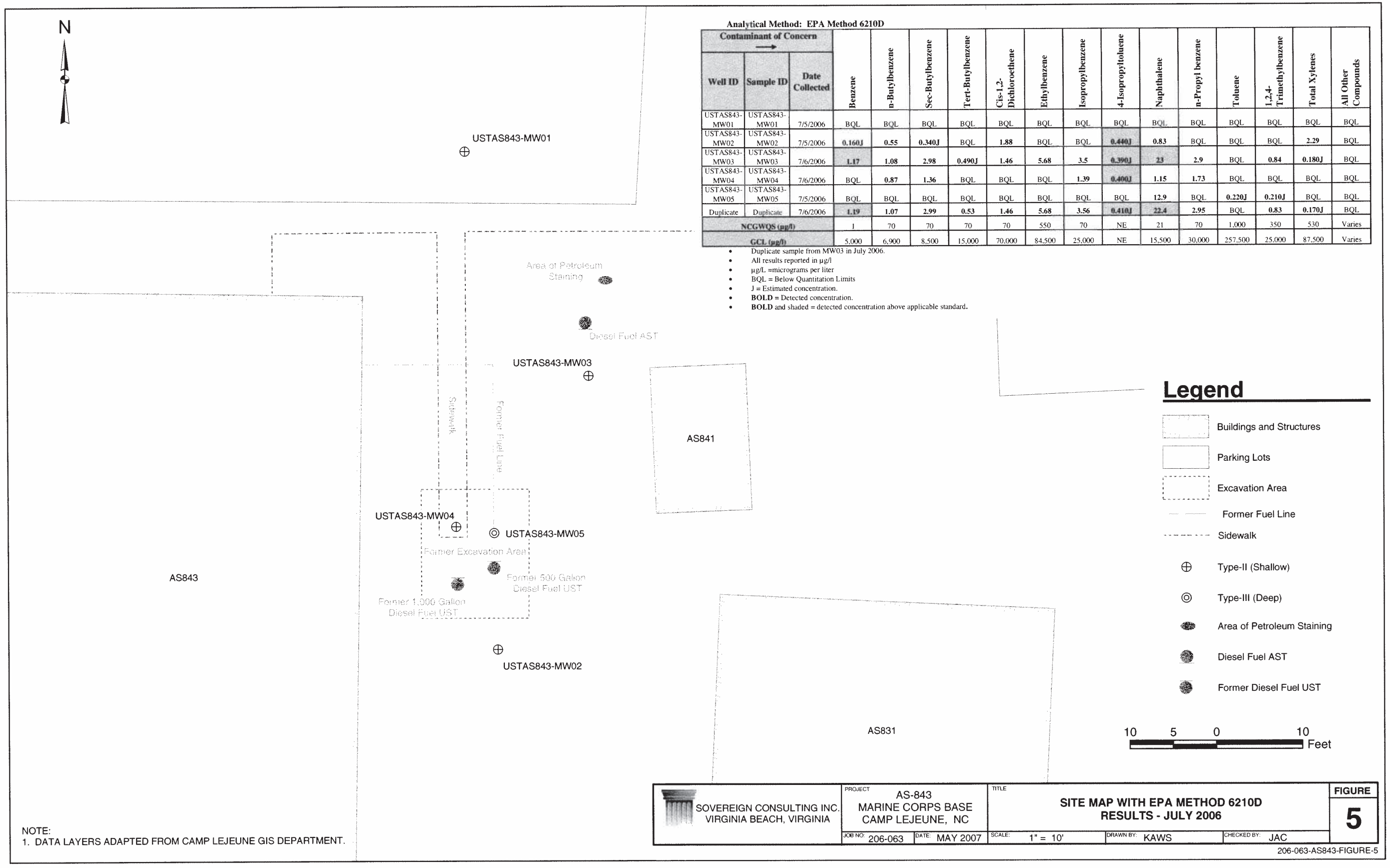


Figure 2-58

USTAS-4158 - Dissolved Groundwater Contaminant Isoconcentration Map



Analytical Method: EPA Method 6210D

Contaminant of Concern →			Benzene	n-Butylbenzene	Sec-Butylbenzene	Tert-Butylbenzene	Cis-1,2-Dichloroethene	Ethylbenzene	Isopropylbenzene	4-Isopropyltoluene	Naphthalene	n-Propyl benzene	Toluene	1,2,4-Trimethylbenzene	Total Xylenes	All Other Compounds
Well ID	Sample ID	Date Collected														
USTAS843-MW01	USTAS843-MW01	7/5/2006	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
USTAS843-MW02	USTAS843-MW02	7/5/2006	**0.160J**	**0.55**	**0.340J**	BQL	**1.88**	BQL	BQL	**0.440J**	**0.83**	BQL	BQL	BQL	**2.29**	BQL
USTAS843-MW03	USTAS843-MW03	7/6/2006	**1.17**	**1.08**	**2.98**	**0.490J**	**1.46**	**5.68**	**3.5**	**0.390J**	**23**	**2.9**	BQL	**0.84**	**0.180J**	BQL
USTAS843-MW04	USTAS843-MW04	7/6/2006	BQL	**0.87**	**1.36**	BQL	BQL	BQL	**1.39**	**0.400J**	**1.15**	**1.73**	BQL	BQL	BQL	BQL
USTAS843-MW05	USTAS843-MW05	7/5/2006	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	**12.9**	BQL	**0.220J**	**0.210J**	BQL	BQL
Duplicate	Duplicate	7/6/2006	**1.19**	**1.07**	**2.99**	**0.53**	**1.46**	**5.68**	**3.56**	**0.410J**	**22.4**	**2.95**	BQL	**0.83**	**0.170J**	BQL
NCGWQS (µg/l)			1	70	70	70	70	550	70	NE	21	70	1,000	350	530	Varies
GCL (µg/l)			5,000	6,900	8,500	15,000	70,000	84,500	25,000	NE	15,500	30,000	257,500	25,000	87,500	Varies

- Duplicate sample from MW03 in July 2006.
- All results reported in µg/l
- µg/L =micrograms per liter
- BQL = Below Quantitation Limits
- J = Estimated concentration.
- **BOLD** = Detected concentration.
- **BOLD** and shaded = detected concentration above applicable standard.

Figure 2-59
UST AS 843 - Site Map with EPA Method 6210D Results - July 2006

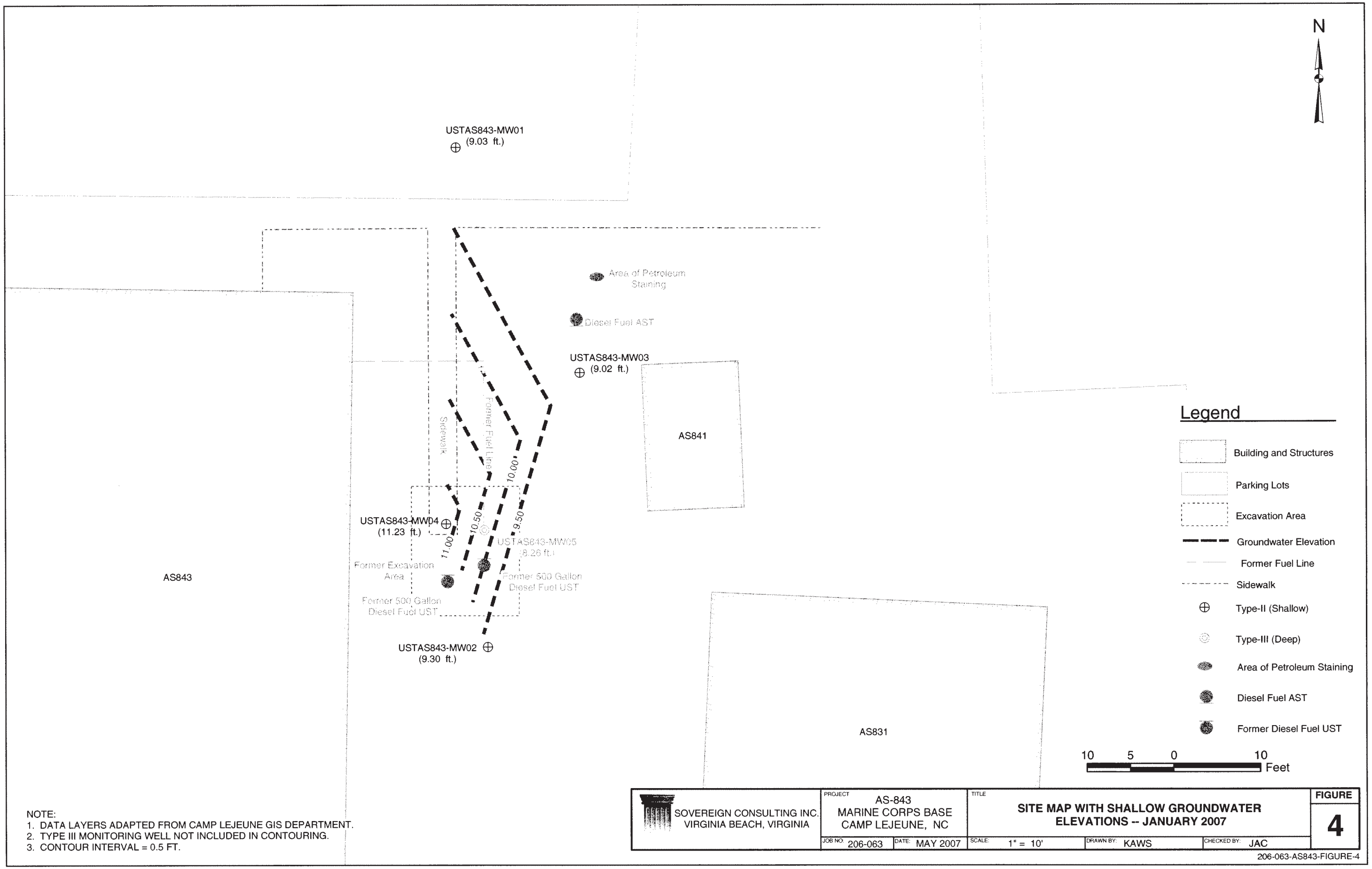


Figure 2-60

UST AS-843 - Site Map with Shallow Groundwater Elevations - January 2007

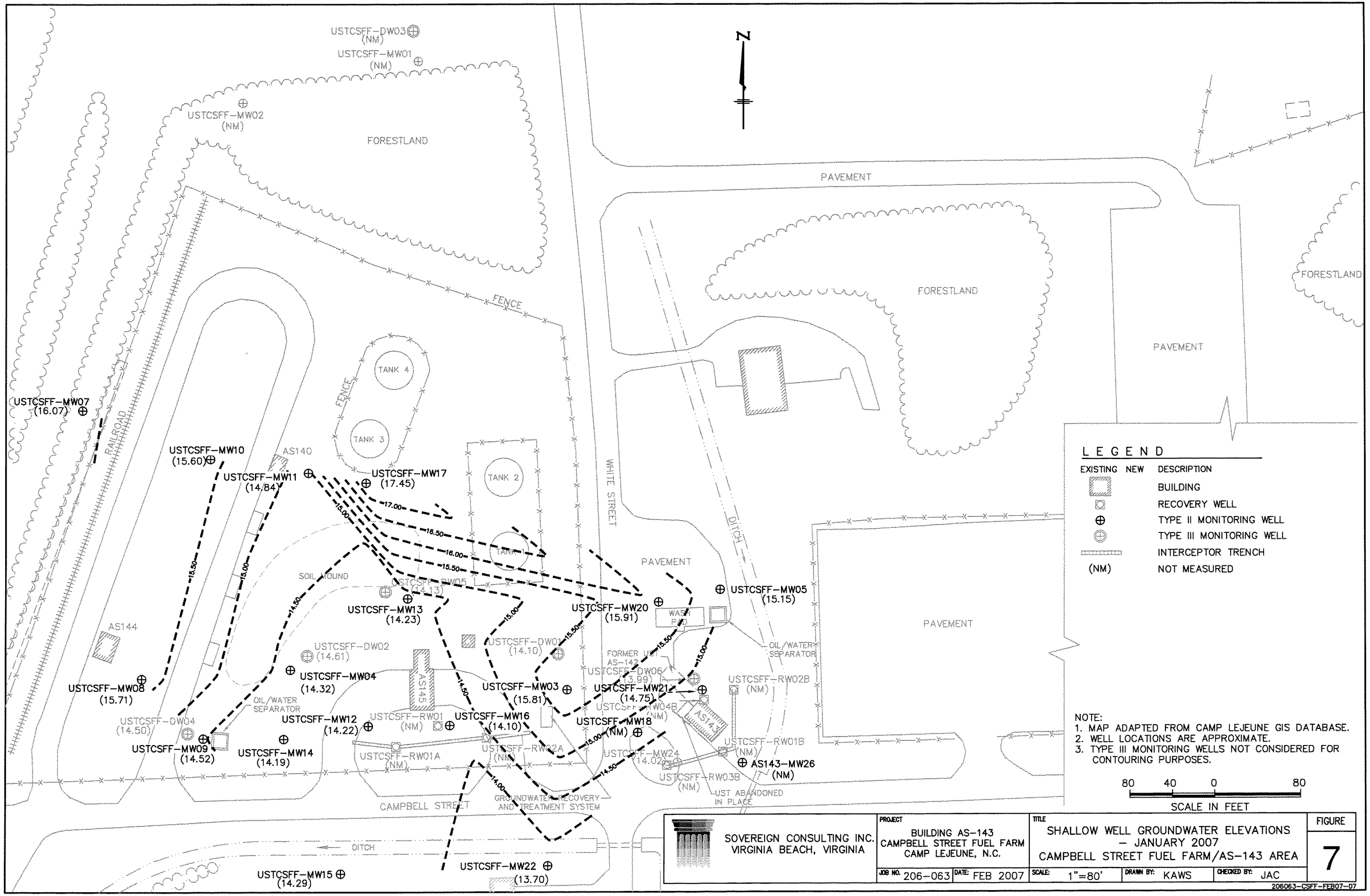


Figure 2-61

USTCSFF - Shallow Well Groundwater Elevations, January 2007

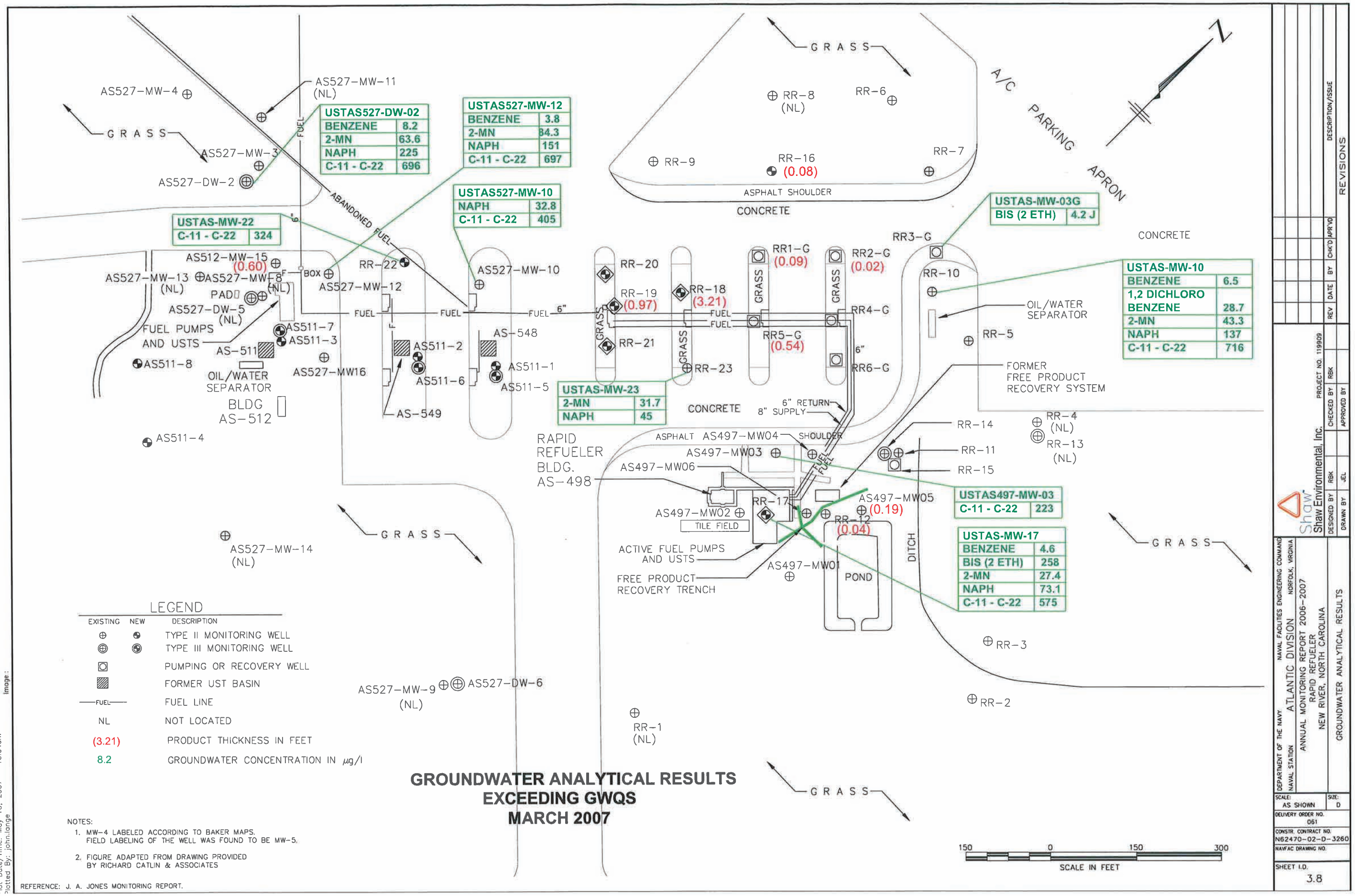


Figure 2-62
USTRR - Groundwater Analytical Results Exceeding GWQS March 2007

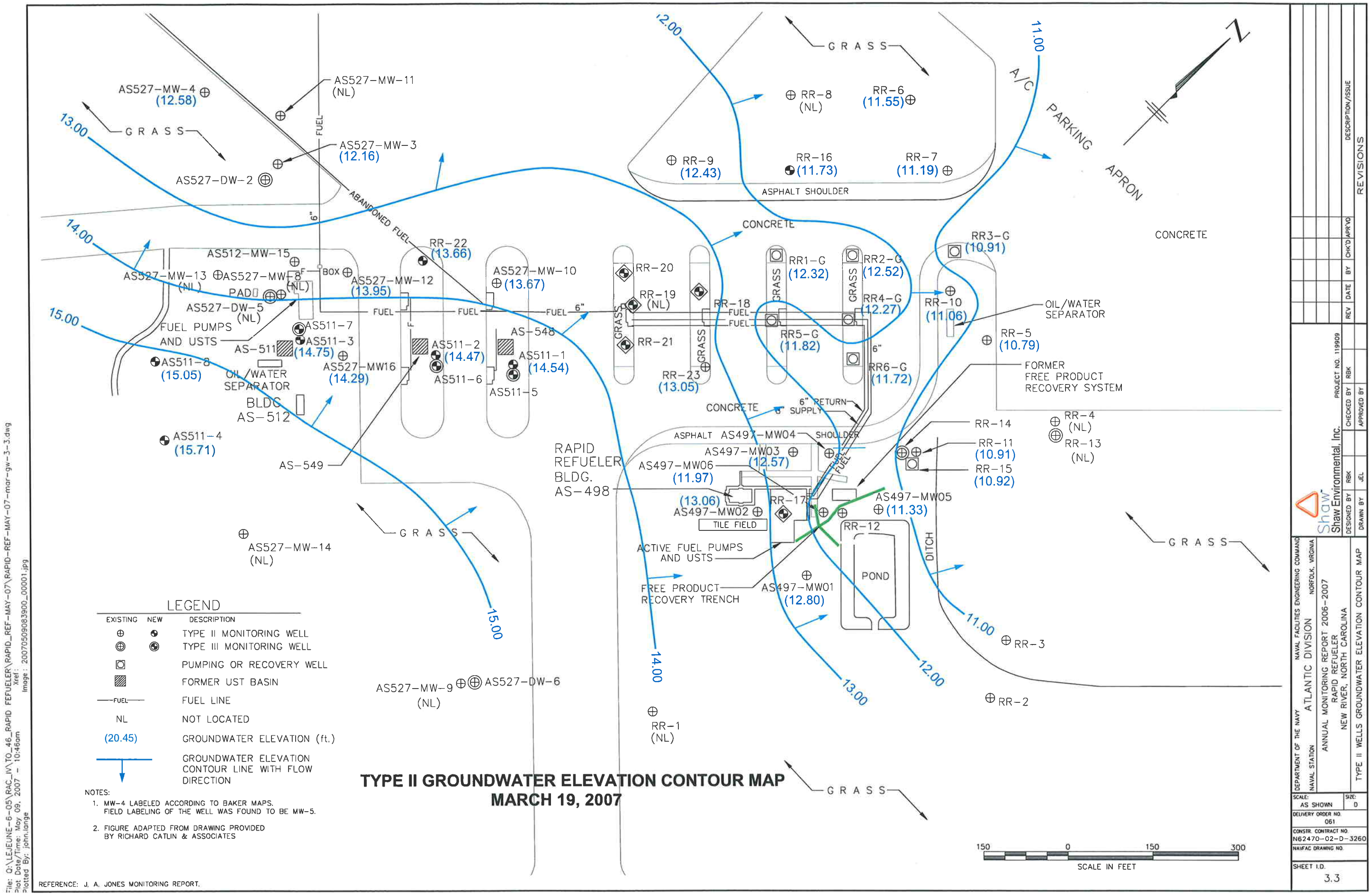


Figure 2-63
USTRR - Type II Groundwater Elevation Contour Map - March 2007

\\aphrodite\Proj\USNavFacEngCom\315007CampLejeune\Projects\Site73_SRI\Figure_5_2_Approx_Extents_TCE_Impacts_April2006.mxd 02/07/08 RHURSEY

Well ID	TCE
IR73-A47/3-09	3.1
IR73-A47/3-12	0.5 U
IR73-A47/3-15	0.5 U
IR73-A47/3-16	0.5 U
IR73-A47/3-19	0.5 U
IR73-A47/3-22	0.5 U
IR73-A47/3-8	0.5 U
IR73-MW01	0.5 U
IR73-MW02	0.5 U
IR73-MW02IW	0.32 J
IR73-MW03	0.5 U
IR73-MW06	0.5 U
IR73-MW08	0.5 U
IR73-MW09	0.5 U
IR73-MW10	0.5 U
IR73-MW11	0.62
IR73-MW12	0.5 U
IR73-MW13	0.5 U
IR73-MW15	0.5 U
IR73-MW15N	0.5 U
IR73-MW16	0.5 U
IR73-MW17	0.5 U
IR73-MW18	0.5 U
IR73-MW19	0.5 U
IR73-MW20	0.5 U
IR73-MW21	0.5 U
IR73-MW23	0.5 U
IR73-MW25	0.5 U
IR73-MW27	0.5 U
IR73-MW28	0.5 U
IR73-MW29	0.5 U
IR73-MW30	0.5 U
IR73-MW31	0.5 U
IR73-MW34	0.5 U
IR73-MW35	1.5
IR73-MW54	0.5 U
IR73-MW55	0.5 U
IR73-MW56	0.5 U
IR73-MW58	0.5 U
IR73-MW61	0.5 U
IR73-MW62DW	0.5 U

Well ID	TCE
IR73-MW01DW	0.5 U
IR73-MW01IW	0.5 U
IR73-MW06IW	0.5 U
IR73-MW11DW	0.5 U
IR73-MW11IW	0.5 U
IR73-MW13DW	200
IR73-MW15IW	0.5 U
IR73-MW17DW	0.5 U
IR73-MW20DW	0.5 U
IR73-MW26DW	0.5 U
IR73-MW27DW	52
IR73-MW31DW	0.5 U
IR73-MW33DW	0.5 U
IR73-MW34DW	0.5 U
IR73-MW35DW	0.5 U
IR73-MW38DW	0.5 U
IR73-MW39DW	20 J
IR73-MW40DW	0.5 U
IR73-MW41DW	0.5 U
IR73-MW42DW	0.5 U
IR73-MW43DW	0.5 U
IR73-MW44DW	290
IR73-MW45DW	7.1
IR73-MW46DW	9
IR73-MW47DW	1.8
IR73-MW48DW	82
IR73-MW49DW	840
IR73-MW49DWA	0.5 U
IR73-MW49IW	170
IR73-MW50DW	0.5 U
IR73-MW51	0.5 U
IR73-MW51DW	0.5 U
IR73-MW52	0.5 U
IR73-MW52DW	0.87
IR73-MW53	0.5 U
IR73-MW63DW	520

Legend

- Monitoring Wells
- Base Boundary
- Groundwater impacted above NC 2L Groundwater Quality Standard (> 2.8 µg/L)

U Not Detected
J Estimated Value

Note:
All concentrations are reported in µg/L. Isoconcentration lines have been interpolated between monitoring well locations. Actual conditions may differ from those shown on this figure. Extent of contamination is approximate and is based on analytical data collected from monitoring wells screened at multiple depths in both the surficial and deep aquifers. Additional information illustrating the horizontal and vertical extent of impacts is provided in plume cross sectional views.

N

0 400 800 Feet

1 inch equals 400 feet

Figure 5-1
Approximate Extents of TCE Impacts, April 2006
Operable Unit No. 21 (Site 73)
Supplemental Remedial Investigation
Marine Corps Base, Camp Lejeune
North Carolina

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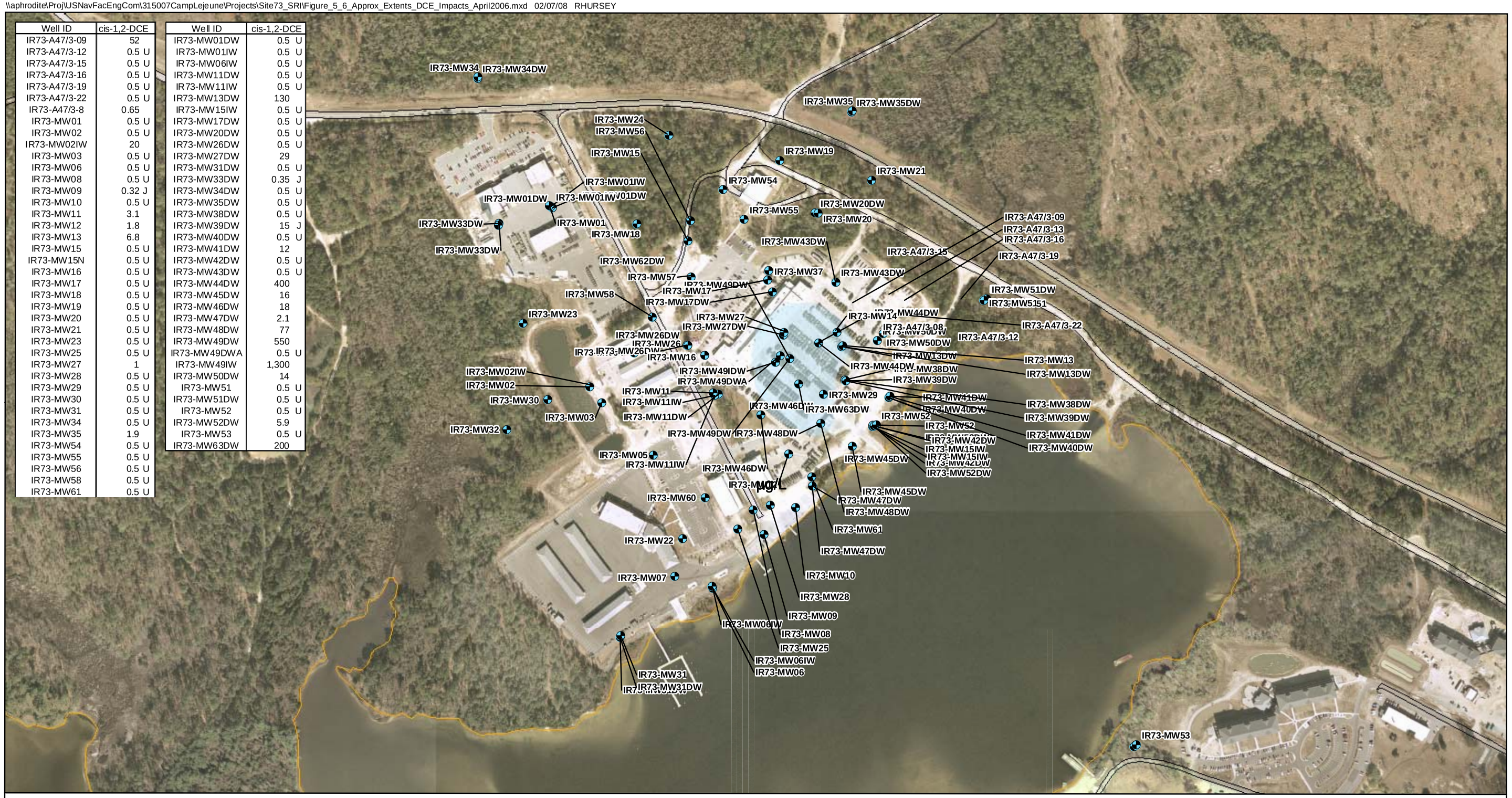
Figure 2-64

Site 73 - Approximate Extents of TCE Impacts, April 2006

\\aphrodite\Proj\USNavFacEngCom\315007CampLejeune\Projects\Site73_SRI\Figure_5_6_Approx_Extents_DCE_Impacts_April2006.mxd 02/07/08 RHURSEY

Well ID	cis-1,2-DCE
IR73-A47/3-09	52
IR73-A47/3-12	0.5 U
IR73-A47/3-15	0.5 U
IR73-A47/3-16	0.5 U
IR73-A47/3-19	0.5 U
IR73-A47/3-22	0.5 U
IR73-A47/3-8	0.65
IR73-MW01	0.5 U
IR73-MW02	0.5 U
IR73-MW02IW	20
IR73-MW03	0.5 U
IR73-MW06	0.5 U
IR73-MW08	0.5 U
IR73-MW09	0.32 J
IR73-MW10	0.5 U
IR73-MW11	3.1
IR73-MW12	1.8
IR73-MW13	6.8
IR73-MW15	0.5 U
IR73-MW15N	0.5 U
IR73-MW16	0.5 U
IR73-MW17	0.5 U
IR73-MW18	0.5 U
IR73-MW19	0.5 U
IR73-MW20	0.5 U
IR73-MW21	0.5 U
IR73-MW23	0.5 U
IR73-MW25	0.5 U
IR73-MW27	1
IR73-MW28	0.5 U
IR73-MW29	0.5 U
IR73-MW30	0.5 U
IR73-MW31	0.5 U
IR73-MW34	0.5 U
IR73-MW35	1.9
IR73-MW54	0.5 U
IR73-MW55	0.5 U
IR73-MW56	0.5 U
IR73-MW58	0.5 U
IR73-MW61	0.5 U

Well ID	cis-1,2-DCE
IR73-MW01DW	0.5 U
IR73-MW01IW	0.5 U
IR73-MW06IW	0.5 U
IR73-MW11DW	0.5 U
IR73-MW11IW	0.5 U
IR73-MW13DW	130
IR73-MW15IW	0.5 U
IR73-MW17DW	0.5 U
IR73-MW20DW	0.5 U
IR73-MW26DW	0.5 U
IR73-MW27DW	29
IR73-MW31DW	0.5 U
IR73-MW33DW	0.35 J
IR73-MW34DW	0.5 U
IR73-MW35DW	0.5 U
IR73-MW38DW	0.5 U
IR73-MW39DW	15 J
IR73-MW40DW	0.5 U
IR73-MW41DW	12
IR73-MW42DW	0.5 U
IR73-MW43DW	0.5 U
IR73-MW44DW	400
IR73-MW45DW	16
IR73-MW46DW	18
IR73-MW47DW	2.1
IR73-MW48DW	77
IR73-MW49DW	550
IR73-MW49DWA	0.5 U
IR73-MW49IW	1,300
IR73-MW50DW	14
IR73-MW51	0.5 U
IR73-MW51DW	0.5 U
IR73-MW52	0.5 U
IR73-MW52DW	5.9
IR73-MW53	0.5 U
IR73-MW63DW	200



Legend

- Monitoring Wells
- Base Boundary
- Groundwater impacted above NC 2L Groundwater Quality Standard (> 70 µg/L)

U Not Detected
J Estimated Value

Note:
All concentrations are reported in µg/L. Isoconcentration lines have been interpolated between monitoring well locations. Actual conditions may differ from those shown on this figure. Extent of contamination is approximate and is based on analytical data collected from monitoring wells screened at multiple depths in both the surficial and deep aquifers. Additional information illustrating the horizontal and vertical extent of impacts is provided in plume cross sectional views.

N

0 400 800 Feet

1 inch equals 400 feet

Figure 5-5
Approximate Extents of cis-1,2 DCE Impacts, April 2006
Operable Unit No. 21 (Site 73)
Supplemental Remedial Investigation
Marine Corps Base, Camp Lejeune
North Carolina

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Figure 2-65

Site 73 - Approximate Extents of cis-1,2 DCE Impacts, April 2006

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Well ID	VC
IR73-A47/3-09	6.2
IR73-A47/3-12	0.5 U
IR73-A47/3-15	0.5 U
IR73-A47/3-16	0.5 U
IR73-A47/3-19	0.5 U
IR73-A47/3-22	0.5 U
IR73-A47/3-8	3.7
IR73-MW01	0.5 U
IR73-MW02	0.5 U
IR73-MW02IW	0.5 U
IR73-MW03	0.5 U
IR73-MW06	0.5 U
IR73-MW08	0.5 U
IR73-MW09	3.5
IR73-MW10	0.5 U
IR73-MW11	0.5 U
IR73-MW12	0.38 J
IR73-MW13	7.8 J
IR73-MW15	0.5 U
IR73-MW15N	0.5 U
IR73-MW16	0.5 UJ
IR73-MW17	0.5 UJ
IR73-MW18	0.5 U
IR73-MW19	0.5 U
IR73-MW20	0.5 U
IR73-MW21	0.5 U
IR73-MW23	0.5 U
IR73-MW25	0.5 U
IR73-MW27	0.5 U
IR73-MW28	0.5 U
IR73-MW29	0.5 U
IR73-MW30	0.5 U
IR73-MW31	0.5 U
IR73-MW34	0.5 U
IR73-MW35	0.5 U
IR73-MW54	0.5 U
IR73-MW55	0.5 U
IR73-MW56	0.5 U
IR73-MW58	0.5 U
IR73-MW61	0.5 U
IR73-MW62DW	0.5 U

Well ID	VC
IR73-MW01DW	0.5 U
IR73-MW01IW	0.5 U
IR73-MW06IW	0.5 U
IR73-MW11DW	0.5 U
IR73-MW11IW	0.5 U
IR73-MW13DW	32
IR73-MW15IW	0.5 U
IR73-MW17DW	0.5 U
IR73-MW20DW	0.5 U
IR73-MW26DW	0.5 U
IR73-MW27DW	3.1
IR73-MW31DW	0.5 U
IR73-MW33DW	0.5 R
IR73-MW34DW	0.5 U
IR73-MW35DW	0.5 U
IR73-MW38DW	0.5 UJ
IR73-MW39DW	14 J
IR73-MW40DW	0.5 U
IR73-MW41DW	5
IR73-MW42DW	0.5 U
IR73-MW43DW	0.5 U
IR73-MW44DW	130 J
IR73-MW45DW	1.2
IR73-MW46DW	2.9
IR73-MW47DW	0.5 U
IR73-MW48DW	4
IR73-MW49DW	70 J
IR73-MW49DWA	0.5 U
IR73-MW49IW	57 J
IR73-MW50DW	37 J
IR73-MW51	0.5 U
IR73-MW51DW	0.5 U
IR73-MW52	0.5 U
IR73-MW52DW	2.1
IR73-MW53	0.5 U
IR73-MW63DW	10

Legend

- Monitoring Wells
- Base Boundary
- Groundwater impacted above NC 2L Groundwater Quality Standard (> 0.5 µg/L)

U Not Detected
J Estimated Value

Note:
All concentrations are reported in µg/L. Isoconcentration lines have been interpolated between monitoring well locations. Actual conditions may differ from those shown on this figure. Extent of contamination is approximate and is based on analytical data collected from monitoring wells screened at multiple depths in both the surficial and deep aquifers. Additional information illustrating the horizontal and vertical extent of impacts is provided in plume cross sectional views.

N

0 400 800 Feet

1 inch equals 400 feet

Figure 5-9
Approximate Extents of VC Impacts, April 2006
Operable Unit No. 21 (Site 73)
Supplemental Remedial Investigation
Marine Corps Base, Camp Lejeune
North Carolina

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Figure 2-66

Site 73 - Approximate Extents of VC Impacts, April 2006

\\aphrodite\Proj\USNavFacEngCom\315007CampLejeune\Projects\Site73_SRI\Figure_5_14_Approx_Extents_Benzene_Impacts_April2006.mxd 02/08/08 RHURSEY

Well ID	Benzene
IR73-A47/3-09	3.3
IR73-A47/3-12	0.33 J
IR73-A47/3-15	0.5 U
IR73-A47/3-16	0.5 U
IR73-A47/3-19	0.5 U
IR73-A47/3-22	0.5 U
IR73-A47/3-8	2.8
IR73-MW01	0.5 U
IR73-MW02	0.5 U
IR73-MW02IW	0.5 U
IR73-MW03	0.5 U
IR73-MW06	0.5 U
IR73-MW08	0.5 U
IR73-MW09	0.5 U
IR73-MW10	0.5 U
IR73-MW11	0.5 U
IR73-MW12	0.5 U
IR73-MW13	2.9
IR73-MW15	0.5 U
IR73-MW15N	0.5 U
IR73-MW16	0.5 U
IR73-MW17	0.5 U
IR73-MW18	0.5 U
IR73-MW19	0.5 U
IR73-MW20	0.5 U
IR73-MW21	0.5 U
IR73-MW23	0.5 U
IR73-MW25	0.5 U
IR73-MW27	0.51
IR73-MW28	0.5 U
IR73-MW29	0.5 U
IR73-MW30	0.5 U
IR73-MW31	0.5 U
IR73-MW34	0.5 U
IR73-MW35	0.5 U
IR73-MW54	0.5 U
IR73-MW55	0.5 U
IR73-MW56	0.5 U
IR73-MW58	0.5 U
IR73-MW61	0.5 U
IR73-MW62DW	0.5 U

Well ID	Benzene
IR73-MW01DW	0.5 U
IR73-MW01IW	0.5 U
IR73-MW06IW	0.5 U
IR73-MW11DW	0.5 U
IR73-MW11IW	0.5 U
IR73-MW13DW	3.7
IR73-MW15IW	0.5 U
IR73-MW17DW	0.5 U
IR73-MW20DW	0.56
IR73-MW26DW	0.5 U
IR73-MW27DW	0.73
IR73-MW31DW	0.5 U
IR73-MW33DW	0.5 U
IR73-MW34DW	0.5 U
IR73-MW35DW	0.5 U
IR73-MW38DW	0.5 U
IR73-MW39DW	5.5 J
IR73-MW40DW	0.5 U
IR73-MW41DW	1.6
IR73-MW42DW	0.5 U
IR73-MW43DW	0.5 U
IR73-MW44DW	8.9
IR73-MW45DW	0.73
IR73-MW46DW	0.5 U
IR73-MW47DW	0.5 U
IR73-MW48DW	1.7
IR73-MW49DW	8.1
IR73-MW49DWA	0.5 U
IR73-MW49IW	5.1
IR73-MW50DW	5.7
IR73-MW51	0.5 U
IR73-MW51DW	0.5 U
IR73-MW52	0.5 U
IR73-MW52DW	0.51
IR73-MW53	0.5 U
IR73-MW63DW	4.4

Legend

- Monitoring Wells
- Base Boundary
- Groundwater impacted above NC 2L Groundwater Quality Standard (> 1.0 µg/L)

U Not Detected
J Estimated Value

Note:
All concentrations are reported in µg/L. Isoconcentration lines have been interpolated between monitoring well locations. Actual conditions may differ from those shown on this figure. Extent of contamination is approximate and is based on analytical data collected from monitoring wells screened at multiple depths in both the surficial and deep aquifers. Additional information illustrating the horizontal and vertical extent of impacts is provided in plume cross sectional views.

N

0 400 800 Feet

1 inch equals 400 feet

Figure 5-13
Approximate Extents of Benzene Impacts, April 2006
Operable Unit No. 21 (Site 73)
Supplemental Remedial Investigation
Marine Corps Base, Camp Lejeune
North Carolina

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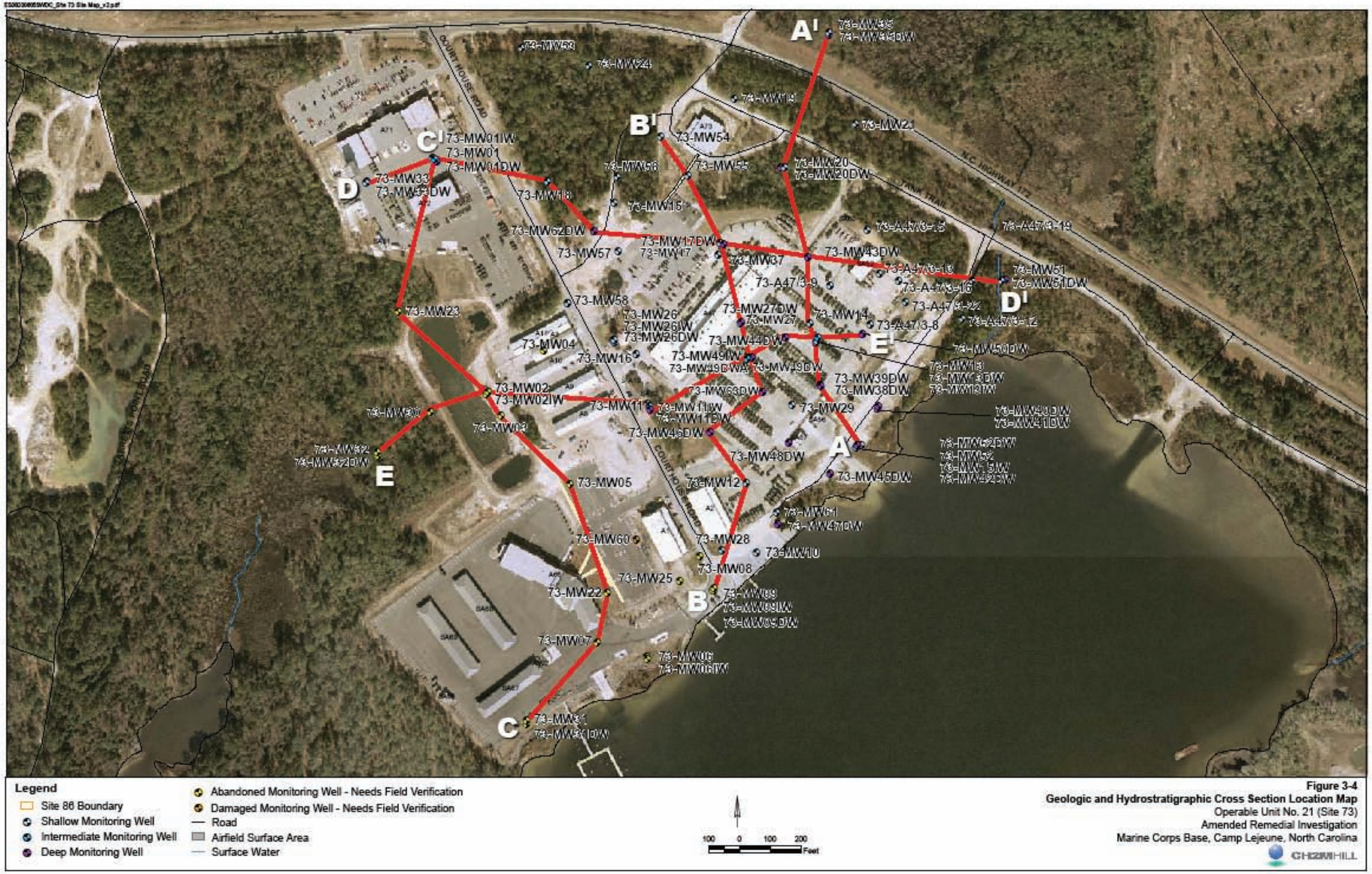
Figure 2-67

Site 73 - Approximate Extents of Benzene Impacts, April 2006



Legend

- Site 86 Boundary
- Shallow Monitoring Well
- Intermediate Monitoring Well
- Deep Monitoring Well
- Abandoned Monitoring Well - Needs Field Verification
- Damaged Monitoring Well - Needs Field Verification
- Road
- Airfield Surface Area
- Surface Water

100 0 100 200 Feet

Figure 3-4
Geologic and Hydrostratigraphic Cross Section Location Map
Operable Unit No. 21 (Site 73)
Amended Remedial Investigation
Marine Corps Base, Camp Lejeune, North Carolina

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Figure 2-68
Site 73 - Cross Sections - Locations

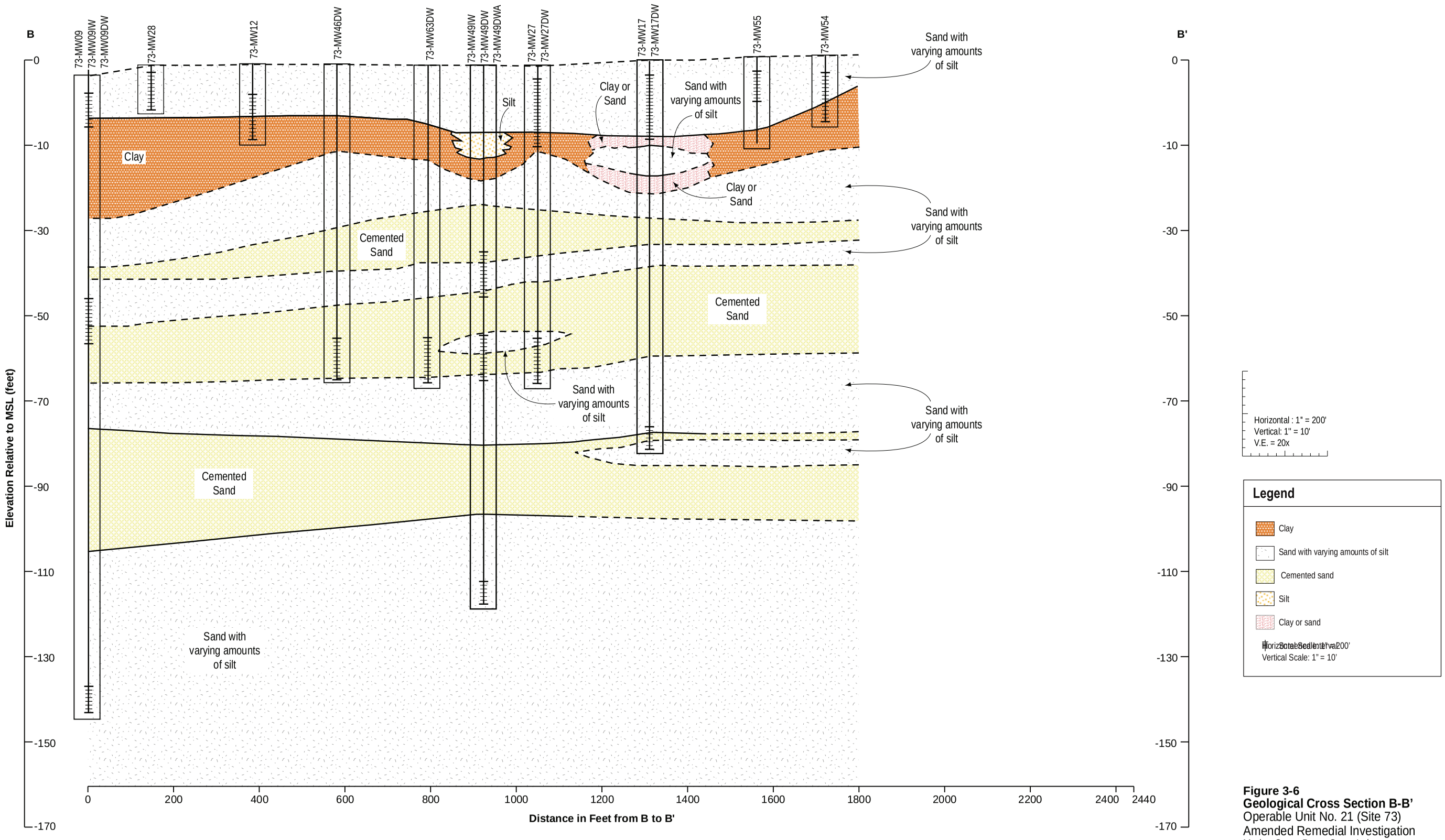

Figure 3-6
Geological Cross Section B-B'
Operable Unit No. 21 (Site 73)
Amended Remedial Investigation
Marine Corps Base, Camp Lejeune
North Carolina

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ES082006055WDC_Figure3-6_BB_v3.ai

Figure 2-69
Site 73 - Cross Section B - B'

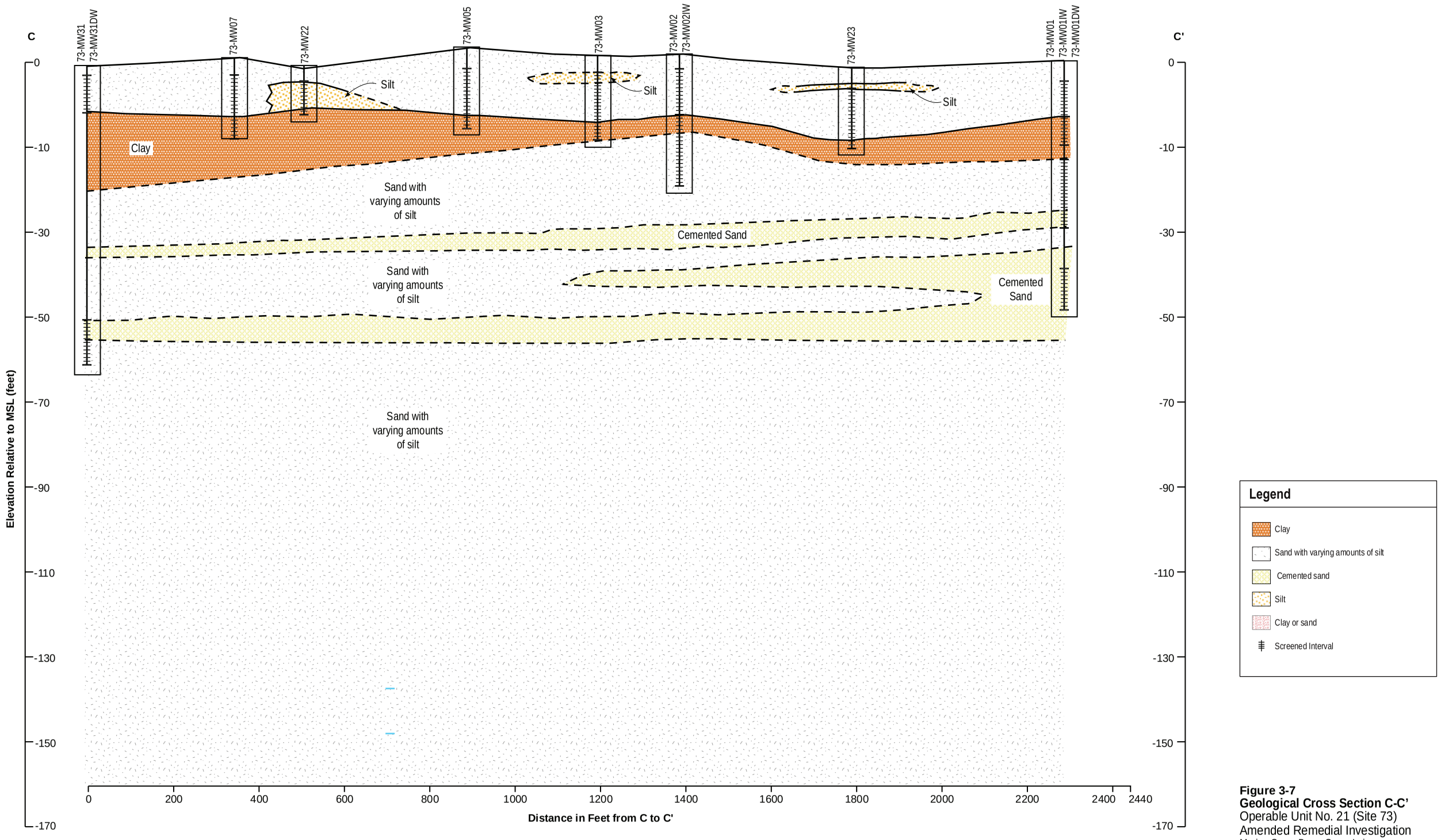

Figure 3-7
Geological Cross Section C-C'
Operable Unit No. 21 (Site 73)
Amended Remedial Investigation
Marine Corps Base, Camp Lejeune
North Carolina

ES082006055WDC_Figure3-7_CC_v1.ai

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Figure 2-70
Site 73 Cross Section C - C'

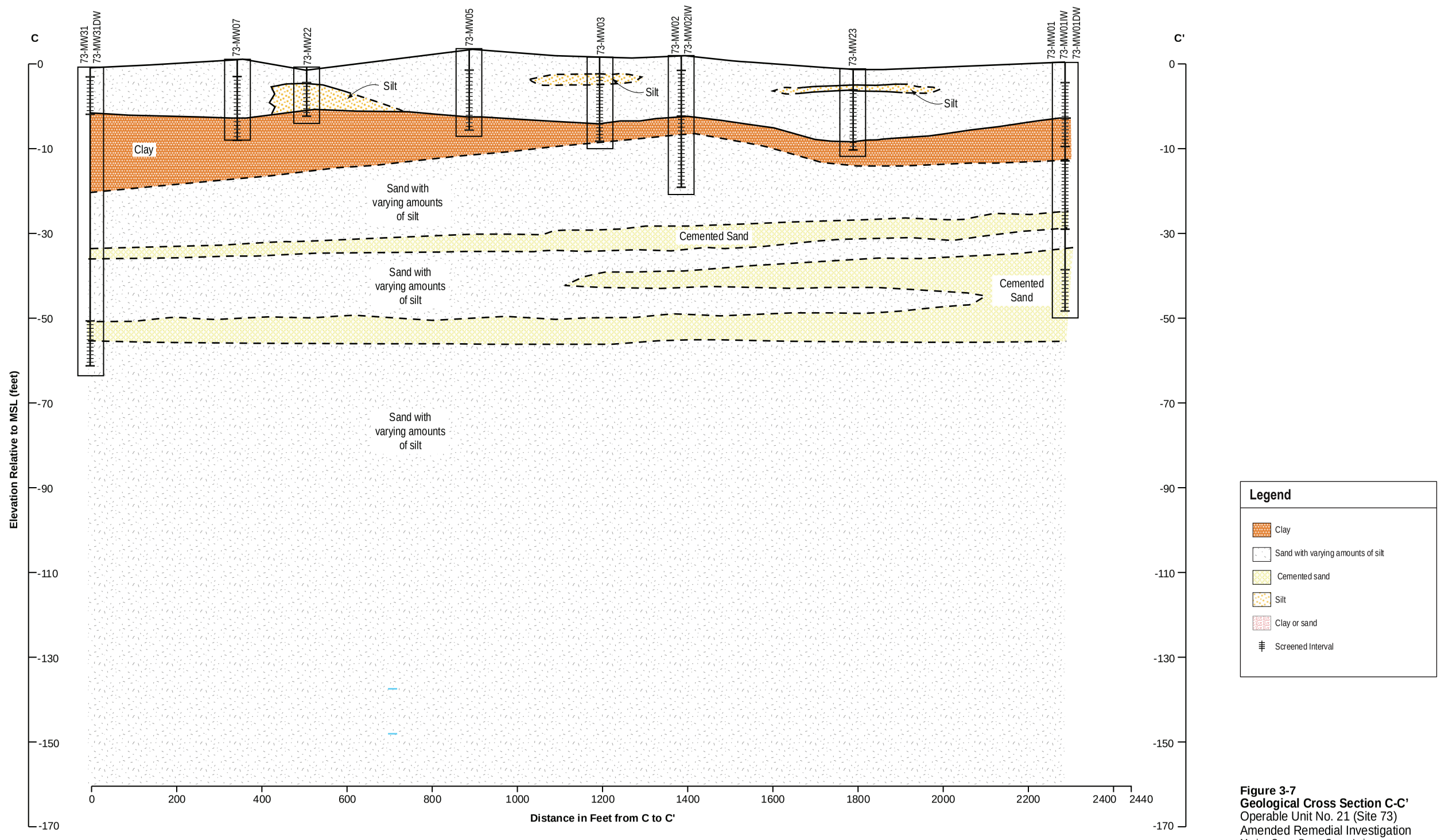

Figure 3-7
Geological Cross Section C-C'
Operable Unit No. 21 (Site 73)
Amended Remedial Investigation
Marine Corps Base, Camp Lejeune
North Carolina

ES082006055WDC_Figure3-7_CC_v1.ai

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Figure 2-71
Site 73 - Cross Section C - C'

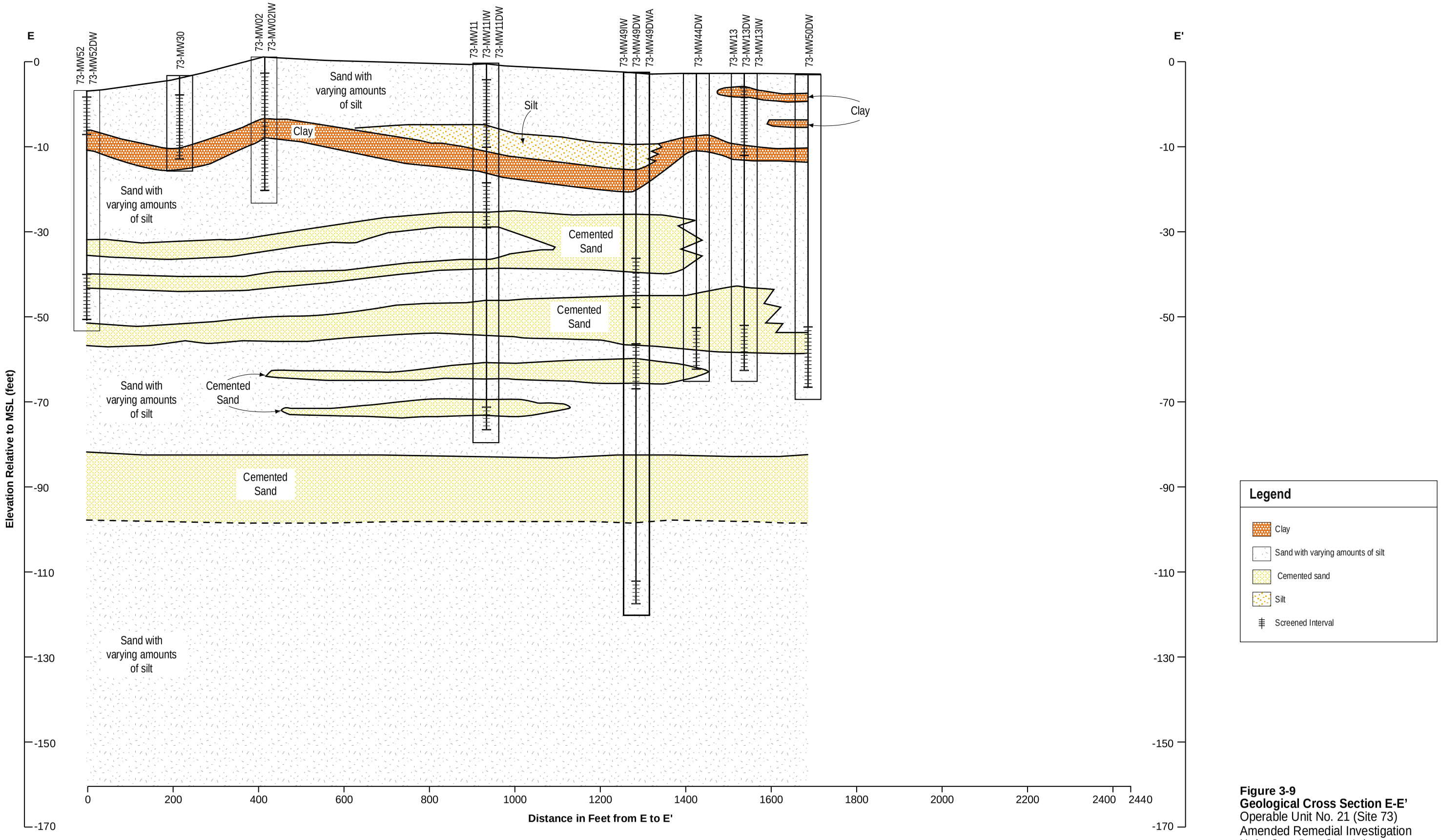

Figure 3-9
Geological Cross Section E-E'
Operable Unit No. 21 (Site 73)
Amended Remedial Investigation
Marine Corps Base, Camp Lejeune
North Carolina

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ES082006055WDC_Figure3-9_EE_v1.ai

Figure 2-72
Site 73 - Cross Section E - E'

\\aphrodite\Proj\USNavFacEngCom\315007CampLejeune\Projects\Site73_SRI\Figure_5_2_Approx_Extents_TCE_Impacts_April2006.mxd 02/07/08 RHURSEY

Well ID	TCE
IR73-A47/3-09	3.1
IR73-A47/3-12	0.5 U
IR73-A47/3-15	0.5 U
IR73-A47/3-16	0.5 U
IR73-A47/3-19	0.5 U
IR73-A47/3-22	0.5 U
IR73-A47/3-8	0.5 U
IR73-MW01	0.5 U
IR73-MW02	0.5 U
IR73-MW02IW	0.32 J
IR73-MW03	0.5 U
IR73-MW06	0.5 U
IR73-MW08	0.5 U
IR73-MW09	0.5 U
IR73-MW10	0.5 U
IR73-MW11	0.62
IR73-MW12	0.5 U
IR73-MW13	0.5 U
IR73-MW15	0.5 U
IR73-MW15N	0.5 U
IR73-MW16	0.5 U
IR73-MW17	0.5 U
IR73-MW18	0.5 U
IR73-MW19	0.5 U
IR73-MW20	0.5 U
IR73-MW21	0.5 U
IR73-MW23	0.5 U
IR73-MW25	0.5 U
IR73-MW27	0.5 U
IR73-MW28	0.5 U
IR73-MW29	0.5 U
IR73-MW30	0.5 U
IR73-MW31	0.5 U
IR73-MW34	0.5 U
IR73-MW35	1.5
IR73-MW54	0.5 U
IR73-MW55	0.5 U
IR73-MW56	0.5 U
IR73-MW58	0.5 U
IR73-MW61	0.5 U
IR73-MW62DW	0.5 U

Well ID	TCE
IR73-MW01DW	0.5 U
IR73-MW01IW	0.5 U
IR73-MW06IW	0.5 U
IR73-MW11DW	0.5 U
IR73-MW11IW	0.5 U
IR73-MW13DW	200
IR73-MW15IW	0.5 U
IR73-MW17DW	0.5 U
IR73-MW20DW	0.5 U
IR73-MW26DW	0.5 U
IR73-MW27DW	52
IR73-MW31DW	0.5 U
IR73-MW33DW	0.5 U
IR73-MW34DW	0.5 U
IR73-MW35DW	0.5 U
IR73-MW38DW	0.5 U
IR73-MW39DW	20 J
IR73-MW40DW	0.5 U
IR73-MW41DW	0.5 U
IR73-MW42DW	0.5 U
IR73-MW43DW	0.5 U
IR73-MW44DW	290
IR73-MW45DW	7.1
IR73-MW46DW	9
IR73-MW47DW	1.8
IR73-MW48DW	82
IR73-MW49DW	840
IR73-MW49DWA	0.5 U
IR73-MW49IW	170
IR73-MW50DW	0.5 U
IR73-MW51	0.5 U
IR73-MW51DW	0.5 U
IR73-MW52	0.5 U
IR73-MW52DW	0.87
IR73-MW53	0.5 U
IR73-MW63DW	520

Legend

- Monitoring Wells
- Base Boundary
- Groundwater impacted above NC 2L Groundwater Quality Standard (> 2.8 µg/L)

U Not Detected
J Estimated Value

Note:
All concentrations are reported in µg/L. Isoconcentration lines have been interpolated between monitoring well locations. Actual conditions may differ from those shown on this figure. Extent of contamination is approximate and is based on analytical data collected from monitoring wells screened at multiple depths in both the surficial and deep aquifers. Additional information illustrating the horizontal and vertical extent of impacts is provided in plume cross sectional views.

N

0 400 800 Feet

1 inch equals 400 feet

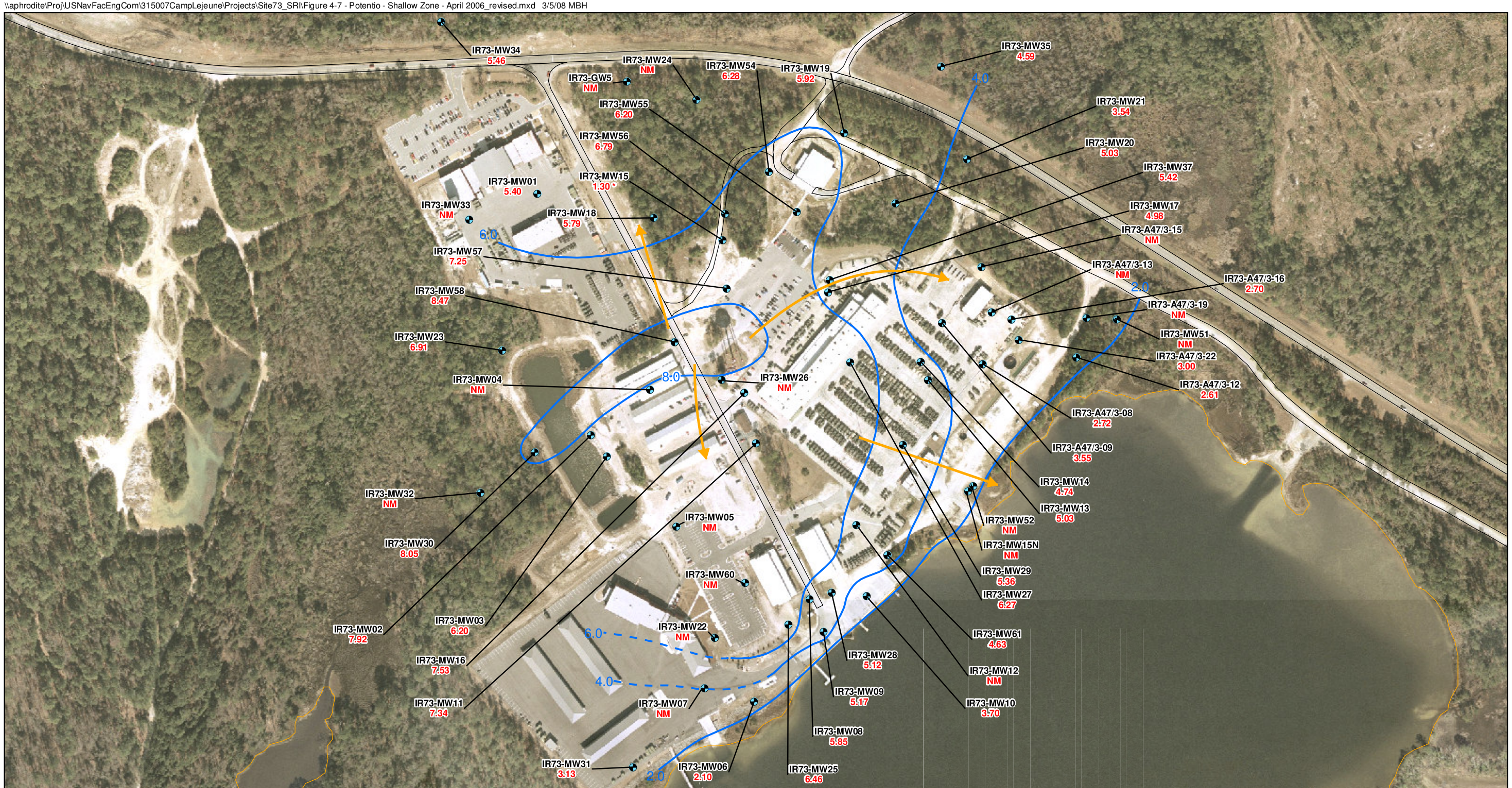
Figure 5-1
Approximate Extents of TCE Impacts, April 2006
Operable Unit No. 21 (Site 73)
Supplemental Remedial Investigation
Marine Corps Base, Camp Lejeune
North Carolina

CH2MHILL

Figure 2-73

Site 73 - Approximate Extents of TCE Impacts, April 2006

\\aphrodite\Proj\USNavFacEngCom\315007CampLejeune\Projects\Site73_SRI\Figure 4-7 - Potentio - Shallow Zone - April 2006_revised.mxd 3/5/08 MBH



Legend

- Monitoring Wells
- Potentiometric Surface Contour (dashed where inferred)
- Base Boundary
- Direction of Groundwater Flow
- bgs Below Ground Surface

Note:
All water level elevations are reported in feet above mean seal level.
Potentiometric surface contours have been interpolated between monitoring well locations. Actual conditions may differ from those shown on this figure.
NM = Not measured
IR73-MW15 not used for contouring due to questionable survey data (surface elevation)
2.12 Water level elevation

N

0 300 600 Feet

1 inch equals 300 feet

Figure 4-7
Potentiometric Surface Map of Water Table, April 2006
Operable Unit No. 21 (Site 73)
Supplemental Remedial Investigation
Marine Corps Base, Camp Lejeune
North Carolina

CH2MHILL

Figure 2-74

Site 73 - Potentiometric Surface Map of Water Table, April 2006

PARAMETER	NCGWQS	GCL	BH190-MW01	BH190-MW02	BH190-MW03	BH190-MW04	BH190-MW05	BH190-MW06	BH190-MW07	BH190-MW08	BH190-MW09	BH190-MW10	BH190-MW11	BH190-MW12	BH190-MW13	BH190-MW14	BH190-MW15	BH190-MW16	BH190-MW17	Duplicate (MW16)	Water Supply Well BH47
VOCs by EPA Method 602 (µg/L)																					
Benzene	1	5,000	NS	HQL	HQL	NS	NS	NS	HQL	HQL	NS	NS	NS	HQL	NS	NS	HQL	**10.2**	HQL	**9.88**	HQL
Diisopropyl Ether (DIPE)	70	70,000	NS	HQL	HQL	NS	NS	NS	**5.31**	HQL	NS	NS	NS	HQL	NS	NS	HQL	**3.75J**	HQL	**4.15J**	HQL
Ethylbenzene	550	84,500	NS	HQL	HQL	NS	NS	NS	**112**	HQL	NS	NS	NS	HQL	NS	NS	HQL	**108**	HQL	**107**	HQL
Methyl Tert Butyl Ether	200	200,000	NS	HQL	HQL	NS	NS	NS	HQL	HQL	NS	NS	NS	HQL	NS	NS	HQL	HQL	HQL	HQL	HQL
Toluene	1,000	257,500	NS	HQL	HQL	NS	NS	NS	HQL	HQL	NS	NS	NS	HQL	NS	NS	HQL	HQL	HQL	HQL	HQL
Xylenes (total)	530	87,500	NS	HQL	HQL	NS	NS	NS	**77.11**	HQL	NS	NS	NS	HQL	NS	NS	HQL	**6.61J**	HQL	**6.66J**	HQL
SVOCs by EPA Method 625 (µg/L)																					
Acenaphthene	80	2,120	NS	**6.20 J**	HQL	NS	NS	NS	HQL	**5.00J**	NS	NS	NS	**2.30J**	NS	NS	HQL	**2.40J**	HQL	**2.50J**	HQL
Bis(2-chloroisopropyl)ether	NE	NE	NS	HQL	HQL	NS	NS	NS	**10.9**	HQL	NS	NS	NS	HQL	NS	NS	HQL	HQL	HQL	HQL	HQL
Bis(2-ethylhexyl)phthalate	2.5	2,500	NS	HQL	HQL	NS	NS	NS	HQL	HQL	NS	NS	NS	**1.60J**	NS	NS	HQL	HQL	HQL	HQL	HQL
Diethylphthalate	5,000	NE	NS	HQL	HQL	NS	NS	NS	HQL	HQL	NS	NS	NS	**2.00J**	NS	NS	HQL	HQL	HQL	HQL	HQL
Dimethylphthalate	NE	NE	NS	HQL	HQL	NS	NS	NS	**3.80J**	HQL	NS	NS	NS	**1.50J**	NS	NS	HQL	HQL	HQL	HQL	HQL
Di-n-butylphthalate	NE	NE	NS	HQL	HQL	NS	NS	NS	HQL	HQL	NS	NS	NS	**1.70J**	NS	NS	HQL	HQL	HQL	HQL	HQL
Fluorene	280	950	NS	**2.80 J**	HQL	NS	NS	NS	**1.80 J**	**1.40J**	NS	NS	NS	HQL	NS	NS	HQL	**1.80J**	HQL	**2.00J**	HQL
Naphthalene	21	15,500	NS	HQL	HQL	NS	NS	NS	**67.5**	**1.30J**	NS	NS	NS	HQL	NS	NS	HQL	**68.3**	**1.10J**	**71.4**	HQL
Phenanthrene	210	410	NS	HQL	HQL	NS	NS	NS	**1.80J**	HQL	NS	NS	NS	HQL	NS	NS	HQL	**1.40J**	HQL	**1.40J**	HQL
Phenol	300	NE	NS	HQL	HQL	NS	NS	NS	HQL	HQL	NS	NS	NS	HQL	NS	NS	HQL	HQL	HQL	HQL	HQL
TICs (Total)			NS	**9.12**	**18.1**	NS	NS	NS	**755.30**	**7.44**	NS	NS	NS	**10.2**	NS	NS	**10.5**	**356**	**10.3**	**363.6**	**24.1**
VPH (ug/L)																					
C5 - C8 Aliphatics	420	NE	NS	<100	<100	NS	NS	NS	**640**	<100	NS	NS	NS	<100	NS	NS	<100	**360**	<100	**370**	<100
C9 - C12 Aliphatics			NS	<100	<100	NS	NS	NS	**1,100**	<100	NS	NS	NS	<100	NS	NS	<100	**580**	<100	**600**	<100
C9 - C10 Aromatics			NS	<100	<100	NS	NS	NS	**1,200**	<100	NS	NS	NS	<100	NS	NS	<100	**230**	<100	**240**	<100
EPH (ug/L)																					
C9 - C18 Aliphatics			NS	<100	<100	NS	NS	NS	<100	<100	NS	NS	NS	<100	NS	NS	<100	<100	<100	<100	<100
C19 - C36 Aliphatics			NS	<100	<100	NS	NS	NS	<100	<100	NS	NS	NS	<100	NS	NS	<100	<100	<100	<100	<100
C11-C22 Aromatics	42,000	NE	NS	<100	<100	NS	NS	NS	**120**	<100	NS	NS	NS	<100	NS	NS	<100	<100	<100	<100	<100
VPH + EPH (ug/L)																					
C9 - C12 + C9 - C18 Aliphatics	4,200	NE	NS	<200	<200	NS	NS	NS	**<1,200**	<200	NS	NS	NS	<200	NS	NS	<200	**<680**	<200	**<700**	<200
C9 - C10 + C11 - C22 Aromatics	210	NE	NS	<200	<200	NS	NS	NS	**1,320**	<200	NS	NS	NS	<200	NS	NS	<200	**<330**	<200	**<340**	<200

Bold type indicates detectable concentrations.
Bold and highlighted indicates detectable concentrations above the NCGWQS or reporting limit.
NCGWQS - North Carolina Groundwater Quality Standard
GCL - Gross Contaminant Level
-# - not detected at the indicated reporting limit
µg/L - micrograms per liter
NE - Not established
NS - Not Sampled, scope of work revised as of January 2007 - wells not sampled since historical data review showed no contaminants.
RL - the NCGWQS for the constituent is the reporting limit
HQL - Below Quantitation Limits; see lab report for specific limits.
J - estimated concentration between minimium detection limit and reporting limit

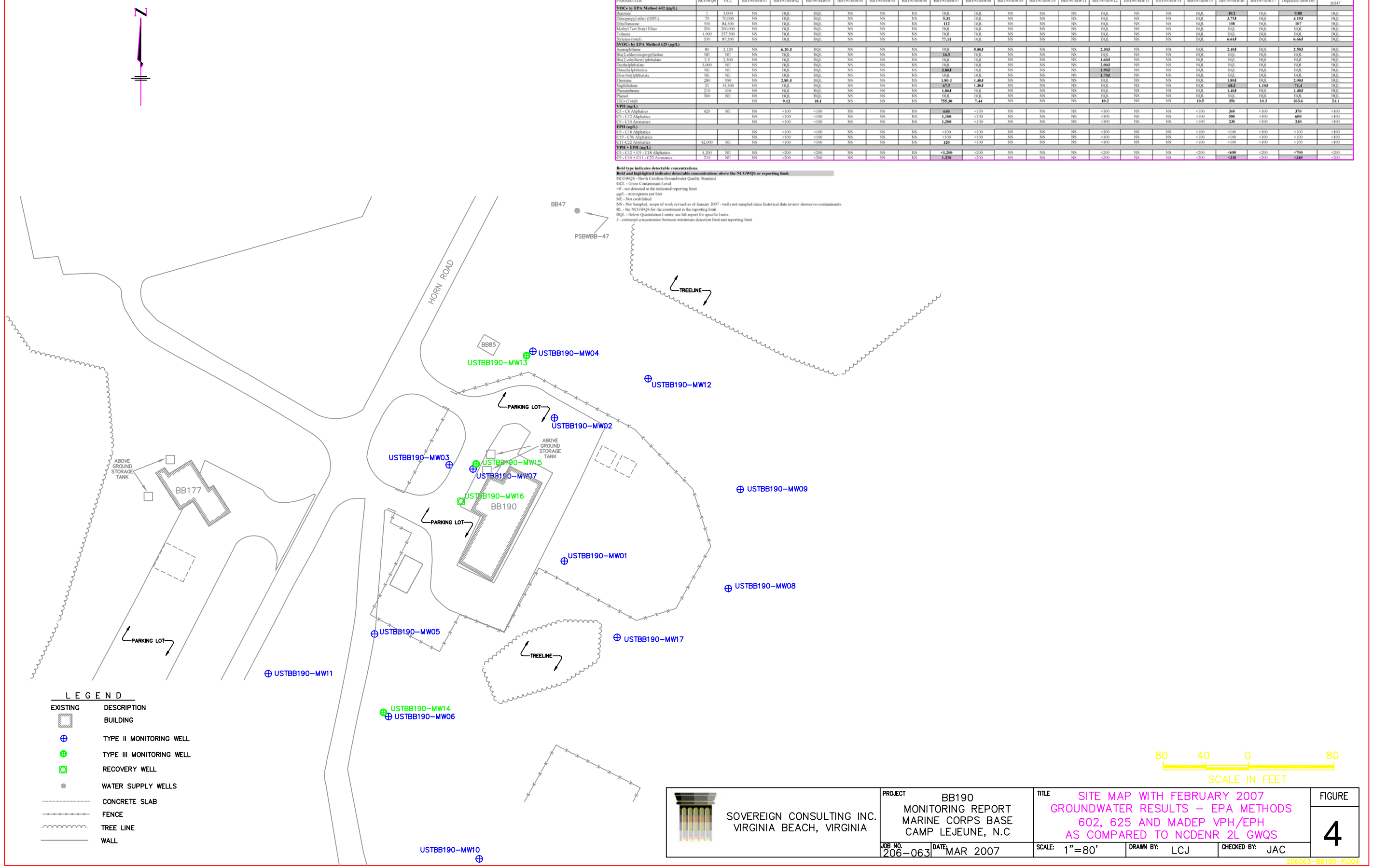


Figure 2-75
Building BB-190 - Site Map with February 2007 Groundwater Results

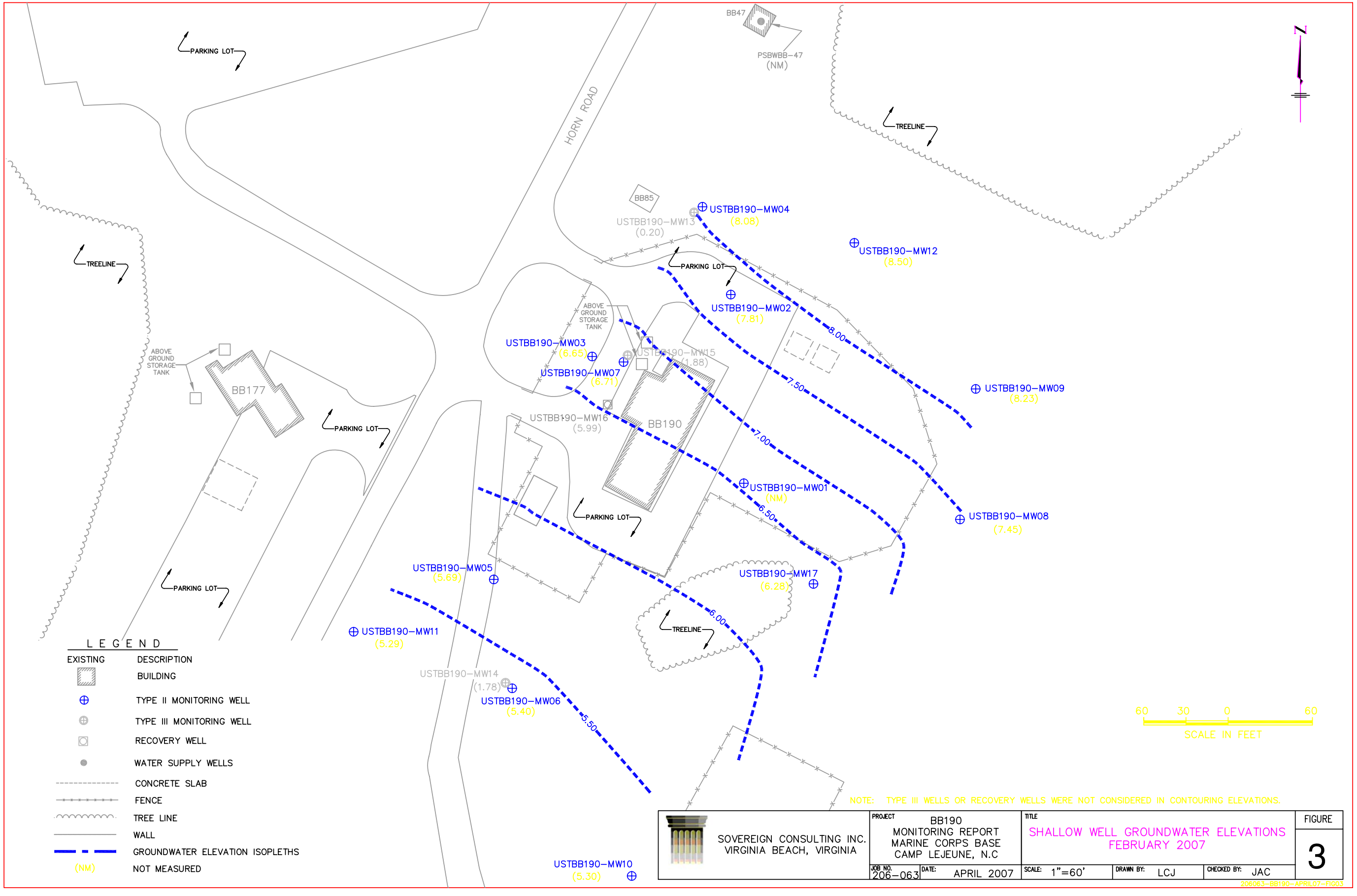
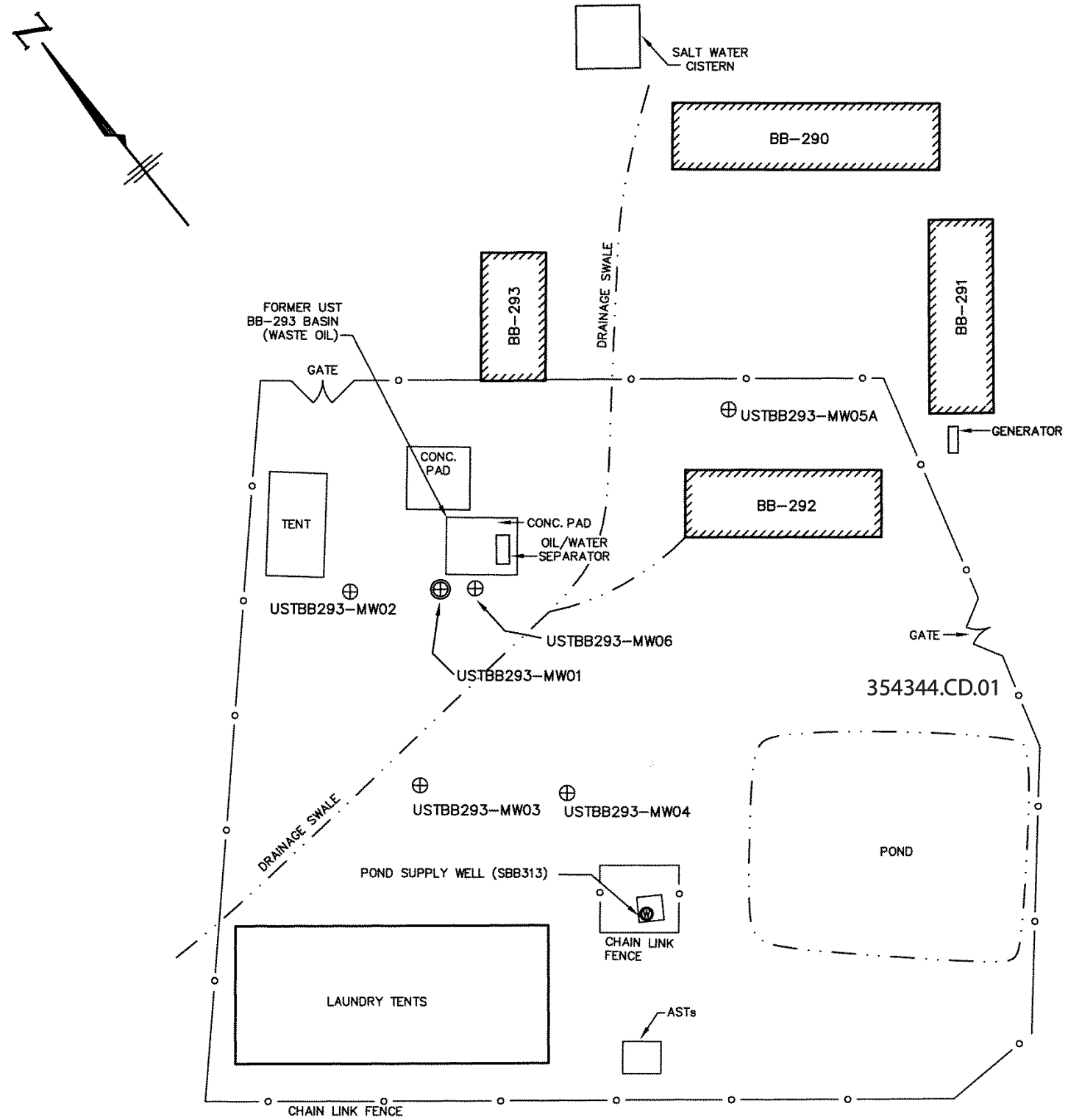


Figure 2-76

Building BB-190- Shallow Well Groundwater Elevations, February 2007



Analytical Method: EPA Method 6210D

Contaminant of Concern			Benzene	sec-Butylbenzene	Bromoform	Chloroform	Dibromochloromethane	Ethylbenzene	Isopropylbenzene	4-Isopropyltoluene	Methylene chloride	n-Propylbenzene	Toluene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Total Xylenes
Well ID	Sample ID	Date Collected														
USTBB293-MW01	USTBB293-MW01	11/27/2006	<0.500	<0.500	**0.550**	<0.500	**0.550**	**0.230**	<0.500	<0.500	**1.52**	<0.500	**1.29**	<0.500	<0.500	**0.540**
USTBB293-MW02	USTBB293-MW02	11/27/2006	<0.500	<0.500	**0.930**	<0.500	**0.750**	<0.500	<0.500	<0.500	**1.64**	<0.500	**0.820**	<0.500	<0.500	<0.500
USTBB293-MW03	USTBB293-MW03	11/27/2006	<0.500	<0.500	**0.680**	**0.710**	**0.330**	<0.500	<0.500	<0.500	**1.72**	<0.500	**0.780**	<0.500	<0.500	<0.500
USTBB293-MW04	USTBB293-MW04	11/27/2006	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	**1.55**	<0.500	**1.02**	<0.500	<0.500	<0.500
USTBB293-MW05A	USTBB293-MW05A	11/27/2006	<0.500	**0.610**	<0.500	**1.93**	<0.500	**0.450**	**0.310**	**0.620**	**0.320**	**0.580**	**1.00**	**1.12**	**0.210**	**0.170**
USTBB293-MW06	USTBB293-MW06	11/27/2006	**0.190**	<0.500	**0.640**	<0.500	**0.320**	**0.220**	<0.500	<0.500	**1.26**	<0.500	**1.50**	<0.500	<0.500	**0.560**
Pond Well	SBB313	11/28/2006	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	**0.370**	<0.500	<0.500	<0.500
Duplicate	Duplicate	11/27/2006	<0.500	<0.500	**0.420**	**0.720**	**0.340**	<0.500	<0.500	<0.500	**3.29**	<0.500	**0.560**	<0.500	<0.500	<0.500
Trip Blank	Trip Blank	11/27/2006	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	**0.440**	<0.500	<0.500	<0.500	<0.500	<0.500
2L Standard (µg/l)			1	70	0.19	70	0.41	550	70	NE	4.6	70	1,000	350	350	530
GCL (µg/l)			5,000	8,500	190	70,000	410	84,500	25,000	NE	4,600	30,000	257,500	28,500	25,000	87,500

- All results reported in µg/l
- µg/L = micrograms per liter
- GCL = Gross Contamination Level
- <# = less than the specified laboratory quantitation limit
- **BOLD**= detected contaminant concentration
- NE = Not established
- SHADED Concentrations exceed 2L Standard.
- Duplicate Sample Obtained from MW03.

LEGEND

EXISTING	NEW	DESCRIPTION
		BUILDING
		TYPE II WELL (SHALLOW)
		TYPE III WELL (DEEP)
		POND SUPPLY WELL

40 0 40
SCALE IN FEET

NOTES:

1. VERTICAL DATUM IS BASED ON MILITARY CONTROL MONUMENT PW-31 WHICH IS A 2"ø BRASS DISK SET IN A 10"ø CONCRETE MONUMENT SET FLUSH WITH THE GROUND AND HAS AN ELEVATION OF 13.87 FEET BASED ON NGVD 1929 DATUM. PW-31 IS LOCATED 0.6 MILES SOUTH FROM THE INTERSECTION OF SNEADS FERRY AND HORN ROAD AND IS ON THE EAST SIDE OF HORN ROAD. PW-31 IS ALSO LOCATED 5.0 FEET FROM THE SOUTHWEST CORNER OF A CHAIN LINK FENCE AROUND A WATER TANK.
2. FORMER UST BASIN LOCATION IS APPROXIMATE.

SOVEREIGN CONSULTING INC.
VIRGINIA BEACH, VIRGINIA

PROJECT: BUILDING BB-293
MARINE CORPS BASE
CAMP LEJEUNE, N.C.

TITLE: SITE MAP WITH NOVEMBER 2006 GROUNDWATER RESULTS – EPA METHOD 6210D

FIGURE 4

JOB NO. 206-063 | DATE: FEB 2007 | SCALE: 1"=40' | DRAWN BY: KAWS | CHECKED BY: MEM

206063-BB293-FEB07-FIG04

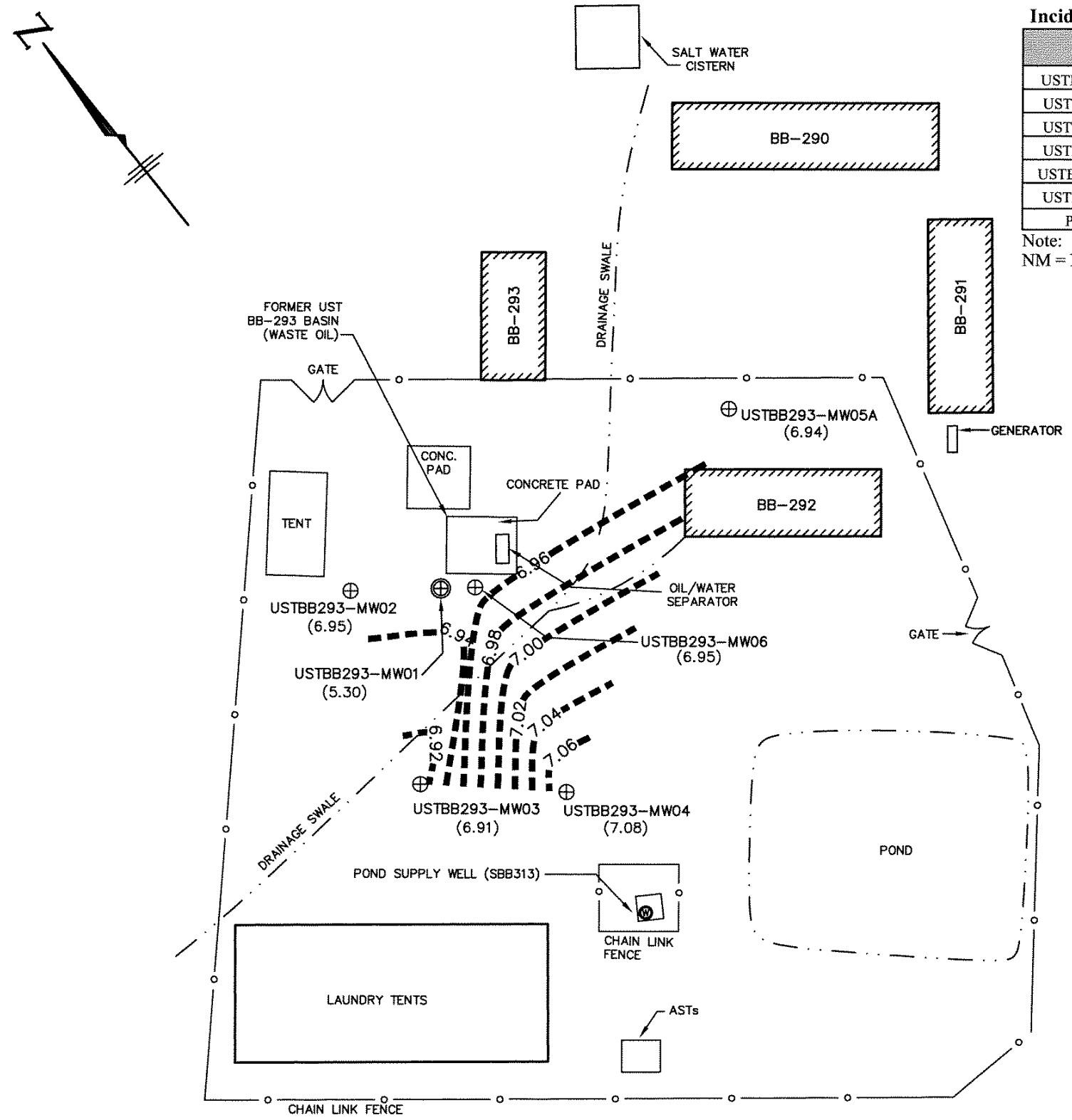
Figure 2-77

Building BB-293 - Site Map with Nov. 2006 Groundwater Results - EPA Method 6210D

Incident Number and Name: 32049 - Building BB-293

Monitoring Well	Top of Casing Elevation (feet)	Depth to Water (DTW) 11/27/06	Groundwater Elevation (feet) 11/27/06	Product Thickness (feet) 11/27/06
USTBB293-MW01 (Type III)	9.52	4.22	5.30	--
USTBB293-MW02 (Type II)	8.87	1.92	6.95	--
USTBB293-MW03 (Type II)	9.44	2.53	6.91	--
USTBB293-MW04 (Type II)	9.28	2.20	7.08	--
USTBB293-MW05A (Type II)	10.69	3.75	6.94	--
USTBB293-MW06 (Type II)	9.53	2.58	6.95	--
Pond Well (SBB313)	Unknown	NM	Not Calculated	NM

Note: "--" = free product not present during gauging event.
NM = Not Measured



LEGEND

EXISTING	NEW	DESCRIPTION
		BUILDING
		TYPE II WELL (SHALLOW)
		TYPE III WELL (DEEP)
		POND SUPPLY WELL

40 0 40
SCALE IN FEET

NOTES:

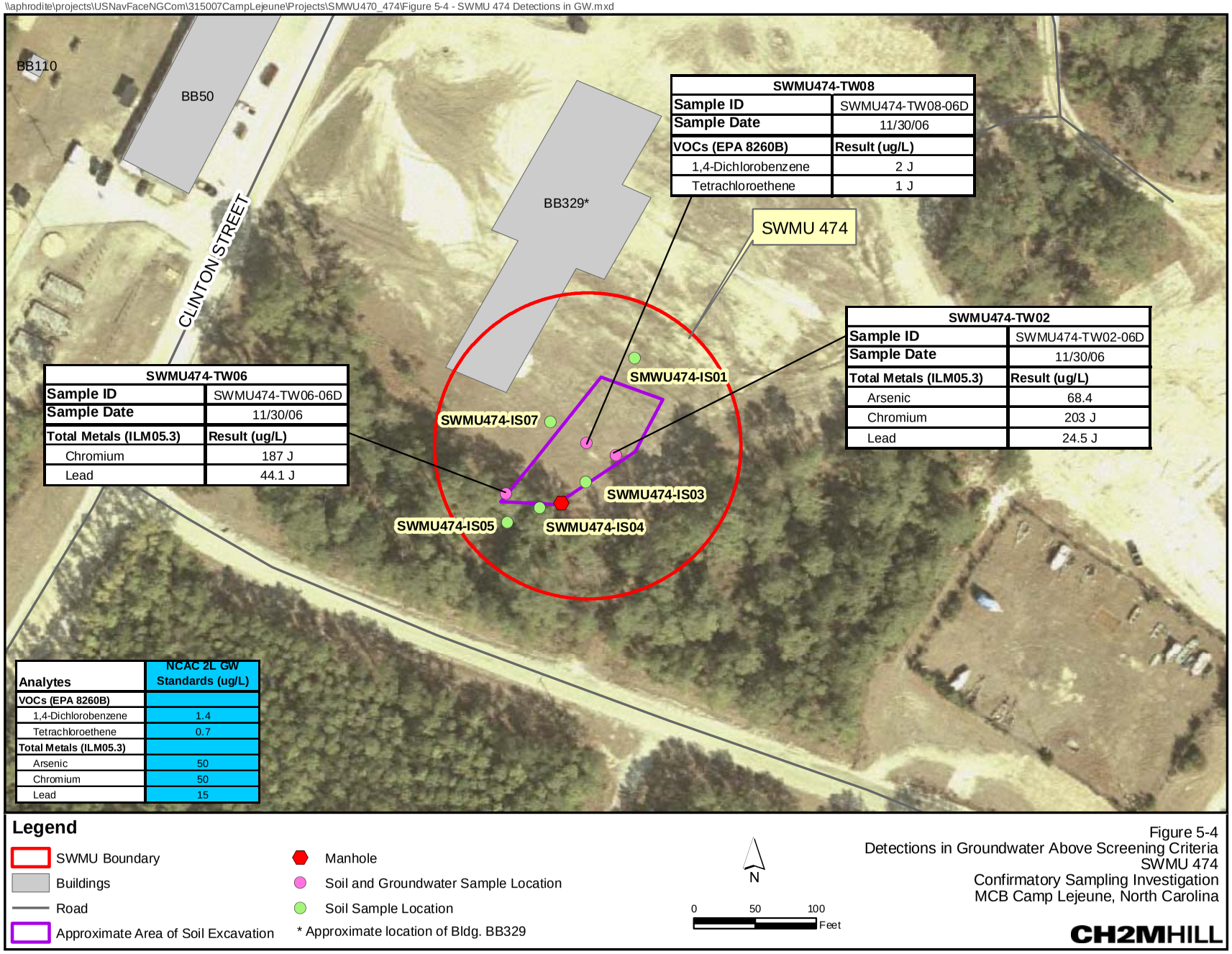
1. VERTICAL DATUM IS BASED ON MILITARY CONTROL MONUMENT PW-31 WHICH IS A 2"ø BRASS DISK SET IN A 10"ø CONCRETE MONUMENT SET FLUSH WITH THE GROUND AND HAS AN ELEVATION OF 13.87 FEET BASED ON NGVD 1929 DATUM. PW-31 IS LOCATED 0.6 MILES SOUTH FROM THE INTERSECTION OF SNEADS FERRY AND HORN ROAD AND IS ON THE EAST SIDE OF HORN ROAD. PW-31 IS ALSO LOCATED 5.0 FEET FROM THE SOUTHWEST CORNER OF A CHAIN LINK FENCE AROUND A WATER TANK.
2. FORMER UST BASIN LOCATION IS APPROXIMATE.

SOVEREIGN CONSULTING INC. VIRGINIA BEACH, VIRGINIA	PROJECT: BUILDING BB-293 MARINE CORPS BASE CAMP LEJEUNE, N.C.	TITLE: SHALLOW WELL GROUNDWATER ELEVATIONS – NOVEMBER 2006	FIGURE 3
	JOB NO. 206-063 / DATE: FEB 2007	SCALE: 1"=40' / DRAWN BY: KAWS / CHECKED BY: MEM	

206063-BB293-FEB07-FIG03

Figure 2-78
Building BB-293 - Shallow Well Groundwater Elevations, November 2006

\\aphrodite\projects\USNavFaceNGCom\315007CampLejeune\Projects\SMWU470_474\Figure 5-4 - SWMU 474 Detections in GW.mxd



SWMU474-TW08	
Sample ID	SWMU474-TW08-06D
Sample Date	11/30/06
VOCs (EPA 8260B)	Result (ug/L)
1,4-Dichlorobenzene	2 J
Tetrachloroethene	1 J

SWMU474-TW02	
Sample ID	SWMU474-TW02-06D
Sample Date	11/30/06
Total Metals (ILM05.3)	Result (ug/L)
Arsenic	68.4
Chromium	203 J
Lead	24.5 J

SWMU474-TW06	
Sample ID	SWMU474-TW06-06D
Sample Date	11/30/06
Total Metals (ILM05.3)	Result (ug/L)
Chromium	187 J
Lead	44.1 J

Analytes	NCAC 2L GW Standards (ug/L)
VOCs (EPA 8260B)	
1,4-Dichlorobenzene	1.4
Tetrachloroethene	0.7
Total Metals (ILM05.3)	
Arsenic	50
Chromium	50
Lead	15

Legend

- SWMU Boundary
- Buildings
- Road
- Approximate Area of Soil Excavation
- Manhole
- Soil and Groundwater Sample Location
- Soil Sample Location

* Approximate location of Bldg. BB329

Figure 5-4
Detections in Groundwater Above Screening Criteria
SWMU 474
Confirmatory Sampling Investigation
MCB Camp Lejeune, North Carolina

CH2MHILL

Figure 2-79

SWMU 474 - Detections in Groundwater Above Screening Criteria

\\aphrodite\projects\USNavFaceNGCom\315007CampLejeune\Projects\SMWU470_474\Figure 5-3 - SMWU474 - Potentio Surface Map.mxd

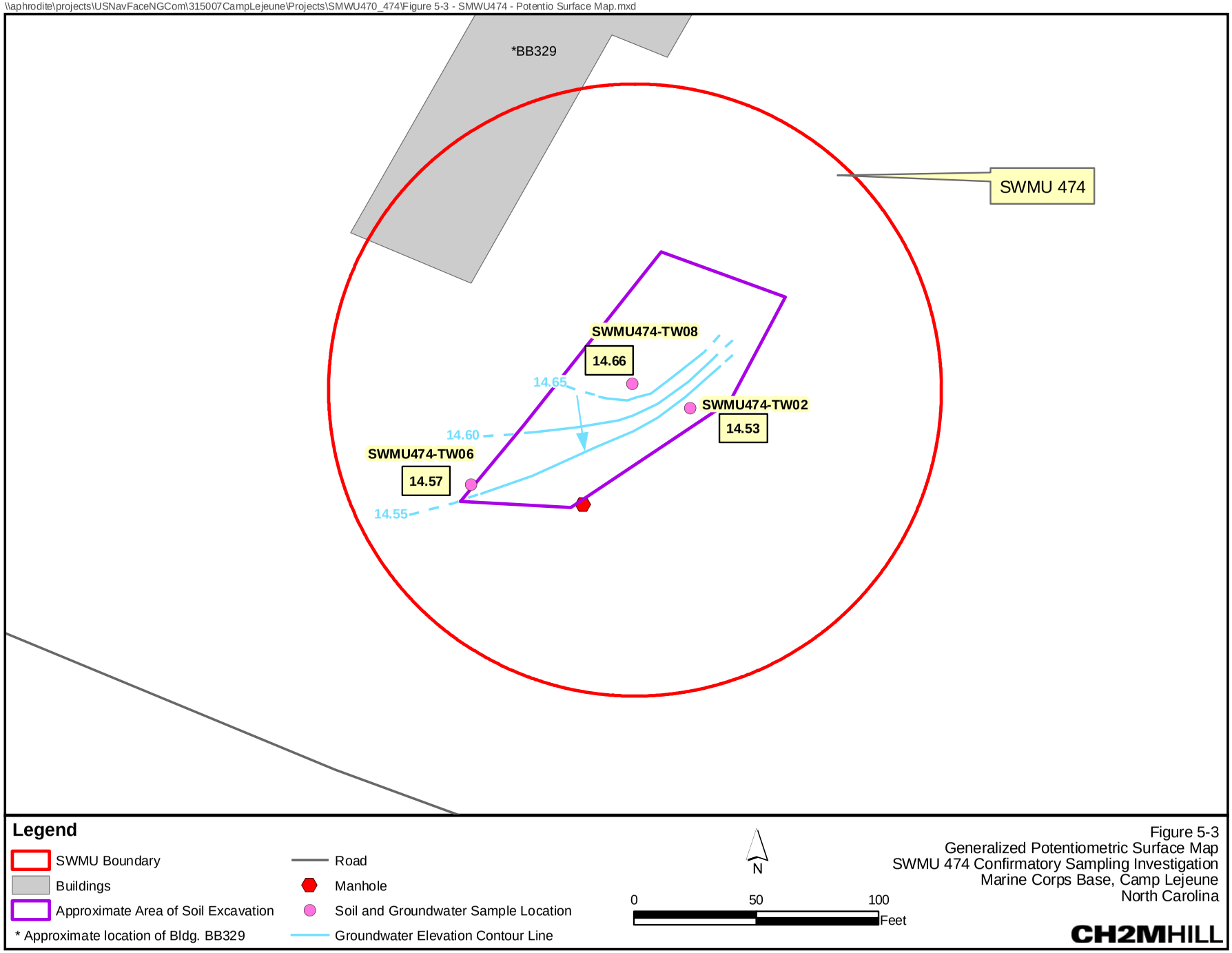


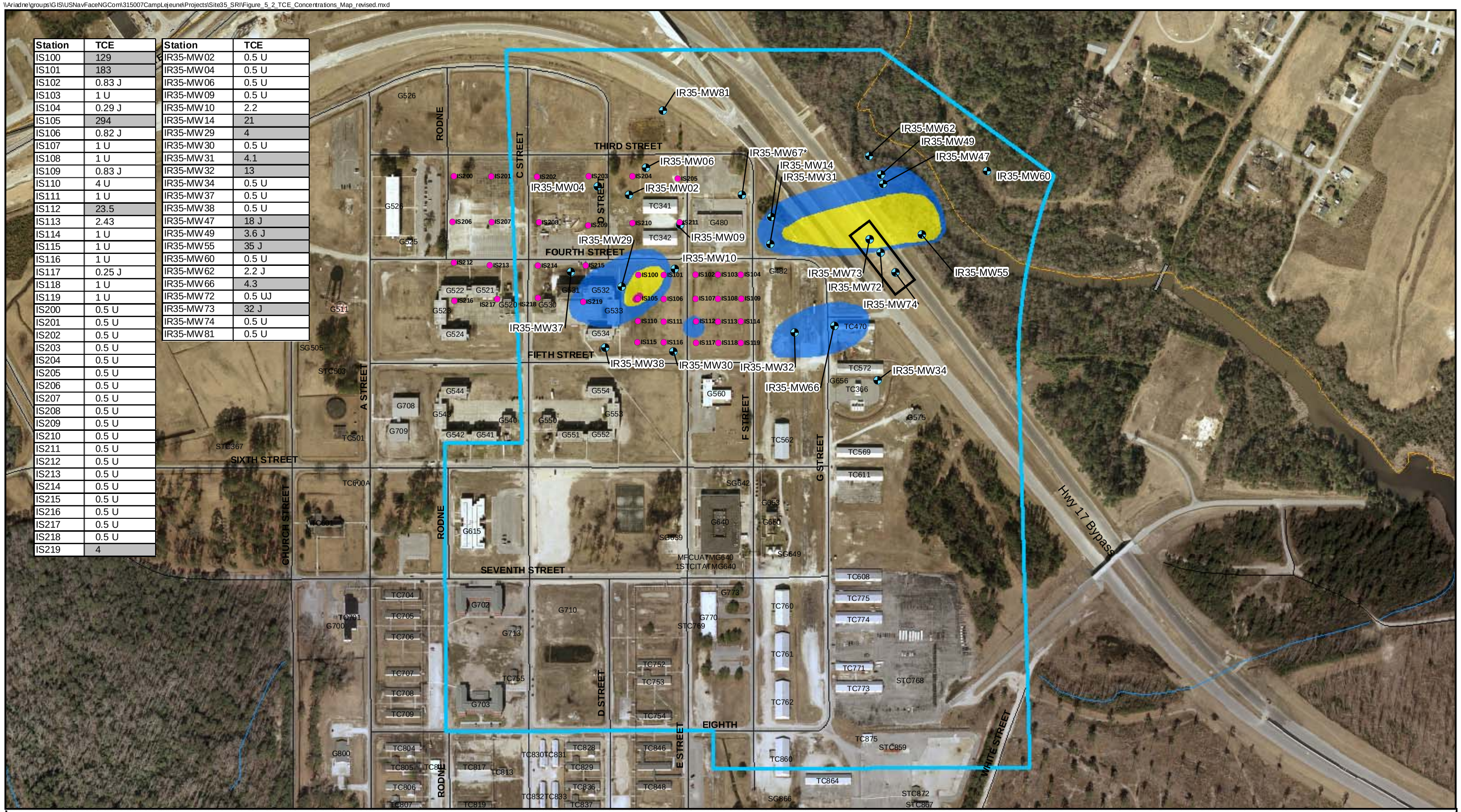
Figure 2-80

SWMU 474 - Generalized Potentiometric Surface Map

\\Ariadne\groups\GIS\USNavFaceNGCom\315007CampLejeune\Projects\Site35_SRI\Figure_5_2_TCE_Concentrations_Map_revised.mxd

Station	TCE
IS100	129
IS101	183
IS102	0.83 J
IS103	1 U
IS104	0.29 J
IS105	294
IS106	0.82 J
IS107	1 U
IS108	1 U
IS109	0.83 J
IS110	4 U
IS111	1 U
IS112	23.5
IS113	2.43
IS114	1 U
IS115	1 U
IS116	1 U
IS117	0.25 J
IS118	1 U
IS119	1 U
IS200	0.5 U
IS201	0.5 U
IS202	0.5 U
IS203	0.5 U
IS204	0.5 U
IS205	0.5 U
IS206	0.5 U
IS207	0.5 U
IS208	0.5 U
IS209	0.5 U
IS210	0.5 U
IS211	0.5 U
IS212	0.5 U
IS213	0.5 U
IS214	0.5 U
IS215	0.5 U
IS216	0.5 U
IS217	0.5 U
IS218	0.5 U
IS219	4

Station	TCE
IR35-MW02	0.5 U
IR35-MW04	0.5 U
IR35-MW06	0.5 U
IR35-MW09	0.5 U
IR35-MW10	2.2
IR35-MW14	21
IR35-MW29	4
IR35-MW30	0.5 U
IR35-MW31	4.1
IR35-MW32	13
IR35-MW34	0.5 U
IR35-MW37	0.5 U
IR35-MW38	0.5 U
IR35-MW47	18 J
IR35-MW49	3.6 J
IR35-MW55	35 J
IR35-MW60	0.5 U
IR35-MW62	2.2 J
IR35-MW66	4.3
IR35-MW72	0.5 UJ
IR35-MW73	32 J
IR35-MW74	0.5 U
IR35-MW81	0.5 U



Legend

- Shallow Monitoring Wells
- DPT Groundwater Location
- Road Centerline
- Approximate Location of Pilot Study
- Base Boundary
- Maximum Extent of Previous Groundwater Investigations

TCE Concentrations in the 2 to 25 Foot bgs Interval

- > 280 µg/L
- > 28 µg/L
- > 2.8 µg/L

U Not Detected
J Estimate Value

Note:
All concentrations are reported in µg/L. Contours have been interpolated between monitoring well locations. Actual conditions may differ from those shown on this figure.
Highlighted values exceed NCGWQS (2.8 µg/L)
IS100 - IS119 were sampled in October 2005
IS200 - IS219 were sampled in February 2006
Monitoring wells sampled in June 2006
* Monitoring well not sampled

N

0 400 800 Feet

1 inch equals 400 feet

Figure 5-2
Groundwater TCE Concentrations (2 to 25 feet bgs)
Operable Unit No. 10 (Site 35)
Supplemental Remedial Investigation
Marine Corps Base, Camp Lejeune
North Carolina

CH2MHILL

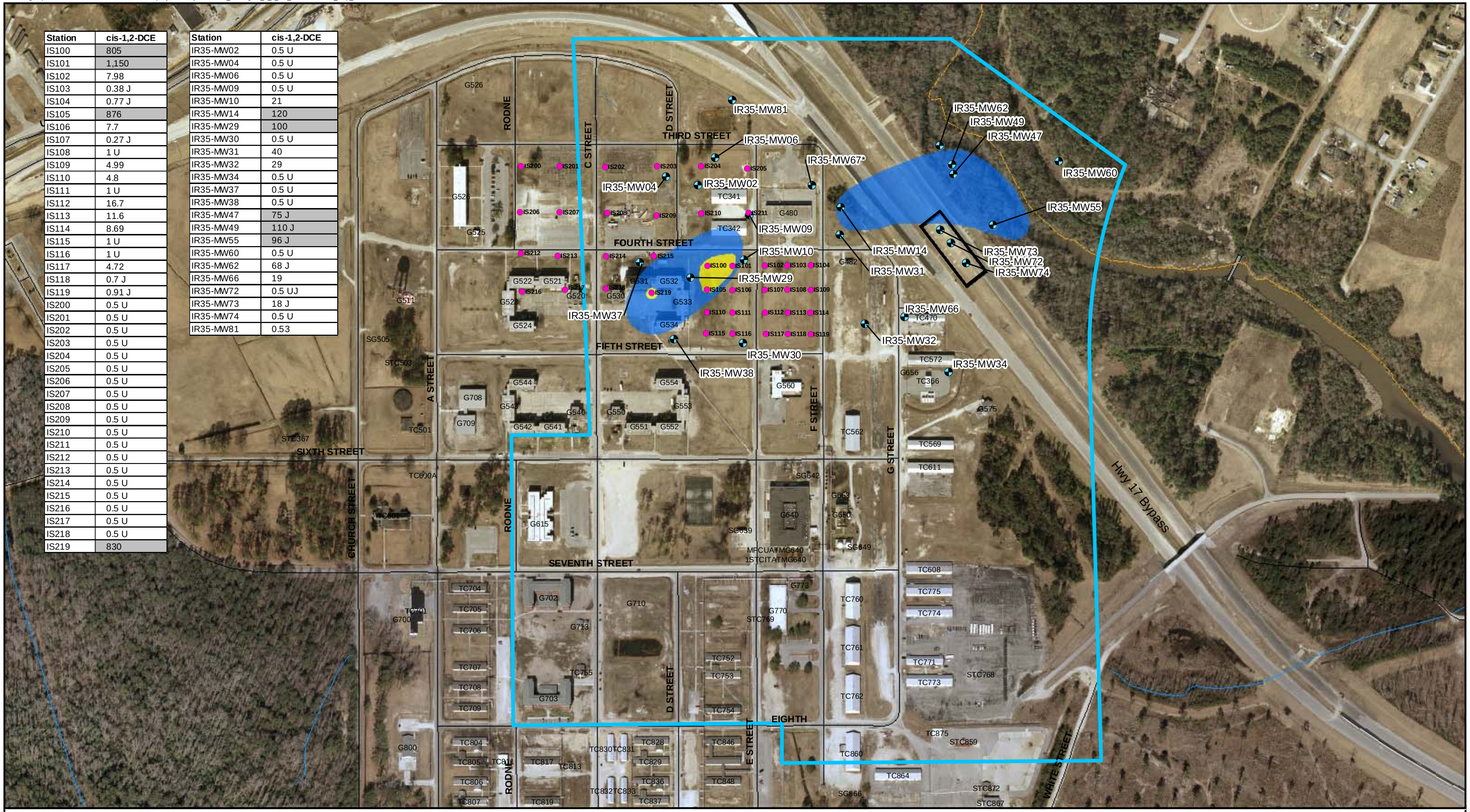
Figure 2-81

Site 35 - Groundwater TCE Concentrations (2 to 25 ft. bgs)

\\Ariadne\groups\GIS\USNavFaceNGCom\315007CampLejeune\Projects\Site35_SRI\Figure_5_6_Cis_Concentrations_Map_Revised.mxd

Station	cis-1,2-DCE
IS100	805
IS101	1,150
IS102	7.98
IS103	0.38 J
IS104	0.77 J
IS105	876
IS106	7.7
IS107	0.27 J
IS108	1 U
IS109	4.99
IS110	4.8
IS111	1 U
IS112	16.7
IS113	11.6
IS114	8.69
IS115	1 U
IS116	1 U
IS117	4.72
IS118	0.7 J
IS119	0.91 J
IS200	0.5 U
IS201	0.5 U
IS202	0.5 U
IS203	0.5 U
IS204	0.5 U
IS205	0.5 U
IS206	0.5 U
IS207	0.5 U
IS208	0.5 U
IS209	0.5 U
IS210	0.5 U
IS211	0.5 U
IS212	0.5 U
IS213	0.5 U
IS214	0.5 U
IS215	0.5 U
IS216	0.5 U
IS217	0.5 U
IS218	0.5 U
IS219	830

Station	cis-1,2-DCE
IR35-MW02	0.5 U
IR35-MW04	0.5 U
IR35-MW06	0.5 U
IR35-MW09	0.5 U
IR35-MW10	21
IR35-MW14	120
IR35-MW29	100
IR35-MW30	0.5 U
IR35-MW31	40
IR35-MW32	29
IR35-MW34	0.5 U
IR35-MW37	0.5 U
IR35-MW38	0.5 U
IR35-MW47	75 J
IR35-MW49	110 J
IR35-MW55	96 J
IR35-MW60	0.5 U
IR35-MW62	68 J
IR35-MW66	19
IR35-MW72	0.5 UJ
IR35-MW73	18 J
IR35-MW74	0.5 U
IR35-MW81	0.53



Legend

- DPT Groundwater Location
- Shallow Monitoring Wells
- Road Centerline
- Base Boundary
- Approximate Location of Pilot Study
- Maximum Extent of Previous Groundwater Investigations

Cis-1,2-DCE Concentrations in the 2 to 25 Foot bgs Interval

- >700 µg/L
- >70 µg/L

U Not Detected
J Estimate Value

Note:
All concentrations are reported in µg/L. Contours have been interpolated between monitoring well locations. Actual conditions may differ from those shown on this figure.
Highlighted values exceed NCGWQS (70 µg/L)
IS100 - IS119 were sampled in October 2005
IS200 - IS219 were sampled in February 2006
Monitoring wells sampled in June 2006
* Monitoring well not sampled

N
0 400 800 Feet
1 inch equals 400 feet

Figure 5-6
Groundwater Cis-1,2-DCE Concentrations (2 to 25 feet bgs)
Operable Unit No. 10 (Site 35)
Supplemental Remedial Investigation
Marine Corps Base, Camp Lejeune
North Carolina

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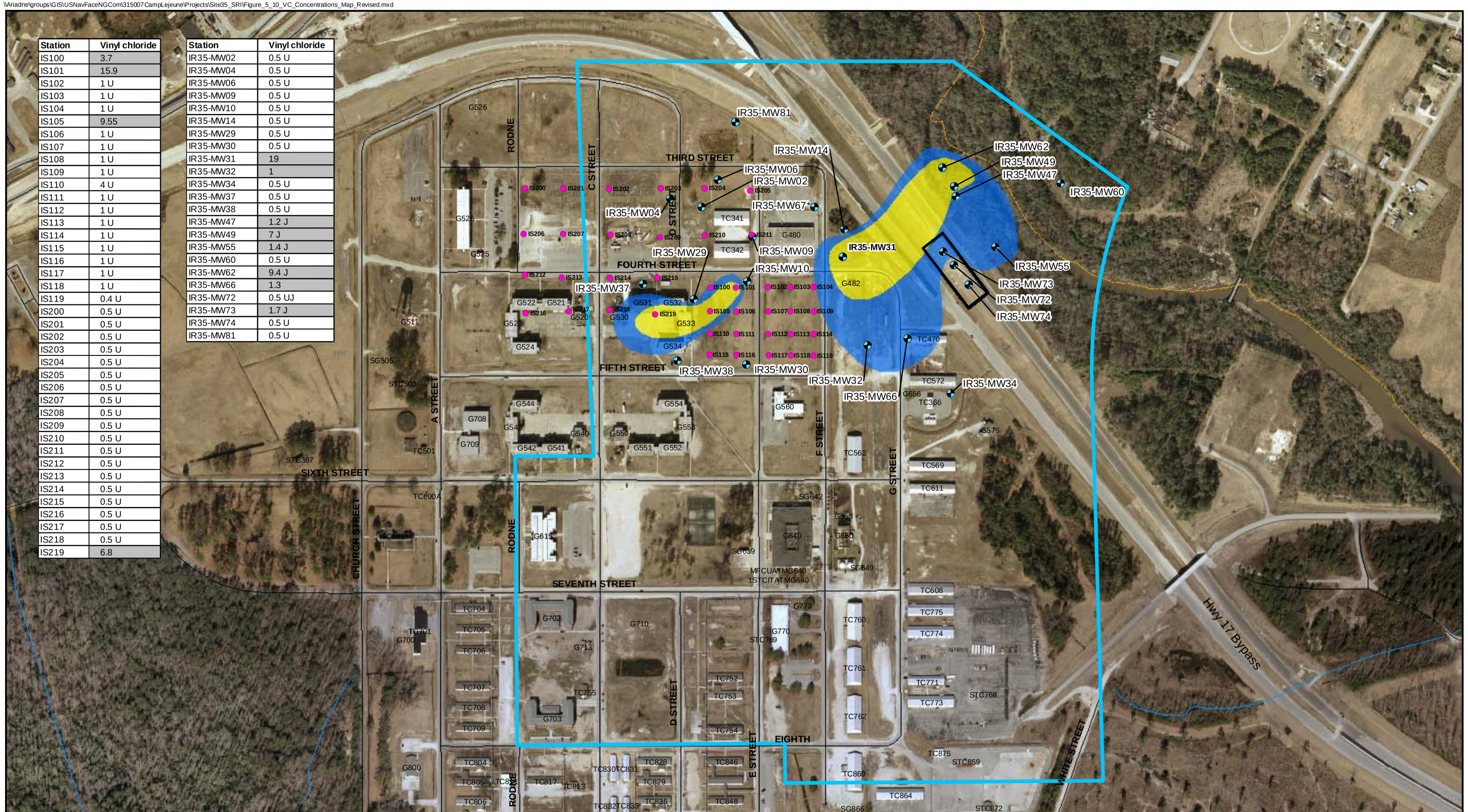
Figure 2-82
Site 35 - Groundwater Cis-1,2-DCE Concentrations (2 to 25 ft. bgs)

\\Ariadne\groups\GIS\USNavFaceNGCom\315007CampLejeune\Projects\Site35_SRI\Figure_5_10_VC_Concentrations_Map_Revised.mxd

Station	Vinyl chloride
IS100	3.7
IS101	15.9
IS102	1 U
IS103	1 U
IS104	1 U
IS105	9.55
IS106	1 U
IS107	1 U
IS108	1 U
IS109	1 U
IS110	4 U
IS111	1 U
IS112	1 U
IS113	1 U
IS114	1 U
IS115	1 U
IS116	1 U
IS117	1 U
IS118	1 U
IS119	0.4 U
IS200	0.5 U
IS201	0.5 U
IS202	0.5 U
IS203	0.5 U
IS204	0.5 U
IS205	0.5 U
IS206	0.5 U
IS207	0.5 U
IS208	0.5 U
IS209	0.5 U
IS210	0.5 U
IS211	0.5 U
IS212	0.5 U
IS213	0.5 U
IS214	0.5 U
IS215	0.5 U
IS216	0.5 U
IS217	0.5 U
IS218	0.5 U
IS219	6.8

Station	Vinyl chloride
IR35-MW02	0.5 U
IR35-MW04	0.5 U
IR35-MW06	0.5 U
IR35-MW09	0.5 U
IR35-MW10	0.5 U
IR35-MW14	0.5 U
IR35-MW29	0.5 U
IR35-MW30	0.5 U
IR35-MW31	19
IR35-MW32	1
IR35-MW34	0.5 U
IR35-MW37	0.5 U
IR35-MW38	0.5 U
IR35-MW47	1.2 J
IR35-MW49	7 J
IR35-MW55	1.4 J
IR35-MW60	0.5 U
IR35-MW62	9.4 J
IR35-MW66	1.3
IR35-MW72	0.5 UJ
IR35-MW73	1.7 J
IR35-MW74	0.5 U
IR35-MW81	0.5 U



Legend

- DPT Groundwater Location
- Shallow Monitoring Wells
- Road Centerline
- Base Boundary
- Approximate Location of Pilot Study
- Maximum Extent of Previous Groundwater Investigations

VC Concentrations in the 2 to 25 Foot bgs Screened Interval

- > 5.0 µg/L
- > 0.5 µg/L

U Not Detected
J Estimate Value

Note:
All concentrations are reported in µg/L. Contours have been interpolated between monitoring well locations. Actual conditions may differ from those shown on this figure.
Highlighted values exceed NCGWQS (0.015 µg/L)
IS100 - IS119 were sampled in October 2005
IS200 - IS219 were sampled in February 2006
Monitoring wells sampled in June 2006
* Monitoring well not sampled

N

0 400 800 Feet

1 inch equals 400 feet

Figure 5-10
Vinyl Chloride Concentrations (2 to 25 feet bgs)
Operable Unit No. 10 (Site 35)
Supplemental Remedial Investigation
Marine Corps Base, Camp Lejeune
North Carolina

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Figure 2-83

Site 35 - Vinyl Chloride Concentrations (2 to 25 ft. bgs)

\\aphrodite\projects\USNavFaceNGCom\315007CampLejeune\Projects\Site35_SRI\Figure_4_6_GW_Contour_Map.mxd 7/20/07

Legend

- Shallow Monitoring Well
- Base Boundary
- Road Centerline
- Potentiometric Surface Line (dashed where inferred)
- 12 Groundwater Elevation (feet mean sea level) on 06/19/2006
- Groundwater flow direction
- NM Water level not collected
- Surface Water Course Centerline

Note: Potentiometric surface lines have been interpolated between monitoring well locations. Actual conditions may differ from those shown in this figure.
*Monitoring well IR35-MW62 not used for determining groundwater contours

N

0 400 800 Feet

1 inch equals 400 feet

Figure 4-6
Groundwater Contour Map of the Shallow Aquifer Zone
Operable Unit No. 10 (Site 35)
Supplemental Remedial Investigation
Marine Corps Base, Camp Lejeune
North Carolina

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Figure 2-84

Site 35- Groundwater Contour Map of the Shallow Aquifer Zone

\\ariadne\groups\gis\USNavFaceNGCom\Projects\Site89_RI\Figure_5_9_TCE_PCA_Surficial_NovDec2005.mxd

Legend
- Shallow Groundwater Monitoring Well
- Site 89 Boundary
- Base Boundary
- Water Bodies

J - estimated value
1,1,2,2, - PCA - 1,1,2,2, Tetrachloroethane
TCE - Trichloroethene

N

0 125 250
Feet

Note:
All concentrations are reported in µg/L.

Figure 5-9
TCE and PCA Concentrations Within the Surficial Aquifer, November and December 2005
Operable Unit No. 16 - Site 89
Site 89 Comprehensive RI
Marine Corps Base, Camp Lejeune
North Carolina

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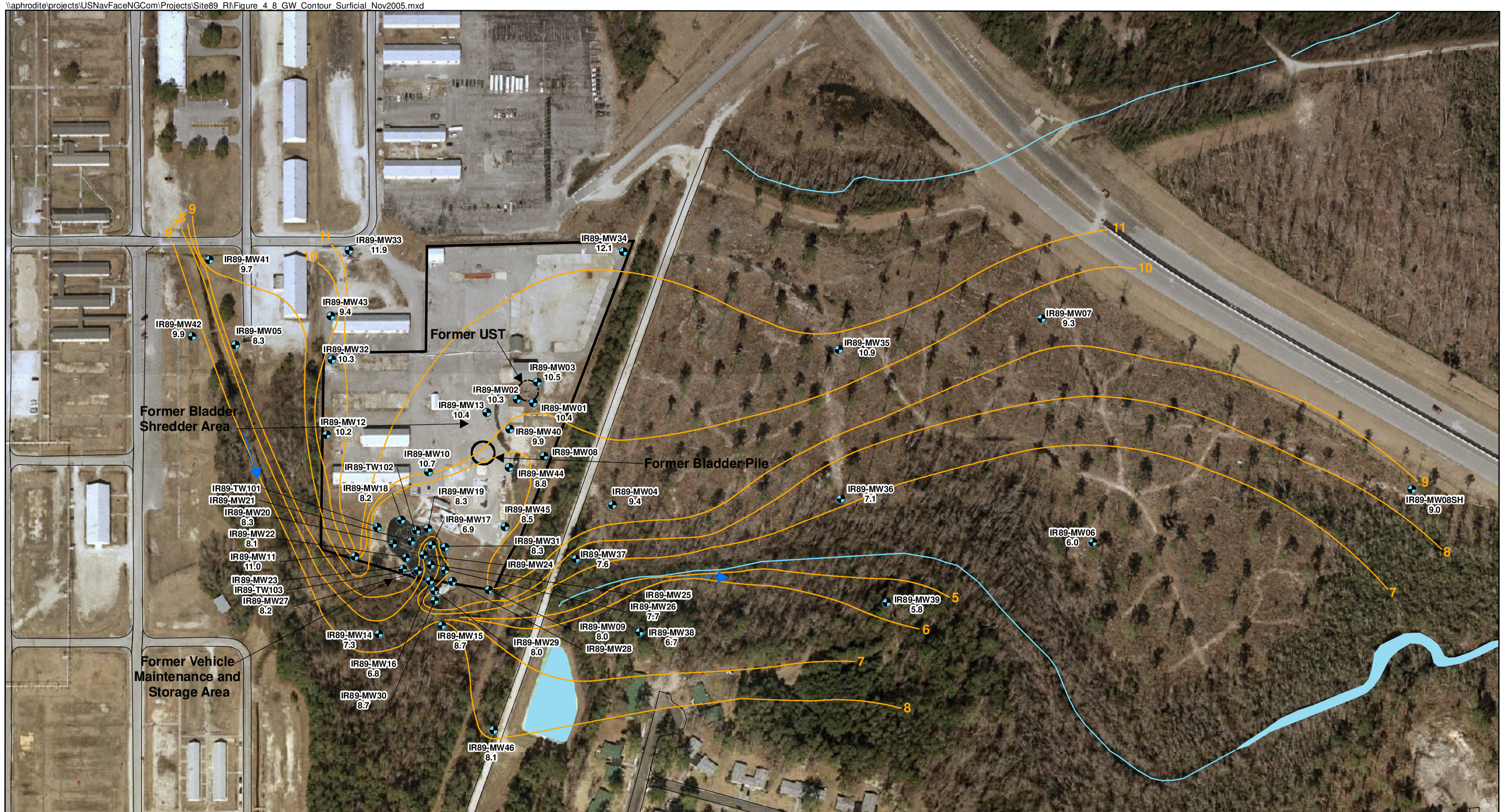
Figure 2-85
Site 89 - TCE and PCA Concentrations Within the Surficial Aquifer, Nov. and Dec. 2005

\\aphrodite\projects\USNavFaceNGCom\Projects\Site89_RI\Figure_4_8_GW_Contour_Surficial_Nov2005.mxd



Legend

- Monitoring Wells
- Former UST
- Site 89 Boundary
- Water Bodies
- Surface Water Flow Direction
- 8 Groundwater Elevation Contour

Note: All data reported in ft msl

N

0 125 250 Feet

Figure 4-8
Groundwater Contour Map of the Surficial Aquifer, November 2005
Site 89 Comprehensive RI
Marine Corps Base, Camp Lejeune
North Carolina

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Figure 2-86
Site 89 - Groundwater Contour Map of the Surficial Aquifer, November 2005

\\Aphrodite\proj\USNavFaceNGCom\315007CampLejeune\Projects\Site93_ROD\Figure 2-4 - Shallow Groundwater Contamination.mxd

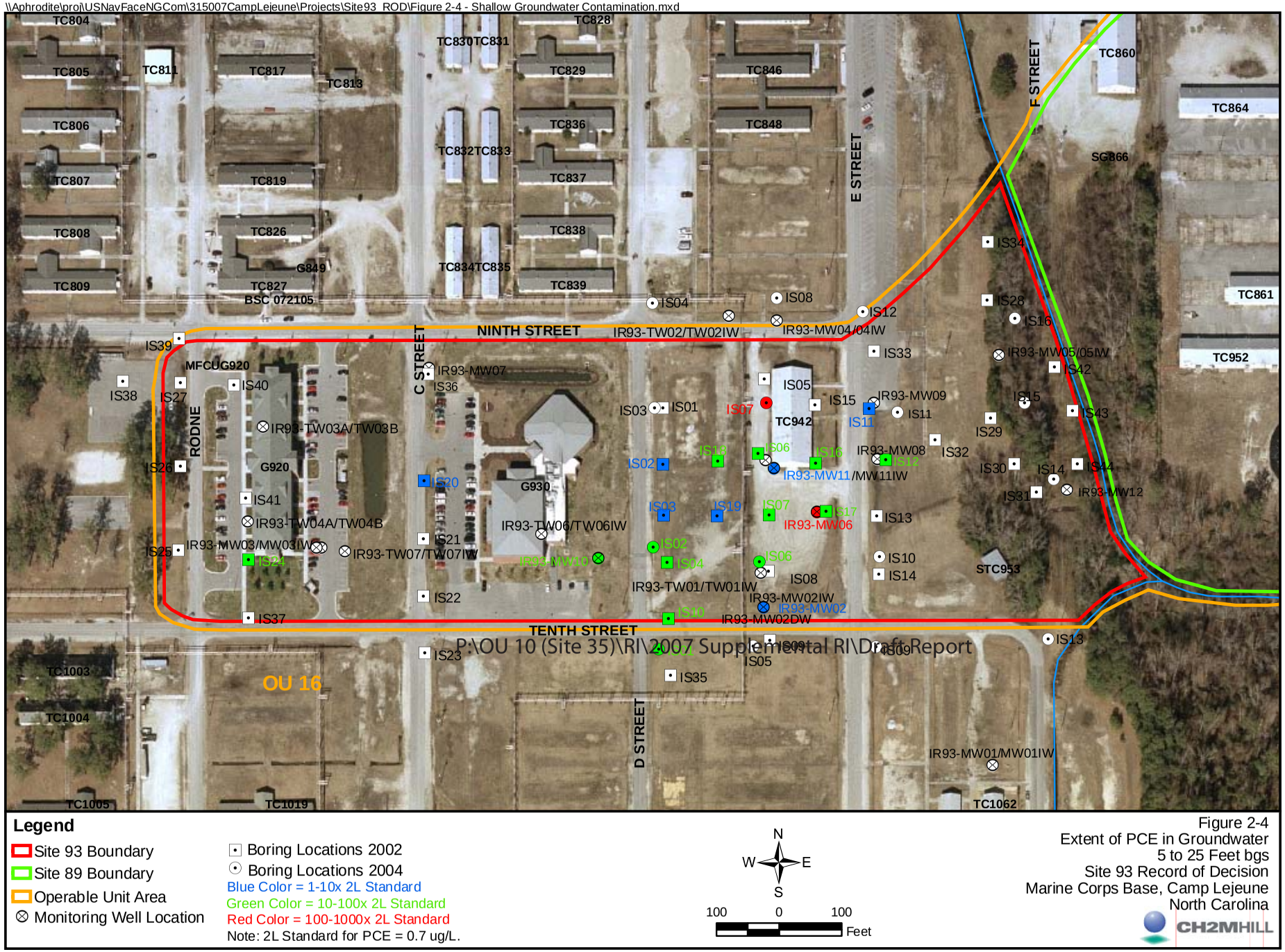
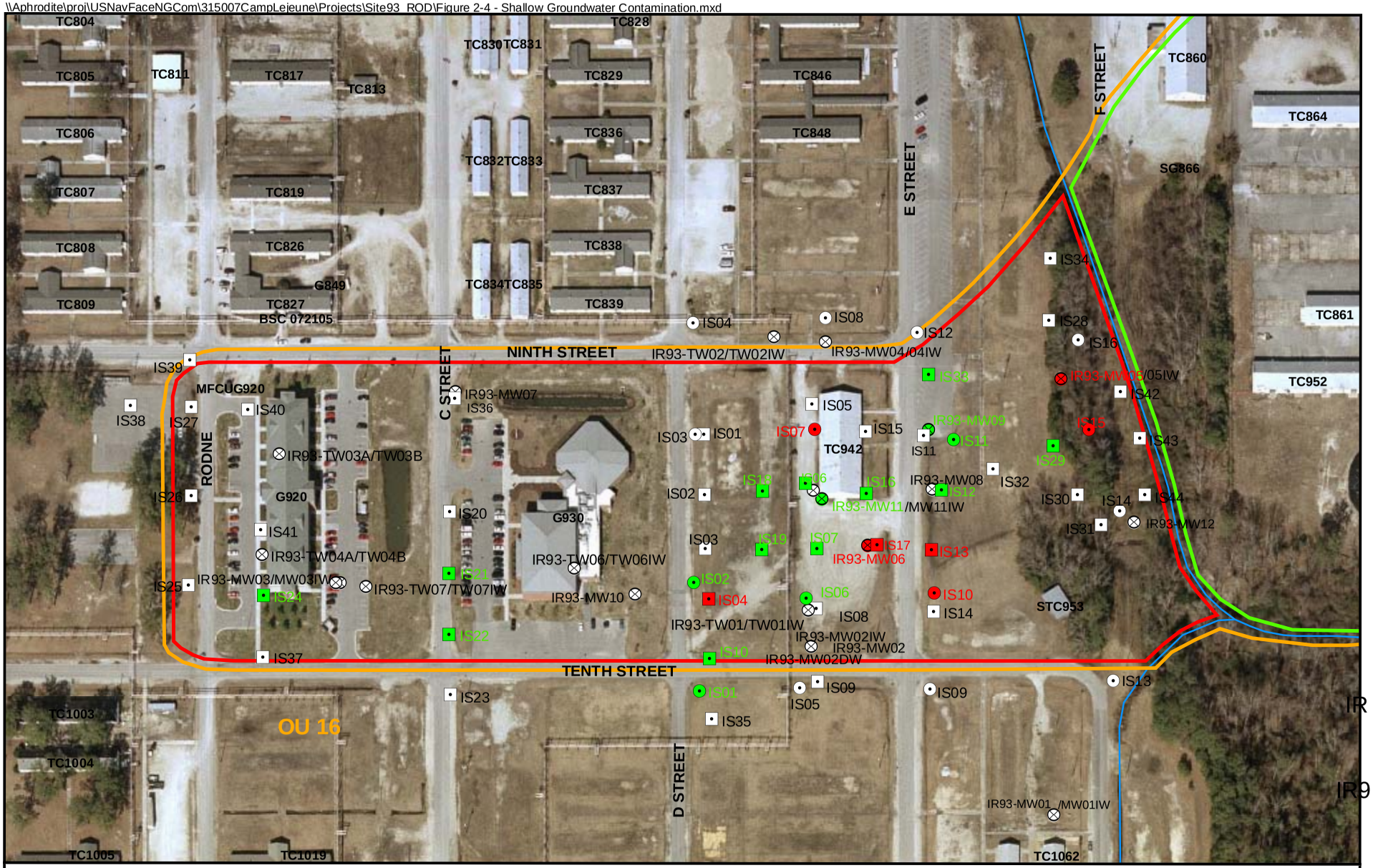


Figure 2-87

Site 93 - Extent of PCE in Groundwater (5 - 25 ft. bgs)

\\Aphrodite\proj\USNavFaceNGCom\315007CampLejeune\Projects\Site93_ROD\Figure 2-4 - Shallow Groundwater Contamination.mxd



Legend

- Site 93 Boundary
- Site 89 Boundary
- Operable Unit Area
- Monitoring Well Location
- Boring Locations 2002
- Boring Locations 2004

Green Color = 1-10x 2L Standard
Red Color = 10-100x 2L Standard
Note: 2L Standard for TCE = 2.8 ug/L.

N W E S
100 0 100 Feet

Figure 2-6
Extent of TCE in Groundwater
5 to 25 Feet bgs
Site 93 Record of Decision
Marine Corps Base, Camp Lejeune
North Carolina

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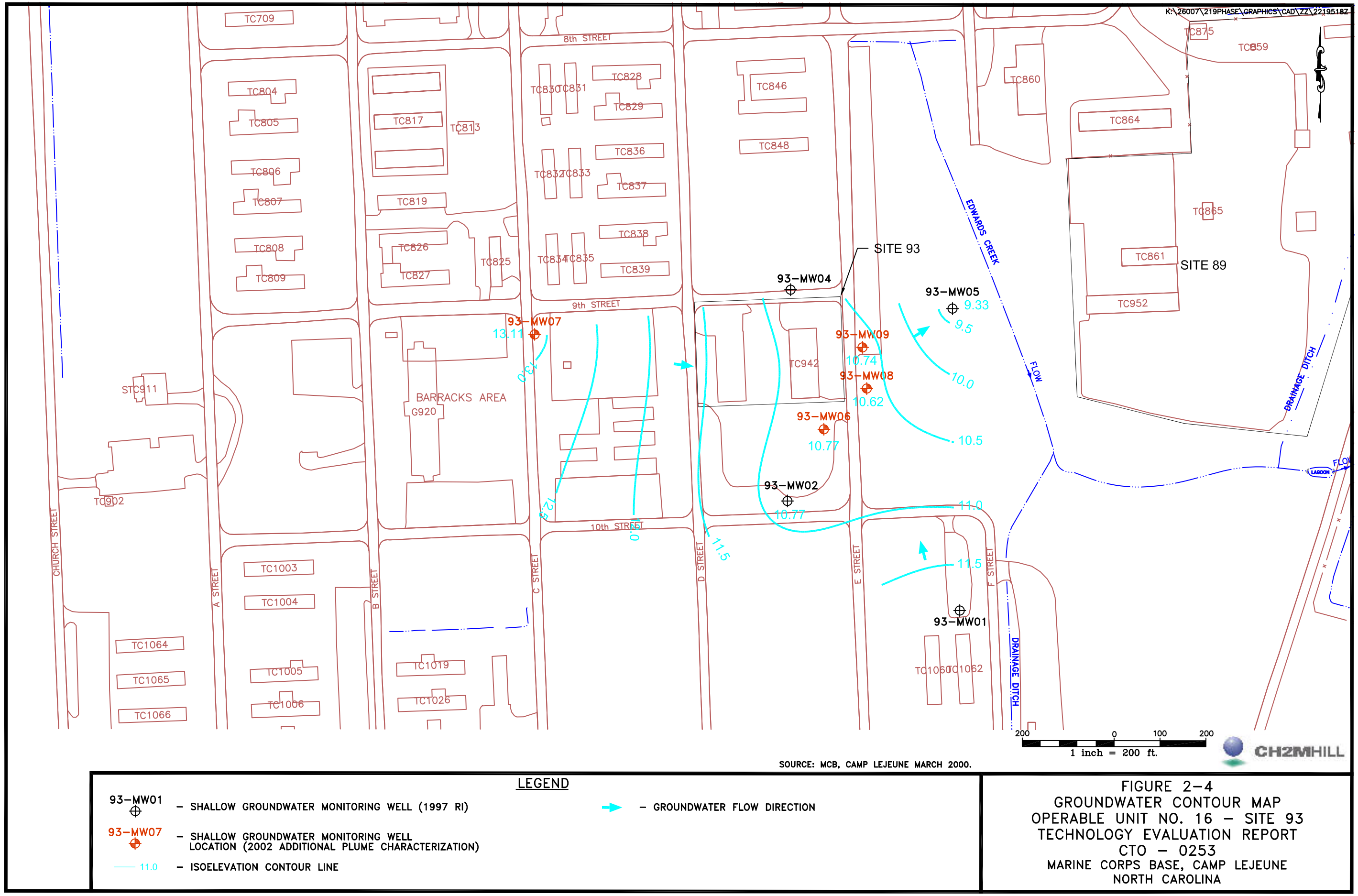
Figure 2-88

Site 93 - Extent of TCE in Groundwater (5-25 ft bgs)



SOURCE: MCB, CAMP LEJEUNE MARCH 2000.

LEGEND

93-MW01 – SHALLOW GROUNDWATER MONITORING WELL (1997 RI)

93-MW07 – SHALLOW GROUNDWATER MONITORING WELL LOCATION (2002 ADDITIONAL PLUME CHARACTERIZATION)

11.0 – ISOELEVATION CONTOUR LINE

– GROUNDWATER FLOW DIRECTION

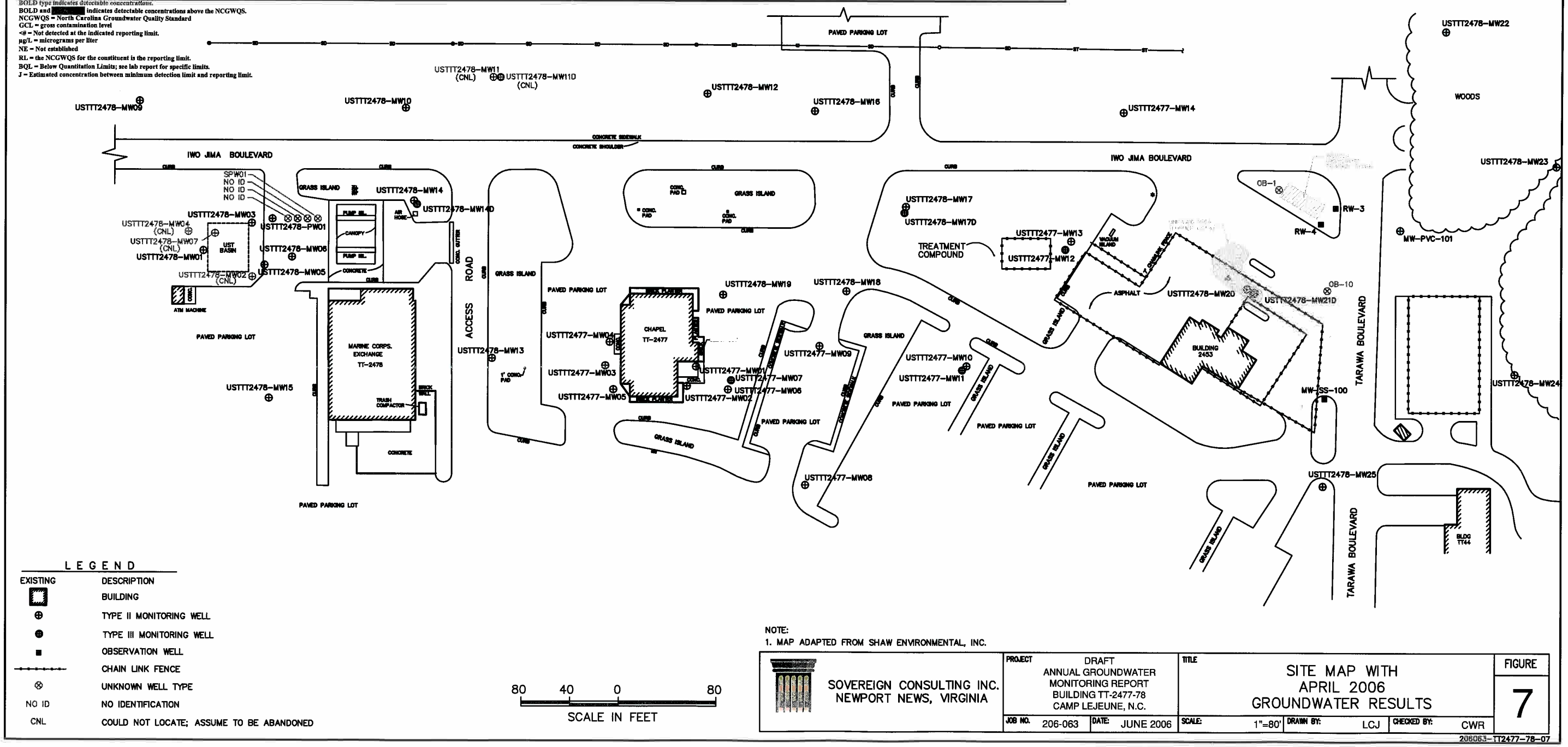
FIGURE 2-4
GROUNDWATER CONTOUR MAP
OPERABLE UNIT NO. 16 – SITE 93
TECHNOLOGY EVALUATION REPORT
CTO – 0253
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

Figure 2-89
Site 93 - Groundwater Contour Map

Table 5
Analytical Data for April 2006 Sampling Event
Building TT2477 and TT2478

Parameter	NCGWQS	GCL	2477-MWOB01	2477-MWOB10	2477-MWPVC101	2477-MW01	2477-MW02	2477-MW06	2477-MW11	2477-MW14	2478-MW17	2478-MW17D	2478-MW18	2478-MW19	2478-MW20	2478-MW21D	2478-MW23	2478-MW24	2478-MWSS100
VOCs by EPA Method 601 (µg/L)																			
Benzene	100	5,000	BQL	13.6	1450	0.665J	BQL	BQL	BQL	BQL	BQL	BQL	1.05	BQL	BQL	BQL	BQL	BQL	BQL
Diisopropyl ether (DIPE)	70	70,000	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	**2.06J**	BQL	BQL	BQL	BQL
Ethylbenzene	550	84,500	256	59.4	1850	0.856J	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	**80.6**	BQL	BQL	BQL	BQL
Methyl Ter-butyl Ether	200	200,000	BQL	BQL	BQL	BQL	**6.3**	BQL	BQL	BQL	BQL	BQL	BQL	BQL	**3.84J**	BQL	BQL	BQL	BQL
Toluene	1,000	257,500	**591**	**18.9**	**476**	**2.39J**	BQL	**4.85**	BQL	BQL	BQL	BQL	**1.17**	BQL	**90.4**	BQL	BQL	BQL	BQL
Xylenes (total)	530	87,500	851	94.5	1790	**1.494J**	**0.778J**	BQL	BQL	BQL	BQL	BQL	BQL	BQL	**310**	BQL	BQL	BQL	BQL
SVOCs by EPA Method 625 (µg/L)																			
Acenaphthene	80	2,120	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Bis(2-ethylhexyl)phthalate	3	3,000	7.10J	BQL	BQL	10.6	5.40J	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Diethylphthalate	5,000	NE	BQL	BQL	BQL	BQL	**4.90J**	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Fluorene	280	950	BQL	BQL	BQL	**2.10J**	**1.80J**	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Naphthalene	21	15,500	68.4	7.30J	311	**3.00J**	**1.10J**	BQL	BQL	BQL	BQL	BQL	BQL	BQL	**10.9**	BQL	BQL	BQL	BQL
Phenol	300	NE	BQL	BQL	**11.1**	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
TICs (Total)			**1,645.90**	**165.38**	**9478**	**763.8**	**1,187.70**	BQL	**35.34**	BQL	BQL	BQL	BQL	**75.3**	**895.6**	BQL	BQL	BQL	BQL
MPH (µg/L)																			
C5 - C8 Aliphatics	420	NE	1,100	**220**	**4,200**	<100	<100	<100	<100	<100	<100	<100	**120**	**210**	**650**	<100	<100	<100	<100
C9 - C12 Aliphatics			**940**	**180**	**6,000**	<100	**100**	<100	<100	<100	<100	<100	<100	<100	**640**	<100	<100	<100	<100
C9 - C10 Aromatics			**260**	<100	**2,100**	<100	<100	<100	<100	<100	<100	<100	<100	<100	**340**	<100	<100	<100	<100
EPH (µg/L)																			
C11 - C22 Aromatics			<100	<100	**450**	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
C9 - C18 Aliphatics			<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
C19 - C36 Aliphatics	42,000	NE	<100	<100	<100	**30**	**190**	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
NPH + EPH (µg/L)																			
C9 - C12 + C9 - C18 Aliphatics	4,200	NE	**<1,040**	**<280**	**<6,100**	<200	**100**	<200	<200	<200	<200	<200	<200	<200	**<740**	<200	<200	<200	<200
C9 - C10 + C11 - C22 Aromatics	210	NE	<360	<200	2,550	<200	<200	<200	<200	<200	<200	<200	<200	<200	<440	<200	<200	<200	<200

BOLD type indicates detectable concentrations.
BOLD and [redacted] indicates detectable concentrations above the NCGWQS.
NCGWQS = North Carolina Groundwater Quality Standard
GCL = gross contamination level
<# = Not detected at the indicated reporting limit.
µg/L = micrograms per liter
NE = Not established
RL = the NCGWQS for the constituent is the reporting limit.
BQL = Below Quantitation Limits; see lab report for specific limits.
J = Estimated concentration between minimum detection limit and reporting limit.



LEGEND

EXISTING	DESCRIPTION
	BUILDING
	TYPE II MONITORING WELL
	TYPE III MONITORING WELL
	OBSERVATION WELL
	CHAIN LINK FENCE
	UNKNOWN WELL TYPE
NO ID	NO IDENTIFICATION
CNL	COULD NOT LOCATE; ASSUME TO BE ABANDONED

80 40 0 80
SCALE IN FEET

NOTE:
1. MAP ADAPTED FROM SHAW ENVIRONMENTAL, INC.

SOVEREIGN CONSULTING INC.
NEWPORT NEWS, VIRGINIA

PROJECT: DRAFT ANNUAL GROUNDWATER MONITORING REPORT BUILDING TT-2477-78 CAMP LEJEUNE, N.C.

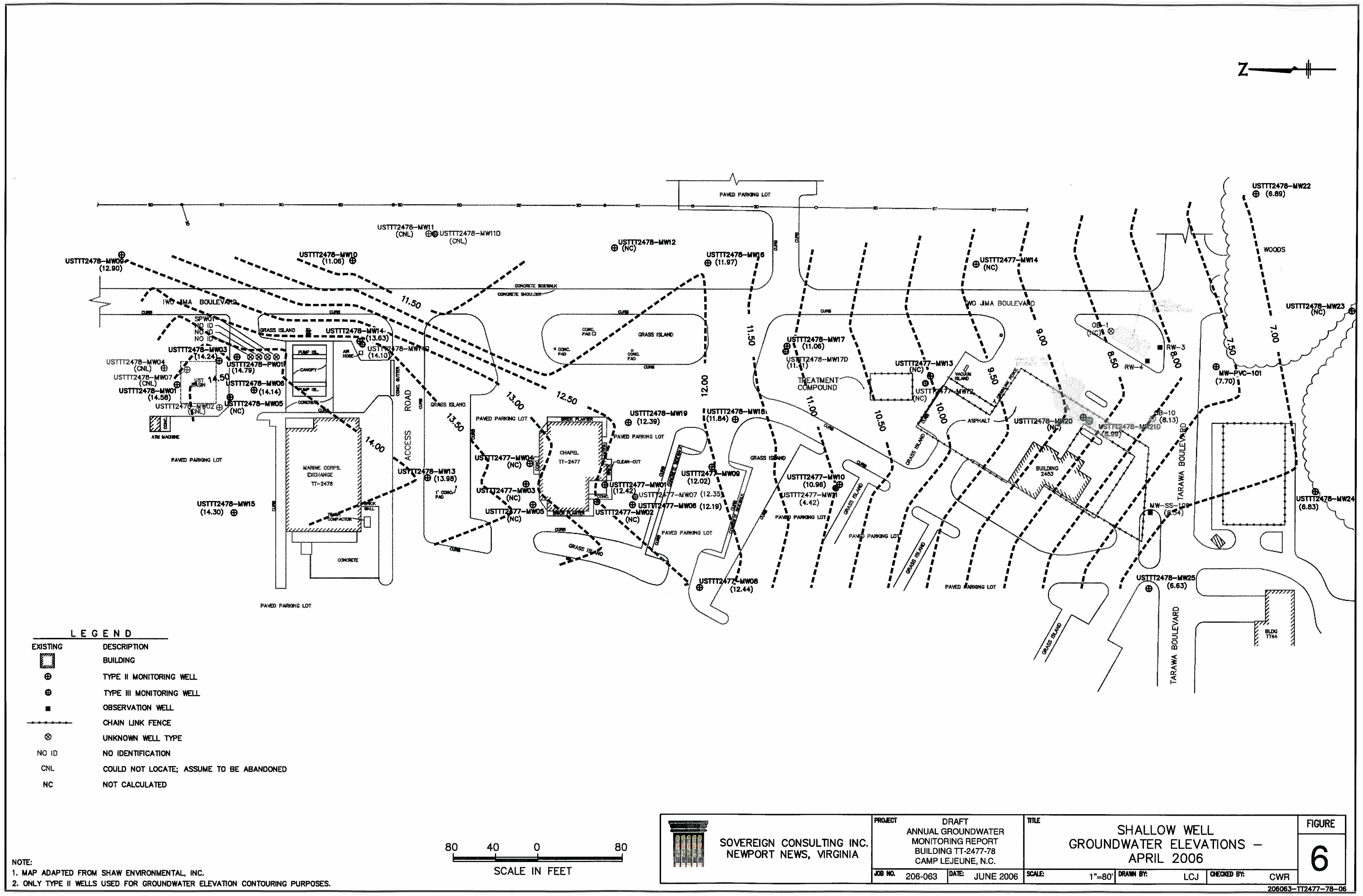
TITLE: SITE MAP WITH APRIL 2006 GROUNDWATER RESULTS

FIGURE 7

JOB NO. 206-063 | DATE: JUNE 2006 | SCALE: 1"=80' | DRAWN BY: LCJ | CHECKED BY: CWR

206063-TT2477-78-07

Figure 2-90
Building TT-2477/78 - Site Map With April 2006 Groundwater Results



LEGEND

EXISTING	DESCRIPTION
▨	BUILDING
⊕	TYPE II MONITORING WELL
⊕	TYPE III MONITORING WELL
■	OBSERVATION WELL
-+-+-+-	CHAIN LINK FENCE
⊗	UNKNOWN WELL TYPE
NO ID	NO IDENTIFICATION
CNL	COULD NOT LOCATE; ASSUME TO BE ABANDONED
NC	NOT CALCULATED

80 40 0 80
SCALE IN FEET

NOTE:
1. MAP ADAPTED FROM SHAW ENVIRONMENTAL, INC.
2. ONLY TYPE II WELLS USED FOR GROUNDWATER ELEVATION CONTOURING PURPOSES.

SOVEREIGN CONSULTING INC.
NEWPORT NEWS, VIRGINIA

PROJECT: DRAFT ANNUAL GROUNDWATER MONITORING REPORT BUILDING TT-2477-78 CAMP LEJEUNE, N.C.

TITLE: SHALLOW WELL GROUNDWATER ELEVATIONS – APRIL 2006

FIGURE 6

JOB NO. 206-063 | DATE: JUNE 2006 | SCALE: 1"=80' | DRAWN BY: LCJ | CHECKED BY: CWR

206063-TT2477-78-06

Figure 2-91

Building TT-2477/78 - Shallow Well Groundwater Elevations, April 2006

SECTION 3

Identification of Buildings of Interest

Using the information collected as part of the site evaluation described in Section 2 and existing groundwater sampling data, buildings of interest were identified in each of the six identified areas of the base (Mainside, Hadnot Point, Air Station, Camp Geiger, Courthouse Bay, and Tarawa Terrace) for vapor intrusion evaluation. The buildings of interest were selected using a tiered process in accordance with EPA and ITRC guidance. The screening process is described in detail in Sections 3.1 through 3.6 and includes the following steps:

1. **Selection of COPCs—**Existing groundwater VOC data exceeding NCGWQS and/or USEPA's generic screening levels (USEPA, 2002) most frequently and with the greatest magnitude were selected as COPCs for use as indicator compounds. The Camp Lejeune database containing groundwater VOC data from IR and RCRA sites was used as the primary data source. To complete the dataset, UST data was obtained from Catlin Engineers and Scientists and added to the database. For purposes of the evaluation, only data collected from September 2002 to September 2007 was used in the screening process.

2. **Identification of Buildings of Interest—**COPC concentrations in groundwater were mapped using GIS and buildings located within 100 ft of monitoring wells containing groundwater concentrations exceeding the NCGWQS and/or target groundwater concentrations (USEPA, 2002) were identified as buildings of interest. In addition, buildings found to be located within 100 ft of free product or a remediation system which may contribute to vapor intrusion based on the site evaluation detailed in Section 2 were also identified as buildings of interest.

3. **Refinement of Buildings of Interest List—**A preliminary building survey was conducted to gather information (e.g., construction material, use, size) for the buildings of interest. Using the information collected during the preliminary building survey, site-specific screening levels were developed for the COPCs using the J&E model and the groundwater data was re-screened.

4. **Selection of Buildings to be Sampled—**Buildings located within 100 ft of shallow monitoring wells containing groundwater concentrations exceeding the site-specific screening criteria, free product, or remediation systems which may contribute to vapor intrusion risks were mapped using GIS. Additional data will be collected at these buildings as described in Section 4.

3.1 Selection of Constituents of Potential Concern

The data set for each investigation area was screened against two sets of preliminary screening criteria (Table 3-1):

1. NCGWQS
2. The 2002 USEPA Draft Vapor Intrusion Guidance target groundwater concentrations based on a 1×10^{-6} cancer risk and a non-cancer hazard quotient (HQ) of 1.0

In accordance with USEPA guidance, Table 3C-GW, *Groundwater Screening Levels for Scenario-Specific Vapor Attenuation Factors,* was referred to determine the screening criteria for each investigation area. The estimated scenario-specific vapor attenuation factors for each investigation area were selected from Figure 3b, *Vapor Attenuation Factors – Ground Water to Indoor Air Pathway.*

Boring logs and water table information were reviewed to determine the predominant soil type and average depth to groundwater for each of the six investigation areas. The selected soil type and depth to groundwater that were used to determine the vapor attenuation factors from Figure 3b are shown in Table 3-2. The vapor attenuation factors for all six investigation area were estimated to be 1.0E-03. USEPA guidance document lists generic screening values for an attenuation factor of 1.0E-03 in Table 2C. As noted in Table 3-1, the generic groundwater screening levels for several chemicals were updated using the methodology presented in Appendix D of the 2002 EPA Draft Vapor Intrusion Guidance. The values were revised due to updates in toxicity values presented in USEPA's Integrated Risk Information System (IRIS) database (USEPA, 2008).

TABLE 3-2
Scenario-Specific Vapor Attenuation Factors

Investigation Area	Soil Type	Depth to Groundwater (ft)	Vapor Attenuation Factor
Mainside	Sand	5	1.0E-03
Hadnot Point	Sand	9	1.0E-03
Air Station	Sand	5	1.0E-03
Courthouse Bay	Sand	5	1.0E-03
Camp Geiger	Sand	5	1.0E-03
Tarawa Terrace	Sand	10.5	1.0E-03

The two sets of preliminary screening criteria were loaded into the database and tables of exceedances were generated for each investigation area (Tables 3-3 through 3-8). The VOCs which were detected most frequently and with the greatest maximum detections above the screening levels within each investigation area were selected as the COPCs. It is important to note that COPCs were selected for use as indicator parameters in order to streamline the building identification process. Individual VOCs are not being excluded from the vapor intrusion evaluation and full VOC analyses will be performed as part of data collection.

In order to account for degradation products, parent and daughter compounds were carried through to the risk evaluation step as a group. For example, PCE, TCE, DCE, and VC are considered to be one group. Compounds associated with chlorination by-products, determined not to be site-related, (such as chloroform, bromoform and bromodichloromethane) were not selected as COPCs. The COPCs for each area are presented below.

- **Mainside**. The preliminary screening for Mainside is provided in Table 3-3. Three groups of COPCs were identified for this investigation area.
  - Group 1: PCE, TCE, cis-1,2-DCE, VC
  - Group 2: Benzene
  - Group 3: 1,1,2,2-PCA, 1,1,2-TCA
- **Hadnot Point**. The preliminary screening for Hadnot Point is provided in Table 3-4. Three groups of COPCs were identified for this investigation area.
  - Group 1: PCE, TCE, cis-1,2-DCE, VC
  - Group 2: Benzene, ethylbenzene, xylenes
  - Group 3: 1,1,2-TCA, 1,2-DCA
  - Group 4: Isopropylbenzene
- **Air Station**. The preliminary screening for Air Station is provided in Table 3-5. Four groups of COPCs were identified for this investigation area.
  - Group 1: PCE, TCE, cis-1,2-DCE VC
  - Group 2: Benzene
  - Group 3: 1,2-DCA
  - Group 4: 1,1-DCE
- **Courthouse Bay**. The preliminary screening for Courthouse Bay is provided in Table 3-6. Four groups of COPCs were identified for this investigation area.
  - Group 1: Benzene
  - Group 2: TCE, cis-1,2-DCE, VC
  - Group 3: 1,2-DCA
  - Group 4: 1,1-DCE
- **Camp Geiger**. The preliminary screening for Camp Geiger is provided in Table 3-7. Four groups of COPCs were identified for this investigation area.
  - Group 1: PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, VC
  - Group 2: Benzene
  - Group 3: 1,1,2,2-PCA, 1,1,2-TCA, 1,2-DCA
  - Group 4: 1,1-DCE
- **Tarawa Terrace**. The preliminary screening for Camp Geiger is provided in Table 3-8. Two groups of COPCs were identified for this investigation area.
  - Group 1: Benzene, ethylbenzene, xylenes
  - Group 2: PCE

3.2 Identification of Buildings of Interest

Buildings of interest were identified by mapping groundwater data for each COPC. Only the most recent data from each monitoring well were used for mapping. The GIS was used to generate figures identifying wells with VOC exceedances of the NCGWQS and/or target groundwater concentrations (USEPA, 2002) and buildings within 100 ft of these wells. The buildings identified within 100 ft of a well in each investigation area are listed on the building inventory spreadsheet for each area (Tables 3-9 through 3-14) and are briefly discussed below. In some instances, buildings were included on the list due to their proximity to a nearby remediation system (e.g., sparge/pulsing system) or free product.

- **Mainside—**40 buildings were identified as shown on Table 3-9 and Figures 3-1 through 3-8
- **Hadnot Point—**56 buildings were identified as shown on Table 3-10 and Figures 3-9 through 3-14
- **Air Station—**30 buildings were identified as shown on Table 3-11 and Figures 3-15 through 3-17
- **Courthouse Bay—**Seven buildings were identified as shown on Table 3-12 and Figure 3-18
- **Camp Geiger—**34 buildings were identified as shown on Table 3-13 and Figures 3-19 through 3-21
- **Tarawa Terrace—**Two buildings were identified as shown on Table 3-13 and Figures 3-19 through 3-21

3.3 Refinement of Buildings of Interest List

3.3.1 Preliminary Building Survey

A preliminary survey of the buildings of interest was performed to obtain additional information for the building inventory. The preliminary surveys of the Mainside and Hadnot Point buildings were performed on January 2, 2008. The preliminary surveys for Air Station, Courthouse Bay, Camp Geiger, and Tarawa Terrace were performed the week of March 24. 2008. A JV 2 employee went to each building and recorded the following building-specific characteristics which is presented on the building inventory spreadsheets (Tables 3-9 through 3-14):

- Approximate dimensions
- Number of stories
- Slab on grade, crawl space, or basement
- Building construction materials
- Number of doors windows and loading docks
- Residential, commercial or industrial
- Building use
- Approximate number of occupants

Notes were added throughout the evaluation process to document which buildings were screened out and the reasons these buildings were not carried through for further evaluation.

3.3.2 Site-Specific Screening

Based on the groundwater data, information collected during the site review, and the preliminary building survey, site-specific screening levels were developed for each site area. Groundwater data wasscreened against the site-specific screening levels. Specific information regarding the development of the site-specific screening levels is included below.

The J&E model was used to develop site-specific screening levels for the COPCs within each investigation area. The J&E model is a one-dimensional analytical solution to convective and diffusive vapor transport into indoor spaces and provides an estimated attenuation coefficient that relates the vapor concentration in the indoor air space to the vapor concentration at the source of contamination. The model is constructed as both a steady-state solution to vapor transport (infinite or non-diminishing source) and as a quasi-steady-state solution (finite or diminishing source). Inputs to the model include chemical parameters of the contaminant, saturated and unsaturated zone soil properties, and structural properties of the building. The following represent the major conceptual assumptions/limitations of the J&E model:

- No free phase liquid/precipitate (e.g., non-aqueous-phase liquid or solid) is present
- Contaminant vapors enter the structure primarily through cracks and openings in the walls and foundation
- Convective transport occurs primarily within the building zone of influence and vapor velocities decrease rapidly with increasing distance from the structure
- Diffusion dominates vapor transport between the source of contamination and the building zone of influence
- All vapors originating from below the building will enter the building unless the floors and walls are perfect vapor barriers
- All soil properties in stratum are homogeneous (up to three strata with different properties can be simulated in the model).
- The contaminant is homogeneously distributed within the zone of contamination.
- The areal extent of contamination is greater than that of the building floor in contact with the soil
- Vapor transport occurs in the absence of convective water movement within the soil column (i.e., evaporation or infiltration), and in the absence of mechanical dispersion
- The model does not account for transformation processes (e.g., biodegradation, hydrolysis)

- The soil layer in contact with the structure floor and walls is isotropic with respect to permeability
- Both the building ventilation rate and the difference in dynamic pressure between the interior of the structure and the soil surface are constant values

The J&E model was run for each investigation area for both industrial and residential scenarios. Three scenarios were developed based on building characteristics observed during the building surveys. These scenarios include: an industrial large building, an industrial small building, and a residential building. The industrial screening levels were used to identify existing buildings, confirmed as having industrial use, where vapor intrusion might warrant further evaluation. The residential screening levels were used to identify areas where vapor intrusion might be a concern for buildings confirmed as having residential use.

Information from the preliminary building surveys (specifically, the building footprints and ceiling heights) were used to select building and air exchange parameters for modeling. The parameters were selected to provide a conservative representation of the potential for vapor intrusion in the buildings of interest within the area. Existing boring logs and water level data from each investigation area were reviewed to select subsurface parameters (e.g., soil type, depth to groundwater) which provide a conservative representation of vapor diffusion through soil in each area.

The parameters used in the J&E model for each investigation area are provided in Tables 3-15 through 3-29. A discussion of select parameters is provided below.

- **Depth of Contamination (Source—Building Separation or L_T).** This parameter represents separation between the contaminant and the structure. Shallow groundwater was assumed to occur beneath the buildings at a depth of approximately 5 ft bgs (Mainside, Air Station, Camp Geiger, and Courthouse Bay) and 9 ft bgs (Hadnot Point) based on existing soil boring logs, well construction records, and water level measurements from each investigation area.
- **Soil Type.** The J&E model contains default characteristic for the 12 Soil Conservation Survey (SCS) soil texture classifications. Existing data provided on the soil boring logs for the six investigation area were used to determine the soil type at each area, which are predominantly sands. Some silts (e.g., Mainside) and clays (e.g., Mainside, Camp Geiger) are present; however, parameters associated with sands were used in the model as a conservative measure.
- **Enclosed Space Volume (Space Floor Length, Floor, Width, and Height).** As mentioned above, three building scenarios were identified for the investigation areas: an industrial large building, an industrial small building, and a residential building. The indoor air mixing volume was based on the average length, width, and height of each building scenario. The average floor length, width, and height of the industrial buildings were based on dimensions of each building obtained during the preliminary building surveys. In most instances, large industrial buildings were considered to be greater than 5,000 square feet (ft^2), while small buildings were considered to be less than 5,000 ft^2. Buildings with open construction (e.g., picnic shelters) were excluded from the calculation of the averaged building dimensions. For the residential building

dimensions, the default parameters provided in the vapor intrusion guidance were used in the modeling (i.e., 1000 centimeters [cm] by 1000 cm by 244 cm).

- **Air-Filled Porosity.** Air-filled porosity is used to calculate the effective diffusion coefficient in soil for each chemical, and is also considered to be a sensitive parameter in the model. The air-filled porosity was calculated as a function of soil class in the J&E model. The air-filled porosity calculated for sand is 0.321 cubic centimeters per cubic centimeters (cm^3/cm^3).
- **Soil Gas Entry Rate.** The soil gas entry rate for the each building scenario was calculated by scaling up the default residential soil gas entry rate described in USEPA's draft vapor intrusion guidance (USEPA, 2002) to the building footprints. This procedure is described in the New Jersey Department of Environmental Protection (NJDEP) vapor intrusion guidance document (NJDEP, 2007). As seen in Tables 3-15 through 3-29, the soil gas entry rate varies widely depending on the building dimensions.
- **Indoor Air Exchange Rate.** The building fresh air flow rate is based on the air exchange rate for the building and the volume of air inside the building. The air-exchange rate for a each building scenario was calculated using the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) standard *Ventilation for Acceptable Indoor Air Quality* (ASHRAE, 2004). As seen in Tables 3-15 through 3-29, the indoor air exchange rate varies depending on the building dimensions.

The resulting site-specific screening levels for COPCs within each investigation area are presented in Tables 3-30 through 3-34. In instances where the site-specific screening level was lower than the NCGWQS, the NCGWQS was selected as a default site-specific screening level for conservativeness.

3.4 Selection of Buildings to be Sampled

Once the site-specific screening levels were calculated using the J&E model, the COPC groundwater data for each investigation area was re-plotted in GIS to identify monitoring wells with COPC groundwater concentrations that exceed these site-specific screening levels. Buildings located within 100 ft of a monitoring well containing COPC concentrations above large industrial, small industrial, and residential site-specific screening levels are provided as Tables 3-35, 3-36, and 3-37, respectively.

Based on this second round of screening and mapping, the buildings of interest on the building inventory spreadsheets were revised to prioritize which buildings may require further investigation (i.e., sampling). The buildings selected are presented on Figures 3-23 through 3-38.

Buildings located within 100 ft of a monitoring well exceeding the NCGWQS and/or target groundwater concentrations (USEPA, 2002), but not located within 100 ft of a well exceeding the site-specific screening levels (as generated by the J&E model) were excluded from the buildings of interest list with the exception of buildings located within 100 ft of AS/biopulsing systems or free product. Because remedial technologies such as AS, bioventing, and *in situ* thermal treatment can create pressure gradients that may promote vapor intrusion, buildings located within 100 ft of active remedial systems were included on

the building of interest list. Additionally, because the J&E model is limited where free phase liquids are present, buildings located within 100 ft of known free product were included on the building of interest list.

Open shelters and other buildings open construction designs and buildings with no occupants were excluded from the list. In addition, studies have shown that VOCs in shallow groundwater represent the most likely source for vapor intrusion[1]. Therefore, buildings within 100 ft of intermediate and deep monitoring wells containing VOC groundwater concentrations exceeding site-specific screening levels, but where groundwater samples from shallow monitoring wells do not indicate shallow groundwater contamination were also excluded from the list.

The building inventories (Table 3-9 through 3-14) identify which buildings were retained as buildings of interest and indicate which buildings have been excluded based on information gathered to date and reasons for exclusion. The buildings of interest for each investigation area are briefly discussed below.

- **Mainside**—10 buildings were retained as buildings of interest as shown on Table 3-9 and Figures 3-23 through 3-27
- **Hadnot Point**—22 buildings were retained as buildings of interest as shown on Table 3-10 and Figures 3-28 through 3-31
- **Air Station**—7 buildings were retained as buildings of interest as shown on Table 3-11 and Figures 3-32 through 3-33
- **Courthouse Bay**—3 buildings were retained as buildings of interest as shown on Table 3-12 and Figure 3-34
- **Camp Geiger**—9 buildings were retained as buildings of interest as shown on Table 3-13 and Figures 3-35 through 3-38
- **Tarawa Terrace**—No buildings were retained as buildings of interest and this area was eliminated from further evaluation as shown on Table 3-14

A preliminary CSM was developed for each of the buildings retained for sampling to evaluate whether a complete exposure pathway for vapor intrusion exists. The buildings determined to have the greatest potential of vapor intrusion based on the CSM and proximity to VOC plumes were selected for sampling. The preliminary CSM and sampling plan for each building is presented in Section 4.

[1] Field studies and modeling presented in Rivett, 1995 suggest that groundwater concentrations 1 meter below the water table are unlikely to create significant soil gas signatures in the overlying vadose zone. See Rivett, Michael O. 1995. “Soil-Gas Signatures from Volatile Chlorinated Solvents: Borden Field Experiments,” GROUND WATER, Vol. 33, No. 1, January-February 1995.

TABLE 3-1
Premliminary Screening Criteria
MCB Camp Lejeune, North Carolina

CAS Number	Chemical	NCAC 2L GW[a]	EPA Vapor Intrusion Screening Levels[b] (Risk = 1E-06; HI = 1)	
71-55-6	1,1,1-Trichloroethane	200	7,092	(c)
79-34-5	1,1,2,2-Tetrachloroethane	0.17	3	
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	210,000	1,500	
79-00-5	1,1,2-Trichloroethane	NA	5	
75-34-3	1,1-Dichloroethane	70	2,200	
75-35-4	1,1-Dichloroethene	7	190	
87-61-6	1,2,3-Trichlorobenzene	NA	3,400	
120-82-1	1,2,4-Trichlorobenzene	70	3,400	
96-12-8	1,2-Dibromo-3-chloropropane	0.025	33	
106-93-4	1,2-Dibromoethane	0.0004	0.27	(c)
95-50-1	1,2-Dichlorobenzene	24	2,600	
107-06-2	1,2-Dichloroethane	0.38	5	
540-59-0	1,2-Dichloroethene (total)	NA	NA	
78-87-5	1,2-Dichloropropane	0.51	35	
541-73-1	1,3-Dichlorobenzene	170	830	
106-46-7	1,4-Dichlorobenzene	1.4	8,200	
78-93-3	2-Butanone	4,200	2,183,406	(c)
591-78-6	2-Hexanone	280	NA	
108-10-1	4-Methyl-2-pentanone	NA	886,525	(c)
67-64-1	Acetone	700	201,258	(c)
71-43-2	Benzene	1	1.4	(c)
74-97-5	Bromochloromethane	NA	2.1	
75-27-4	Bromodichloromethane	0.56	2.1	
75-25-2	Bromoform	4.43	0.0083	
74-83-9	Bromomethane	NA	20	(c)
75-15-0	Carbon disulfide	700	560	
56-23-5	Carbon tetrachloride	0.269	5	
108-90-7	Chlorobenzene	50	390	
75-00-3	Chloroethane	2,800	28,000	
67-66-3	Chloroform	70	80	
74-87-3	Chloromethane	2.6	6.7	
156-59-2	cis-1,2-Dichloroethene	70	210	
10061-01-5	cis-1,3-Dichloropropene	0.19	0.84	
110-82-7	Cyclohexane	NA	898	(c)
124-48-1	Dibromochloromethane	0.41	3	
75-71-8	Dichlorodifluoromethane (Freon-12)	1,400	14	
100-41-4	Ethylbenzene	550	700	
108-20-3	Isopropyl ether	70	NA	
98-82-8	Isopropylbenzene	70	8.4	
m&pXYLENE	m- and p-Xylene	530	319	(c)
79-20-9	Methyl acetate	NA	720,000	
108-87-2	Methylcyclohexane	NA	710	
75-09-2	Methylene chloride	4.6	58	
1634-04-4	Methyl-tert-butyl ether (MTBE)	200	120,000	
95-47-6	o-Xylene	530	471.7	(c)
100-42-5	Styrene	100	8,900	
127-18-4	Tetrachloroethene	0.7	5	
108-88-3	Toluene	1,000	18,382	(c)
156-60-5	trans-1,2-Dichloroethene	100	180	
10061-02-6	trans-1,3-Dichloropropene	0.19	0.84	
79-01-6	Trichloroethene	2.8	2.9	(c)
75-69-4	Trichlorofluoromethane(Freon-11)	2,100	180	
75-01-4	Vinyl chloride	0.015	2	
1330-20-7	Xylene, total	530	341	(c)

Notes:

NA = Not available.

[a] North Carolina groundwater quality standards (15A NCAC 02L .0202, Groundwater Quality Standards).

[b] Screening value is target groundwater concentration from Table 2c, Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils. (EPA, 2002: Subsurface Vapor Intrusion Guidance, EPA530-D-02-004.)

[c] Due to change in toxicty value(s), the vapor intrusion screening level was updated using the methodology presented in Appendix D of Subsurface Vapor Intrusion Guidance (EPA, 2002). (For calculations, see Table 3-1 Supplement A.)

TABLE 3-1 Supplement A
Calculation of Target Groundwater Concentrations1
MCB Camp Lejeune, North Carolina

Constituent	Unit Risk Factor (URF) $(\mu g/m^3)^{-1}$	Reference Concentration (RfC) mg/m^3	Target Indoor Air Concentration, carcinogen (C_{Cancer}) $\mu g/m^3$	Target Indoor Air Concentration, non-carcinogen ($C_{non\text{-}Cancer}$) $\mu g/m^3$	Target Indoor Air Concentration ($C_{target,ia}$) $\mu g/m^3$	Henry's Law Dimensionless	Target Groundwater Concentration (C_{gw}) µg/L
1,1,1-Trichloroethane		5.00E+00	NA	5.00E+03	5.00E+03	7.05E-01	7.09E+03
1,2-Dibromoethane	3.00E-04	9.00E-03	8.11E-03	9.00E+00	8.11E-03	3.04E-02	2.67E-01
2-Butanone		5.00E+00	NA	5.00E+03	5.00E+03	2.29E-03	2.18E+06
4-Methyl-2-pentanone		5.00E+00	NA	5.00E+03	5.00E+03	5.64E-03	8.87E+05
Acetone		3.20E-01	NA	3.20E+02	3.20E+02	1.59E-03	2.01E+05
Benzene	7.80E-06	3.00E-02	3.12E-01	3.00E+01	3.12E-01	2.28E-01	1.37E+00
Bromomethane		5.00E-03	NA	5.00E+00	5.00E+00	2.56E-01	1.95E+01
Cyclohexane		6.00E+00	NA	6.00E+03	6.00E+03	6.68E+00	8.98E+02
m-Xylene		1.00E-01	NA	1.00E+02	1.00E+02	3.00E-01	3.33E+02
o-Xylene		1.00E-01	NA	1.00E+02	1.00E+02	2.12E-01	4.72E+02
p-Xylene		1.00E-01	NA	1.00E+02	1.00E+02	3.13E-01	3.19E+02
Toluene		5.00E+00	NA	5.00E+03	5.00E+03	2.72E-01	1.84E+04
Trichloroethene	2.00E-06		1.22E+00	NA	1.22E+00	4.21E-01	2.89E+00
Xylene, total		1.00E-01	NA	1.00E+02	1.00E+02	2.93E-01	3.41E+02

Notes:
[1] Due to change in toxicity value(s), the vapor intrusion screening level [i.e., target groundwater concentration from Table 2c, Subsurface Vapor Intrusion Guidance (EPA, 2002)] for this constituent was updated using the methodology presented in Appendix D of Subsurface Vapor Intrusion Guidance.
URF and RfCs obtained from EPA's Integrated Risk Information System (IRIS) Database. [Online at http://www.epa.gov/iris/index.html].
URF for Trichloroethene obtained from California EPA's Toxicity Criteria Database: Cancer Potency. [Online at http://www.oehha.ca.gov/risk/chemicalDB//index.asp].

Variables	Units	Value
C_{Cancer} = Target indoor air conc., cancer	$\mu g/m^3$	Solved by Eq. 1
$C_{non\text{-}Cancer}$ = Target indoor air conc., non-cancer	$\mu g/m^3$	Solved by Eq. 2
$C_{target,ia}$ = Target indoor air conc., minimum	$\mu g/m^3$	Solved by Eq. 3
C_{gw} = Target groundwater conc.	µg/L	Solved by Eq. 4
TCR = Target Cancer Risk	unitless	1.00E-06
THQ = Target Hazard Quotient	unitless	1
URF = Unit Risk Factor	$(\mu g/m^3)^{-1}$	Chemical-specific
RfC = Reference Concentration	mg/m^3	Chemical-specific
ATc = Averaging Time, carcinogens	days	25,550
EF = Exposure Frequency	days/year	350
ED = Exposure Duration	years	30
CF = Conversion Factor	µg/mg	1000
H = Dimensionless Henry's Law Constant	unitless	Chemical-specific
alpha (α) = Attenuation Factor	unitless	0.001

Equation 1:	C_{cancer} =	[(TCR x ATc)/(EF x ED x URF)]
Equation 2:	$C_{non\text{-}cancer}$ =	(THQ x RfC x CF)
Equation 3:	$C_{target,ia}$ =	Minimum(C_{cancer}, $C_{non\text{-}cancer}$)
Equation 4:	Cgw =	$C_{target,ia}$ x 10^{-3} m^3/L * 1/H * 1/α

TABLE 3-3

Summary of VOC Groundwater Data and Identification of Chemicals of Potential Concern - Mainside

MCB Camp Lejeune, North Carolina

CAS Number	Parameter	Units	Number of Analyses	Frequency of Detects (%)	Minimum Detect		Minimum Field Location ID	Minimum Field Sample Date	Maximum Detect		Maximum Field Location ID	Maximum Field Sample Date	Number of Detects	Number of Non-Detects	Minimum MDL	Maximum MDL	NCAC 2L GW[a]	Number of Exceedances above NCAC 2L	EPA Vapor Intrusion Screening Levels[b] (Risk = 1E-06; HI = 1)	Number of Exceedances above EPA Vapor Intrusion Screening Levels
79-00-5	**1,1,2-Trichloroethane**	**µg/L**	**757**	**4.89%**	**0.21**	**J**	**IR06-GW28DW**	**2/21/06**	**480**	**J**	**IR06-SRW01**	**1/15/02**	**37**	**720**	**0.5**	**500**	**-**	**-**	**5**	**24**
87-61-6	1,2,3-Trichlorobenzene	µg/L	266	0.75%	0.15	J	IR06-GW43DW	8/23/06	0.19	J	IR06-GW15D	9/7/06	2	264	0.5	0.5	-	-	3,400	0
540-59-0	1,2-Dichloroethene (total)	µg/L	399	42.11%	0.3	J	IR06-GW36D	1/22/04	8,400	D	IR06-GW28DW	1/22/04	168	231	2	2,000	-	-	-	-
67-63-0	2-Propanol	µg/L	22	4.55%	4,600	D	IR88-SEARIW01	7/26/02	4,600	D	IR88-SEARIW01	7/26/02	1	21	210	210	-	-	-	-
108-10-1	4-Methyl-2-pentanone	µg/L	756	0.26%	1.6	J	IR06-DRW01	8/14/07	6	J	IR88-SEARIW01	7/26/02	2	754	2.5	10	-	-	886,525	0
74-83-9	Bromomethane	µg/L	758	0.53%	2	J	IR88-MW18IW	10/28/04	230	J	IR88-MW02IW	10/28/04	4	754	10	500	-	-	20	1
110-82-7	Cyclohexane	µg/L	422	18.01%	0.1	J	IR06-GW33	8/23/06	480	J	IR06-DRW04	8/22/06	76	346	0.5	130	-	-	898	0
74-82-8	Methane	µg/L	7	100%	0.7	BJ	IR06-GW52IW	6/14/07	240	BD	IR06-GW49IW	6/14/07	7	0	1	20	-	-	-	-
79-20-9	Methyl acetate	µg/L	388	0.26%	6	J	IR88-RABBITTMW6	7/23/02	6	J	IR88-RABBITTMW6	7/23/02	1	387	13	13	-	-	720,000	0
108-87-2	Methylcyclohexane	µg/L	422	0.71%	0.1	J	IR02-GW03	8/22/06	47	J	IR06-MW47	5/20/05	3	419	0.5	130	-	-	710	0
79-01-6	**Trichloroethene**	**µg/L**	**758**	**47.63%**	**0.1**	**J**	**IR88-MW37DW**	**8/10/07**	**41,000**		**IR88-MW29**	**8/31/05**	**361**	**397**	**0.5**	**25,000**	**2.8**	**292**	**2.9**	**292**
127-18-4	**Tetrachloroethene**	**µg/L**	**757**	**40.42%**	**0.11**	**J**	**IR88-MW21IW**	**8/12/07**	**120,000**		**IR88-MW31**	**11/15/05**	**306**	**451**	**0.5**	**50,000**	**0.7**	**274**	**5**	**252**
156-59-2	**cis-1,2-Dichloroethene**	**µg/L**	**758**	**48.81%**	**0.12**	**J**	**IR88-MW23IW**	**8/7/07**	**390,000**		**IR88-MW31**	**2/22/06**	**370**	**388**	**0.5**	**50,000**	**70**	**189**	**210**	**158**
75-01-4	**Vinyl chloride**	**µg/L**	**756**	**19.05%**	**0.11**	**J**	**IR88-MW33DW**	**11/18/05**	**45,000**	**D**	**IR88-SEARIW01**	**7/26/02**	**144**	**612**	**0.5**	**5,000**	**0.015**	**144**	**2**	**117**
156-60-5	trans-1,2-Dichloroethene	µg/L	758	32.59%	0.1	J	IR88-MW23IW	11/18/05	13,000	J	IR88-MW27	2/19/05	247	511	0.5	25,000	100	85	180	72
79-34-5	**1,1,2,2-Tetrachloroethane**	**µg/L**	**758**	**9.37%**	**0.19**	**J**	**IR06-GW41**	**10/10/05**	**61,000**	**E**	**IR06-SRW01**	**1/15/02**	**71**	**687**	**0.5**	**1,000**	**0.17**	**71**	**3**	**64**
71-43-2	**Benzene**	**µg/L**	**758**	**12.40%**	**0.1**	**J**	**IR88-MW16DW2**	**8/8/07**	**57**		**IR88-MW05**	**7/25/02**	**94**	**664**	**0.5**	**16**	**1**	**59**	**1.4**	**47**
75-35-4	1,1-Dichloroethene	µg/L	758	17.81%	0.1	J	IR06-GW01DB	9/7/06	130		IR06-GW27DW	8/23/06	135	623	0.5	170	7	58	190	0
75-09-2	Methylene chloride	µg/L	758	5.15%	0.11	J	IR88-MW07DW	11/16/05	1,100	JB	IR88-MW31	8/24/06	39	719	0.5	10,000	4.6	29	58	9
67-64-1	Acetone	µg/L	715	10.63%	1.3	BJ	IR06-GW47IW	6/13/07	170,000		IR88-MW29	2/23/05	76	639	2.5	50,000	700	19	201,258	0
108-90-7	Chlorobenzene	µg/L	758	4.62%	0.11	J	IR06-DRW01	8/14/07	11,000	D	IR06-GW16	1/20/04	35	723	0.5	1,000	50	10	390	7
106-46-7	1,4-Dichlorobenzene	µg/L	422	3.32%	0.1	J	IR02-GW03	10/10/05	130	J	IR88-MW30IW	8/10/07	14	408	0.5	630	1.4	7	8,200	0
107-06-2	1,2-Dichloroethane	µg/L	758	0.79%	0.4	J	IR02-GW03IW	7/30/02	3	J	IR06-GW28DW	7/23/03	6	752	5	5	0.38	6	5	0
56-23-5	Carbon tetrachloride	µg/L	758	0.79%	0.2	J	IR06-GW03	1/21/04	0.9	J	IR06-SRW01	7/25/03	6	752	0.5	5	0.269	4	5	0
74-87-3	Chloromethane	µg/L	758	1.06%	0.13	J	IR88-MW13IW	11/16/05	83		IR88-SEARIW01	7/26/02	8	750	0.5	10	2.6	3	6.7	1
75-27-4	Bromodichloromethane	µg/L	758	0.79%	0.35	J	IR88-MW35IW	11/17/05	1.6		IR88-MW32IW	8/12/07	6	752	0.5	10	0.56	2	2.1	0
75-25-2	Bromoform	µg/L	758	1.45%	0.13	J	IR88-MW23IW	8/7/07	5,800		IR88-MW31	8/24/06	11	747	0.5	5,000	4.43	2	0.0083	11
1330-20-7	Xylene, total	µg/L	752	7.98%	0.1	J	IR06-GW52IW	8/15/07	880	J	IR02-GW03	7/26/03	60	692	0.5	130	530	2	341	4
78-87-5	1,2-Dichloropropane	µg/L	758	0.13%	2	J	IR06-GW37D	8/22/07	2	J	IR06-GW37D	8/22/07	1	757	10	10	0.51	1	35	0
67-66-3	Chloroform	µg/L	758	11.21%	0.11	J	IR88-MW06IW	8/10/07	96	B	IR06-GW16	1/20/04	85	673	0.5	100	70	1	80	1
124-48-1	Dibromochloromethane	µg/L	758	0.13%	1,000	E	IR06-DRW01	7/31/02	1,000	E	IR06-DRW01	7/31/02	1	757	5	5	0.41	1	3.2	1
m&pXYLENE	m- and p-Xylene	µg/L	341	10.56%	0.1	J	IR88-MW03IW	10/7/03	580	J	IR02-GW03	7/26/03	36	305	2	250	530	1	319	2
10061-02-6	trans-1,3-Dichloropropene	µg/L	758	0.13%	1		IR88-MW16	10/21/03	1		IR88-MW16	10/21/03	1	757	1	1	0.19	1	0.84	1
71-55-6	1,1,1-Trichloroethane	µg/L	758	0.4%	0.28	J	IR06-SRW01	8/22/06	2	J	IR06-GW34	1/22/04	3	755	0.5	5	200	0	7,092	0
75-34-3	1,1-Dichloroethane	µg/L	758	5.28%	0.17	J	IR88-MW16DW2	8/8/07	22		IR06-GW27DW	8/23/06	40	718	0.5	10	70	0	2,200	0
120-82-1	1,2,4-Trichlorobenzene	µg/L	422	0.71%	0.24	J	IR06-GW15D	9/7/06	42	J	IR06-MW47	5/20/05	3	419	0.5	130	70	0	3,400	0
95-50-1	1,2-Dichlorobenzene	µg/L	422	0.71%	0.11	J	IR88-MW16DW2	8/8/07	0.13	J	IR88-MW03IW	11/19/05	3	419	0.5	0.5	24	0	2,600	0
541-73-1	1,3-Dichlorobenzene	µg/L	422	0.95%	0.1	J	IR06-GW01DB	9/7/06	33	J	IR06-MW47	5/20/05	4	418	0.5	130	170	0	830	0
78-93-3	2-Butanone	µg/L	758	2.64%	1	J	IR06-GW28DW	12/5/06	400		IR06-GW49IW	8/15/07	20	738	2.5	250	4,200	0	2,183,406	0
591-78-6	2-Hexanone	µg/L	757	0.26%	3.8		IR06-DRW01	6/13/07	4.6		IR06-DRW01	8/14/07	2	755	2.5	2.5	280	0	-	-
75-15-0	Carbon disulfide	µg/L	758	6.07%	0.11	J	IR88-MW16DW2	8/8/07	73	BJ	IR06-GW50IW	6/13/07	46	712	0.5	250	700	0	560	0
75-00-3	Chloroethane	µg/L	758	0.26%	0.79		IR06-GW27DW	8/23/06	2	J	IR88-RABBITTMW6	7/23/02	2	756	0.5	13	2,800	0	28000	0
10061-01-5	cis-1,3-Dichloropropene	µg/L	758	0.13%	0.11	J	IR88-MW09	11/19/05	0.11	J	IR88-MW09	11/19/05	1	757	0.5	0.5	0.19	0	0.84	0
100-41-4	Ethylbenzene	µg/L	758	5.94%	0.1	J	IR88-MW12IW	8/8/07	93	B	IR02-GW03	7/26/03	45	713	0.5	130	550	0	700	0
1634-04-4	Methyl-tert-butyl ether (MTBE)	µg/L	422	1.90%	0.13	J	IR06-GW27DW	8/23/06	5.3	J	IR88-MW05DW	8/9/07	8	414	0.5	13	200	0	120,000	0
95-47-6	o-Xylene	µg/L	341	9.09%	0.1	J	IR06-GW52IW	8/15/07	300	J	IR02-GW03	7/26/03	31	310	0.5	20	530	0	471.7	0
100-42-5	Styrene	µg/L	758	0.13%	1		IR88-EX07IW	10/19/03	1		IR88-EX07IW	10/19/03	1	757	1	1	100	0	8,900	0
108-88-3	Toluene	µg/L	758	10.55%	0.1	J	IR88-MW38IW	11/18/05	58		IR88-MW05	7/25/02	80	678	0.5	170	1,000	0	18,382	0
75-69-4	Trichlorofluoromethane(Freon-11)	µg/L	422	0.47%	0.22	J	IR88-MW16	8/8/07	0.5	J	IR88-MW01	7/23/02	2	420	0.5	10	2,100	0	180	0
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	µg/L	422	1.42%	0.1	J	IR06-GW31	8/23/06	12,000	D	IR88-SEARIW01	7/26/02	6	416	0.5	5,000	210,000		1,500	1
75-71-8	Dichlorodifluoromethane (Freon-12)	µg/L	422	3.32%	0.1	J	IR06-GW33	11/15/05	100	J	IR88-MW16IW	8/8/07	14	408	0.5	250	1,400		14	3
98-82-8	Isopropylbenzene	µg/L	422	2.37%	0.11	J	IR03-MW02	8/22/06	9	J	IR88-MW30	8/24/06	10	412	0.5	13	70		8.4	1

Notes:

Bolded indicates chemical is retained as a COPCs

[a]NCAC 2L GW - North Carolina Adminstrative Code, Section 2L, updated December 2005

[b]EPA Vapor Intrusion Screening Levels (GW, Risk = 1E-06; Hazard Index = 1) (EPA, 2002)

COPC = Chemical of Potential Concern

NA = Not Available

VOC = Volatile Organic Compounds

TABLE 3-4

Summary of VOC Groundwater Data and Identification of Chemicals of Potential Concern - Hadnot Point

MCB Camp Lejeune, North Carolina

CAS Number	Parameter	Units	Number of Analyses	Frequency of Detects (%)	Minimum Detect		Minimum Field Location ID	Minimum Field Sample Date	Maximum Detect		Maximum Field Location ID	Maximum Field Sample Date	Number of Detects	Number of Non-Detects	Minimum MDL	Maximum MDL	NCAC 2L GW[a]	Number of Exceedances above NCAC 2L	EPA Vapor Intrusion Screening Levels[b] (Risk = 1E-06; HI = 1)	Number of Exceedances above EPA Vapor Intrusion Screening Levels
79-00-5	**1,1,2-Trichloroethane**	**µg/L**	**769**	**2.60%**	**0.4**	**J**	**UST1613-MW18**	**10/6/04**	**78**		**IR78-GW60**	**7/25/02**	**20**	**749**	**0.5**	**5**	**-**	**-**	**5**	**13**
540-59-0	1,2-Dichloroethene (total)	µg/L	402	64.68%	0.88	J	IR78-1512-TW03	7/1/02	7,900		IR78-GW74	12/5/06	260	142	2	1,000	-	-	-	-
108-10-1	4-Methyl-2-pentanone	µg/L	696	0.29%	3.5		IR78-GW48	10/9/04	7	J	IR78-GW60	8/21/07	2	694	2.5	20	-	-	886524.8227	0
74-83-9	Bromomethane	µg/L	769	0.52%	0.15	J	UST1613-MW03	10/6/04	30		IR78-GW43	4/10/03	4	765	0.5	10	-	-	20	1
110-82-7	Cyclohexane	µg/L	306	36.93%	0.1	J	IR78-GW41	8/22/06	1,000		IR78-GW73	9/10/07	113	193	0.5	1,000	-	-	898.2035928	3
74-84-0	Ethane	µg/L	36	63.89%	0.73	J	UST1115-MW111521	8/19/03	61.4		UST1115-MW25	1/23/06	23	13	1	1	-	-	-	-
74-85-1	Ethene	µg/L	36	30.56%	1.08		UST1115-MW111524	2/19/03	31.4		UST1115-MW25	1/23/06	11	25	1	1	-	-	-	-
74-82-8	Methane	µg/L	36	91.67%	0.89		UST1115-MW01	10/3/06	434		UST1115-MW25	1/23/06	33	3	0.5	0.5	-	-	-	-
79-20-9	Methyl acetate	µg/L	288	0.69%	0.17	J	IR78-GW68	10/8/04	7.2		IR78-GW21	10/12/04	2	286	0.5	0.5	-	-	720000	0
108-87-2	Methylcyclohexane	µg/L	306	21.57%	0.11	J	IR78-GW22-2	10/11/04	490		IR78-GW60	12/4/06	66	240	0.5	1,000	-	-	710	0
71-43-2	**Benzene**	**µg/L**	**794**	**44.58%**	**0.11**	**J**	**IR78-GW24-3**	**10/10/05**	**18,700**		**UST1115-MW20**	**8/20/07**	**354**	**440**	**0.5**	**1,000**	**1**	**287**	**1.4**	**284**
79-01-6	**Trichloroethene**	**µg/L**	**770**	**43.12%**	**0.11**	**J**	**IR78-GW50**	**10/10/2004**	**8,800**		**IR78-GW75-2**	**1/30/2003**	**332**	**438**	**0.5**	**500**	**2.8**	**240**	**2.9**	**240**
75-01-4	**Vinyl chloride**	**µg/L**	**769**	**25.23%**	**0.1**	**J**	**IR78-GW10**	**10/10/2005**	**3,000**	**E**	**IR78-GW44**	**1/28/2003**	**194**	**575**	**0.5**	**170**	**0.015**	**194**	**2**	**149**
156-59-2	**cis-1,2-Dichloroethene**	**µg/L**	**754**	**53.32%**	**0.15**	**J**	**IR78-GW02**	**10/10/04**	**11,000**	**J**	**IR78-GW75-2**	**10/8/04**	**402**	**352**	**0.5**	**1,000**	**70**	**170**	**210**	**104**
1330-20-7	**Xylene, total**	**µg/L**	**727**	**25.23%**	**0.11**	**J**	**IR78-GW24-1**	**10/10/2005**	**8,400**	**B**	**IR78-GW78**	**3/5/2003**	**265**	**462**	**0.5**	**1,000**	**530**	**84**	**341**	**91**
100-41-4	**Ethylbenzene**	**µg/L**	**794**	**31.61%**	**0.1**	**J**	**IR78-RW12**	**7/24/03**	**2,200**	**B**	**IR78-GW78**	**3/5/03**	**251**	**543**	**0.5**	**1,000**	**550**	**67**	**700**	**64**
107-06-2	**1,2-Dichloroethane**	**µg/L**	**769**	**9.10%**	**0.16**	**J**	**UST900-MW09**	**1/15/07**	**930**		**UST1115GT-MW23**	**8/17/05**	**70**	**699**	**0.5**	**250**	**0.38**	**66**	**5**	**38**
m&pXYLENE	**m- and p-Xylene**	**µg/L**	**478**	**36.61%**	**0.2**	**J**	**IR78-GW72**	**7/24/03**	**6,300**		**IR78-GW78**	**7/28/03**	**175**	**303**	**1**	**1,000**	**530**	**64**	**319**	**72**
127-18-4	**Tetrachloroethene**	**µg/L**	**770**	**11.69%**	**0.11**	**J**	**IR78-RW08**	**9/7/06**	**160**		**SWMU360-MW01D**	**7/24/03**	**90**	**680**	**0.5**	**250**	**0.7**	**60**	**5**	**28**
95-47-6	o-Xylene	µg/L	478	37.45%	0.12	J	IR78-RW13	10/10/04	2,700		IR78-GW75-1	4/10/03	179	299	0.5	1,000	530	59	472	59
108-88-3	Toluene	µg/L	794	34.51%	0.11	J	IR78-GW63	8/23/2006	17,000		IR78-GW75-1	4/10/2003	274	520	0.5	1,000	1,000	56	18382.35294	0
75-09-2	Methylene chloride	µg/L	769	6.63%	0.64	J	IR78-MW06	10/1/03	220	J	IR78-GW52	1/11/02	51	718	0.5	500	4.6	39	58	16
75-35-4	1,1-Dichloroethene	µg/L	769	18.34%	0.13	J	IR78-GW31-2	10/10/04	130		IR78-GW60	4/10/03	141	628	0.5	170	7	38	190	0
74-87-3	Chloromethane	µg/L	769	5.85%	0.15	J	IR78-GW04-2	10/11/04	110		IR78-GW60	4/10/03	45	724	0.5	5	2.6	18	7	12
75-34-3	1,1-Dichloroethane	µg/L	769	7.54%	0.25	J	IR78-GW17-2	10/11/04	260		IR78-GW42	10/10/04	58	711	0.5	100	70	16	2200	0
75-27-4	Bromodichloromethane	µg/L	769	2.34%	0.14	J	IR94-MW04DW	10/7/04	5.6		IR78-1409-TW01	7/1/02	18	751	0.5	5	0.56	11	2.1	5
79-34-5	1,1,2,2-Tetrachloroethane	µg/L	769	1.04%	0.52	J	UST1115-GT01	8/22/03	167	E	UST1115GT-MW07	8/20/03	8	761	1	20	0.17	8	3	5
124-48-1	Dibromochloromethane	µg/L	769	1.04%	0.11	J	IR94-MW03IW	10/7/04	16	J	IR78-GW60	4/10/03	8	761	0.5	5	0.41	6	3.2	1
98-82-8	**Isopropylbenzene**	**µg/L**	**306**	**21.90%**	**0.1**	**J**	**IR78-GW59**	**8/23/06**	**100**	**J**	**IR78-GW60**	**12/4/06**	**67**	**239**	**0.5**	**250**	**70**	**6**	**8.4**	**31**
10061-02-6	trans-1,3-Dichloropropene	µg/L	769	0.65%	0.32	J	IR78-GW59	10/8/2004	130		IR78-GW60	4/10/2003	5	764	0.5	5	0.19	5	0.84	3
10061-01-5	cis-1,3-Dichloropropene	µg/L	769	0.52%	13	J	IR78-GW06	7/23/02	150		IR78-GW60	4/10/03	4	765	1	250	0.19	4	0.84	4
106-93-4	1,2-Dibromoethane	µg/L	336	0.89%	10	J	IR78-GW74	12/5/06	50	J	IR78-GW75-1	10/8/04	3	333	10	130	0.0004	3	0.27	3
67-66-3	Chloroform	µg/L	769	9.10%	0.11	J	IR78-GW22	10/10/05	98		IR78-GW60	4/10/03	70	699	0.5	100	70	2	80	1
100-42-5	Styrene	µg/L	696	6.03%	0.7	J	IR78-GW52	1/27/04	140		IR78-GW60	4/10/03	42	654	0.5	50	100	2	8900	0
78-87-5	1,2-Dichloropropane	µg/L	769	3.25%	0.11	J	UST1613-MW15	10/7/04	57		UST1115-MW05	10/11/04	25	744	0.5	13	0.51	1	35	1
67-64-1	Acetone	µg/L	624	11.38%	1.5	J	SWMU360-MW06	1/19/06	1,200		IR78-RW11	8/23/07	71	553	5	100	700	1	201257.86	0
56-23-5	Carbon tetrachloride	µg/L	769	0.13%	88		IR78-GW60	4/10/03	88		IR78-GW60	4/10/03	1	768	1	1	0.269	1	5	1
1634-04-4	Methyl-tert-butyl ether (MTBE)	µg/L	403	7.69%	0.11	J	IR94-MW06DW	10/7/04	260		UST1613-MW15	10/7/04	31	372	0.5	13	200	1	120000	0
156-60-5	trans-1,2-Dichloroethene	µg/L	754	29.44%	0.11	J	IR78-RW13	10/10/2004	160		IR78-GW60	4/10/2003	222	532	0.5	130	100	1	180	0
71-55-6	1,1,1-Trichloroethane	µg/L	769	1.43%	1	J	IR78-GW60	5/3/07	100		IR78-GW09-1	1/11/02	11	758	0.5	10	200	0	7092.198582	0
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	µg/L	305	1.31%	0.1	J	IR78-RW09	10/8/04	85	J	IR78-GW74	10/8/04	4	301	0.5	250	210,000	0	1500	0
120-82-1	1,2,4-Trichlorobenzene	µg/L	305	1.31%	0.15	J	IR78-RW06	9/7/06	52	J	IR78-GW74	10/8/04	4	301	0.5	250	70	0	3400	0
95-50-1	1,2-Dichlorobenzene	µg/L	402	0.75%	0.11	J	IR78-RW06	9/7/06	0.81	J	UST1115-MW18	1/25/06	3	399	0.5	1	24	0	2600	0
541-73-1	1,3-Dichlorobenzene	µg/L	402	0.75%	0.1	J	UST1613-MW22	7/26/07	0.88	J	UST1115-MW22	1/20/06	3	399	0.5	1	170	0	830	0
106-46-7	1,4-Dichlorobenzene	µg/L	402	2.49%	0.1	J	IR78-GW41	10/10/05	0.27	J	IR78-RW11	9/7/06	10	392	0.5	5	1.4	0	8200	0
78-93-3	2-Butanone	µg/L	689	2.76%	1	J	IR78-GW54	8/21/07	260	J	IR78-GW60	8/24/06	19	670	2.5	1,300	4,200	0	2183406	0
591-78-6	2-Hexanone	µg/L	696	1.44%	2.2	J	UST1613-MW15	10/7/04	55.1		UST1115-MW18	8/22/07	10	686	2.5	20	280	0	-	-
75-25-2	Bromoform	µg/L	769	0.13%	0.39	J	IR78-GW64	9/28/05	0.39	J	IR78-GW64	9/28/05	1	768	1.3	1.3	4.43	0	0.0083	1
75-15-0	Carbon disulfide	µg/L	696	8.33%	0.1	J	IR78-RW12	10/9/04	140		IR78-GW60	4/10/03	58	638	0.5	250	700	0	560	0
108-90-7	Chlorobenzene	µg/L	793	3.03%	0.11	J	IR78-GW30-2	10/11/04	6		IR78-GW60	7/25/02	24	769	0.5	10	50	0	390	0
75-00-3	Chloroethane	µg/L	769	2.34%	0.25	J	IR78-GW59	10/8/04	180		IR78-GW60	4/10/03	18	751	0.5	10	2,800	0	28000	0
75-71-8	Dichlorodifluoromethane (Freon-12)	µg/L	347	3.75%	0.1	J	IR78-GW44	8/22/06	20	J	IR78-GW41	10/11/04	13	334	0.5	10	1,400	0	14	1
108-20-3	Isopropyl ether	µg/L	31	19.35%	0.55	J	UST900-MW02	3/13/07	12.8	J	UST900-MW04	1/15/07	6	25	1	16	70	0	-	-
75-69-4	Trichlorofluoromethane(Freon-11)	µg/L	378	1.59%	0.14	J	IR78-RW06	9/7/2006	3.3		IR78-GW36	10/10/2004	6	372	0.5	1	2,100	0	180	0

Notes:

Bolded indicates chemical is retained as a COPCs

[a]NCAC 2L GW - North Carolina Adminstrative Code, Section 2L, updated December 2005

[b]EPA Vapor Intrusion Screening Levels (GW, Risk = 1E-06; Hazard Index = 1) (EPA, 2002)

COPC = Chemical of Potential Concern

NA = Not Available

VOC = Volatile Organic Compounds

TABLE 3-5

Summary of VOC Groundwater Data and Identification of Chemicals of Potential Concern - Air Station

MCB Camp Lejeune, North Carolina

CAS Number	Parameter	Units	Number of Analyses	Frequency of Detects (%)	Minimum Detect		Minimum Field Location ID	Minimum Field Sample Date	Maximum Detect		Maximum Field Location ID	Maximum Field Sample Date	Number of Detects	Number of Non-Detects	Minimum MDL	Maximum MDL	NCAC 2L GW[a]	Number of Exceedances above NCAC 2L	EPA Vapor Intrusion Screening Levels[b] (Risk = 1E-06; HI = 1)	Number of Exceedances above EPA Vapor Intrusion Screening Levels
540-59-0	1,2-Dichloroethene (total)	µg/L	74	63.51%	0.2	J	IR86-MW08IW	1/27/04	670	D	SWMU318-GW10	3/20/04	47	27	2	100	-	-	-	-
74-83-9	Bromomethane	µg/L	283	1.06%	0.14	J	IR86-MW28IW	5/11/05	0.8		IR86-MW32IW	3/2/05	3	280	0.5	0.5	-	-	20	0
110-82-7	Cyclohexane	µg/L	193	0.52%	6	J	SWMU318-MW06	2/19/05	6	J	SWMU318-MW06	2/19/05	1	192	10	10	-	-	898.20	0
79-20-9	Methyl acetate	µg/L	193	1.04%	0.2	J	IR86-MW37IWB	8/29/2005	1.2	J	IR86-MW36IWC	8/30/2005	2	191	0.5	2.5	-	-	720000	0
108-87-2	Methylcyclohexane	µg/L	193	1.55%	1	J	SWMU318-GW01	3/19/2004	12		SWMU318-MW03	4/4/2004	3	190	10	10	-	-	710	0
74296-31-4	n-Propylbenzene	µg/L	5	40.00%	1.73		USTAS843-GW04	7/6/2006	2.9		USTAS843-MW03	7/6/2006	2	3	0.5	0.5	-	-	-	-
99-87-6	p-Isopropyltoluene	µg/L	5	60.00%	0.39	J	USTAS843-MW03	7/6/06	0.44	J	USTAS843-MW02	7/5/06	3	2	0.5	0.5	-	-	5.6	0
79-01-6	**Trichloroethene**	**µg/L**	**281**	**58.36%**	**0.13**	**J**	**IR86-MW35IWA**	**10/19/04**	**1200**	**D**	**SWMU318-GW10**	**3/20/04**	**164**	**117**	**0.5**	**100**	**2.8**	**109**	**2.9**	**107**
71-43-2	**Benzene**	**µg/L**	**498**	**27.91%**	**0.1**	**J**	**IR86-MW08IW**	**1/27/04**	**273**		**USTCSFF-MW21**	**3/26/03**	**139**	**359**	**0.5**	**10**	**1**	**82**	**1.4**	**67**
75-01-4	**Vinyl chloride**	**µg/L**	**283**	**19.79%**	**0.17**	**J**	**IR86-MW32IW**	**11/16/2005**	**140**		**SWMU318-GW23**	**6/23/2004**	**56**	**227**	**0.5**	**10**	**0.015**	**56**	**2**	**29**
156-59-2	**cis-1,2-Dichloroethene**	**µg/L**	**282**	**57.45%**	**0.18**	**J**	**IR86-MW35IWA**	**10/19/04**	**670**	**D**	**SWMU318-GW10**	**3/20/04**	**162**	**120**	**0.5**	**100**	**70**	**28**	**210**	**11**
95-50-1	1,2-Dichlorobenzene	µg/L	430	4.88%	0.38	J	IR86-GW15IW	4/6/06	73		IR86-MW25IW	4/4/04	21	409	0.5	10	24	8	2600	0
127-18-4	**Tetrachloroethene**	**µg/L**	**283**	**8.48%**	**0.16**		**IR86-MW38IWA**	**5/2/2006**	**290**		**IR86-MW10IW**	**1/28/2004**	**24**	**259**	**0.5**	**50**	**0.7**	**6**	**5**	**2**
75-35-4	**1,1-Dichloroethene**	**µg/L**	**283**	**18.73%**	**0.1**	**J**	**IR86-MW36IWC**	**11/16/05**	**660**		**IR86-MW25IW**	**1/24/03**	**53**	**230**	**0.5**	**100**	**7**	**5**	**190**	**3**
107-06-2	**1,2-Dichloroethane**	**µg/L**	**283**	**1.77%**	**0.47**	**J**	**IR86-MW20IW**	**4/6/06**	**7**		**IR86-MW25IW**	**1/24/03**	**5**	**278**	**0.5**	**10**	**0.38**	**5**	**5**	**2**
75-09-2	Methylene chloride	µg/L	283	3.53%	0.14	J	IR86-MW38IWB	11/16/05	10	JB	IR86-GW29IW	1/24/03	10	273	0.5	25	4.6	5	58	0
75-27-4	Bromodichloromethane	µg/L	283	2.12%	0.17	J	IR86-MW37IWC	10/18/04	7.1		IR86-MW38IWA	10/19/04	6	277	0.5	1.3	0.56	4	2.1	3
106-46-7	1,4-Dichlorobenzene	µg/L	431	0.93%	0.1	J	IR86-MW37IWC	11/17/05	31.5		USTRF-MW22	10/27/06	4	427	0.5	1	1.4	3	8200	0
124-48-1	Dibromochloromethane	µg/L	283	2.47%	0.1	J	IR86-MW37IWC	3/2/05	3.3		IR86-MW36IWC	10/19/04	7	276	0.5	1.3	0.41	3	3	1
75-34-3	1,1-Dichloroethane	µg/L	283	7.77%	0.1	J	IR86-MW37IWC	3/2/05	71		IR86-MW25IW	1/24/03	22	261	0.5	10	70	1	2200	0
91-20-3	Naphthalene	µg/L	5	80.00%	0.83		USTAS843-MW02	7/5/2006	23		USTAS843-MW03	7/6/2006	4	1	0.5	0.5	21	1	150	0
108-88-3	Toluene	µg/L	498	17.07%	0.1	J	IR86-MW37IWC	11/17/2005	9300		IR86-MW37IWB	10/18/2004	85	413	0.5	250	1000	1	18382.35	0
71-55-6	1,1,1-Trichloroethane	µg/L	283	0.71%	0.58		IR86-MW32IW	10/19/04	5.2		IR86-MW36IWC	5/12/05	2	281	0.5	3.1	200	0	7092.20	0
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	µg/L	201	8.96%	0.16	J	IR86-MW37IWC	11/17/05	1600		IR86-MW10IW	1/28/04	18	183	0.5	100	210000	0	1500	1
120-82-1	1,2,4-Trichlorobenzene	µg/L	197	0.51%	6.2	J	IR86-MW36IWB	10/20/04	6.2	J	IR86-MW36IWB	10/20/04	1	196	25	25	70	0	3400	0
95-63-6	1,2,4-Trimethylbenzene	µg/L	5	40.00%	0.21	J	USTAS843-GW05	7/5/06	0.84		USTAS843-MW03	7/6/06	2	3	0.5	0.5	350	0	24	0
541-73-1	1,3-Dichlorobenzene	µg/L	431	1.16%	0.11	J	IR86-MW37IWC	11/17/05	21.3		USTAS4141-MW17	10/23/06	5	426	0.5	1	170	0	830	0
78-93-3	2-Butanone	µg/L	240	7.50%	0.93	J	IR86-MW37IWA	8/30/05	53	J	IR86-MW36IWB	10/20/04	18	222	2.5	130	4200	0	2183406.11	0
67-64-1	Acetone	µg/L	241	17.01%	0.83	J	IR86-MW35IWC	5/11/05	530	J	IR86-MW37IWB	10/18/04	41	200	2.5	1300	700	0	201257.86	0
75-25-2	Bromoform	µg/L	282	1.06%	0.19	J	IR86-MW36IWA	10/20/04	0.32	J	IR86-MW38IWA	10/19/04	3	279	0.5	1.3	4.43	0	0.0083	3
75-15-0	Carbon disulfide	µg/L	243	14.40%	0.12	J	IR86-MW37IWA	10/19/04	31		IR86-MW36IWB	3/3/05	35	208	0.5	10	700	0	560	0
108-90-7	Chlorobenzene	µg/L	482	0.21%	1	B	SWMU318-GW20	6/24/04	1	B	SWMU318-GW20	6/24/04	1	481	1	1	50	0	390	0
67-66-3	Chloroform	µg/L	283	5.30%	0.13	J	IR86-MW38IWA	3/2/05	31		IR86-MW36IWC	10/19/04	15	268	0.5	10	70	0	80	0
74-87-3	Chloromethane	µg/L	283	1.77%	0.12	J	IR86-MW35IWC	5/11/05	0.27	J	IR86-MW36IWB	5/12/05	5	278	0.5	1.3	2.6	0	6.7	0
75-71-8	Dichlorodifluoromethane (Freon-12)	µg/L	228	2.63%	0.11	J	IR86-MW37IWC	11/17/05	47		IR86-MW10IW	5/11/06	6	222	0.5	20	1400	0	14	1
100-41-4	Ethylbenzene	µg/L	498	16.67%	0.1	J	IR86-MW35IWA	10/19/04	209		USTCSFF-MW21	3/26/03	83	415	0.5	10	550	0	700	0
98-82-8	Isopropylbenzene	µg/L	198	4.04%	0.39	J	IR86-MW25IW	5/10/06	3.5		USTAS843-MW03	7/6/06	8	190	0.5	10	70	0	8.40	0
m&pXYLENE	m- and p-Xylene	µg/L	218	7.80%	0.3	J	IR86-MW15DW	1/23/03	210		USTAS4158-MW09	1/14/03	17	201	1	10	530	0	319	0
1634-04-4	Methyl-tert-butyl ether (MTBE)	µg/L	448	8.26%	0.23	J	IR86-MW37IWB	8/29/05	141		USTCSFF-MW21	3/26/03	37	411	0.5	10	200	0	120000	0
104-51-8	n-Butylbenzene	µg/L	5	60.00%	0.55		USTAS843-MW02	7/5/06	1.08		USTAS843-MW03	7/6/06	3	2	0.5	0.5	70	0	260	0
95-47-6	o-Xylene	µg/L	226	6.64%	0.1	J	IR86-MW37IWA	11/17/2005	190		USTAS4158-MW09	1/14/2003	15	211	0.5	10	530	0	471.7	0
135-98-8	sec-Butylbenzene	µg/L	5	60.00%	0.34	J	USTAS843-MW02	7/5/06	2.98		USTAS843-MW03	7/6/06	3	2	0.5	0.5	70	0	250	0
98-06-6	tert-Butylbenzene	µg/L	5	20.00%	0.49	J	USTAS843-MW03	7/6/06	0.49	J	USTAS843-MW03	7/6/06	1	4	0.5	0.5	70	0	290	0
156-60-5	trans-1,2-Dichloroethene	µg/L	283	30.39%	0.15	J	IR86-MW35IWC	8/30/05	42		IR86-GW21IW	2/17/05	86	197	0.5	14	100	0	180	0
1330-20-7	Xylene, total	µg/L	480	13.33%	0.18	J	USTAS843-MW03	7/6/06	262	E	USTAS522-MW08	9/27/05	64	416	0.5	15	530	0	341	0

Notes:

Bolded indicates chemical is retained as a COPCs

[a]NCAC 2L GW - North Carolina Adminstrative Code, Section 2L, updated December 2005

[b]EPA Vapor Intrusion Screening Levels (GW, Risk = 1E-06; Hazard Index = 1) (EPA, 2002)

COPC = Chemical of Potential Concern

NA = Not Available

VOC = Volatile Organic Compounds

TABLE 3-6

Summary of VOC Groundwater Data and Identification of Chemicals of Potential Concern - Courthouse Bay

MCB Camp Lejeune, North Carolina

CAS Number	Parameter	Units	Number of Analyses	Frequency of Detects (%)	Minimum Detect		Minimum Field Location ID	Minimum Field Sample Date	Maximum Detect		Maximum Field Location ID	Maximum Field Sample Date	Number of Detects	Number of Non-Detects	Minimum MDL	Maximum MDL	NCAC 2L GW[a]	Number of Exceedances above NCAC 2L	EPA Vapor Intrusion Screening Levels[b] (Risk = 1E-06; HI = 1)	Number of Exceedances above EPA Vapor Intrusion Screening Levels
540-59-0	1,2-Dichloroethene (total)	µg/L	104	68.27%	0.4	J	IR73-A47/3-MW11	4/22/04	1,100	D	IR73-MW49IW	4/22/04	71	33	2	200	-	-	-	-
108-10-1	4-Methyl-2-pentanone	µg/L	284	0.35%	10	J	IR73-MW29	10/24/03	10	J	IR73-MW29	10/24/03	1	283	10	10	-	-	886,524.82	0
110-82-7	Cyclohexane	µg/L	145	12.41%	0.14	J	IR73-MW27	7/5/07	2.9		IR73-A47/3-8	4/10/06	18	127	0.5	5	-	-	898.20	0
108-87-2	Methylcyclohexane	µg/L	145	3.45%	0.13	J	IR73-MW27	9/25/07	4.6		IR73-A47/3-8	4/10/06	5	140	0.5	1	-	-	710	0
74296-31-4	n-Propylbenzene	µg/L	31	3.23%	0.58		USTBB293-MW05	11/27/06	0.58		USTBB293-MW05	11/27/06	1	30	0.5	0.5	-	-	-	-
99-87-6	p-Isopropyltoluene	µg/L	30	6.67%	0.23	J	USTBB293-MW04	38643	0.62		USTBB293-MW05	39048	2	28	0.5	0.5	-	-	5.6	0
75-01-4	**Vinyl chloride**	**µg/L**	**298**	**46.64%**	**0.3**	**J**	**IR73-MW27DW**	**4/22/04**	**240**		**IR73-MW44DW**	**7/5/07**	**139**	**159**	**0.5**	**20**	**0.015**	**139**	**2**	**122**
71-43-2	**Benzene**	**µg/L**	**404**	**36.39%**	**0.13**	**J**	**IR73-MW27**	**7/5/07**	**35.2**		**UST1613-HPGW6**	**8/3/05**	**147**	**257**	**0.5**	**20**	**1**	**120**	**1.4**	**115**
79-01-6	**Trichloroethene**	**µg/L**	**299**	**40.80%**	**0.32**	**J**	**IR73-MW02IW**	**4/11/06**	**2,000**		**IR73-MW49DW**	**1/29/04**	**122**	**177**	**0.5**	**100**	**2.8**	**103**	**2.9**	**102**
156-59-2	**cis-1,2-Dichloroethene**	**µg/L**	**299**	**51.17%**	**0.1**	**J**	**IR73-A47/3-MW11**	**4/22/04**	**1,700**		**IR73-MW49IW**	**9/24/07**	**153**	**146**	**0.5**	**100**	**70**	**73**	**210**	**47**
75-35-4	**1,1-Dichloroethene**	**µg/L**	**298**	**32.89%**	**0.26**	**J**	**IR73-MW46DW**	**7/6/07**	**40**		**IR73-MW44DW**	**3/20/07**	**98**	**200**	**0.5**	**20**	**7**	**23**	**190**	**0**
107-06-2	**1,2-Dichloroethane**	**µg/L**	**299**	**9.7%**	**0.18**	**J**	**IR73-MW48DW**	**12/19/07**	**2.6**		**IR73-MW44DW**	**3/20/07**	**29**	**270**	**1**	**5**	**0.38**	**21**	**5**	**0**
75-09-2	Methylene chloride	µg/L	298	5.7%	0.32	J	USTBB293-MW05	11/27/2006	44		IR73-MW49IW	7/2/2007	17	281	0.5	40	4.6	8	58	0
124-48-1	Dibromochloromethane	µg/L	299	1.34%	0.32	J	USTBB293-MW06	11/27/06	0.75		USTBB293-MW02	11/27/06	4	295	0.5	0.5	0.41	2	3.2	0
78-87-5	1,2-Dichloropropane	µg/L	299	0.33%	0.6	J	IR73-MW27	9/25/07	0.6	J	IR73-MW27	9/25/07	1	298	1	1	0.51	1	35	0
106-46-7	1,4-Dichlorobenzene	µg/L	200	3%	0.33	J	IR73-A47/3-12	4/12/06	3	J	IR73-MW49IW	9/24/07	5	195	0.5	20	1.4	1	8,200	0
75-27-4	Bromodichloromethane	µg/L	299	0.33%	1.2	J	IR73-MW27DW	9/25/07	1.2	J	IR73-MW27DW	9/25/07	1	298	5	5	0.56	1	2.1	0
1330-20-7	**Xylene, total**	**µg/L**	**380**	**9.74%**	**0.24**	**J**	**IR73-MW49DW**	**3/19/2007**	**3,080**		**UST1613-HPGW6**	**8/3/2005**	**37**	**343**	**0.5**	**60**	**530**	**1**	**341**	**1**
75-34-3	1,1-Dichloroethane	µg/L	298	0.34%	0.2	J	IR73-MW44DW	10/27/03	0.2	J	IR73-MW44DW	10/27/03	1	297	5	5	70	0	2200	0
95-63-6	1,2,4-Trimethylbenzene	µg/L	31	29.03%	0.25	J	USTBB293-MW01	10/18/05	1.43		UST45/S941-MW09	6/19/07	9	22	0.5	1	350	0	24	0
108-67-8	1,3,5-Trimethylbenzene	µg/L	31	6.45%	0.21	J	USTBB293-MW05	11/27/06	0.56	J	UST45/S941-MW09	6/19/07	2	29	0.5	1	350	0	25	0
78-93-3	2-Butanone	µg/L	277	1.44%	2.1	J	IR73-MW49DWA	7/2/07	140		IR73-MW49IW	3/19/07	4	273	10	10	4,200	0	2,183,406.11	0
67-64-1	Acetone	µg/L	270	4.07%	2	J	IR73-MW46DW	9/26/07	200		IR73-MW49IW	9/24/07	11	259	10	200	700	0	201,257.86	0
75-25-2	Bromoform	µg/L	298	1.34%	0.55		USTBB293-MW01	11/27/06	0.93		USTBB293-MW02	11/27/06	4	294	0.5	0.5	4.43	0	0.0083	4
75-15-0	Carbon disulfide	µg/L	283	0.71%	0.79		IR73-MW15N	4/12/06	1.4		IR73-MW27	12/18/07	2	281	0.5	1	700	0	560	0
108-90-7	Chlorobenzene	µg/L	306	0.65%	0.2	J	IR73-A47/3-MW11	4/22/04	6.7		IR73-A47/3-12	4/12/06	2	304	0.5	5	50	0	390	0
75-00-3	Chloroethane	µg/L	298	0.34%	2	J	IR73-MW35	4/11/03	2	J	IR73-MW35	4/11/03	1	297	5	5	2,800	0	28,000	0
67-66-3	Chloroform	µg/L	273	3.66%	0.2	J	USTBB293-MW06	10/18/05	31		IR73-MW49IW	9/24/07	10	263	0.5	20	70	0	80	0
74-87-3	Chloromethane	µg/L	298	1.68%	0.4	J	IR73-MW39DW	7/3/07	1		UST45/S941-MW01/45	12/19/07	5	293	1	2	2.6	0	7	0
100-41-4	Ethylbenzene	µg/L	403	10.67%	0.1	J	IR73-MW14	10/27/03	243		UST1613-HPGW6	8/3/05	43	360	0.5	10	550	0	700	0
108-20-3	Isopropyl ether	µg/L	128	2.34%	0.3	J	UST45/S941-MW09	39107	0.51	J	UST45/S941-MW09	39252	3	125	1	1	70	0	-	-
98-82-8	Isopropylbenzene	µg/L	176	5.68%	0.2	J	IR73-MW13	39350	13		IR73-A47/3-8	38817	10	166	0.5	1	70	0	8.4	1
m&pXYLENE	m- and p-Xylene	µg/L	126	12.7%	0.2	J	IR73-MW14	10/27/03	1	JB	IR73-MW13	1/29/04	16	110	2	10	530	0	319	0
1634-04-4	Methyl-tert-butyl ether (MTBE)	µg/L	283	3.89%	0.57	J	UST1613-HPGW5	38567	18.8		UST45/S941-MW09	37701	11	272	1	2	200	0	120,000	0
91-20-3	Naphthalene	µg/L	42	2.38%	0.59	J	UST45/S941-MW14	6/20/07	0.59	J	UST45/S941-MW14	6/20/07	1	41	1	1	21	0	150	0
95-47-6	o-Xylene	µg/L	126	15.08%	0.2	J	IR73-MW49IW	10/24/2003	1	B	IR73-MW44DW	1/29/2004	19	107	1	5	530	0	471.7	0
135-98-8	sec-Butylbenzene	µg/L	31	3.23%	0.61		USTBB293-MW05	39048	0.61		USTBB293-MW05	39048	1	30	0.5	0.5	70	0	250	0
108-88-3	Toluene	µg/L	404	21.29%	0.11	J	UST45/S941-MW09	39435	199		UST1613-HPGW6	38567	86	318	0.5	10	1,000	0	18382.35294	0
156-60-5	trans-1,2-Dichloroethene	µg/L	298	38.59%	0.2	J	IR73-MW39DW	12/18/2007	47		IR73-MW44DW	4/22/2004	115	183	0.5	50	100	0	180	0

Notes:

Bolded indicates chemical is retained as a COPCs

[a]NCAC 2L GW - North Carolina Adminstrative Code, Section 2L, updated December 2005

[b]EPA Vapor Intrusion Screening Levels (GW, Risk = 1E-06; Hazard Index = 1) (EPA, 2002)

COPC = Chemical of Potential Concern

NA = Not Available

VOC = Volatile Organic Compounds

TABLE 3-7

Summary of VOC Groundwater Data and Identification of Chemicals of Potential Concern - Camp Geiger

MCB Camp Lejeune, North Carolina

CAS Number	Parameter	Units	Number of Analyses	Frequency of Detects (%)	Minimum Detect		Minimum Field Location ID	Minimum Field Sample Date	Maximum Detect		Maximum Field Location ID	Maximum Field Sample Date	Number of Detects	Number of Non-Detects	Minimum MDL	Maximum MDL	NCAC 2L GW[a]	Number of Exceedances above NCAC 2L	EPA Vapor Intrusion Screening Levels[b] (Risk = 1E-06; HI = 1)	Number of Exceedances above EPA Vapor Intrusion Screening Levels
79-00-5	**1,1,2-Trichloroethane**	**µg/L**	**711**	**14.21%**	**0.12**	**J**	**IR36-GW13**	**8/24/06**	**9,600**	**J**	**IR89-GW17**	**4/12/03**	**101**	**610**	**0.5**	**13,000**	**-**	**-**	**5**	**38**
540-59-0	1,2-Dichloroethene (total)	µg/L	294	61.90%	0.2	J	IR89-MW15IW	4/21/04	67,000		IR89-GW16	4/12/03	182	112	2	1,000	-	-	-	-
108-10-1	4-Methyl-2-pentanone	µg/L	645	0.78%	0.42	J	IR89-MW62	6/27/07	2.7	J	IR89-MW16	12/4/05	5	640	5	5	-	-	886524.82	0
74-83-9	Bromomethane	µg/L	704	0.43%	0.42	J	IR89-MW16	12/4/05	31	J	IR35-MW76IW	7/26/04	3	701	0.5	31	-	-	20	1
110-82-7	Cyclohexane	µg/L	361	1.66%	0.12	J	IR35-MW86IW	12/5/07	16	J	IR35-MW78IW	4/13/05	6	355	0.5	21	-	-	898.20	0
79-20-9	Methyl acetate	µg/L	345	1.45%	2.2		IR89-MW45	3/27/2007	15		IR89-MW62	3/27/2007	5	340	1	1	-	-	720000.00	0
108-87-2	Methylcyclohexane	µg/L	361	1.66%	0.18	J	IR35-MW55B	3/30/2004	13		IR35-MW74B	3/29/2004	6	355	0.5	13	-	-	710	0
99-87-6	p-Isopropyltoluene	µg/L	66	3.03%	1.3		IR89-MW02	1/4/07	8.4		IR89-MW54	1/3/07	2	64	1	1	-	-	5.6	1
79-01-6	**Trichloroethene**	**µg/L**	**710**	**66.34%**	**0.2**	**J**	**IR89-MW14IW**	**4/21/04**	**620,000**		**IR89-GW16**	**4/12/03**	**471**	**239**	**0.5**	**13,000**	**2.8**	**406**	**2.9**	**405**
75-01-4	**Vinyl chloride**	**µg/L**	**711**	**53.02%**	**0.14**	**J**	**IR89-MW07IW**	**12/4/2005**	**28,000**		**IR89-MW28**	**6/26/2007**	**377**	**334**	**0.5**	**13,000**	**0.015**	**377**	**2**	**299**
156-59-2	**cis-1,2-Dichloroethene**	**µg/L**	**711**	**74.54%**	**0.1**	**J**	**IR93-MW05IW**	**4/14/04**	**230,000**		**IR89-MW20**	**9/19/07**	**530**	**181**	**0.5**	**13,000**	**70**	**307**	**210**	**216**
127-18-4	**Tetrachloroethene**	**µg/L**	**710**	**27.46%**	**0.12**	**J**	**IR35-MW85IW**	**12/5/2007**	**6,900**	**J**	**IR89-MW20**	**12/3/2005**	**195**	**515**	**0.5**	**13,000**	**0.7**	**162**	**5**	**81**
79-34-5	**1,1,2,2-Tetrachloroethane**	**µg/L**	**711**	**19.41%**	**0.15**	**J**	**IR36-GW20IW**	**8/24/06**	**1,200,000**		**IR89-GW17**	**4/12/03**	**138**	**573**	**0.5**	**13,000**	**0.17**	**136**	**3**	**99**
156-60-5	**trans-1,2-Dichloroethene**	**µg/L**	**710**	**60.85%**	**0.14**	**J**	**IR89-MW06IW**	**12/4/05**	**35,000**		**IR89-MW20**	**9/19/07**	**432**	**278**	**0.5**	**13,000**	**100**	**135**	**180**	**101**
71-43-2	**Benzene**	**µg/L**	**711**	**18.85%**	**0.1**	**J**	**IR89-MW03IW**	**4/16/04**	**44**		**IR35-MW29**	**9/6/07**	**134**	**577**	**0.5**	**13**	**1**	**63**	**1.4**	**56**
75-35-4	**1,1-Dichloroethene**	**µg/L**	**711**	**28.41%**	**0.11**	**J**	**IR89-MW06IW**	**12/4/05**	**1,600**	**J**	**IR89-MW22**	**12/3/05**	**202**	**509**	**0.5**	**6,300**	**7**	**59**	**190**	**12**
107-06-2	**1,2-Dichloroethane**	**µg/L**	**711**	**4.22%**	**0.13**	**J**	**IR36-GW18**	**9/28/05**	**46**		**IR89-MW20**	**12/3/05**	**30**	**681**	**0.5**	**50**	**0.38**	**23**	**5**	**9**
75-09-2	Methylene chloride	µg/L	710	2.96%	0.14	J	IR35-MW64B	2/25/04	460		IR89-MW53	3/15/07	21	689	0.5	400	4.6	9	58	3
74-87-3	Chloromethane	µg/L	711	1.41%	0.5	J	IR35-MW79B	7/25/05	17	J	IR35-MW14	4/9/03	10	701	0.5	63	2.6	7	6.7	4
75-27-4	Bromodichloromethane	µg/L	711	1.13%	0.3	J	IR35-MW82IW	5/24/07	9.4		IR89-MW32	11/30/05	8	703	0.5	1	0.56	6	2	2
124-48-1	Dibromochloromethane	µg/L	711	1.13%	0.082	J	IR35-MW82IW	5/24/07	3.8		IR89-MW32	11/30/05	8	703	0.5	5	0.41	5	3.2	1
56-23-5	Carbon tetrachloride	µg/L	711	0.42%	0.5	J	IR35-MW79B	7/25/05	0.5	J	IR35-MW79B	7/25/05	3	708	0.5	0.5	0.269	3	5	0
106-46-7	1,4-Dichlorobenzene	µg/L	427	0.94%	0.12	J	IR35-MW55B	3/30/04	15		IR35-MW74B	3/29/04	4	423	0.5	13	1.4	2	8,200	0
78-87-5	1,2-Dichloropropane	µg/L	711	0.14%	1	J	IR89-MW43	6/6/07	1	J	IR89-MW43	6/6/07	1	710	2	2	0.51	1	35	0
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	µg/L	360	0.83%	0.25	J	IR35-MW64B	3/30/04	13		IR35-MW74B	3/29/04	3	357	0.5	21	210,000	0	1,500	0
75-34-3	1,1-Dichloroethane	µg/L	711	0.14%	0.75	J	IR89-MW50	6/5/07	0.75	J	IR89-MW50	6/5/07	1	710	5	5	70	0	2,200	0
120-82-1	1,2,4-Trichlorobenzene	µg/L	427	2.11%	0.11	J	IR35-MW78IW	8/2/04	24		IR35-MW74B	3/29/04	9	418	0.5	31	70	0	3,400	0
95-63-6	1,2,4-Trimethylbenzene	µg/L	66	4.55%	1.1	J	IR89-MW51	1/4/07	4.5		IR89-MW56	1/5/07	3	63	1	2	350	0	24	0
95-50-1	1,2-Dichlorobenzene	µg/L	427	0.23%	8.5	J	IR35-MW74B	3/29/04	8.5	J	IR35-MW74B	3/29/04	1	426	13	13	24	0	2,600	0
541-73-1	1,3-Dichlorobenzene	µg/L	426	1.17%	0.1	J	IR35-MW55B	3/30/04	13		IR35-MW74B	3/29/04	5	421	0.5	13	170	0	830	0
78-93-3	2-Butanone	µg/L	592	2.87%	0.92	J	IR35-MW73IW	7/25/05	3,800	J	IR35-MW73B	2/24/04	17	575	2.5	420	4,200	0	2183406.11	0
591-78-6	2-Hexanone	µg/L	636	0.16%	3.9	J	IR89-MW55	3/15/07	3.9	J	IR89-MW55	3/15/07	1	635	5	5	280	0	-	-
67-64-1	Acetone	µg/L	542	6.83%	1.8	J	IR89-MW45	6/27/07	260		IR89-MW59	3/27/07	37	505	2.5	1,000	700	0	201,257.86	0
75-25-2	Bromoform	µg/L	711	0.28%	0.36	J	IR36-GW10IW	8/24/06	0.87		IR35-MW32	4/23/06	2	709	0.5	1.3	4.43	0	0.0083	2
75-15-0	Carbon disulfide	µg/L	645	2.33%	0.17	J	IR89-MW38	11/30/05	21		IR89-MW20	12/3/05	15	630	0.5	25	700	0	560	0
108-90-7	Chlorobenzene	µg/L	711	0.42%	0.3	J	IR93-MW08	4/24/04	14	J	IR36-GW21IW	8/24/06	3	708	1.3	13	50	0	390	0
75-00-3	Chloroethane	µg/L	711	0.28%	0.29	J	IR89-MW59	6/26/07	1.4	J	IR89-MW59	3/27/07	2	709	2	2	2,800	0	28,000	0
67-66-3	Chloroform	µg/L	711	5.63%	0.1	J	IR35-MW73IW	4/21/04	35		IR89-MW32	11/30/05	40	671	0.5	100	70	0	80	0
75-71-8	Dichlorodifluoromethane (Freon-12)	µg/L	427	0.94%	0.23	J	IR35-MW55B	3/30/04	15		IR35-MW74B	3/29/04	4	423	0.5	13	1,400	0	14	1
100-41-4	Ethylbenzene	µg/L	711	4.36%	0.2	J	IR89-MW02	10/25/03	265		IR35-MWMP5S	3/31/03	31	680	0.5	13	550	0	700	0
98-82-8	Isopropylbenzene	µg/L	427	3.98%	0.13	J	IR35-MW10IW	12/4/07	13		IR35-MW29	9/6/07	17	410	0.5	13	70	0	8.4	2
m&pXYLENE	m- and p-Xylene	µg/L	420	1.90%	0.23	J	IR35-MW64B	3/30/04	20	J	IR35-MW74B	3/29/04	8	412	1	25	530	0	319	0
1634-04-4	Methyl-tert-butyl ether (MTBE)	µg/L	439	1.37%	0.13	J	IR35-MW76IW	2/25/04	17	J	IR35-MW78IW	4/13/05	6	433	0.5	21	200	0	120,000	0
91-20-3	Naphthalene	µg/L	66	9.09%	1.2	J	IR89-MW08	1/3/2007	6.6		IR89-MW61	12/29/2006	6	60	1	1	21	0	150	0
95-47-6	o-Xylene	µg/L	420	2.38%	0.2	J	IR35-MW30	4/17/2004	4.3	J	IR35-MW74B	3/29/2004	10	410	1	13	530	0	471.7	0
100-42-5	Styrene	µg/L	711	1.27%	0.39	J	IR35-MW37IW	5/23/2007	5.8	J	IR35-MW74B	3/29/2004	9	702	1	13	100	0	8,900	0
108-88-3	Toluene	µg/L	711	8.72%	0.11	J	IR36-GW20IW	9/28/2005	56		IR35-MW29	9/6/2007	62	649	0.5	10	1,000	0	18382.35	0
75-69-4	Trichlorofluoromethane(Freon-11)	µg/L	427	0.47%	0.14	J	IR35-MW64B	3/30/04	11	J	IR35-MW74B	3/29/04	2	425	0.5	13	2,100	0	180	0
1330-20-7	Xylene, total	µg/L	642	2.80%	0.24	J	IR35-MW64B	3/30/04	86		IR89-MW20	12/3/05	18	624	0.5	13	530	0	341	0

Notes:

Bolded indicates chemical is retained as a COPCs

[a]NCAC 2L GW - North Carolina Adminstrative Code, Section 2L, updated December 2005

[b]EPA Vapor Intrusion Screening Levels (GW, Risk = 1E-06; Hazard Index = 1) (EPA, 2002)

COPC = Chemical of Potential Concern

NA = Not Available

VOC = Volatile Organic Compounds

TABLE 3-8

Summary of VOC Groundwater Data and Identification of Chemicals of Potential Concern - Tarrawa Terrace

MCB Camp Lejeune, North Carolina

CAS Number	Parameter	Units	Number of Analyses	Frequency of Detects (%)	Minimum Detect		Minimum Field Location ID	Minimum Field Sample Date	Maximum Detect		Maximum Field Location ID	Maximum Field Sample Date	Number of Detects	Number of Non-Detects	Minimum MDL	Maximum MDL	NCAC 2L GW[a]	Number of Exceedances above NCAC 2L	EPA Vapor Intrusion Screening Levels[b] (Risk = 1E-06; HI = 1)	Number of Exceedances above EPA Vapor Intrusion Screening Levels
67-64-1	Acetone	µg/L	16	6.25%	5.8	J	MR04-MW06	9/12/07	5.8	J	MR04-MW06	9/12/07	1	15	5	5	700	0	201257.86	0
71-43-2	Benzene	µg/L	135	6.67%	0.66	J	USTTT2477-MW01	4/12/06	1,930		USTTT2477-MWPVC101	8/18/05	9	126	1	100	1	6	1.4	5
67-66-3	Chloroform	µg/L	55	3.64%	1.2		MR04-MW02	9/12/07	5.1	J	MR04-MW02	4/1/06	2	53	0.5	10	70	0	80	0
74-87-3	Chloromethane	µg/L	56	7.14%	0.2	J	MR04-MW01	9/9/07	0.28	J	MR04-MW03	9/9/07	4	52	0.5	0.5	2.6	0	7	0
100-41-4	Ethylbenzene	µg/L	135	17.04%	0.18	J	USTM232-236-MW05	1/23/07	1,850		USTTT2477-MWPVC101	4/11/06	23	112	1	100	550	3	700	3
108-20-3	Isopropyl ether	µg/L	80	1.25%	2.06	J	USTTT2478-MW20	4/11/06	2.06	J	USTTT2478-MW20	4/11/06	1	79	4	4	70	0	-	-
1634-04-4	Methyl-tert-butyl ether (MTBE)	µg/L	135	4.44%	0.46	J	USTM232-236-MW08	12/18/07	8		USTTT2477-MW06	8/11/05	6	129	1	8	200	0	120,000	0
127-18-4	Tetrachloroethene	µg/L	55	1.82%	1.5		USTTT2477-MW11	8/15/05	1.5		USTTT2477-MW11	8/15/05	1	54	1	1	0.7	1	5	0
108-88-3	Toluene	µg/L	135	20.74%	0.31		USTM232-236-MW22	8/16/06	476		USTTT2477-MWPVC101	4/11/06	28	107	1	100	1,000	0	18382.35	0
1330-20-7	Xylene, total	µg/L	119	12.61%	0.47	J	USTM232-236-MW22	1/23/2007	1,870		USTTT2477-MWPVC101	8/18/2005	15	104	2	300	530	2	341	3

Notes:

Bolded indicates chemical is retained as a COPCs

[a]NCAC 2L GW - North Carolina Adminstrative Code, Section 2L, updated December 2005

[b]EPA Vapor Intrusion Screening Levels (GW, Risk = 1E-06; Hazard Index = 1) (EPA, 2002)

COPC = Chemical of Potential Concern

NA = Not Available

VOC = Volatile Organic Compounds

TABLE 3-9
Building Inventory List - Mainside
MCB Camp Lejeune, North Carolina

Building Number	Located near COPC plume or active remedial system?	Building Length (approximate)	Building Width (approximate)	Building Height (approximate)	Number of Stories	Slab on Grade? (Y/N)	Basement or Crawl Space?	Building Construction Materials	Number of Doors, Windows, Loading Docks	Residential? (Y/N)	Building Use	Occupancy (occupied/limited occupancy/unoccupied)	Excluded from Evaluation? (Y/N)	Reason for Exclusion
3	Site 88	150	35	35-40	2	?	?	Brick and mortar	Being renovated (subject to change) currently 7 doors/ 1 double door/ 56 windows	N	PMO HQ	50+	N	
37	Site 88	180	30	20	1.5	Y	N	Brick and mortar	4 double entrance doors/ 2 doubles maintenance room doors/ 35 windows	N	Confidential	NA	N	
43	Site 88	40	20	18	1	Y	N	Brick and mortar	3 doors/ 14 windows	N	1/2 MP Operations, 1/2 MP motor pool	<15	N	
728	SWMU-118	30	30	20	2	?	Y	cinder block, wood	18 windows, 2 doors	N	Nautical gift shop	<10	N	
820	Site 820	80	80	30	1	Y	N	Concrete slab, brick	glass front, 2 double doors, door for unloading	Y	Gas Station	<10	N	
1828	Near SWMU 360	300	45	25	1.5	Y	N	Corr. steel	2 doors/ 5 large double warehouse doors	N	Food service company, CLR27, 2nd MLG	<10	N	
1855	Near SWMU 360	175	80	25	2	Y	N	Brick and mortar	4 doors/ 6 double windows/1 loading dock	N	2nd MARDIV Tank Battalion HQ	13-15 personnel	N	
3B	Site 88	60	12	15	1	Y	N	1/2 brick and mortar, 1/2 siding	1 door/ 3 windows on brick side/ 2 doors and 4 windows on siding 1/2	N	1/2 PMO operations/ 1/2 PMO storage	<5	N	
LCH-4014	LCH-4015 - UST site	80	50	20	1	Y	N	Cement, brick	2 doors, 2 windows	N	Gas station and store	< 10	N	
LCH- 4034	LCH-4015 - UST site	250	50	25	1	Y	N	Concrete slab, brick	13 doors, 24 windows	N	Theater, HR Service, Post office	< 40	Y	Wells within 100 ft do not exceed site specific screening level
1826	Near SWMU 360	100	50	25	1	Y	N	steel warehouse	4 sliding steel doors, 1 single door	N	Military supply -- some office space	10 - 30	Y	Wells within 100 ft do not exceed site specific screening level
1854	Near SWMU 360	300	150	80	2	Y	N	Cement Slab, brick	20 tall bays on each side, offices in center, 14 side bay doors, several single doors	N	Tank Maintenance building	10 - 200	Y	Wells within 100 ft do not exceed site specific screening level
LCH 4035	LCH 4034	10	10	12	1	Y	N	Cement slab and brick	1 door	Y	small building - controls/pump for USTs…ur	0	Y	Not occupied
40	UST 645	450	10								elementary school		Y	Wells within 100 ft do not exceed site specific screening level
887	UST 645	10	20								storage shed	0	Y	Wells within 100 ft do not exceed site specific screening level
S49		10	50								Shelter	0	Y	Open area, not occupied
822	UST820	50	25	15	1	Y	N	steel structure	open steel structure - overhang for gas pumps	Y	Overhang open structure for gas pumps	0	Y	Open area, not occupied
S865	UST820	10	5	5	1	Y	N	Fence	open fenced in area with tanks and pumps (concrete pad)	Y	Fenced area next to AST - pumps to control	0	Y	Open area, not occupied
4	Site 88 side gradient of plume	150	30	18	1.5	?	?	Brick and mortar	1 single door/2 double doors/21 windows	N	Health clinic	~10	Y	Wells within 100 ft do not exceed site specific screening level
6	Site 88	250	50	50	2	Y	N	Concrete slab	156 windows, 14 doors -- 3 50' X 50' sections jut out from building	N	Personnel Administration Center (PAC)	< 150 ?	Y	No shallow GW impacts within 100 ft
19	Site 88	250	250	100	2?	Y	?	Concrete slab, brick	Several glass doors/ windows in front, 15 windows, 3 double doors, 1 20' loading door	N	Base theater	during shows, 500?	Y	Wells within 100 ft do not exceed site specific screening level
41	Site 88	75	40	30	1	Y	N	Concrete slab, brick	35 windows, 3 doors	N	Community Counseling Center	<40	Y	Wells within 100 ft do not exceed site specific screening level
67	Site 88 side gradient of plume	200	60	45	2	N	Y	Brick and mortar	1 double door - front main/ 9 doors/1 basement door/ 161 windows	N	Public Affairs Office/JAG/Jewish Chapel	<100	Y	Wells within 100 ft do not exceed site specific screening level
80	Site 88	100	50	25	1	Y	N	Cement Slab, brick	22 windows, 3 doors	N	Document Automation & production service	< 20	Y	Wells within 100 ft do not exceed site specific screening level
107		100	50	25	1	Y	N	Concrete slab, brick	35 windows, 3 roll up doors, 5 single doors	N	Headquarters -- company supply	none	Y	No occupancy
113	Near Site 88 downgradient plume	75	20	18	1.5	Y	N	Brick and mortar	1 door/3 large double warehouse doors/ 14 windows	N	Radiological storage	0	Y	Wells within 100 ft do not exceed site specific screening level
147	Near Site 88 downgradient plume	15	12	12	1	Y	N	Brick and mortar	1 door	N	Sprint communications hub/control room	0	Y	Wells within 100 ft do not exceed site specific screening level
236	Site 88	200	100	80	1	Y	N	Concret slab, brick	Windows all along sides, 2 sets double doors	N	Swimming pool	<100	Y	No shallow GW impacts within 100 ft
254	Near Site 88 downgradient plume	10	10	12	1	Y	N	Cinder block and mortar	1 door	N	Storage (unsure of current occupant)		Y	Wells within 100 ft do not exceed site specific screening level
1827	Near SWMU 360	300	45	25	1.5	Y	N	Corr. steel	1 door/ 7-8 large double warehouse doors	N	Storage (unsure of current occupant)	0-5	Y	Wells within 100 ft do not exceed site specific screening level
CONT16		50	12	15	1	Y	Y	Steel trailer	2 doors, 2 windows	N	Contractor Office Trailer	10 - 15	Y	Wells within 100 ft do not exceed site specific screening level
CONT17		50	12	15	1	Y	Y	Steel Trailer	2 doors, 2 windows	N	Contractor Office Trailer	10 - 15	Y	Wells within 100 ft do not exceed site specific screening level
CONT18		50	12	15	1	Y	Y	Steel trailer	2 doors, 2 windows	N	Contractor Office Trailer	10 - 15	Y	Wells within 100 ft do not exceed site specific screening level
HP56	Site 88	100	50	25	1	Y	N	Concrete slab, brick	14 windows, 4 doors	N	TRMD Supply	< 30	Y	Wells within 100 ft do not exceed site specific screening level
HP57	Site 88 upgradient	200	35	45	3	?	?	Brick and mortar	87 doors/ 79 double windows	Y	PMO barracks	?	Y	Wells within 100 ft do not exceed site specific screening level
S1847A	Near SWMU 360	NA	NA	NA	NA	Y	N	Steel	NA	N	Covered wash rack - no sides	0	Y	Building not enclosed, no vapor accumulation
S195	SWMU-118	25	10	12	1	?	Y	Wooden structure	Open area, covered entrance to dock, lattice crawl space	N	Decorative entrance to dock	none	Y	Open area, not occupied
S2633	UST2633 (Soveriegn Site)	10	5	10	1	Y	N	steel structure	Open overhang to cover some type of pump	N	Protects pump	0	Y	Open area, not occupied
S637	Site 6	10	10	10	1	Y	N	Cement slab, steel	1 door	N	Hut for recovery well	none	Y	No occupancy
S94	Site 88	NA	NA	NA	1	N	NA	Cinder block and mortar	NA	N	bunker with steam controls (see pictures)	0	Y	Not occupied

Notes:
Includes only buildings within 100 feet of groundwater concentrations exceeding NCAC 2L or EPA VI guidance groundwater standards
Buildings to be carried through remainder of evaluation.

TABLE 3-10
Building Inventory List - Hadnot Poin
MCB Camp Lejeune, North Carolina

Building Number	Located near COPC plume or active remedial system?	Building Length (approximate)	Building Width (approximate)	Building Height (approximate)	Number of Stories	Slab on Grade? (Y/N)	Basement or Crawl Space?	Building Construction Materials	Number of Doors, Windows, Loading Docks	Residential? (Y/N)	Building Use	Occupancy (occupied/limited occupancy/unoccupied)	Excluded from Evaluation? (Y/N)	Reason for Exclusion
901	Near Site 78 North	200	50	50	2	Y	N	Corr. steel and fiberglass	4 single doors/ 6 warehouse rollup doors/ ~ 100 small windows	N	Unknown	<20	N	
902	Near Site 78 North	350	100	30	1.5	Y	N	Brick and mortar	2 single doors/ 7-8 large sliding warehouse doors/ 38 doubles windows	N	Contractors - construction vehicle maintenance	<25	N	
903	Near Site 78 North	350	100	30	1.5	Y	N	Brick and mortar	11 large sliding warehouse doors/ 36 windows/ full loading docks in front and back	N	II MEF tire changing facility	<25	N	
1068	Fuel Farm	75	40	15	1	Y	N	Concrete slab and brick	11 windows, 1 door, large scale for rail cars in front	N	Traffic management office for railroad cars	<5	N	
1101	UST1115	350	100	25	1	?	?	Cinder block and mortar	8 single doors/ 5 large warehouse doors/ 36 windows	N	MCCS Retail Warehouse Will Call and Layaway	<30	N	
1108	UST1115	350	100	25	2	?	?	Cinder block and mortar	11 single doors secured by locking warehouse door/ 3 large warehouse doors/ 1 double glass ent door/ 47 double windows/ 17 single windows	N	Retail warehouse (occupant unknown)	<50	N	
1111	USTHPFFC	25	20	18	1	Y	N	Cinder block and mortar	2 single doors/ 3 warehouse rollup doors/ 10 windows	N	Storage MCCS - Recreational equipment	<3	N	
1114	Hadnot Point Fuel Farm	100	50	30	1	Y	N	Cement slab, steel warehouse	2 rollup doors, no windows, 2 single doors	N	Base Telephone, storage - gov. employees in and out	> 20	N	
1115	USTHPFFC	25	20	18	1	Y	N	Cinder block and mortar	3 single doors/ 10 windows	N	Office MCCS - Recreational equipment rentals	Varies seasonally	N	
1200	UST1115	350	35	20	1	?	?	Cinder block and mortar	5 single doors/ 2 double steel doors/1 double glass (thrift shop ent.)/ Windows - 6 double/3 triple/ 4 quadruple	N	NE 1/2 - Thrift shop/ SW 1/2 II MEF HQ group CBRND	<35	N	
1201	Hadnot Point Fuel Farm	300	100	80	1	Y	N	concrete	13 double doors, 1 large slide door, 16 windows	N	Base Maintenance project section	<25	N	Added due to sparge/pulsing system
1202	Hadnot Point Fuel Farm	400	150	40/80	2	Y	N	Cement slab, Cinder block	7 doors, several windows ~80, back sided gated off	N	Lejeune Support Services, office and storage	<80	N	Added due to sparge/pulsing system
1220	Hadnot Point Fuel Farm	100	100	50	1	Y	N	Concrete slab, cinder block	12 long windows, 2 double doors, 1 single, drive thru windows	N	Burger King	5 - 100	N	Added due to sparge/pulsing system
1301	Hadnot Point Fuel Farm	400	100	80	1	Y	N	Cement slab, concrete	4 steel loading doors, 10 large double doors, 2 single doors, 9 windows	N	Command Element 22nd MEU supply	> 20	N	
1502	Site 78 South	350	100	25	2	?	?	Cinder block and mortar	Identical to Bldg 1601	N	Base motor transport/	21 gov emp and 12 maint contractors	N	
1601	Site 78 South	350	100	25	2	?	?	Cinder block and mortar	4 single doors/ 1 double door/ 4 rollup doors/ too many windows to count (see pictures)	N	MCSC - NBC (nuc/biol/chem) equip warehouse - NE 4/5 occupied by New Breed Inc Contractors/ SW 1/5 Occupied by civ gov emp testing equipment	<50 working/ ~250/day come in and out	N	
1603	Site 78 South	125	30	20	1	Y	N	Cinder block and mortar	3 single doors/ 3 rollup doors/ 9 windows	N	10th Marines survey/meteorological team	<15	N	
1611	Site 78 South/ UST1613	50	50	30	1	Y	N	Concrete slab, brick	7 doors, 13 windows,	N	Central Service Station -- vehicle maint.	< 10	N	
1613	Site 78 South	30	15	30	1	Y	N	Concrete slab, brick	4 doors, 2 windows, 50' overhang on each side (8 total gas pumps)	N	Gas station and budget rental office	<8	N	
1707	Site 78 South	100	100	18	1	Y	N	Cinder block and mortar	3 single doors/ 9 windows	N	2nd MARDIV motor transport AC/S G-4	<10	N	
1817	Near SWMU 360	250	25	20	1.5	Y	N	Corr. steel	3 singles doors/6+ double warehouse doors	N	NW 1/2 - 8th Communication Battalion Support Company CST Platoon/ SE 1/2 8th Comm Batt Hazmat Consolidation Center	<30	N	
1819	Near SWMU 360	250	25	20	1.5	Y	N	Corr. steel	2 single doors/ 4 double warehouse doors	N	NW 1/2 - Storage for 8th Comm Batt Spport Comp/ SE 1/2 Tank Batt storage	<5	N	
1005	Fuel Farm	300	200	25	1	Y	N	mortar	Building has several sections; construction in back, approx 70 windows, approx 10 doors	N	Public works, ROICC office	several ~ 100	N	Retained due to nearby system
1100	USTHPFFC	20	20	18	1	Y	N	Cinder block and mortar	3 single doors/ 9 windows	N	MCCS Recreational office		N	
UN744	USTHPFFC				1	NA	NA	Cinder block and mortar	Bunker - sub terranean pit 1 door	N	?	0	Y	Not occupied
751	Site 78 South	150	150	90	3	Y	N	Cement slab, brick	5 doubte doors, 20 double windows, 34 triple windows	N	Gymnasium	20-150	Y	Wells within 100 ft do not exceed site-specific screening level
1050	Hadnot Point Fuel Farm	30	30	15	1	Y	N	Cement slab, Cinder block	1 rollup steel door, 1 double door	N	Unmarked storage across from car wash	none	Y	Not occupied
1112	Hadnot Point Fuel Farm	25	25	20	1	Y	N	Cement slab, Cinder block	1 door	N	Storage for building 1101, haz mat? (hase eyewash station)	none	Y	Not occupied
1120	Hadnot Point Fuel Farm	400	50	80	1	Y	N	Concrete slab, cinder block	28 large bay doors, 34 windows, 2 single doors, additional 30' X 40' X 50' building	N	Motor transport/vehicle hobby shop	Not continuous ~ 100	Y	Wells within 100 ft do not exceed site-specific screening level
1503	Fuel Farm/Site 78 South	200	80	80	1	Y	N	Concrete slab, cinder block	2 steel roll up, 1 door, 15 windows	N	Accident prevention/shop store for vehicle maint.	occasional - 10?	Y	Wells within 100 ft do not exceed site-specific screening level
1504	Fuel Farm/Site 78 South	200	80	80	1	Y	N	Concrete slab, cinder block	7 bay doors, 1 single door, 11 windows	N	Tire shop	occasional - 10?	Y	Wells within 100 ft do not exceed site-specific screening level
1602	Site 78 South	100	30	40	1	Y	N	Concrete slab and cinder block	5 roll up bays, approx 20 windows,	N	Transport Battalion Maint. Building	> 15	Y	Wells within 100 ft do not exceed site-specific screening level
1604	Site 78 South	100	50	30	1	Y	N	Concrete slab and cinder block	4 bays, approx 12 windows, 1 door	N	Jeep Maintenance warehouse	approx. 15	Y	Wells within 100 ft do not exceed site-specific screening level
1606	Site 78 South	400	200	50	1	Y	N	Concrete masonry	11 bay doors, 5 double doors, 14 windows, loading dock	N	Lejeune First Choice supplies - storage warehouse	< 50 delivenes in and out	Y	Wells within 100 ft do not exceed site-specific screening level
1610	UST1613	80	50	30	1	Y	N	Concrete slab and brick	8 bay doors, 3 doors, 10 windows	N	Gen., tune-up, electrical repairs, alignment and balance shop	< 10	Y	Wells within 100 ft do not exceed site-specific screening level
1688	UST 1613	50	50	30	1	Y	N	Brick and mortar	3 doors, five windows	N	Admin building for steam plant	<5	Y	Wells within 100 ft do not exceed site-specific screening level
1701	Site 78 South	100	80	50	1	Y	N	Concrete slab and steel	2 bay doors, 3 doors, 2 windows, 2 large vents	N	Treatment plant for Site 78	none	Y	Wells within 100 ft do not exceed site-specific screening level
1810	Near SWMU 360	250	25	20	1.5	Y	N	Corr. steel	3 single doors/ 7-8 double warehouse doors	N	NE 1/2 - 2nd Combat Eng Battalion dehumid storage facility/ SW 1/2 construction support	5 on the construction side	Y	Wells within 100 ft do not exceed site-specific screening level
1880	Site 78 South	150	100	75	1	Y	N	Cement slab, brick	4 bay doors, 2 single doors (cannot access back-secure area)	N	Convoy truck maint. Building	<50	Y	Wells within 100 ft do not exceed site-specific screening level
1883	Site 78 South	100	50	60	1	Y	N	Cement slab, steel warehouse	4 -10' sliding steel doors- fenced in areas	N	Maint. Warehouse	no continuous occ.	Y	Wells within 100 ft do not exceed site-specific screening level
1711A	Site 78 South	15	15	15	1	Y	N	Concrete slab and steel	2 doors, large front window, 1 side window	N	Office for 1711 jeep maint.	none	Y	Wells within 100 ft do not exceed site-specific screening level
976A	Site 78 North	10	10	10	1	Y	N	Concrete slab, steel building	1 door	N	Sovereign soil vapor system	none	Y	Not occupied
S1053	UST-1115	100	50	15	1	Y	N	Concrete slab and cinder block	6 open bays, 1 central storage area with 1 door	N	Manual carwash	None	Y	Open shelter
S1124		75	50	50	1	Y	N	Concrete slab, cinder block	open in front and back with fence	N	Storage area - wacker mobile lights	none	Y	Wells within 100 ft do not exceed site-specific screening level
S1135	USTHPFFC	NA	NA	NA	NA	NA	N	Steel	Open storage shelter with no sides	N	MCCS Recreational storage shelter	0	Y	Open shelter
S1136	Hadnot Point Fuel Farm	12	6	10	1	Y	N	cement slab, steel structure	Open structure - cover for fuel tank	N	Covers fuel tank	None	Y	Wells within 100 ft do not exceed site-specific screening level
S1715 (2 bldgs)	Site 78 South	NA	NA	NA	NA	NA	NA	Concrete and steel	1715 is comprised of 3 structures; the baseball field backstop, and the associated dugouts	N	Baseball field	0	Y	Open shelter
1728	Site 78 South	15	10	12	1	Y	N	Cinder block and mortar	1 single door/ 2 swing out hatches	N	Temporary field concession stand	0	Y	Wells within 100 ft do not exceed site-specific screening level
S1752	Site 78 South	100	50	80	1	Y	N	Steel warehouse	2 large bay doors,	N	Storage shed for transport vehicles	None	Y	Wells within 100 ft do not exceed site-specific screening level
S1753	Site 78 South	60	30	20	1.5	Y	N	Corr. steel	1 single door/ 1 double door/ 2 rollup doors/ 3 windows	N	2nd MARDIV motor transport storage	0	Y	Not occupied
S892	Near Site 78 North	NA	NA	NA	NA	Y	N	Wood	No sides - open shelter	N	Wood storage shelter	0	Y	Open shelter
S90	Site 78 South	20	30	18	1	Y	N	Cinder block and mortar	1 single door/ 1 roll up door	N	1/2 sports equipment storage/ 1/2 grounds equip	0	Y	Wells within 100 ft do not exceed site-specific screening level
S930	Near Site 78 North	NA	NA	NA	1	Y	N	Cinder block and mortar	2 metal doors	N	Enclosed storage shed	0	Y	Unoccupied
S926	Site 78 North	100	50	30	1	Y	N	Cinder block/mortar; steel top half	two large bay doors, no windows, single door in back	N	Haz mat storage and fuel truck parking, gov veh parking in lot	Not continuous	Y	Wells within 100 ft do not exceed site-specific screening level
S965	Near Site 78 North	NA	NA	NA	NA	Y	N	Steel and wood	No sides - open shelter	N	Wood and steel storage shelter	0	Y	Open shelter

Notes:
Includes only buildings within 100 feet of groundwater concentrations exceeding NCAC 2L or EPA VI guidance groundwater standards
Buildings to be carried through remainder of evaluation.

TABLE 3-11
Building Inventory List - Air Station
MCB Camp Lejeune

Building Number	Located near COPC plume or active remedial system?	Building Length (approximate)	Building Width (approximate)	Building Height (approximate)	Number of Stories	Slab on Grade? (Y/N)	Basement or Crawl Space?	Building Construction Materials	Number of Doors, Windows, Loading Docks	Residential? (Y/N)	Building Use	Occupancy (occupied/limited occupancy/unoccupied)	Excluded from Evaluation? (Y/N)	Reason for Exclusion
AS143	USTCSFF/SIte 86	35	20	15	1	Y	N	Concrete masonry	3 doors, 6 windows,	N	Gas station, base fuel office	< 5	N	
AS4106	SWMU 336	290	120	35	1	Y	N	Cinder block, steel on top	12 rollup doors (large doors for helicopter entrance), 10 single doors	N	Wolverine Hanger for Ospreys	varies < 100	N	
AS4151	JP-5 Area	70	70	45	1	Y	N	Cinder block, steel on top	4 single doors, 4 rollup doors, 2 windows	N	Steam plant	< 5	N	
AS502	Site 86	115	100	12–35	1	Y	N	Cement slab, cinder block	8 tall rollup doors,7 windows, 2 doors	N	Crash rescue building -- firetrucks	approx 15	N	
AS510	Site 86	150	180	70	1	Y	N	Concrete slab, brick	5 bays, 8 double doors,	N	Training facility	varies < 100	N	
AS515	Site 86	450	100	40	1	Y	N	Cinder block, steel on top	steel front, all panels slide open, 27 doors, 3 roll up doors, 2 long windows	N	Blacknight hangar	varies < 100	N	
AS541	SIte 86	270	50	40	1	Y	N	Concrete, 4'X4' cinder block	6 doors, 7 steel bay doors	N	Marine aviation logistic building	~ 10	N	
AS145	CF fuel farm	10	15	10	1	Y	N	Concrete slab, steel beams	Open structure, roof and 8 steel beams	N	Structure for fueling	none	Y	Open structure, no occupancy
AS146	CF fuel farm	10	15	10	1	Y	N	concrete, cinder block	1 door, 3 windows	N	Pump house (controls fuel for fuel farm)	none	Y	No occupancy
AS3905	USTAS4141	580	530	50	1	Y	N	Cinder block, steel on top	4 large openings for Osprey entrance, 33 doors, 18 windows	N	Iron horse/condor osprey hangar	varies < 100	Y	Wells within 100 ft do not exceed site-specific screening level
AS410	USTAS410	55	40	15	1	Y	N	Concrete masonry	5 door, 6 windows	N	gas station	< 5	Y	Wells within 100 ft do not exceed site-specific screening level
AS4114	SWMU 336	30	20	12	1	Y	N	concrete slab, cinder block	3 doors	N	Storage	none	Y	No occupancy
AS4165													Y	Wells within 100 ft do not exceed site-specific screening level
AS424	Site 86	165	180	30	1	Y	N	Cinder block	5 roll up doors, 2 bay doors, loading ramp, 4 single doors, loading dock	N	Ground supply for flightline	< 80	Y	Shallow wells within 100 ft do not exceed site-specific screening level
AS498	Rapid Refueler	35	20	15	1	Y	N	concrete slab, cinder block	3 doors, 13 windows	N	Control building, center of flightline	none	Y	No occupancy
AS511	Rapid Refueler	10	10	12	1	Y	N	concrete slab, cinder block	1 window, 1 door	N	bathroom and electronics for rapid refueler	none	Y	No occupancy
AS512		15	15	12	1	Y	N	Cinder block	1 door - located in middle of flightline	N	Storage building for flightline	0	Y	No occupancy
AS520		25	15	10	1	Y	N	Concrete masonry	1 door	N	storage - located in center of flightline area	none	Y	No occupancy
AS522		10	70	10	1	Y	N	concrete masonry	1 door	N	electrical room (has transformer attached)	none	Y	No occupancy
AS566	Site 86	12	32	15	1	Y	N	Concrete masonry	1 door, 2 windows	N	Storage -- use to store waste	none	Y	No occupancy
AS568	Site 86	55	25	20	1	Y	N	Cement slab, Steel	8 windows, 2 roll up doors, 2 doors	N	Storage	none	Y	No occupancy
AS831	AS843	45	45	15	1	Y	N	Cement slab,steel structure	1 door, 6 windows	N	Old flightline classroom (flooded, no longer and use)	none	Y	No occupancy
AS841	AS843	15	21	15	1	Y	N	Cement slab, brick	1/2 door	N	Utility room	none	Y	No occupancy
AS843	AS843	65	50	20	1	Y	N	cement slab, brick	8 doors, 42 windows,	N	Flightline operations	~ 25	Y	Wells within 100 ft do not exceed site-specific screening level
NEW8069		10	5	10	1	Y	N	steel building	1 door	N	Soil vapor extraction building -- not labeled	none	Y	No occupancy
SAS139		5	2	8	n/a	N	N	steel	n/a	N	Generator for fuel control	none	Y	No occupancy
SAS4182	SWMU 336	5	5	8	1	Y	N	cement slab, steel	1 front door	N	Small material storage shed	none	Y	No occupancy
SAS500	Site 86	Does not exist -- new construction in area.											Y	Demolished
UNK169	Rapid Refueler	10	10	10	1	Y	N	cinder block	1 door	N	Utility room/control building?	none	Y	No occupancy
AS4141	USTAS4141	80	50	20	1	Y	N	Concrete slab and brick	5 steel bays, 5 doors, 10 windows, 1 loading dock	N	MALs-26 IMRL - office building for hazardous material storage	<10	Y	Wells within 100 ft do not exceed site-specific screening level

Notes:
Includes only buildings within 100 feet of groundwater concentrations exceeding NCAC 2L or EPA VI guidance groundwater standard
Buildings to be carried through remainder of evaluation.

TABLE 3-12
Building Inventory List - Courthouse Bay
MCB Camp Lejuene,North Carolina

Building Number	Located near COPC plume or active remedial system?	Building Length (approximate)	Building Width (approximate)	Building Height (approximate)	Number of Stories	Slab on Grade? (Y/N)	Basement or Crawl Space?	Building Construction Materials	Number of Doors, Windows, Loading Docks	Residential? (Y/N)	Building Use	Occupancy (occupied/limited occupancy/unoccupied)	Excluded from Evaluation? (Y/N)	Reason for Exclusion
A47	Site 73	400	200	50	2	Y	N	Cement slab, cinder block	Approx. 28 bay doors, 10 single doors, 12 long windows	N	Amphibious vehicle Maint. Area	~ 50 - 300	N	
BB190	UST BB190	100	50	22	1	Y	N	Cement slab and brick	5 windows, two doors, steel bay door	N	Water Treatment plant	<5	Y	Wells within 100 ft do not exceed site-specific screening level
BB329		250	100	30	2	Y	N	Cement slab and brick	7 windows, 7 doors, 4 bay doors, 5 vents on top story	N	Maint. And supply building (corner of Poe Rd and DA Munro)	20 - 75	Y	Wells within 100 ft do not exceed site-specific screening level
A2	Site 73	200	100	50	2	Y	N	Cement Slab, masonry	38 sets of 3 windows, 2 single windows, 3 bay doors, 3 single doors	N	Vehicle Maintenance	< 30	Y	Wells within 100 ft do not exceed site-specific screening level
SA52	Site 73	25	20	20	1	Y	N	Cement slab, cinder block	2 bays open on each side, oil water separator under each cement slab	N	Amphibious vehicle wash station	none	Y	No Occupancy
SA56	Site 73	25	20	20	1	Y	N	Cement slab, cinder block	2 bays open on each side, oil water separator under each cement slab	N	Amphibious vehicle wash station	none	Y	No Occupancy
SA57	Site 73	5	5	10	1	Y	N	Concrete slab, steel structure	1 door	N	Storage shed?	none	Y	No Occupancy

Notes:
Includes only buildings within 100 feet of groundwater concentrations exceeding NCAC 2L or EPA VI guidance groundwater standards
Buildings to be carried through remainder of evaluation.

TABLE 3-13
Building Inventory List - Camp Geiger
MCB Camp Lejeune, North Carolina

Building Number	Located near COPC plume or active remedial system?	Building Length (approximate)	Building Width (approximate)	Building Height (approximate)	Number of Stories	Slab on Grade? (Y/N)	Basement or Crawl Space?	Building Construction Materials	Number of Doors, Windows, Loading Docks	Residential? (Y/N)	Building Use	Occupancy (occupied/limited occupancy/unoccupied)	Excluded from Evaluation? (Y/N)	Reason for Exclusion
G480	Site 35	200	75	50	1	Y	N	Concrete slab, brick	13 windows, 11 doors	N	Restricted area, some type of storage	~ 50	N	
G521	Site 35	150	75	80	3	Y	N	Concrete slab, brick	66 windows, 9 doors and stairs on each side	N	School of Infantry Barracks	100+	N	
G530	Site 35	40	40-70	40	2	Y	N	Concrete slab, brick	20' continuous windows on each side, 2 doors, bottom of buildings have vents	N	School of Infantry Barracks	100+	N	
G531	Site 35	150	75	80	3	Y	N	Concrete slab, brick	66 windows, 9 doors and stairs on each side	N	School of Infantry Barracks	100+	N	
G532	Site 35	150	75	80	3	Y	N	Concrete slab, brick	66 windows, 9 doors and stairs on each side	N	School of Infantry Barracks	100+	N	
G533	Site 35	150	75	80	3	Y	N	Concrete slab, brick	66 windows, 9 doors and stairs on each side	N	School of Infantry Barracks	100+	N	
G930	Site 93 (?)	200	200	80	2	Y	N	Concrete slab, brick	4 doors, 32 windows	N	Gymnasium	varies,	N	
TC860	Site 35/Site 89	200	100	50	1	Y	N	Concrete slab, steel warehouse	8 doors, 8 windows, additional bldg. attached 50 X 20 X 50	N	Student check in and office admin.	20 - 80	N	
TC864	Site 89	150	50	40	1	Y	N	Concrete slab, steel warehouse	11 windows, 3 double doors, 1 single door, 4 bay doors	N	Student gear staging area	0 - 40	N	
G520	Site 35	40	40-70	40	2	Y	N	Concrete slab, brick	20' continuous windows on each side, 2 doors, bottom of buildings have vents	N	Meeting space for students in barracks		Y	Wells within 100 ft do not exceed site-specific screening level
SG649		10	10	10	1	Y	N	Concrete slab, brick	1 door	N	Fuel farm pump house	none	Y	No occupancy, Open Structure
SG866	Site 89/Site 93	150	50	40	1	Y	N	concrete, steel	Open area, roof with 10 support beams	N	New student gathering	occasional (20)	Y	Open structure
STC867	Site 89	50	50	70	1	Y	N	Concrete slab, steel structure	Open area, roof with 8 support beams, has oil/ water separator	N	Old DRMO drum handling area	none	Y	No occupancy, Open Structure
STC872	Site 89	50	25	20	1	Y	N	Concrete slab, steel structure	Open area (fencing around bldg.)	N	old DRMO drum storage area	none	Y	No occupancy, Open Structure
TC1060	Site 93	150	75	20	1	Y	N	Concrete, cinder block	18 doors, 20 windows	N	Barracks		Y	Wells within 100 ft do not exceed site-specific screening level
TC1062	Site 93	150	75	50	1	Y	N	Concrete, cinder block	18 doors, 20 windows	N	Barracks		Y	Wells within 100 ft do not exceed site-specific screening level
TC341	Site 35	Building has been torn down. Concrete pad left over 100 x 50 x 2											Y	Demolished
TC342	Site 35	Building has been torn down. Concrete pad left over 100 x 50 x 2											Y	Demolished
TC365		5	5	10	1	Y	N	cement slab, steel building	No windows or doors	N	Building at pump station, fuel pump control, electrical bldg?	none	Y	No occupancy
TC366	Site 35	40	25	30	1	Y	N	concrete slab	open building - steel roof, cover for 4 gas pumps	N	Gas station	none	Y	Open structure
TC470	Site 35	200	50	50	1	Y	N	Concrete slab, steel warehouse	6 windows, 2 boarded doors, 2 single doors, 3 bay slide doors	N	Storage warehouse	none	Y	No occupancy
TC562	Site 35	100	50	40	1	Y	N	Concrete slab, steel warehouse	Loading dock in front, 5 double doors, no windows	N	Storage warehouse	none	Y	No occupancy
TC572	Site 35	200	50	50	1	Y	N	Concrete slab, steel warehouse	2 large double doors	N	SNCO supply warehouse	none	Y	No occupancy
TC761	Site 35/Site 89	200	100	50	1	Y	N	Concrete (3'), Steel	9 double doors with windows, 6 windows, 1 ramp	N	Supply warehouse	none	Y	No occupancy
TC762	Site 35/Site 89	200	100	50	1	Y	N	Concrete (3'), Steel	16 windows, 9 double doors, 1 single, 1 loading dock	N	Student supply warehouse	none	Y	No occupancy
TC861	Site 89	150	50	50	1	Y	N	Concrete slab, steel warehouse	8 sliding bay doors, 17 windows, 1 large bay door	N	Empty DRMO warehouse	none	Y	No occupancy
TC875	Site 35/Site 89	50	50	25	1	Y	N	concrete, steel	3 windows, 1 door	N	Old post office - empty	none	Y	No occupancy
TC942	Site 93	100	75	50	1	Y	N	Concrete slab, steel	6 double doors, 1 single door, 2 windows	N	School of Infantry supply warehouse	none	Y	No occupancy
TC952	Site 89	200	50	50	1	Y	N	concrete slab, steel warehouse	9 large bay doors, 1 single doors	N	Empty warehouse -- used by contractors	none	Y	No occupancy
G522	Site 35	150	75	80	3	Y	N	Concrete slab, brick	66 windows, 9 doors and stairs on each side	N	School of Infantry Barracks	100+		Wells within 100 ft do not exceed site-specific screening level
G523	Site 35	150	75	80	3	Y	N	Concrete slab, brick	66 windows, 9 doors and stairs on each side	N	School of Infantry Barracks	100+		Wells within 100 ft do not exceed site-specific screening level
G550	Site 35	40	40-70	40	3	Y	N	Concrete slab, brick	20' continuous windows on each side, 2 doors, bottom of buildings have vents	N	School of Infantry Barracks	100+		Wells within 100 ft do not exceed site-specific screening level
G551	Site 35	150	75	80	3	Y	N	Concrete slab, brick	66 windows, 9 doors and stairs on each side	N	School of Infantry Barracks	100+		Wells within 100 ft do not exceed site-specific screening level
G554	Site 35	150	75	80	3	Y	N	Concrete slab, brick	66 windows, 9 doors and stairs on each side	N	School of Infantry Barracks	100+		Wells within 100 ft do not exceed site-specific screening level

Notes:
Includes only buildings within 100 feet of groundwater concentrations exceeding NCAC 2L or EPA VI guidance groundwater standards
Buildings to be carried through remainder of evaluation.

TABLE 3-14
Building Inventory List - Tarawa Terrace
MCB Camp Lejuene, North Carolina

Building Number	Located near COPC plume or active remedial system?	Building Length (approximate)	Building Width (approximate)	Building Height (approximate)	Number of Stories	Slab on Grade? (Y/N)	Basement or Crawl Space?	Building Construction Materials	Number of Doors, Windows, Loading Docks	Residential? (Y/N)	Building Use	Occupancy (occupied/limited occupancy/ unoccupied)	Excluded from Evaluation? (Y/N)	Reason for Exclusion
STT2466	UST TT2453	5	5	10	1	Y	N	Wood	open area, small roof, table with bench	Y	Observation area for Tennis court	none	Y	Open Shelter
STT2464	UST TT2453	5	5	10	1	Y	N	Wood	open area, small roof, table with bench	Y	Observation area for Tennis court	none	Y	Open Shelter

Notes:
Includes only buildings within 100 feet of groundwater concentrations exceeding NCAC 2L or EPA VI guidance groundwater standards
Buildings to be carried through remainder of evaluation.

TABLE 3-15
Groundwater to Indoor Air Parameters Used in the Johnson and Ettinger Model
Large Buildings - Mainside
MCB Camp Lejeune, North Carolina

Symbol	Parameter	Description	Selected Value	Units	Sources
T_S	Average Soil/Groundwater Temperature		22.6	°C	Site-specific average from October 2004 sampling events at Site 88.
L_F	Depth Below Grade to Bottom of Enclosed Space Floor	This is the depth from soil surface to the bottom of the floor in contact with soil	15	cm	Majority of buildings are slab-on-grade construction. Represents 6 inch thick concrete slab.
L_{WT}	Depth Below Grade to Water Table		152	cm	Based on average depth to groundwater (5 ft) in Mainside.
h_A	Thickness of Soil Stratum A		152	cm	Soil stratum is modeled as a single soil type.
h_B	Thickness of Soil Stratum B		NA	cm	Not Used
h_C	Thickness of Soil Stratum C		NA	cm	Not Used
	Soil Stratum Directly Above Water Table		A	unitless	Consistent with the deepest stratum with a specified thickness (h_A).
	SCS Soil Type Above Water Table		S	unitless	Based on site borings, sand is predominant soil type in Hadnot Point.
	Soil Stratum A SCS Soil Type	Used to estimate soil vapor permeability	S	unitless	Soils modeled using most prominent soil type present.
k_v	User-defined Soil Vapor Permeability	A parameter associated with convective transport of vapors within the zone of influence of a building. It is related to the size and shape of connected soil pores	NA	cm^2	Not Used
ρ_b^A	Stratum A Soil Dry Bulk Density		1.66	g/cm^3	model calculated based on soil type
n^A	Stratum A Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	0.375	unitless	model calculated based on soil type
θ_w^A	Stratum A Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	0.054	cm^3/cm^3	model calculated based on soil type
ρ_b^B	Stratum B Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^B	Stratum B Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^B	Stratum B Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
ρ_b^C	Stratum C Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^C	Stratum C Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^C	Stratum C Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
L_{crack}	Enclosed Space Floor Thickness		15	cm	Represents a 6-inch thick concrete slab. (Corresponds to L_F)
Δ_P	Soil-Building Pressure Differential		NA	$g/cm\text{-}s^2$	Not Used - Qsoil calculated directly from building parameters.
L_B	Enclosed Space Floor Length		6096	cm	Average length (200 feet) of large buildings (i.e., length >100') within 100' of plume(s); range: 150-300 ft
W_B	Enclosed Space Floor Width		1372	cm	Average width (45 feet) of large buildings within 100' of plume(s); range 30-80 ft
H_B	Enclosed Space Height		914	cm	Average height (30 feet) of large buildings within 100' of plume(s); range: 18-45 ft
w	Floor-Wall Seam Crack Width	Represents a gap assumed to exist at the junction between the floor and the foundation perimeter. This gap is due to building design or concrete shrinkage. It represents the only route for soil gas intrusion into a building	NA	cm	Not Used - Qsoil calculated directly from building parameters.
ER	Indoor air exchange rate	Building ventilation rate, expressed in units of air changes per hour (ACH)	0.28	(1/h)	Calculated - ANSI/ASHRAE Standard 62-2001 (see Table 1 Supplement A)
Qsoil	Average vapor flow rate into building		18.67	(L/m)	Calculated - NJDEP, 2007 (see Table 1 Supplement B)
AT_C	Averaging Time for Carcinogens		70	yrs	default
AT_{NC}	Averaging Time for Noncarcinogens		25	yrs	EPA, 1991
ED	Exposure Duration		25	yrs	EPA, 1991
EF	Exposure Frequency		250	days/yr	EPA, 1991
TR	Target Risk for Carcinogens	Used to calculate risk-based groundwater concentration	1×10^{-6}	unitless	
THQ	Target Hazard Quotient for Noncarcinogens	Used to calculate risk-based groundwater concentration	1	days/yr	

ASHRAE. 2001. Standard 62-2001, Ventilation for Acceptable Indoor Air Quality
USEPA, 1991. U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B, Development of Risk-based Preliminary
USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings. Office of Emergency and Remedial Response. February 2004.
NA = not applicable

TABLE 3-15 Supplement A
Site-Specific Air Exchange Rate
Calculations of Building Air Exchange Rate Per Hour
Large Buildings - Mainside
MCB Camp Lejeune, North Carolina

Calculation of Air Changes Per Hour Indoors

$$ACH = \frac{Qbuilding}{V} = \frac{m^3/hr}{m^3} = 1/hr$$

Calculation of $Q_{building}$ (volumetric flow into indoor space)

Assumption	Value	Units	Source
Assumed volumetric airflow per person	20	ft^3/min per person	ASHRAE, 2001, Table 2, minimum outside air requirement for an office
Number of persons per floorspace	7	persons/ 1,000 ft^2	ASHRAE, 2001, Table 2
Building floorspace (do not input value here)	9,000	ft^2	200 ft x 45 ft (Average size of large buildings within 100' of plume.)
Calculated volumetric flow into indoor space	1,260	ft^3/min	Includes division by 1000 to account for persons per 1000 ft^2
	2,139	m^3/hr	Includes conversion of 0.0283 ft^3/m^3

Calculation of V (volume of indoor space)

Assumption	Value	Units	Source
Building floorspace (input value here)	9,000	ft^2	200 ft x 45 ft (Average size of large buildings within 100' of plume.)
Ceiling height	30	ft	Average height of buildings within 100' of plume.
Volume	270,000	ft^3	
	7,641	m^3	Includes conversion of 0.0283 ft^3/m^3

Calculation of ACH

$Q_{building}$	2,139	m^3/hr
Volume	7,641	m^3
ACH = Q/V	**0.28**	**1/hr**

Source:
ASHRAE. 2001. ANSI/ASHRAE Standard 62-2001, Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating and Air-Conditioning Engineers.

TABLE 3-15 Supplement B

Calculation of Soil Vapor Entry Rate for Johnson and Ettinger Modeling

Large Buildings - Mainside

MCB Camp Lejeune, North Carolina

$$Qsoil\ (L/\min) = 5\ L/\min \times \frac{Perimeter\ (cm)}{4{,}000\ cm}$$

Length (cm) =	6,096
Width (cm) =	1,372
Perimeter (cm) = 2L + 2W	14,936
Qsoil (L/min) =	18.67

This presents a method for calculating the soil vapor entry rate (Qsoil) into a building for purposes of performing vapor intrusion modeling using the Johnson and Ettinger model.

It scales up the default residential soil gas entry rate described in EPA's draft vapor intrusion guidance document (USEPA, 2002) to any other building footprint. This procedure and the accompanying rationale is discussed in detail in the NJDEP vapor intrusion guidance document (NJDEP, 2007). It is based on the following assumptions:

1. The residential default Qsoil value is 5 L/min.
2. The Qsoil value is proportional to the building perimeter.
3. The building is rectangular

TABLE 3-16

Groundwater to Indoor Air Parameters Used in the Johnson and Ettinger Model

Small Buildings - Mainside

MCB Camp Lejeune, North Carolina

Symbol	Parameter	Description	Selected Value	Units	Sources
T_S	Average Soil/Groundwater Temperature		22.6	°C	Site-specific average from October 2004 sampling events at Site 88.
L_F	Depth Below Grade to Bottom of Enclosed Space Floor	This is the depth from soil surface to the bottom of the floor in contact with soil	15	cm	Majority of buildings are slab-on-grade construction. Represents 6 inch thick concrete slab.
L_{WT}	Depth Below Grade to Water Table		152	cm	Based on average depth to groundwater (5 ft) in Mainside.
h_A	Thickness of Soil Stratum A		152	cm	Soil stratum is modeled as a single soil type.
h_B	Thickness of Soil Stratum B		NA	cm	Not Used
h_C	Thickness of Soil Stratum C		NA	cm	Not Used
	Soil Stratum Directly Above Water Table		A	unitless	Consistent with the deepest stratum with a specified thickness (h_A).
	SCS Soil Type Above Water Table		S	unitless	Based on site borings, sand is predominant soil type in Hadnot Point.
	Soil Stratum A SCS Soil Type	Used to estimate soil vapor permeability	S	unitless	Soils modeled using most predominant soil type present.
k_v	User-defined Soil Vapor Permeability	A parameter associated with convective transport of vapors within the zone of influence of a building. It is related to the size and shape of connected soil pores	NA	cm^2	Not Used
ρ_b^A	Stratum A Soil Dry Bulk Density		1.66	g/cm^3	model calculated based on soil type
n^A	Stratum A Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	0.375	unitless	model calculated based on soil type
θ_w^A	Stratum A Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	0.054	cm^3/cm^3	model calculated based on soil type
ρ_b^B	Stratum B Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^B	Stratum B Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^B	Stratum B Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
ρ_b^C	Stratum C Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^C	Stratum C Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^C	Stratum C Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
L_{crack}	Enclosed Space Floor Thickness		15	cm	Represents a 6-inch thick concrete slab. (Corresponds to L_F)
Δ_P	Soil-Building Pressure Differential		NA	$g/cm\text{-}s^2$	Default
L_B	Enclosed Space Floor Length		1280	cm	Average length (42 feet) of small buildings (i.e., length <100') within 100' of plume(s); range 10 - 75 ft.
W_B	Enclosed Space Floor Width		488	cm	Average width (16 feet) of small buildings within 100' of plume(s); range 10 - 25 ft.
H_B	Enclosed Space Height		488	cm	Average height (16 feet) of small buildings within 100' of plume(s); range 12 - 20 ft.
w	Floor-Wall Seam Crack Width	Represents a gap assumed to exist at the junction between the floor and the foundation perimeter. This gap is due to building design or concrete shrinkage. It represents the only route for soil gas intrusion into a building	NA	cm	Default
ER	Indoor air exchange rate	Building ventilation rate, expressed in units of air changes per hour (ACH)	0.53	(1/h)	Calculated - ANSI/ASHRAE Standard 62-2001 (see Table 2 Supplement A)
Qsoil	Average vapor flow rate into building		4.42	(L/m)	Calculated - NJDEP, 2007 (see Table 2 Supplement B)
AT_C	Averaging Time for Carcinogens		70	yrs	default
AT_{NC}	Averaging Time for Noncarcinogens		25	yrs	EPA, 1991
ED	Exposure Duration		25	yrs	EPA, 1991
EF	Exposure Frequency		250	days/yr	EPA, 1991
TR	Target Risk for Carcinogens	Used to calculate risk-based groundwater concentration	1×10^{-6}	unitless	
THQ	Target Hazard Quotient for Noncarcinogens	Used to calculate risk-based groundwater concentration	1	days/yr	

ASHRAE. 2001. Standard 62-2001, Ventilation for Acceptable Indoor Air Quality

USEPA, 1991. U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B, Development of Risk-based Preliminary

USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings. Office of Emergency and Remedial Response. February 2004.

NA = not applicable

TABLE 3-16 Supplement A

Site-Specific Air Exchange Rate

Calculations of Building Air Exchange Rate Per Hour

Small Buildlings - Mainside

MCB Camp Lejeune, North Carolina

Calculation of Air Changes Per Hour Indoors

$$ACH = \frac{Qbuilding}{V} = \frac{m^3/hr}{m^3} = 1/hr$$

Calculation of $Q_{building}$ (volumetric flow into indoor space)

Assumption	Value	Units	Source
Assumed volumetric airflow per person	20	ft^3/min per person	ASHRAE, 2001, Table 2, minimum outside air requirement for an office
Number of persons per floorspace	7	persons/ 1,000 ft^2	ASHRAE, 2001, Table 2
Building floorspace (do not input value here)	672	ft^2	42 ft x 16 ft (Average size of small buildings within 100' of plume.)
Calculated volumetric flow into indoor space	94	ft^3/min	Includes division by 1000 to account for persons per 1000 ft^2
	160	m^3/hr	Includes conversion of 0.0283 ft^3/m^3

Calculation of V (volume of indoor space)

Assumption	Value	Units	Source
Building floorspace (input value here)	672	ft^2	42 ft x 16 ft (Average size of small buildings within 100' of plume.)
Ceiling height	16	ft	Average height of buildings within 100' of plume.
Volume	10,752	ft^3	
	304	m^3	Includes conversion of 0.0283 ft^3/m^3

Calculation of ACH

$Q_{building}$	160	m^3/hr
Volume	304	m^3
ACH = Q/V	**0.53**	**1/hr**

Source:

ASHRAE. 2001. ANSI/ASHRAE Standard 62-2001, Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating and Air-Conditioning Engineers.

TABLE 3-16 Supplement B

Calculation of Soil Vapor Entry Rate for Johnson and Ettinger Modeling

Small Buildings - Mainside

MCB Camp Lejeune, North Carolina

$$Qsoil\ (L/\min) = 5\ L/\min \times \frac{Perimeter\ (cm)}{4{,}000\ cm}$$

Length (cm) =	1,280
Width (cm) =	488
Perimeter (cm) = 2L + 2W	3,536
Qsoil (L/min) =	4.42

This presents a method for calculating the soil vapor entry rate (Qsoil) into a building for purposes of performing vapor intrusion modeling using the Johnson and Ettinger model.

It scales up the default residential soil gas entry rate described in EPA's draft vapor intrusion guidance document (USEPA, 2002) to any other building footprint. This procedure and the accompanying rationale is discussed in detail in the NJDEP vapor intrusion guidance document (NJDEP, 2007). It is based on the following assumptions:

1. The residential default Qsoil value is 5 L/min.
2. The Qsoil value is proportional to the building perimeter.
3. The building is rectangular

TABLE 3-17
Groundwater to Indoor Air Parameters Used in the Johnson and Ettinger Model
Residential - Mainside
MCB Camp Lejeune, North Carolina

Symbol	Parameter	Description	Selected Value	Units	Sources
T_S	Average Soil/Groundwater Temperature		22.6	°C	Site-specific average from October 2004 sampling events at Site 88.
L_F	Depth Below Grade to Bottom of Enclosed Space Floor	This is the depth from soil surface to the bottom of the floor in contact with soil	15	cm	Majority of buildings are slab-on-grade construction. Represents 6 inch thick concrete slab.
L_{WT}	Depth Below Grade to Water Table		152	cm	Based on average depth to groundwater (5 ft) in Mainside.
h_A	Thickness of Soil Stratum A		152	cm	Soil stratum is modeled as a single soil type.
h_B	Thickness of Soil Stratum B		NA	cm	Not Used
h_C	Thickness of Soil Stratum C		NA	cm	Not Used
	Soil Stratum Directly Above Water Table		A	unitless	Consistent with the deepest stratum with a specified thickness (h_A).
	SCS Soil Type Above Water Table		S	unitless	Based on site borings, sand is predominant soil type in Hadnot Point.
	Soil Stratum A SCS Soil Type	Used to estimate soil vapor permeability	S	unitless	Soils modeled using most predominant soil type present.
k_v	User-defined Soil Vapor Permeability	A parameter associated with convective transport of vapors within the zone of influence of a building. It is related to the size and shape of connected soil pores	NA	cm^2	Not Used
ρ_b^A	Stratum A Soil Dry Bulk Density		1.66	g/cm^3	model calculated based on soil type
n^A	Stratum A Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	0.375	unitless	model calculated based on soil type
θ_w^A	Stratum A Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	0.054	cm^3/cm^3	model calculated based on soil type
ρ_b^B	Stratum B Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^B	Stratum B Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^B	Stratum B Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
ρ_b^C	Stratum C Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^C	Stratum C Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^C	Stratum C Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
L_{crack}	Enclosed Space Floor Thickness		15	cm	Represents a 6-inch thick concrete slab. (Corresponds to L_F)
Δ_P	Soil-Building Pressure Differential		NA	$g/cm\text{-}s^2$	Default
L_B	Enclosed Space Floor Length		1000	cm	Default, users guide (USEPA, 2004)
W_B	Enclosed Space Floor Width		1000	cm	Default, users guide (USEPA, 2004)
H_B	Enclosed Space Height		244	cm	Default, users guide (USEPA, 2004)
w	Floor-Wall Seam Crack Width	Represents a gap assumed to exist at the junction between the floor and the foundation perimeter. This gap is due to building design or concrete shrinkage. It represents the only route for soil gas intrusion into a building	NA	cm	Default, users guide (USEPA, 2004)
ER	Indoor air exchange rate	Building ventilation rate, expressed in units of air changes per hour (ACH)	0.25	(1/h)	Default, users guide (USEPA, 2004)
Qsoil	Average vapor flow rate into building		5.0	(L/m)	Default, users guide (USEPA, 2004)
AT_C	Averaging Time for Carcinogens		70	yrs	default
AT_{NC}	Averaging Time for Noncarcinogens		30	yrs	EPA, 1989
ED	Exposure Duration		30	yrs	EPA, 1991
EF	Exposure Frequency		350	days/yr	EPA, 1991
TR	Target Risk for Carcinogens	Used to calculate risk-based groundwater concentration	1×10^{-6}	unitless	
THQ	Target Hazard Quotient for Noncarcinogens	Used to calculate risk-based groundwater concentration	1	days/yr	

ASHRAE. 2001. Standard 62-2001, Ventilation for Acceptable Indoor Air Quality
USEPA, 1991. U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B, Development of Risk-based Preliminary
USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings. Office of Emergency and Remedial Response. February 2004.
NA = not applicable

TABLE 3-18

Groundwater to Indoor Air Parameters Used in the Johnson and Ettinger Model

Large Buildings - Hadnot Point

MCB Camp Lejeune, North Carolina

Symbol	Parameter	Description	Selected Value	Units	Sources
T_S	Average Soil/Groundwater Temperature		23	°C	Site-specific average from October 2004 sampling events at Site 78 and Hadnot Point Fuel Farm
L_F	Depth Below Grade to Bottom of Enclosed Space Floor	This is the depth from soil surface to the bottom of the floor in contact with soil	15	cm	Majority of buildings are slab-on-grade construction. Represents 6 inch thick concrete slab.
L_{WT}	Depth Below Grade to Water Table		274	cm	Based on average depth to groundwater (9 ft) in Hadnot Point.
h_A	Thickness of Soil Stratum A		274	cm	Soil stratum is modeled as a single soil type.
h_B	Thickness of Soil Stratum B		NA	cm	Not Used
h_C	Thickness of Soil Stratum C		NA	cm	Not Used
	Soil Stratum Directly Above Water Table		A	unitless	Consistent with the deepest stratum with a specified thickness (h_A).
	SCS Soil Type Above Water Table		S	unitless	Based on site borings, sand is predominant soil type in Hadnot Point.
	Soil Stratum A SCS Soil Type	Used to estimate soil vapor permeability	S	unitless	Soils modeled using most predominant soil type present.
k_v	User-defined Soil Vapor Permeability	A parameter associated with convective transport of vapors within the zone of influence of a building. It is related to the size and shape of connected soil pores	NA	cm^2	Not Used
ρ_b^A	Stratum A Soil Dry Bulk Density		1.66	g/cm^3	model calculated based on soil type
n^A	Stratum A Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	0.375	unitless	model calculated based on soil type
θ_w^A	Stratum A Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	0.054	cm^3/cm^3	model calculated based on soil type
ρ_b^B	Stratum B Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^B	Stratum B Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^B	Stratum B Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
ρ_b^C	Stratum C Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^C	Stratum C Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^C	Stratum C Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
L_{crack}	Enclosed Space Floor Thickness		15	cm	Represents a 6-inch thick concrete slab. (Corresponds to L_F)
Δ_P	Soil-Building Pressure Differential		NA	$g/cm\text{-}s^2$	Not Used - Qsoil calculated directly from building parameters.
L_B	Enclosed Space Floor Length		8504	cm	Average length (279 feet) of large buildings (i.e., length >100') within 100' of plume(s); range 100-350 ft
W_B	Enclosed Space Floor Width		2073	cm	Average width (68 feet) of large buildings within 100' of plume(s); range 25-100 ft
H_B	Enclosed Space Height		762	cm	Average height (25 feet) of large buildings within 100' of plume(s); range 18-50 ft
w	Floor-Wall Seam Crack Width	Represents a gap assumed to exist at the junction between the floor and the foundation perimeter. This gap is due to building design or concrete shrinkage. It represents the only route for soil gas intrusion into a building	NA	cm	Not Used - Qsoil calculated directly from building parameters.
ER	Indoor air exchange rate	Building ventilation rate, expressed in units of air changes per hour (ACH)	0.34	(1/h)	Calculated - ANSI/ASHRAE Standard 62-2001 (see Table 1 Supplement A)
Qsoil	Average vapor flow rate into building		26.4	(L/m)	Calculated - NJDEP, 2007 (see Table 1 Supplement B)
AT_C	Averaging Time for Carcinogens		70	yrs	default
AT_{NC}	Averaging Time for Noncarcinogens		25	yrs	EPA, 1991
ED	Exposure Duration		25	yrs	EPA, 1991
EF	Exposure Frequency		250	days/yr	EPA, 1991
TR	Target Risk for Carcinogens	Used to calculate risk-based groundwater concentration	1×10^{-6}	unitless	
THQ	Target Hazard Quotient for Noncarcinogens	Used to calculate risk-based groundwater concentration	1	days/yr	

ASHRAE. 2001. Standard 62-2001, Ventilation for Acceptable Indoor Air Quality

USEPA, 1991. U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B, Development of Risk-based Preliminary

USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings. Office of Emergency and Remedial Response. February 2004.

NA = not applicable

TABLE 3-18 Supplement A

Site-Specific Air Exchange Rate

Calculations of Building Air Exchange Rate Per Hour

Large Buildings - Hadnot Point

MCB Camp Lejeune, North Carolina

Calculation of Air Changes Per Hour Indoors

$$ACH = \frac{Qbuilding}{V} = \frac{m^3/hr}{m^3} = 1/hr$$

Calculation of $Q_{building}$ (volumetric flow into indoor space)

Assumption	Value	Units	Source
Assumed volumetric airflow per person	20	ft^3/min per person	ASHRAE, 2001, Table 2, minimum outside air requirement for an office
Number of persons per floorspace	7	persons/ 1,000 ft^2	ASHRAE, 2001, Table 2
Building floorspace (do not input value here)	18,972	ft^2	279 ft x 68 ft (Average size of large buildings within 100' of plume.)
Calculated volumetric flow into indoor space	2,656	ft^3/min	Includes division by 1000 to account for persons per 1000 ft^2
	4,510	m^3/hr	Includes conversion of 0.0283 ft^3/m^3

Calculation of V (volume of indoor space)

Assumption	Value	Units	Source
Building floorspace (input value here)	18,972	ft^2	279 ft x 68 ft (Average size of large buildings within 100' of plume.)
Ceiling height	25	ft	Average height of buildings within 100' of plume.
Volume	474,300	ft^3	
	13,423	m^3	Includes conversion of 0.0283 ft^3/m^3

Calculation of ACH

$Q_{building}$	4,510	m^3/hr
Volume	13,423	m^3
ACH = Q/V	**0.34**	**1/hr**

Source:

ASHRAE. 2001. ANSI/ASHRAE Standard 62-2001, Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating and Air-Conditioning Engineers.

TABLE 3-18 Supplement B
Calculation of Soil Vapor Entry Rate for Johnson and Ettinger Modeling
Large Buildings - Hadnot Point
MCB Camp Lejeune, North Carolina

$$Qsoil\ (L/\min) = 5\ L/\min \times Perimeter\ (cm) \Big/ 4{,}000\ cm$$

Length (cm) =	8,504
Width (cm) =	2,073
Perimeter (cm) = 2L + 2W	21,154
Qsoil (L/min) =	26.4425

This presents a method for calculating the soil vapor entry rate (Qsoil) into a building for purposes of performing vapor intrusion modeling using the Johnson and Ettinger model.

It scales up the default residential soil gas entry rate described in EPA's draft vapor intrusion guidance document (USEPA, 2002) to any other building footprint. This procedure and the accompanying rationale is discussed in detail in the NJDEP vapor intrusion guidance document (NJDEP, 2007). It is based on the following assumptions:

1. The residential default Qsoil value is 5 L/min.
2. The Qsoil value is proportional to the building perimeter.
3. The building is rectangular

TABLE 3-19

Groundwater to Indoor Air Parameters Used in the Johnson and Ettinger Model

Small Buildings - Hadnot Point

MCB Camp Lejeune, North Carolina

Symbol	Parameter	Description	Selected Value	Units	Sources
T_S	Average Soil/Groundwater Temperature		23	°C	Site-specific average from October 2004 sampling events at Site 78 and Hadnot Point Fuel Farm
L_F	Depth Below Grade to Bottom of Enclosed Space Floor	This is the depth from soil surface to the bottom of the floor in contact with soil	15	cm	Majority of buildings are slab-on-grade construction. Represents 6 inch thick concrete slab.
L_{WT}	Depth Below Grade to Water Table		274	cm	Based on average depth to groundwater (9 ft) in Hadnot Point.
h_A	Thickness of Soil Stratum A		274	cm	Soil stratum is modeled as a single soil type.
h_B	Thickness of Soil Stratum B		NA	cm	Not Used
h_C	Thickness of Soil Stratum C		NA	cm	Not Used
	Soil Stratum Directly Above Water Table		A	unitless	Consistent with the deepest stratum with a specified thickness (h_A).
	SCS Soil Type Above Water Table		S	unitless	Based on site borings, sand is predominant soil type in Hadnot Point.
	Soil Stratum A SCS Soil Type	Used to estimate soil vapor permeability	S	unitless	Soils modeled using most predominant soil type present.
k_v	User-defined Soil Vapor Permeability	A parameter associated with convective transport of vapors within the zone of influence of a building. It is related to the size and shape of connected soil pores	NA	cm^2	Not Used
ρ_b^A	Stratum A Soil Dry Bulk Density		1.66	g/cm^3	model calculated based on soil type
n^A	Stratum A Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	0.375	unitless	model calculated based on soil type
θ_w^A	Stratum A Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	0.054	cm^3/cm^3	model calculated based on soil type
ρ_b^B	Stratum B Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^B	Stratum B Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^B	Stratum B Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
ρ_b^C	Stratum C Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^C	Stratum C Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^C	Stratum C Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
L_{crack}	Enclosed Space Floor Thickness		15	cm	Represents a 6-inch thick concrete slab. (Corresponds to L_F)
Δ_P	Soil-Building Pressure Differential		40	$g/cm\text{-}s^2$	Not Used - Qsoil calculated directly from building parameters.
L_B	Enclosed Space Floor Length		853	cm	Average length (28 feet) of small buildings (i.e., length <100') within 100' of plume(s); range 15 - 60 ft.
W_B	Enclosed Space Floor Width		671	cm	Average width (22 feet) of small buildings within 100' of plume(s); range 10 - 30 ft.
H_B	Enclosed Space Height		518	cm	Average height (17 feet) of small buildings within 100' of plume(s); range 12 - 20 ft.
w	Floor-Wall Seam Crack Width	Represents a gap assumed to exist at the junction between the floor and the foundation perimeter. This gap is due to building design or concrete shrinkage. It represents the only route for soil gas intrusion into a building	0.1	cm	Not Used - Qsoil calculated directly from building parameters.
ER	Indoor air exchange rate	Building ventilation rate, expressed in units of air changes per hour (ACH)	0.49	(1/h)	Calculated - ANSI/ASHRAE Standard 62-2001 (see Table 2 Supplement A)
Qsoil	Average vapor flow rate into building		3.81	(L/m)	Calculated - NJDEP, 2007 (see Table 1 Supplement B)
AT_C	Averaging Time for Carcinogens		70	yrs	default
AT_{NC}	Averaging Time for Noncarcinogens		25	yrs	EPA, 1991
ED	Exposure Duration		25	yrs	EPA, 1991
EF	Exposure Frequency		250	days/yr	EPA, 1991
TR	Target Risk for Carcinogens	Used to calculate risk-based groundwater concentration	1×10^{-6}	unitless	
THQ	Target Hazard Quotient for Noncarcinogens	Used to calculate risk-based groundwater concentration	1	days/yr	

ASHRAE. 2001. Standard 62-2001, Ventilation for Acceptable Indoor Air Quality

USEPA, 1991. U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B, Development of Risk-based Preliminary

USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings. Office of Emergency and Remedial Response. February 2004.

NA = not applicable

TABLE 3-19 Supplement A

Site-Specific Air Exchange Rate

Calculations of Building Air Exchange Rate Per Hour

Small Buildings - Hadnot Point

MCB Camp Lejeune, North Carolina

Calculation of Air Changes Per Hour Indoors

$$ACH = \frac{Qbuilding}{V} = \frac{m^3/hr}{m^3} = 1/hr$$

Calculation of $Q_{building}$ (volumetric flow into indoor space)

Assumption	Value	Units	Source
Assumed volumetric airflow per person	20	ft^3/min per person	ASHRAE, 2001, Table 2, minimum outside air requirement for an office
Number of persons per floorspace	7	persons/ 1,000 ft^2	ASHRAE, 2001, Table 2
Building floorspace (do not input value here)	616	ft^2	28 ft x 22 ft (Average size of small buildings within 100' of plume.)
Calculated volumetric flow into indoor space	86	ft^3/min	Includes division by 1000 to account for persons per 1000 ft^2
	146	m^3/hr	Includes conversion of 0.0283 ft^3/m^3

Calculation of V (volume of indoor space)

Assumption	Value	Units	Source
Building floorspace (input value here)	616	ft^2	28 ft x 22 ft (Average size of small buildings within 100' of plume.)
Ceiling height	17	ft	Average height of buildings within 100' of plume.
Volume	10,472	ft^3	
	296	m^3	Includes conversion of 0.0283 ft^3/m^3

Calculation of ACH

$Q_{building}$	146	m^3/hr
Volume	296	m^3
ACH = Q/V	**0.49**	**1/hr**

Source:

ASHRAE. 2001. ANSI/ASHRAE Standard 62-2001, Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating and Air-Conditioning Engineers.

TABLE 3-19 Supplement B
Calculation of Soil Vapor Entry Rate for Johnson and Ettinger Modeling
Small Buildings - Hadnot Point
MCB Camp Lejeune, North Carolina

$$Qsoil\ (L/\min) = 5\ L/\min \times Perimeter\ (cm) \big/ 4{,}000\ cm$$

Length (cm) =	853
Width (cm) =	671
Perimeter (cm) = 2L + 2W	3,048
Qsoil (L/min) =	3.81

This presents a method for calculating the soil vapor entry rate (Qsoil) into a building for purposes of performing vapor intrusion modeling using the Johnson and Ettinger model.

It scales up the default residential soil gas entry rate described in EPA's draft vapor intrusion guidance document (USEPA, 2002) to any other building footprint. This procedure and the accompanying rationale is discussed in detail in the NJDEP vapor intrusion guidance document (NJDEP, 2007). It is based on the following assumptions:

1. The residential default Qsoil value is 5 L/min.
2. The Qsoil value is proportional to the building perimeter.
3. The building is rectangular

TABLE 3-20

Groundwater to Indoor Air Parameters Used in the Johnson and Ettinger Model

Residential - Hadnot Point

MCB Camp Lejeune, North Carolina

Symbol	Parameter	Description	Selected Value	Units	Sources
T_S	Average Soil/Groundwater Temperature		23	°C	Site-specific average from October 2004 sampling events at Site 78 and Hadnot Point Fuel Farm
L_F	Depth Below Grade to Bottom of Enclosed Space Floor	This is the depth from soil surface to the bottom of the floor in contact with soil	15	cm	Majority of buildings are slab-on-grade construction. Represents 6 inch thick concrete slab.
L_{WT}	Depth Below Grade to Water Table		274	cm	Based on average depth to groundwater (9 ft) in Hadnot Point.
h_A	Thickness of Soil Stratum A		274	cm	Soil stratum is modeled as a single soil type.
h_B	Thickness of Soil Stratum B		NA	cm	Not Used
h_C	Thickness of Soil Stratum C		NA	cm	Not Used
	Soil Stratum Directly Above Water Table		A	unitless	Consistent with the deepest stratum with a specified thickness (h_A).
	SCS Soil Type Above Water Table		S	unitless	Based on site borings, sand is predominant soil type in Hadnot Point.
	Soil Stratum A SCS Soil Type	Used to estimate soil vapor permeability	S	unitless	Soils modeled using most predominant soil type present.
k_v	User-defined Soil Vapor Permeability	A parameter associated with convective transport of vapors within the zone of influence of a building. It is related to the size and shape of connected soil pores	NA	cm^2	Not Used
ρ_b^A	Stratum A Soil Dry Bulk Density		1.66	g/cm^3	model calculated based on soil type
n^A	Stratum A Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	0.375	unitless	model calculated based on soil type
θ_w^A	Stratum A Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	0.054	cm^3/cm^3	model calculated based on soil type
ρ_b^B	Stratum B Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^B	Stratum B Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^B	Stratum B Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
ρ_b^C	Stratum C Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^C	Stratum C Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
$\theta_{w\backslash}^C$	Stratum C Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
L_{crack}	Enclosed Space Floor Thickness		15	cm	Represents a 6-inch thick concrete slab. (Corresponds to L_F)
Δ_P	Soil-Building Pressure Differential		NA	$g/cm\text{-}s^2$	Not Used - Qsoil calculated directly from building parameters.
L_B	Enclosed Space Floor Length		1000	cm	Default, users guide (USEPA, 2004)
W_B	Enclosed Space Floor Width		1000	cm	Default, users guide (USEPA, 2004)
H_B	Enclosed Space Height		244	cm	Default, users guide (USEPA, 2004)
w	Floor-Wall Seam Crack Width	Represents a gap assumed to exist at the junction between the floor and the foundation perimeter. This gap is due to building design or concrete shrinkage. It represents the only route for soil gas intrusion into a building	NA	cm	Not Used - Qsoil calculated directly from building parameters.
ER	Indoor air exchange rate	Building ventilation rate, expressed in units of air changes per hour (ACH)	0.25	(1/h)	Default, users guide (USEPA, 2004)
Qsoil	Average vapor flow rate into building		5.0	(L/m)	Default, users guide (USEPA, 2004)
AT_C	Averaging Time for Carcinogens		70	yrs	default
AT_{NC}	Averaging Time for Noncarcinogens		30	yrs	EPA, 1989
ED	Exposure Duration		30	yrs	EPA, 1991
EF	Exposure Frequency		350	days/yr	EPA, 1991
TR	Target Risk for Carcinogens	Used to calculate risk-based groundwater concentration	1×10^{-6}	unitless	
THQ	Target Hazard Quotient for Noncarcinogens	Used to calculate risk-based groundwater concentration	1	days/yr	

USEPA, 1991. U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B, Development of Risk-based Preliminary

USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings. Office of Emergency and Remedial Response. February 2004.

NA = not applicable

TABLE 3-21

Groundwater to Indoor Air Parameters Used in the Johnson and Ettinger Model

Large Buildings - Air Station

MCB Camp Lejeune, North Carolina

Symbol	Parameter	Description	Selected Value	Units	Sources
T_S	Average Soil/Groundwater Temperature		23	°C	Based on site-specific averages for Camp Geiger, Courthouse Bay, and Hadnot Point.
L_F	Depth Below Grade to Bottom of Enclosed Space Floor	This is the depth from soil surface to the bottom of the floor in contact with soil	15	cm	Majority of buildings are slab-on-grade construction. Represents 6 inch thick concrete slab.
L_{WT}	Depth Below Grade to Water Table		152	cm	Based on average depth to groundwater (5 ft) in the study area (Air Station).
h_A	Thickness of Soil Stratum A		152	cm	Soil stratum is modeled as a single soil type.
h_B	Thickness of Soil Stratum B		NA	cm	Not Used
h_C	Thickness of Soil Stratum C		NA	cm	Not Used
	Soil Stratum Directly Above Water Table		A	unitless	Consistent with the deepest stratum with a specified thickness (h_A).
	SCS Soil Type Above Water Table		S	unitless	Based on site borings, sand is a predominant soil type in Air Station.
	Soil Stratum A SCS Soil Type	Used to estimate soil vapor permeability	S	unitless	Soils modeled using predominant soil type present.
k_v	User-defined Soil Vapor Permeability	A parameter associated with convective transport of vapors within the zone of influence of a building. It is related to the size and shape of connected soil pores	NA	cm^2	Not Used
ρ_b^A	Stratum A Soil Dry Bulk Density		1.66	g/cm^3	model calculated based on soil type
n^A	Stratum A Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	0.375	unitless	model calculated based on soil type
θ_w^A	Stratum A Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	0.054	cm^3/cm^3	model calculated based on soil type
ρ_b^B	Stratum B Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^B	Stratum B Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^B	Stratum B Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
ρ_b^C	Stratum C Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^C	Stratum C Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
$\theta_{w\backslash}^C$	Stratum C Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
L_{crack}	Enclosed Space Floor Thickness		15	cm	Represents a 6-inch thick concrete slab. (Corresponds to L_F)
Δ_P	Soil-Building Pressure Differential		NA	$g/cm\text{-}s^2$	Not Used - Qsoil calculated directly from building parameters.
L_B	Enclosed Space Floor Length		7315	cm	Average length (240 feet) of large buildings (i.e., length ≥ 100') within 100' of plume(s). (Building length range: 115 - 450 ft)
W_B	Enclosed Space Floor Width		3719	cm	Average width (122 feet) of large buildings within 100' of plume(s). (Building width range: 50 - 180 ft)
H_B	Enclosed Space Height		1158	cm	Average height (38 feet) of large buildings within 100' of plume(s). (Building height range: 12 - 70 ft)
w	Floor-Wall Seam Crack Width	Represents a gap assumed to exist at the junction between the floor and the foundation perimeter. This gap is due to building design or concrete shrinkage. It represents the only route for soil gas intrusion into a building	NA	cm	Not Used - Qsoil calculated directly from building parameters.
ER	Indoor air exchange rate	Building ventilation rate, expressed in units of air changes per hour (ACH)	0.22	(1/h)	Calculated - ANSI/ASHRAE Standard 62-2001 (see Table 1 Supplement A)
Qsoil	Average vapor flow rate into building		27.58	(L/m)	Calculated - NJDEP, 2007 (see Table 1 Supplement B)
AT_C	Averaging Time for Carcinogens		70	yrs	default
AT_{NC}	Averaging Time for Noncarcinogens		25	yrs	EPA, 1991
ED	Exposure Duration		25	yrs	EPA, 1991
EF	Exposure Frequency		250	days/yr	EPA, 1991
TR	Target Risk for Carcinogens	Used to calculate risk-based groundwater concentration	1×10^{-6}	unitless	
THQ	Target Hazard Quotient for Noncarcinogens	Used to calculate risk-based groundwater concentration	1	days/yr	

ASHRAE. 2001. Standard 62-2001, Ventilation for Acceptable Indoor Air Quality

USEPA, 1991. U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B, Development of Risk-based Preliminary

USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings. Office of Emergency and Remedial Response. February 2004.

NA = not applicable

TABLE 3-21 Supplement A

Site-Specific Air Exchange Rate

Calculations of Building Air Exchange Rate Per Hour

Large Buildings - Air Station

MCB Camp Lejeune, North Carolina

Calculation of Air Changes Per Hour Indoors

$$ACH = \frac{Qbuilding}{V} = \frac{m^3/hr}{m^3} = 1/hr$$

Calculation of $Q_{building}$ (volumetric flow into indoor space)

Assumption	Value	Units	Source
Assumed volumetric airflow per person	20	ft^3/min per person	ASHRAE, 2001, Table 2, minimum outside air requirement for an office
Number of persons per floorspace	7	persons/ 1,000 ft^2	ASHRAE, 2001, Table 2
Building floorspace (do not input value here)	29,280	ft^2	240 ft x 122 ft (Average size of large buildings within 100' of plume.)
Calculated volumetric flow into indoor space	4,099	ft^3/min	Includes division by 1000 to account for persons per 1000 ft^2
	6,960	m^3/hr	Includes conversion of 0.0283 ft^3/m^3

Calculation of V (volume of indoor space)

Assumption	Value	Units	Source
Building floorspace (input value here)	29,280	ft^2	240 ft x 122 ft (Average size of large buildings within 100' of plume.)
Ceiling height	38	ft	Average height of buildings within 100' of plume.
Volume	1,112,640	ft^3	
	31,488	m^3	Includes conversion of 0.0283 ft^3/m^3

Calculation of ACH

$Q_{building}$	6,960	m^3/hr
Volume	31,488	m^3
ACH = Q/V	**0.22**	**1/hr**

Source:

ASHRAE. 2001. ANSI/ASHRAE Standard 62-2001, Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating and Air-Conditioning Engineers.

TABLE 3-21 Supplement B

Calculation of Soil Vapor Entry Rate for Johnson and Ettinger Modeling

Large Buildings - Air Station

MCB Camp Lejeune, North Carolina

$$Qsoil\ (L/\min) = 5\ L/\min \times {Perimeter\ (cm)} \big/ {4{,}000\ cm}$$

Length (cm) =	7,315
Width (cm) =	3,719
Perimeter (cm) = 2L + 2W	22,068
Qsoil (L/min) =	**27.58**

This presents a method for calculating the soil vapor entry rate (Qsoil) into a building for purposes of performing vapor intrusion modeling using the Johnson and Ettinger model.

It scales up the default residential soil gas entry rate described in EPA's draft vapor intrusion guidance document (USEPA, 2002) to any other building footprint. This procedure and the accompanying rationale is discussed in detail in the NJDEP vapor intrusion guidance document (NJDEP, 2007). It is based on the following assumptions:

1. The residential default Qsoil value is 5 L/min.
2. The Qsoil value is proportional to the building perimeter.
3. The building is rectangular

TABLE 3-22

Groundwater to Indoor Air Parameters Used in the Johnson and Ettinger Model

Small Buildings - Air Station

MCB Camp Lejeune, North Carolina

Symbol	Parameter	Description	Selected Value	Units	Sources
T_S	Average Soil/Groundwater Temperature		23	°C	Based on site-specific averages for Camp Geiger, Courthouse Bay, and Hadnot Point.
L_F	Depth Below Grade to Bottom of Enclosed Space Floor	This is the depth from soil surface to the bottom of the floor in contact with soil	15	cm	Majority of buildings are slab-on-grade construction. Represents 6 inch thick concrete slab.
L_{WT}	Depth Below Grade to Water Table		152	cm	Based on average depth to groundwater (5 ft) in Air Station.
h_A	Thickness of Soil Stratum A		152	cm	Soil stratum is modeled as a single soil type.
h_B	Thickness of Soil Stratum B		NA	cm	Not Used
h_C	Thickness of Soil Stratum C		NA	cm	Not Used
	Soil Stratum Directly Above Water Table		A	unitless	Consistent with the deepest stratum with a specified thickness (h_A).
	SCS Soil Type Above Water Table		S	unitless	Based on site borings, sand is predominant soil type in Air Station.
	Soil Stratum A SCS Soil Type	Used to estimate soil vapor permeability	S	unitless	Soils modeled using most predominant soil type present.
k_v	User-defined Soil Vapor Permeability	A parameter associated with convective transport of vapors within the zone of influence of a building. It is related to the size and shape of connected soil pores	NA	cm^2	Not Used
ρ_b^A	Stratum A Soil Dry Bulk Density		1.66	g/cm^3	model calculated based on soil type
n^A	Stratum A Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	0.375	unitless	model calculated based on soil type
θ_w^A	Stratum A Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	0.054	cm^3/cm^3	model calculated based on soil type
ρ_b^B	Stratum B Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^B	Stratum B Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^B	Stratum B Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
ρ_b^C	Stratum C Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^C	Stratum C Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^C	Stratum C Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
L_{crack}	Enclosed Space Floor Thickness		15	cm	Represents a 6-inch thick concrete slab. (Corresponds to L_F)
Δ_P	Soil-Building Pressure Differential		NA	$g/cm\text{-}s^2$	Default
L_B	Enclosed Space Floor Length		853	cm	Average length (28 feet) of small buildings (i.e., length <100') within 100' of plume(s). (Building length range: 5 - 70 ft.)
W_B	Enclosed Space Floor Width		823	cm	Average width (27 feet) of small buildings within 100' of plume(s). (Building width range: 5 - 70 ft.)
H_B	Enclosed Space Height		457	cm	Average height (15 feet) of small buildings within 100' of plume(s). (Building height range: 8 - 45 ft.
w	Floor-Wall Seam Crack Width	Represents a gap assumed to exist at the junction between the floor and the foundation perimeter. This gap is due to building design or concrete shrinkage. It represents the only route for soil gas intrusion into a building	NA	cm	Default
ER	Indoor air exchange rate	Building ventilation rate, expressed in units of air changes per hour (ACH)	0.56	(1/h)	Calculated - ANSI/ASHRAE Standard 62-2001 (see Table 2 Supplement A)
Qsoil	Average vapor flow rate into building		4.19	(L/m)	Calculated - NJDEP, 2007 (see Table 2 Supplement B)
AT_C	Averaging Time for Carcinogens		70	yrs	default
AT_{NC}	Averaging Time for Noncarcinogens		25	yrs	EPA, 1991
ED	Exposure Duration		25	yrs	EPA, 1991
EF	Exposure Frequency		250	days/yr	EPA, 1991
TR	Target Risk for Carcinogens	Used to calculate risk-based groundwater concentration	1×10^{-6}	unitless	
THQ	Target Hazard Quotient for Noncarcinogens	Used to calculate risk-based groundwater concentration	1	days/yr	

ASHRAE. 2001. Standard 62-2001, Ventilation for Acceptable Indoor Air Quality

USEPA, 1991. U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B, Development of Risk-based Preliminary

USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings. Office of Emergency and Remedial Response. February 2004.

NA = not applicable

TABLE 3-22 Supplement A

Site-Specific Air Exchange Rate
Calculations of Building Air Exchange Rate Per Hour
Air Station
MCB Camp Lejeune, North Carolina

Calculation of Air Changes Per Hour Indoors

$$ACH = \frac{Qbuilding}{V} = \frac{m^3/hr}{m^3} = 1/hr$$

Calculation of $Q_{building}$ (volumetric flow into indoor space)

Assumption	Value	Units	Source
Assumed volumetric airflow per person	20	ft^3/min per person	ASHRAE, 2001, Table 2, minimum outside air requirement for an office
Number of persons per floorspace	7	persons/ 1,000 ft^2	ASHRAE, 2001, Table 2
Building floorspace (do not input value here)	756	ft^2	28 ft x 27 ft (Average size of small buildings within 100' of plume.)
Calculated volumetric flow into indoor space	106	ft^3/min	Includes division by 1000 to account for persons per 1000 ft^2
	180	m^3/hr	Includes conversion of 0.0283 ft^3/m^3

Calculation of V (volume of indoor space)

Assumption	Value	Units	Source
Building floorspace (input value here)	756	ft^2	28 ft x 27 ft (Average size of small buildings within 100' of plume.)
Ceiling height	15	ft	Average height of buildings within 100' of plume.
Volume	11,340	ft^3	
	321	m^3	Includes conversion of 0.0283 ft^3/m^3

Calculation of ACH

$Q_{building}$	180	m^3/hr
Volume	321	m^3
ACH = Q/V	**0.56**	**1/hr**

Source:
ASHRAE. 2001. ANSI/ASHRAE Standard 62-2001, Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating and Air-Conditioning Engineers.

TABLE 3-22 Supplement B

Calculation of Soil Vapor Entry Rate for Johnson and Ettinger Modeling

Small Buildings - Air Station

MCB Camp Lejeune, North Carolina

$$Qsoil\ (L/\min) = 5\ L/\min \times Perimeter\ (cm) \big/ 4{,}000\ cm$$

Length (cm) =	853
Width (cm) =	823
Perimeter (cm) = 2L + 2W	3,353
Qsoil (L/min) =	**4.19**

This presents a method for calculating the soil vapor entry rate (Qsoil) into a building for purposes of performing vapor intrusion modeling using the Johnson and Ettinger model.

It scales up the default residential soil gas entry rate described in EPA's draft vapor intrusion guidance document (USEPA, 2002) to any other building footprint. This procedure and the accompanying rationale is discussed in detail in the NJDEP vapor intrusion guidance document (NJDEP, 2007). It is based on the following assumptions:

1. The residential default Qsoil value is 5 L/min.
2. The Qsoil value is proportional to the building perimeter.
3. The building is rectangular

TABLE 3-23
Groundwater to Indoor Air Parameters Used in the Johnson and Ettinger Model
Residential - Air Station
MCB Camp Lejeune, North Carolina

Symbol	Parameter	Description	Selected Value	Units	Sources
T_S	Average Soil/Groundwater Temperature		23	°C	Based on site-specific averages for Camp Geiger, Courthouse Bay, and Hadnot Point.
L_F	Depth Below Grade to Bottom of Enclosed Space Floor	This is the depth from soil surface to the bottom of the floor in contact with soil	15	cm	Majority of buildings are slab-on-grade construction. Represents 6 inch thick concrete slab.
L_{WT}	Depth Below Grade to Water Table		152	cm	Based on average depth to groundwater (5 ft) in Air Station.
h_A	Thickness of Soil Stratum A		152	cm	Soil stratum is modeled as a single soil type.
h_B	Thickness of Soil Stratum B		NA	cm	Not Used
h_C	Thickness of Soil Stratum C		NA	cm	Not Used
	Soil Stratum Directly Above Water Table		A	unitless	Consistent with the deepest stratum with a specified thickness (h_A).
	SCS Soil Type Above Water Table		S	unitless	Based on site borings, sand is predominant soil type in Air Station.
	Soil Stratum A SCS Soil Type	Used to estimate soil vapor permeability	S	unitless	Soils modeled using most predominant soil type present.
k_v	User-defined Soil Vapor Permeability	A parameter associated with convective transport of vapors within the zone of influence of a building. It is related to the size and shape of connected soil pores	NA	cm^2	Not Used
ρ_b^A	Stratum A Soil Dry Bulk Density		1.66	g/cm^3	model calculated based on soil type
n^A	Stratum A Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	0.375	unitless	model calculated based on soil type
θ_w^A	Stratum A Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	0.054	cm^3/cm^3	model calculated based on soil type
ρ_b^B	Stratum B Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^B	Stratum B Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^B	Stratum B Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
ρ_b^C	Stratum C Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^C	Stratum C Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_{wl}^C	Stratum C Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
L_{crack}	Enclosed Space Floor Thickness		15	cm	Represents a 6-inch thick concrete slab. (Corresponds to L_F)
Δ_P	Soil-Building Pressure Differential		NA	$g/cm\text{-}s^2$	Default
L_B	Enclosed Space Floor Length		1000	cm	Default, users guide (USEPA, 2004)
W_B	Enclosed Space Floor Width		1000	cm	Default, users guide (USEPA, 2004)
H_B	Enclosed Space Height		244	cm	Default, users guide (USEPA, 2004)
w	Floor-Wall Seam Crack Width	Represents a gap assumed to exist at the junction between the floor and the foundation perimeter. This gap is due to building design or concrete shrinkage. It represents the only route for soil gas intrusion into a building	NA	cm	Default, users guide (USEPA, 2004)
ER	Indoor air exchange rate	Building ventilation rate, expressed in units of air changes per hour (ACH)	0.25	(1/h)	Default, users guide (USEPA, 2004)
Qsoil	Average vapor flow rate into building		5.0	(L/m)	Default, users guide (USEPA, 2004)
AT_C	Averaging Time for Carcinogens		70	yrs	default
AT_{NC}	Averaging Time for Noncarcinogens		30	yrs	EPA, 1989
ED	Exposure Duration		30	yrs	EPA, 1991
EF	Exposure Frequency		350	days/yr	EPA, 1991
TR	Target Risk for Carcinogens	Used to calculate risk-based groundwater concentration	1×10^{-6}	unitless	
THQ	Target Hazard Quotient for Noncarcinogens	Used to calculate risk-based groundwater concentration	1	days/yr	

ASHRAE. 2001. Standard 62-2001, Ventilation for Acceptable Indoor Air Quality
USEPA, 1991. U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B, Development of
USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings. Office of Emergency and Remedial Response. February 2004.
NA = not applicable

TABLE 3-24

Groundwater to Indoor Air Parameters Used in the Johnson and Ettinger Model

Large Buildings - Courthouse Bay

MCB Camp Lejeune, North Carolina

Symbol	Parameter	Description	Selected Value	Units	Sources
T_S	Average Soil/Groundwater Temperature		23	°C	Site-specific average from July and September 2007 sampling events at Site 73.
L_F	Depth Below Grade to Bottom of Enclosed Space Floor	This is the depth from soil surface to the bottom of the floor in contact with soil	15	cm	Majority of buildings are slab-on-grade construction. Represents 6 inch thick concrete slab.
L_{WT}	Depth Below Grade to Water Table		152	cm	Based on average depth to groundwater (5 ft) in the study area (Courthouse Bay).
h_A	Thickness of Soil Stratum A		152	cm	Soil stratum is modeled as a single soil type.
h_B	Thickness of Soil Stratum B		NA	cm	Not Used
h_C	Thickness of Soil Stratum C		NA	cm	Not Used
	Soil Stratum Directly Above Water Table		A	unitless	Consistent with the deepest stratum with a specified thickness (h_A).
	SCS Soil Type Above Water Table		S	unitless	Based on site borings, sand is a predominant soil type in Courthouse Bay.
	Soil Stratum A SCS Soil Type	Used to estimate soil vapor permeability	S	unitless	Soils modeled using predominant soil type present.
k_v	User-defined Soil Vapor Permeability	A parameter associated with convective transport of vapors within the zone of influence of a building. It is related to the size and shape of connected soil pores	NA	cm^2	Not Used
ρ_b^A	Stratum A Soil Dry Bulk Density		1.66	g/cm^3	model calculated based on soil type
n^A	Stratum A Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	0.375	unitless	model calculated based on soil type
θ_w^A	Stratum A Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	0.054	cm^3/cm^3	model calculated based on soil type
ρ_b^B	Stratum B Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^B	Stratum B Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^B	Stratum B Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
ρ_b^C	Stratum C Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^C	Stratum C Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
$\theta_{w\backslash}^C$	Stratum C Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
L_{crack}	Enclosed Space Floor Thickness		15	cm	Represents a 6-inch thick concrete slab. (Corresponds to L_F)
Δ_P	Soil-Building Pressure Differential		NA	$g/cm\text{-}s^2$	Not Used - Qsoil calculated directly from building parameters.
L_B	Enclosed Space Floor Length		11491	cm	Average length (377 feet) of large buildings (i.e., length ≥ 200') within 100' of plume(s). (Building length range: 200 - 530 ft)
W_B	Enclosed Space Floor Width		5151	cm	Average width (169 feet) of large buildings within 100' of plume(s). (Building width range: 100 - 207 ft)
H_B	Enclosed Space Height		1524	cm	Average height (50 feet) of large buildings within 100' of plume(s). (Building height range: 50 - 50 ft)
w	Floor-Wall Seam Crack Width	Represents a gap assumed to exist at the junction between the floor and the foundation perimeter. This gap is due to building design or concrete shrinkage. It represents the only route for soil gas intrusion into a building	NA	cm	Not Used - Qsoil calculated directly from building parameters.
ER	Indoor air exchange rate	Building ventilation rate, expressed in units of air changes per hour (ACH)	0.17	(1/h)	Calculated - ANSI/ASHRAE Standard 62-2001 (see Table 1 Supplement A)
Qsoil	Average vapor flow rate into building		41.61	(L/m)	Calculated - NJDEP, 2007 (see Table 1 Supplement B)
AT_C	Averaging Time for Carcinogens		70	yrs	default
AT_{NC}	Averaging Time for Noncarcinogens		25	yrs	EPA, 1991
ED	Exposure Duration		25	yrs	EPA, 1991
EF	Exposure Frequency		250	days/yr	EPA, 1991
TR	Target Risk for Carcinogens	Used to calculate risk-based groundwater concentration	1×10^{-6}	unitless	
THQ	Target Hazard Quotient for Noncarcinogens	Used to calculate risk-based groundwater concentration	1	days/yr	

ASHRAE. 2001. Standard 62-2001, Ventilation for Acceptable Indoor Air Quality

USEPA, 1991. U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B, Development of Risk-based Preliminary

USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings. Office of Emergency and Remedial Response. February 2004.

NA = not applicable

TABLE 3-24 Supplement A

Site-Specific Air Exchange Rate

Calculations of Building Air Exchange Rate Per Hour

Large Buildings - Courthouse Bay

MCB Camp Lejeune, North Carolina

Calculation of Air Changes Per Hour Indoors

$$ACH = \frac{Qbuilding}{V} = \frac{m^3/hr}{m^3} = 1/hr$$

Calculation of $Q_{building}$ (volumetric flow into indoor space)

Assumption	Value	Units	Source
Assumed volumetric airflow per person	20	ft^3/min per person	ASHRAE, 2001, Table 2, minimum outside air requirement for an office
Number of persons per floorspace	7	persons/ 1,000 ft^2	ASHRAE, 2001, Table 2
Building floorspace (do not input value here)	63,713	ft^2	377 ft x 169 ft (Average size of large buildings within 100' of plume.)
Calculated volumetric flow into indoor space	8,920	ft^3/min	Includes division by 1000 to account for persons per 1000 ft^2
	15,146	m^3/hr	Includes conversion of 0.0283 ft^3/m^3

Calculation of V (volume of indoor space)

Assumption	Value	Units	Source
Building floorspace (input value here)	63,713	ft^2	377 ft x 169 ft (Average size of large buildings within 100' of plume.)
Ceiling height	50	ft	Average height of buildings within 100' of plume.
Volume	3,185,650	ft^3	
	90,154	m^3	Includes conversion of 0.0283 ft^3/m^3

Calculation of ACH

$Q_{building}$	15,146	m^3/hr
Volume	90,154	m^3
ACH = Q/V	**0.17**	**1/hr**

Source:

ASHRAE. 2001. ANSI/ASHRAE Standard 62-2001, Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating and Air-Conditioning Engineers.

TABLE 3-24 Supplement B

Calculation of Soil Vapor Entry Rate for Johnson and Ettinger Modeling

Large Buildings - Courthouse Bay

MCB Camp Lejeune, North Carolina

$$Qsoil\ (L/\min) = 5\ L/\min \times Perimeter\ (cm) \big/ 4{,}000\ cm$$

Length (cm) =	11,491
Width (cm) =	5,151
Perimeter (cm) = 2L + 2W	33,284
Qsoil (L/min) =	**41.61**

This presents a method for calculating the soil vapor entry rate (Qsoil) into a building for purposes of performing vapor intrusion modeling using the Johnson and Ettinger model.

It scales up the default residential soil gas entry rate described in EPA's draft vapor intrusion guidance document (USEPA, 2002) to any other building footprint. This procedure and the accompanying rationale is discussed in detail in the NJDEP vapor intrusion guidance document (NJDEP, 2007). It is based on the following assumptions:

1. The residential default Qsoil value is 5 L/min.
2. The Qsoil value is proportional to the building perimeter.
3. The building is rectangular

TABLE 3-25

Groundwater to Indoor Air Parameters Used in the Johnson and Ettinger Model

Small Buildings - Courthouse Bay

MCB Camp Lejeune, North Carolina

Symbol	Parameter	Description	Selected Value	Units	Sources
T_S	Average Soil/Groundwater Temperature		23	°C	Site-specific average from July and September 2007 sampling events at Site 73.
L_F	Depth Below Grade to Bottom of Enclosed Space Floor	This is the depth from soil surface to the bottom of the floor in contact with soil	15	cm	Majority of buildings are slab-on-grade construction. Represents 6 inch thick concrete slab.
L_{WT}	Depth Below Grade to Water Table		152	cm	Based on average depth to groundwater (5 ft) in Courthouse Bay.
h_A	Thickness of Soil Stratum A		152	cm	Soil stratum is modeled as a single soil type.
h_B	Thickness of Soil Stratum B		NA	cm	Not Used
h_C	Thickness of Soil Stratum C		NA	cm	Not Used
	Soil Stratum Directly Above Water Table		A	unitless	Consistent with the deepest stratum with a specified thickness (h_A).
	SCS Soil Type Above Water Table		S	unitless	Based on site borings, sand is predominant soil type in Courthouse Bay.
	Soil Stratum A SCS Soil Type	Used to estimate soil vapor permeability	S	unitless	Soils modeled using predominant soil type present.
k_v	User-defined Soil Vapor Permeability	A parameter associated with convective transport of vapors within the zone of influence of a building. It is related to the size and shape of connected soil pores	NA	cm^2	Not Used
ρ_b^A	Stratum A Soil Dry Bulk Density		1.66	g/cm^3	model calculated based on soil type
n^A	Stratum A Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	0.375	unitless	model calculated based on soil type
θ_w^A	Stratum A Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	0.054	cm^3/cm^3	model calculated based on soil type
ρ_b^B	Stratum B Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^B	Stratum B Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^B	Stratum B Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
ρ_b^C	Stratum C Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^C	Stratum C Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^C	Stratum C Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
L_{crack}	Enclosed Space Floor Thickness		15	cm	Represents a 6-inch thick concrete slab. (Corresponds to L_F)
Δ_P	Soil-Building Pressure Differential		NA	$g/cm\text{-}s^2$	Default
L_B	Enclosed Space Floor Length		3200	cm	Average length (105 feet) of small buildings (i.e., length <200') within 100' of plume(s). (Building length range: 105 ft.)
W_B	Enclosed Space Floor Width		1494	cm	Average width (49 feet) of small buildings within 100' of plume(s). (Building width range: 49 ft.)
H_B	Enclosed Space Height		1524	cm	Average height (50 feet) of small buildings within 100' of plume(s). (Building height range: 50.)
w	Floor-Wall Seam Crack Width	Represents a gap assumed to exist at the junction between the floor and the foundation perimeter. This gap is due to building design or concrete shrinkage. It represents the only route for soil gas intrusion into a building	NA	cm	Default
ER	Indoor air exchange rate	Building ventilation rate, expressed in units of air changes per hour (ACH)	0.17	(1/h)	Calculated - ANSI/ASHRAE Standard 62-2001 (see Table 2 Supplement A)
Qsoil	Average vapor flow rate into building		11.73	(L/m)	Calculated - NJDEP, 2007 (see Table 2 Supplement B)
AT_C	Averaging Time for Carcinogens		70	yrs	default
AT_{NC}	Averaging Time for Noncarcinogens		25	yrs	EPA, 1991
ED	Exposure Duration		25	yrs	EPA, 1991
EF	Exposure Frequency		250	days/yr	EPA, 1991
TR	Target Risk for Carcinogens	Used to calculate risk-based groundwater concentration	1×10^{-6}	unitless	
THQ	Target Hazard Quotient for Noncarcinogens	Used to calculate risk-based groundwater concentration	1	days/yr	

ASHRAE. 2001. Standard 62-2001, Ventilation for Acceptable Indoor Air Quality

USEPA, 1991. U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B, Development of Risk-based Preliminary

USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings. Office of Emergency and Remedial Response. February 2004.

NA = not applicable

TABLE 3-25 Supplement A

Site-Specific Air Exchange Rate

Calculations of Building Air Exchange Rate Per Hour

Small Buildings - Courthouse Bay

MCB Camp Lejeune, North Carolina

Calculation of Air Changes Per Hour Indoors

$$ACH = \frac{Qbuilding}{V} = \frac{m^3/hr}{m^3} = 1/hr$$

Calculation of $Q_{building}$ (volumetric flow into indoor space)

Assumption	Value	Units	Source
Assumed volumetric airflow per person	20	ft^3/min per person	ASHRAE, 2001, Table 2, minimum outside air requirement for an office
Number of persons per floorspace	7	persons/ 1,000 ft^2	ASHRAE, 2001, Table 2
Building floorspace (do not input value here)	5,145	ft^2	105 ft x 49 ft (Average size of small buildings within 100' of plume.)
Calculated volumetric flow into indoor space	720	ft^3/min	Includes division by 1000 to account for persons per 1000 ft^2
	1,223	m^3/hr	Includes conversion of 0.0283 ft^3/m^3

Calculation of V (volume of indoor space)

Assumption	Value	Units	Source
Building floorspace (input value here)	5,145	ft^2	105 ft x 49 ft (Average size of small buildings within 100' of plume.)
Ceiling height	50	ft	Average height of buildings within 100' of plume.
Volume	257,250	ft^3	
	7,280	m^3	Includes conversion of 0.0283 ft^3/m^3

Calculation of ACH

$Q_{building}$	1,223	m^3/hr
Volume	7,280	m^3
ACH = Q/V	**0.17**	**1/hr**

Source:

ASHRAE. 2001. ANSI/ASHRAE Standard 62-2001, Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating and Air-Conditioning Engineers.

TABLE 3-25 Supplement B

Calculation of Soil Vapor Entry Rate for Johnson and Ettinger Modeling

Small Buildings - Courthouse Bay

MCB Camp Lejeune, North Carolina

$$Qsoil\ (L/\min) = 5\ L/\min \times Perimeter\ (cm) \big/ 4{,}000\ cm$$

Length (cm) =	3,200
Width (cm) =	1,494
Perimeter (cm) = 2L + 2W	9,388
Qsoil (L/min) =	**11.73**

This presents a method for calculating the soil vapor entry rate (Qsoil) into a building for purposes of performing vapor intrusion modeling using the Johnson and Ettinger model.

It scales up the default residential soil gas entry rate described in EPA's draft vapor intrusion guidance document (USEPA, 2002) to any other building footprint. This procedure and the accompanying rationale is discussed in detail in the NJDEP vapor intrusion guidance document (NJDEP, 2007). It is based on the following assumptions:

1. The residential default Qsoil value is 5 L/min.
2. The Qsoil value is proportional to the building perimeter.
3. The building is rectangular

TABLE 3-26

Groundwater to Indoor Air Parameters Used in the Johnson and Ettinger Model

Residential - Courthouse Bay

MCB Camp Lejeune, North Carolina

Symbol	Parameter	Description	Selected Value	Units	Sources
T_S	Average Soil/Groundwater Temperature		23	°C	Site-specific average from July and September 2007 sampling events at Site 73.
L_F	Depth Below Grade to Bottom of Enclosed Space Floor	This is the depth from soil surface to the bottom of the floor in contact with soil	15	cm	Majority of buildings are slab-on-grade construction. Represents 6 inch thick concrete slab.
L_{WT}	Depth Below Grade to Water Table		152	cm	Based on average depth to groundwater (5 ft) in Courthouse Bay.
h_A	Thickness of Soil Stratum A		152	cm	Soil stratum is modeled as a single soil type.
h_B	Thickness of Soil Stratum B		NA	cm	Not Used
h_C	Thickness of Soil Stratum C		NA	cm	Not Used
	Soil Stratum Directly Above Water Table		A	unitless	Consistent with the deepest stratum with a specified thickness (h_A).
	SCS Soil Type Above Water Table		S	unitless	Based on site borings, sand is predominant soil type in Courthouse Bay.
	Soil Stratum A SCS Soil Type	Used to estimate soil vapor permeability	S	unitless	Soils modeled using most predominant soil type present.
k_v	User-defined Soil Vapor Permeability	A parameter associated with convective transport of vapors within the zone of influence of a building. It is related to the size and shape of connected soil pores	NA	cm^2	Not Used
ρ_b^A	Stratum A Soil Dry Bulk Density		1.66	g/cm^3	model calculated based on soil type
n^A	Stratum A Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	0.375	unitless	model calculated based on soil type
θ_w^A	Stratum A Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	0.054	cm^3/cm^3	model calculated based on soil type
ρ_b^B	Stratum B Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^B	Stratum B Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^B	Stratum B Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
ρ_b^C	Stratum C Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^C	Stratum C Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
$\theta_{w\backslash}^C$	Stratum C Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
L_{crack}	Enclosed Space Floor Thickness		15	cm	Represents a 6-inch thick concrete slab. (Corresponds to L_F)
Δ_P	Soil-Building Pressure Differential		NA	$g/cm\text{-}s^2$	Default
L_B	Enclosed Space Floor Length		1000	cm	Default, users guide (USEPA, 2004)
W_B	Enclosed Space Floor Width		1000	cm	Default, users guide (USEPA, 2004)
H_B	Enclosed Space Height		244	cm	Default, users guide (USEPA, 2004)
w	Floor-Wall Seam Crack Width	Represents a gap assumed to exist at the junction between the floor and the foundation perimeter. This gap is due to building design or concrete shrinkage. It represents the only route for soil gas intrusion into a building	NA	cm	Default, users guide (USEPA, 2004)
ER	Indoor air exchange rate	Building ventilation rate, expressed in units of air changes per hour (ACH)	0.25	(1/h)	Default, users guide (USEPA, 2004)
Qsoil	Average vapor flow rate into building		5.0	(L/m)	Default, users guide (USEPA, 2004)
AT_C	Averaging Time for Carcinogens		70	yrs	default
AT_{NC}	Averaging Time for Noncarcinogens		30	yrs	EPA, 1989
ED	Exposure Duration		30	yrs	EPA, 1991
EF	Exposure Frequency		350	days/yr	EPA, 1991
TR	Target Risk for Carcinogens	Used to calculate risk-based groundwater concentration	1×10^{-6}	unitless	
THQ	Target Hazard Quotient for Noncarcinogens	Used to calculate risk-based groundwater concentration	1	days/yr	

ASHRAE. 2001. Standard 62-2001, Ventilation for Acceptable Indoor Air Quality

USEPA, 1991. U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B, Development of Risk-based

USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings. Office of Emergency and Remedial Response. February 2004.

NA = not applicable

TABLE 3-27

Groundwater to Indoor Air Parameters Used in the Johnson and Ettinger Model

Large Buildings - Camp Geiger

MCB Camp Lejeune, North Carolina

Symbol	Parameter	Description	Selected Value	Units	Sources
T_S	Average Soil/Groundwater Temperature		23	°C	Site-specific average from July and September 2007 sampling events at Sites 35 and 89.
L_F	Depth Below Grade to Bottom of Enclosed Space Floor	This is the depth from soil surface to the bottom of the floor in contact with soil	15	cm	Majority of buildings are slab-on-grade construction. Represents 6 inch thick concrete slab.
L_{WT}	Depth Below Grade to Water Table		152	cm	Based on average depth to groundwater (5 ft) in the study area (Camp Geiger).
h_A	Thickness of Soil Stratum A		152	cm	Soil stratum is modeled as a single soil type.
h_B	Thickness of Soil Stratum B		NA	cm	Not Used
h_C	Thickness of Soil Stratum C		NA	cm	Not Used
	Soil Stratum Directly Above Water Table		A	unitless	Consistent with the deepest stratum with a specified thickness (h_A).
	SCS Soil Type Above Water Table		S	unitless	Based on site borings, sand is a predominant soil type in Camp Geiger.
	Soil Stratum A SCS Soil Type	Used to estimate soil vapor permeability	S	unitless	Soils modeled using predominant soil type present.
k_v	User-defined Soil Vapor Permeability	A parameter associated with convective transport of vapors within the zone of influence of a building. It is related to the size and shape of connected soil pores	NA	cm^2	Not Used
ρ_b^A	Stratum A Soil Dry Bulk Density		1.66	g/cm^3	model calculated based on soil type
n^A	Stratum A Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	0.375	unitless	model calculated based on soil type
θ_w^A	Stratum A Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	0.054	cm^3/cm^3	model calculated based on soil type
ρ_b^B	Stratum B Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^B	Stratum B Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^B	Stratum B Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
ρ_b^C	Stratum C Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^C	Stratum C Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^C	Stratum C Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
L_{crack}	Enclosed Space Floor Thickness		15	cm	Represents a 6-inch thick concrete slab. (Corresponds to L_F)
Δ_P	Soil-Building Pressure Differential		NA	$g/cm\text{-}s^2$	Not Used - Qsoil calculated directly from building parameters.
L_B	Enclosed Space Floor Length		4481	cm	Average length (147 feet) of large buildings (i.e., length ≥ 100') within 100' of plume(s). (Building length range: 100 - 200 ft)
W_B	Enclosed Space Floor Width		2103	cm	Average width (69 feet) of large buildings within 100' of plume(s). (Building width range: 50 - 200 ft)
H_B	Enclosed Space Height		1006	cm	Average height (33 feet) of large buildings within 100' of plume(s). (Building height range: 20 - 80 ft; height of barracks conservatively assumed 26 ft based on number of floors)
w	Floor-Wall Seam Crack Width	Represents a gap assumed to exist at the junction between the floor and the foundation perimeter. This gap is due to building design or concrete shrinkage. It represents the only route for soil gas intrusion into a building	NA	cm	Not Used - Qsoil calculated directly from building parameters.
ER	Indoor air exchange rate	Building ventilation rate, expressed in units of air changes per hour (ACH)	0.25	(1/h)	Calculated - ANSI/ASHRAE Standard 62-2001 (see Table 1 Supplement A)
Qsoil	Average vapor flow rate into building		16.46	(L/m)	Calculated - NJDEP, 2007 (see Table 1 Supplement B)
AT_C	Averaging Time for Carcinogens		70	yrs	default
AT_{NC}	Averaging Time for Noncarcinogens		25	yrs	EPA, 1991
ED	Exposure Duration		25	yrs	EPA, 1991
EF	Exposure Frequency		250	days/yr	EPA, 1991
TR	Target Risk for Carcinogens	Used to calculate risk-based groundwater concentration	1×10^{-6}	unitless	
THQ	Target Hazard Quotient for Noncarcinogens	Used to calculate risk-based groundwater concentration	1	days/yr	

ASHRAE. 2001. Standard 62-2001, Ventilation for Acceptable Indoor Air Quality

USEPA, 1991. U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B, Development of Risk-based Preliminary

USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings. Office of Emergency and Remedial Response. February 2004.

NA = not applicable

TABLE 3-27 Supplement A

Site-Specific Air Exchange Rate

Calculations of Building Air Exchange Rate Per Hour

Large Buildings - Camp Geiger

MCB Camp Lejeune, North Carolina

Calculation of Air Changes Per Hour Indoors

$$ACH = \frac{Qbuilding}{V} = \frac{m^3/hr}{m^3} = 1/hr$$

Calculation of $Q_{building}$ (volumetric flow into indoor space)

Assumption	Value	Units	Source
Assumed volumetric airflow per person	20	ft^3/min per person	ASHRAE, 2001, Table 2, minimum outside air requirement for an office
Number of persons per floorspace	7	persons/ 1,000 ft^2	ASHRAE, 2001, Table 2
Building floorspace (do not input value here)	10,143	ft^2	147 ft x 69 ft (Average size of large buildings within 100' of plume.)
Calculated volumetric flow into indoor space	1,420	ft^3/min	Includes division by 1000 to account for persons per 1000 ft^2
	2,411	m^3/hr	Includes conversion of 0.0283 ft^3/m^3

Calculation of V (volume of indoor space)

Assumption	Value	Units	Source
Building floorspace (input value here)	10,143	ft^2	147 ft x 69 ft (Average size of large buildings within 100' of plume.)
Ceiling height	33	ft	Average height of buildings within 100' of plume.
Volume	334,719	ft^3	
	9,473	m^3	Includes conversion of 0.0283 ft^3/m^3

Calculation of ACH

$Q_{building}$	2,411	m^3/hr
Volume	9,473	m^3
ACH = Q/V	**0.25**	**1/hr**

Source:

ASHRAE. 2001. ANSI/ASHRAE Standard 62-2001, Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating and Air-Conditioning Engineers.

TABLE 3-27 Supplement B

Calculation of Soil Vapor Entry Rate for Johnson and Ettinger Modeling

Large Buildings - Camp Geiger

MCB Camp Lejeune, North Carolina

$$Qsoil\ (L/\min) = 5\ L/\min \times Perimeter\ (cm) \big/ 4{,}000\ cm$$

Length (cm) =	4,481
Width (cm) =	2,103
Perimeter (cm) = 2L + 2W	13,167
Qsoil (L/min) =	**16.46**

This presents a method for calculating the soil vapor entry rate (Qsoil) into a building for purposes of performing vapor intrusion modeling using the Johnson and Ettinger model.

It scales up the default residential soil gas entry rate described in EPA's draft vapor intrusion guidance document (USEPA, 2002) to any other building footprint. This procedure and the accompanying rationale is discussed in detail in the NJDEP vapor intrusion guidance document (NJDEP, 2007). It is based on the following assumptions:

1. The residential default Qsoil value is 5 L/min.
2. The Qsoil value is proportional to the building perimeter.
3. The building is rectangular

TABLE 3-28

Groundwater to Indoor Air Parameters Used in the Johnson and Ettinger Model

Small Buildings - Camp Geiger

MCB Camp Lejeune, North Carolina

Symbol	Parameter	Description	Selected Value	Units	Sources
T_S	Average Soil/Groundwater Temperature		23	°C	Site-specific average from July and September 2007 sampling events at Sites 35 and 89.
L_F	Depth Below Grade to Bottom of Enclosed Space Floor	This is the depth from soil surface to the bottom of the floor in contact with soil	15	cm	Majority of buildings are slab-on-grade construction. Represents 6 inch thick concrete slab.
L_{WT}	Depth Below Grade to Water Table		152	cm	Based on average depth to groundwater (5 ft) in Camp Geiger.
h_A	Thickness of Soil Stratum A		152	cm	Soil stratum is modeled as a single soil type.
h_B	Thickness of Soil Stratum B		NA	cm	Not Used
h_C	Thickness of Soil Stratum C		NA	cm	Not Used
	Soil Stratum Directly Above Water Table		A	unitless	Consistent with the deepest stratum with a specified thickness (h_A).
	SCS Soil Type Above Water Table		S	unitless	Based on site borings, sand is predominant soil type in Camp Geiger.
	Soil Stratum A SCS Soil Type	Used to estimate soil vapor permeability	S	unitless	Soils modeled using most predominant soil type present.
k_v	User-defined Soil Vapor Permeability	A parameter associated with convective transport of vapors within the zone of influence of a building. It is related to the size and shape of connected soil pores	NA	cm^2	Not Used
ρ_b^A	Stratum A Soil Dry Bulk Density		1.66	g/cm^3	model calculated based on soil type
n^A	Stratum A Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	0.375	unitless	model calculated based on soil type
θ_w^A	Stratum A Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	0.054	cm^3/cm^3	model calculated based on soil type
ρ_b^B	Stratum B Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^B	Stratum B Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^B	Stratum B Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
ρ_b^C	Stratum C Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^C	Stratum C Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_{wi}^C	Stratum C Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
L_{crack}	Enclosed Space Floor Thickness		15	cm	Represents a 6-inch thick concrete slab. (Corresponds to L_F)
Δ_P	Soil-Building Pressure Differential		NA	$g/cm\text{-}s^2$	Default
L_B	Enclosed Space Floor Length		1097	cm	Average length (31 feet) of small buildings (i.e., length <100') within 100' of plume(s). (Building length range: 10 - 50 ft.)
W_B	Enclosed Space Floor Width		1097	cm	Average width (31 feet) of small buildings within 100' of plume(s). (Building width range: 10 - 50 ft.)
H_B	Enclosed Space Height		945	cm	Average height (28 feet) of small buildings within 100' of plume(s). (Building height range: 10 - 40 ft.
w	Floor-Wall Seam Crack Width	Represents a gap assumed to exist at the junction between the floor and the foundation perimeter. This gap is due to building design or concrete shrinkage. It represents the only route for soil gas intrusion into a building	NA	cm	Default
ER	Indoor air exchange rate	Building ventilation rate, expressed in units of air changes per hour (ACH)	0.27	(1/h)	Calculated - ANSI/ASHRAE Standard 62-2001 (see Table 2 Supplement A)
Qsoil	Average vapor flow rate into building		5.49	(L/m)	Calculated - NJDEP, 2007 (see Table 2 Supplement B)
AT_C	Averaging Time for Carcinogens		70	yrs	default
AT_{NC}	Averaging Time for Noncarcinogens		25	yrs	EPA, 1991
ED	Exposure Duration		25	yrs	EPA, 1991
EF	Exposure Frequency		250	days/yr	EPA, 1991
TR	Target Risk for Carcinogens	Used to calculate risk-based groundwater concentration	1×10^{-6}	unitless	
THQ	Target Hazard Quotient for Noncarcinogens	Used to calculate risk-based groundwater concentration	1	days/yr	

ASHRAE. 2001. Standard 62-2001, Ventilation for Acceptable Indoor Air Quality

USEPA, 1991. U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B, Development of Risk-based

USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings. Office of Emergency and Remedial Response. February 2004.

NA = not applicable

TABLE 3-28 Supplement A

Site-Specific Air Exchange Rate

Calculations of Building Air Exchange Rate Per Hour

Small Buildings - Camp Geiger

MCB Camp Lejeune, North Carolina

Calculation of Air Changes Per Hour Indoors

$$ACH = \frac{Qbuilding}{V} = \frac{m^3/hr}{m^3} = 1/hr$$

Calculation of $Q_{building}$ (volumetric flow into indoor space)

Assumption	Value	Units	Source
Assumed volumetric airflow per person	20	ft^3/min per person	ASHRAE, 2001, Table 2, minimum outside air requirement for an office
Number of persons per floorspace	7	persons/ 1,000 ft^2	ASHRAE, 2001, Table 2
Building floorspace (do not input value here)	1,296	ft^2	36 ft x 36 ft (Average size of small buildings within 100' of plume.)
Calculated volumetric flow into indoor space	181	ft^3/min	Includes division by 1000 to account for persons per 1000 ft^2
	308	m^3/hr	Includes conversion of 0.0283 ft^3/m^3

Calculation of V (volume of indoor space)

Assumption	Value	Units	Source
Building floorspace (input value here)	1,296	ft^2	36 ft x 36 ft (Average size of small buildings within 100' of plume.)
Ceiling height	31	ft	Average height of buildings within 100' of plume.
Volume	40,176	ft^3	
	1,137	m^3	Includes conversion of 0.0283 ft^3/m^3

Calculation of ACH

$Q_{building}$	308	m^3/hr
Volume	1,137	m^3
ACH = Q/V	**0.27**	**1/hr**

Source:

ASHRAE. 2001. ANSI/ASHRAE Standard 62-2001, Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating and Air-Conditioning Engineers.

TABLE 3-28 Supplement B

Calculation of Soil Vapor Entry Rate for Johnson and Ettinger Modeling

Small Buildings - Camp Geiger

MCB Camp Lejeune, North Carolina

$$Qsoil\ (L/\min) = 5\ L/\min \times Perimeter\ (cm) \big/ 4{,}000\ cm$$

Length (cm) =	1,097
Width (cm) =	1,097
Perimeter (cm) = 2L + 2W	4,389
Qsoil (L/min) =	**5.49**

This presents a method for calculating the soil vapor entry rate (Qsoil) into a building for purposes of performing vapor intrusion modeling using the Johnson and Ettinger model.

It scales up the default residential soil gas entry rate described in EPA's draft vapor intrusion guidance document (USEPA, 2002) to any other building footprint. This procedure and the accompanying rationale is discussed in detail in the NJDEP vapor intrusion guidance document (NJDEP, 2007). It is based on the following assumptions:

1. The residential default Qsoil value is 5 L/min.
2. The Qsoil value is proportional to the building perimeter.
3. The building is rectangular

TABLE 3-29

Groundwater to Indoor Air Parameters Used in the Johnson and Ettinger Model

Residential - Camp Geiger

MCB Camp Lejeune, North Carolina

Symbol	Parameter	Description	Selected Value	Units	Sources
T_S	Average Soil/Groundwater Temperature		23	°C	Site-specific average from July and September 2007 sampling events at Sites 35 and 89.
L_F	Depth Below Grade to Bottom of Enclosed Space Floor	This is the depth from soil surface to the bottom of the floor in contact with soil	15	cm	Majority of buildings are slab-on-grade construction. Represents 6 inch thick concrete slab.
L_{WT}	Depth Below Grade to Water Table		152	cm	Based on average depth to groundwater (5 ft) in Camp Geiger
h_A	Thickness of Soil Stratum A		152	cm	Soil stratum is modeled as a single soil type.
h_B	Thickness of Soil Stratum B		NA	cm	Not Used
h_C	Thickness of Soil Stratum C		NA	cm	Not Used
	Soil Stratum Directly Above Water Table		A	unitless	Consistent with the deepest stratum with a specified thickness (h_A).
	SCS Soil Type Above Water Table		S	unitless	Based on site borings, sand is predominant soil type in Camp Geiger.
	Soil Stratum A SCS Soil Type	Used to estimate soil vapor permeability	S	unitless	Soils modeled using most predominant soil type present.
k_v	User-defined Soil Vapor Permeability	A parameter associated with convective transport of vapors within the zone of influence of a building. It is related to the size and shape of connected soil pores	NA	cm^2	Not Used
ρ_b^A	Stratum A Soil Dry Bulk Density		1.66	g/cm^3	model calculated based on soil type
n^A	Stratum A Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	0.375	unitless	model calculated based on soil type
θ_w^A	Stratum A Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	0.054	cm^3/cm^3	model calculated based on soil type
ρ_b^B	Stratum B Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^B	Stratum B Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^B	Stratum B Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
ρ_b^C	Stratum C Soil Dry Bulk Density		NA	g/cm^3	Not Used
n^C	Stratum C Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^C	Stratum C Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm^3/cm^3	Not Used
L_{crack}	Enclosed Space Floor Thickness		15	cm	Represents a 6-inch thick concrete slab. (Corresponds to L_F)
Δ_P	Soil-Building Pressure Differential		NA	$g/cm\text{-}s^2$	Default
L_B	Enclosed Space Floor Length		1000	cm	Default, users guide (USEPA, 2004)
W_B	Enclosed Space Floor Width		1000	cm	Default, users guide (USEPA, 2004)
H_B	Enclosed Space Height		244	cm	Default, users guide (USEPA, 2004)
w	Floor-Wall Seam Crack Width	Represents a gap assumed to exist at the junction between the floor and the foundation perimeter. This gap is due to building design or concrete shrinkage. It represents the only route for soil gas intrusion into a building	NA	cm	Default, users guide (USEPA, 2004)
ER	Indoor air exchange rate	Building ventilation rate, expressed in units of air changes per hour (ACH)	0.25	(1/h)	Default, users guide (USEPA, 2004)
Qsoil	Average vapor flow rate into building		5.0	(L/m)	Default, users guide (USEPA, 2004)
AT_C	Averaging Time for Carcinogens		70	yrs	default
AT_{NC}	Averaging Time for Noncarcinogens		30	yrs	EPA, 1989
ED	Exposure Duration		30	yrs	EPA, 1991
EF	Exposure Frequency		350	days/yr	EPA, 1991
TR	Target Risk for Carcinogens	Used to calculate risk-based groundwater concentration	1×10^{-6}	unitless	
THQ	Target Hazard Quotient for Noncarcinogens	Used to calculate risk-based groundwater concentration	1	days/yr	

ASHRAE. 2001. Standard 62-2001, Ventilation for Acceptable Indoor Air Quality

USEPA, 1991. U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B, Development of Risk-based

USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings. Office of Emergency and Remedial Response. February 2004.

NA = not applicable

TABLE 3-30
Site-Specific Vapor Intrusion Screening Levels
Mainside
MCB Camp Lejeune, North Carolina

CAS #	Chemical Name	Unit Risk Factor (URF) $(\mu g/m^3)^{-1}$	Reference Concentration (RfC) mg/m^3	Final Indoor Exposure Groundwater Concentration (µg/L) [1,2]		
				Industrial Scenario		Residential Scenario
				Large Building	Small Building	Residential Building
71432	Benzene	7.80E-06	3.00E-02	1.19E+01	8.65E+00	1.31E+00
156592	cis-1,2-Dichloroethene	NA	3.50E-02	1.75E+03	1.32E+03	2.37E+02
79345	1,1,2,2-Tetrachloroethane	7.40E-06	1.10E-01	2.91E+01	2.18E+01	3.26E+00
127184	Tetrachloroethene	5.90E-06	6.00E-01	5.49E+00	4.17E+00	7.00E-01[3]
79005	1,1,2-Trichloroethane	1.60E-05	1.40E-02	3.81E+01	2.83E+01	4.25E+00
79016	Trichloroethene	2.00E-06	4.00E-02	2.69E+01	2.00E+01	3.00E+00
75014	Vinyl Chloride	8.80E-06	1.00E-01	1.88E+00	1.30E+00	1.99E-01

Notes:
[1]Site-specific vapor instrusion screening levels were calculated using the Johnson and Ettinger Model.
The assumptions for the Johnson and Ettinger input parameters are provided in Tables 3-15 through 3-17.
[2]Target risk levels used to develop the site-specific screening values were based on $1x10^{-6}$ for carcinogens and an HQ of 1 for noncarcinogens.
[3]The NCAC 2L water quality standard was identified as the screening value in cases where the site-specific screening level is lower than the NCAC 2L value.

TABLE 3-31
Site-Specific Vapor Intrusion Screening Levels
Hadnot Point
MCB Camp Lejeune, North Carolina

CAS #	Chemical Name	Unit Risk Factor (URF) $(\mu g/m^3)^{-1}$	Reference Concentration (RfC) mg/m^3	Final Indoor Exposure Groundwater Concentration (µg/L) [1,2]		
				Industrial Scenario		Residential Scenario
				Large Building	Small Building	Residential Building
71432	Benzene	7.80E-06	3.00E-02	1.58E+01	9.96E+00	1.50E+00
107062	1,2-Dichloroethane	2.60E-05	NA	2.46E+01	1.46E+01	2.22E+00
156592	cis-1,2-Dichloroethene	NA	3.50E-02	2.30E+03	1.53E+03	2.74E+02
100414	Ethylbenzene	NA	1.00E+00	3.47E+04	2.29E+04	4.12E+03
98828	Isopropylbenzene	NA	4.00E-01	8.38E+03	5.76E+03	1.03E+03
127184	Tetrachloroethene	5.90E-06	6.00E-01	7.19E+00	4.80E+00	7.18E-01
79005	1,1,2-Trichloroethane	1.60E-05	1.40E-02	5.03E+01	3.27E+01	4.90E+00
79016	Trichloroethene	2.00E-06	4.00E-02	3.55E+01	2.31E+01	3.46E+00
95476	Xylenes	NA	1.00E-01	4.86E+03	3.07E+03	5.56E+02
75014	Vinyl Chloride	8.80E-06	1.00E-01	2.53E+00	1.51E+00	2.29E-01

Notes:
[1]Site-specific vapor instrusion screening levels were calculated using the Johnson and Ettinger Model.
The assumptions for the Johnson and Ettinger input parameters are provided in Tables 3-18 through 3-20.
[2]Target risk levels used to develop the site-specific screening values were based on $1x10^{-6}$ for carcinogens and an HQ of 1 for noncarcinogens.

TABLE 3-32
Site-Specific Vapor Intrusion Screening Levels
Air Station
MCB Camp Lejeune, North Carolina

CAS #	Chemical Name	Unit Risk Factor (URF) $(\mu g/m^3)^{-1}$	Reference Concentration (RfC) mg/m^3	Final Indoor Exposure Groundwater Concentration (µg/L)[1,2]		
				Industrial Scenario		Residential Scenario
				Large Building	Small Building	Residential Building
71432	Benzene	7.80E-06	3.00E-02	1.74E+01	8.70E+00	1.28E+00
107062	1,2-Dichloroethane	2.60E-05	NA	2.78E+01	2.30E+01[3]	2.30E+01[3]
75354	1,1-Dichloroethene	NA	2.00E-02	2.01E+03	9.96E+02	1.76E+02
156592	cis-1,2-Dichloroethene	NA	3.50E-02	2.47E+03	1.32E+03	2.33E+02
127184	Tetrachloroethene	5.90E-06	6.00E-01	7.69E+00	4.16E+00	7.00E-01[3]
79016	Trichloroethene	2.00E-06	4.00E-02	3.85E+01	2.01E+01	2.95E+00
75014	Vinyl Chloride	8.80E-06	1.00E-01	2.86E+00	1.33E+00	1.97E-01

Notes:
[1]Site-specific vapor instrusion screening levels were calculated using the Johnson and Ettinger Model. The assumptions for the Johnson and Ettinger input parameters are provided in Tables 3-21 through 3-23.
[2]Target risk levels used to develop the site-specific screening values were based on $1x10^{-6}$ for carcinogens and an HQ of 1 for noncarcinogens.
[3]The NCAC 2L water quality standard was identified as the screening value in cases where the site-specific screening level is lower than the NCAC 2L value.

TABLE 3-33
Site-Specific Vapor Intrusion Screening Level
Courthouse Bay
MCB Camp Lejeune, North Carolina

CAS #	Chemical Name	Unit Risk Factor (URF) $(\mu g/m^3)^{-1}$	Reference Concentration (RfC) mg/m^3	Final Indoor Exposure Groundwater Concentration (µg/L) [1,2]		
				Industrial Scenario		Residential Scenario
				Large Building	Small Building	Residential Building
71432	Benzene	7.80E-06	3.00E-02	2.25E+01	1.14E+01	1.28E+00
107062	1,2-Dichloroethane	2.60E-05	NA	3.64E+01	2.30E+01 [3]	2.30E+01 [3]
75354	1,1-Dichloroethene	NA	2.00E-02	5.92E+03	1.31E+03	1.76E+02
156592	cis-1,2-Dichloroethene	NA	3.50E-02	3.14E+03	1.68E+03	2.33E+02
79016	Trichloroethene	2.00E-06	4.00E-02	4.91E+01	2.58E+01	2.95E+00
75014	Vinyl Chloride	8.80E-06	1.00E-01	3.74E+00	1.80E+00	1.97E-01

Notes:
[1]Site-specific vapor instrusion screening levels were calculated using the Johnson and Ettinger Model.
The assumptions for the Johnson and Ettinger input parameters are provided in Tables 3-24 through 3-26.
[2]Target risk levels used to develop the site-specific screening values were based on $1x10^{-6}$ for carcinogens and an HQ of 1 for noncarcinogens.
[3]The NCAC 2L water quality standard was identified as the screening value in cases where the site-specific screening level is lower than the NCAC 2L value.

TABLE 3-34
Site-Specific Vapor Intrusion Screening Level
Camp Geiger
MCB Camp Lejeune, North Carolina

CAS #	Chemical Name	Unit Risk Factor (URF) $(\mu g/m^3)^{-1}$	Reference Concentration (RfC) mg/m^3	Final Indoor Exposure Groundwater Concentration (µg/L)[1,2]		
				Industrial Scenario		Residential Scenario
				Large Building	Small Building	Residential Building
71432	Benzene	7.80E-06	3.00E-02	1.28E+01	9.22E+00	1.28E+00
107062	1,2-Dichloroethane	2.60E-05	NA	2.30E+01[3]	2.30E+01[3]	2.30E+01[3]
75354	1,1-Dichloroethene	NA	2.00E-02	1.48E+03	1.06E+03	1.76E+02
156592	cis-1,2-Dichloroethene	NA	3.50E-02	1.86E+03	1.39E+03	2.33E+02
156605	trans-1,2-Dichloroethene	NA	7.00E-02	1.65E+03	1.24E+03	2.09E+02
79345	1,1,2,2-Tetrachloroethane	7.40E-06	1.10E-01	3.09E+01	2.29E+01	3.19E+00
127184	Tetrachloroethene	5.90E-06	6.00E-01	5.82E+00	4.37E+00	7.00E-01[3]
79005	1,1,2-Trichloroethane	1.60E-05	1.40E-02	4.07E+01	2.99E+01	4.16E+00
79016	Trichloroethene	2.00E-06	4.00E-02	2.87E+01	2.12E+01	2.95E+00
75014	Vinyl Chloride	8.80E-06	1.00E-01	2.06E+00	1.42E+00	1.97E-01

Notes:
[1]Site-specific vapor instrusion screening levels were calculated using the Johnson and Ettinger Model. The assumptions for the Johnson and Ettinger input parameters are provided in Tables 3-27 through 3-29.
[2]Target risk levels used to develop the site-specific screening values were based on $1x10^{-6}$ for carcinogens and an HQ of 1 for noncarcinogens.
[3]The NCAC 2L water quality standard was identified as the screening value in cases where the site-specific screening level is lower than the NCAC 2L value.

TABLE 3-35

Summary of Buildings Exceeding Large Industrial Building Site-Specific Screening Levels

MCB Camp Lejeune, North Carolina

Mainside	Hadnot Point	Air Station	Courthouse Bay	Camp Geiger
254	1707	AS4114	SA56	TC875
3B	S930	SAS500	SA52	STC872
S637	1819	AS4106	SA57	TC864
3	UN744	AS568	A47	TC952
S865	S1135	AS143		TC861
S195	903	AS541		G532
820	1601	AS424		TC762
822	S965	AS566		G530
1828	1111	AS4151		SG866
67	1115	AS510		G930
S634	1050	SAS4182		TC860
S94	902	AS502		G533
43	1101	AS515		G480
LCH4014	S1053	SAS139		G531
LCH4035	1613	AS146		TC761
S2633	901	NEW8069		TC942
HP57	S892	AS145		G521
37	S1753			STC867
728	S1715			
S1847A	1603			
1855	1114			
	1611			
	976A			
	1817			
	1108			
	S943			
	1100			
	1112			
	1200			
	1855			
	1502			

Note:

No site-specific screening levels were developed for Tarawa Terrace due to the lack of enclosed structures within 100 ft of monitoring wells containing VOC concentrations exceeding NCGWQS.

TABLE 3-36

Summary of Buildings Exceeding Small Industrial Building Site-Specific Screening Levels

MCB Camp Lejeune, North Carolina

Mainside	Hadnot Point	Air Station	Courthouse Bay	Camp Geiger
254	1707	AS4114	SA56	TC875
3B	S930	SAS500	SA52	STC872
S637	1819	AS4106	SA57	TC864
3	UN744	AS568	A47	TC952
S865	S1135	AS143		TC861
S195	903	AS541		G532
820	1601	AS424		TC762
822	S965	AS566		G530
1828	1111	AS4151		SG866
67	1115	AS510		G930
S634	1050	AS3905		TC860
S94	902	SAS4182		TC470
43	1101	AS502		G533
LCH4014	S1053	AS522		G480
LCH4035	1613	AS520		G531
S2633	901	AS515		TC761
HP57	S892	SAS139		TC942
37	S1753	AS146		G521
728	S1715	NEW8069		STC867
S1847A	1603	AS145		
1855	1114			
	1611			
	976A			
	1817			
	1108			
	S943			
	1100			
	1112			
	1200			
	1855			
	1502			

Note:

No site-specific screening levels were developed for Tarawa Terrace due to the lack of enclosed structures within 100 ft of monitoring wells containing VOC concentrations exceeding NCGWQS.

TABLE 3-37

Summary of Buildings Exceeding Residential Building Site-Specific Screening Levels

MCB Camp Lejeune, North Carolina

Mainside	Hadnot Point	Air Station	Courthouse Bay	Camp Geiger
1827	1602	AS4165	SA56	TC875
LCH4034	1707	AS4114	A2	STC872
254	S930	SAS500	SA52	TC864
3B	1819	AS4106	SA57	TC952
S637	UN744	AS568	A47	TC366
147	S1135	AS143		TC861
3	903	AS541		G523
40	1601	AS424		G532
S49	S965	AS566		TC762
887	1111	AS4151		G530
113	1115	UNK169		SG866
S865	1050	AS410		G930
S195	1728	AS498		TC860
820	902	AS510		TC342
822	1101	AS3905		TC470
1828	S1053	SAS4182		G550
67	1613	AS502		G533
S634	901	AS511		G522
58	S1136	AS522		G480
S94	S892	AS520		TC572
43	S1753	AS515		G554
LCH4014	S1715	SAS139		G531
LCH4035	1688	AS146		TC761
S2633	1603	NEW8069		TC942
4	1114	AS145		G551
HP57	1611			TC341
37	976A			G521
728	1817			STC867
S1847A	1108			TC365
1855	S943			
	1100			
	1503			
	1112			
	1200			
	S90			
	1504			
	1855			
	1502			

Note:

No site-specific screening levels were developed for Tarawa Terrace due to the lack of enclosed structures within 100 ft of monitoring wells containing VOC concentrations exceeding NCGWQS.

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\Mainside\Figure_3-1_Building_of Interest_Mainside_Map1.mxd

Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

N

0 200 400 800 Feet

Figure 3-1
Building of Interest - Mainside Map 1
MCB Camp Lejeune
North Carolina

AGVIO
CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\Mainside\Figure_3-2_Building_of_Interest_Mainside_Map2.mxd

Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

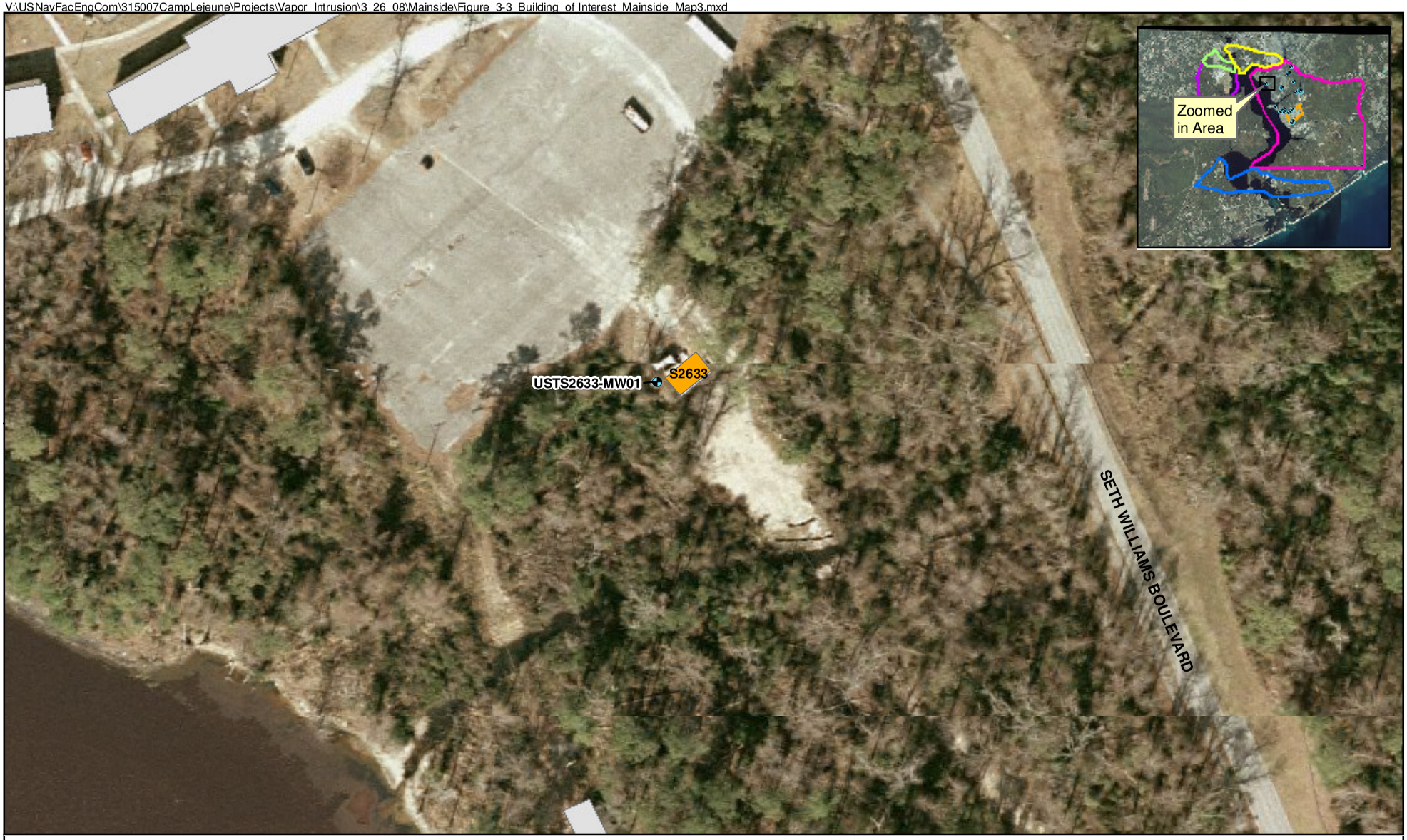
N

0 200 400 800 Feet

Figure 3-2
Buildings of Interest - Mainside Map 2
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\Mainside\Figure_3-3_Building_of_Interest_Mainside_Map3.mxd



Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

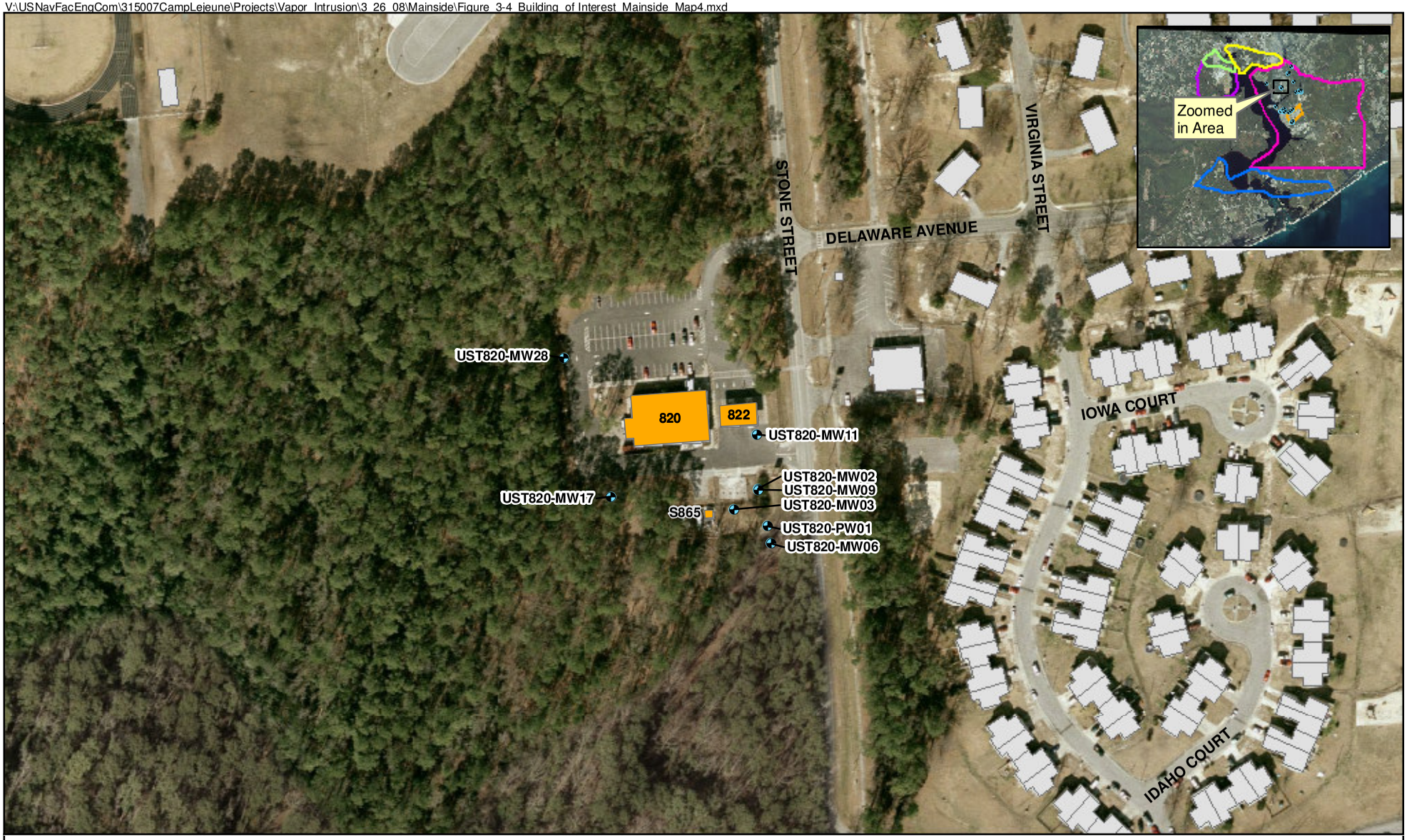
N

0 50 100 200 Feet

Figure 3-3
Buildings of Interest - Mainside Map 3
MCB Camp Lejeune
North Carolina

AGVIO
CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\Mainside\Figure_3-4_Building_of_Interest_Mainside_Map4.mxd



Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

N

0 100 200 400 Feet

Figure 3-4
Buildings of Interest - Mainside Map 4
MCB Camp Lejeune
North Carolina

AGVIO
CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\Mainside\Figure_3-5_Building_of_Interest_Mainside_Map5.mxd

Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

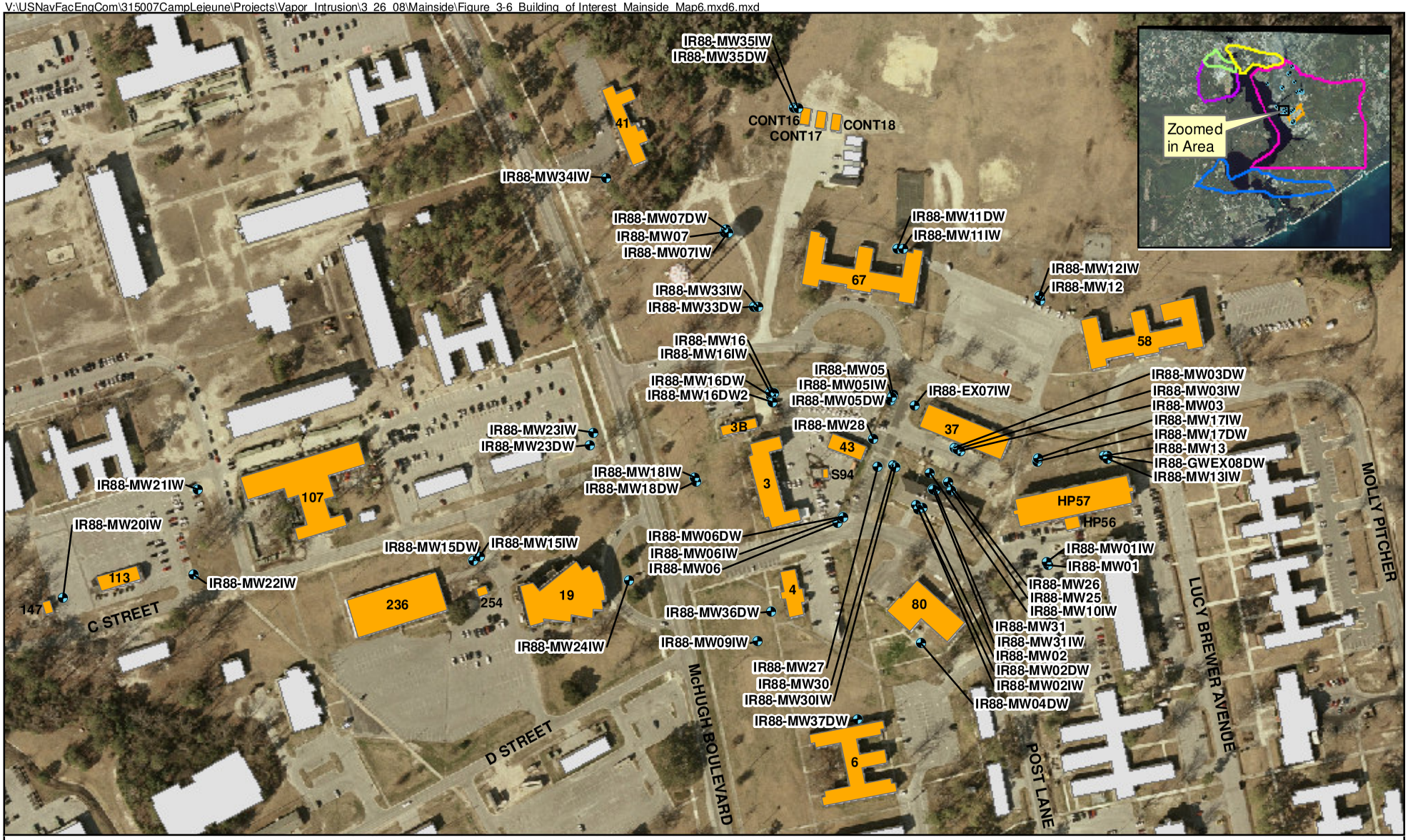
N

0 50 100 200 Feet

Figure 3-5
Buildings of Interest - Mainside Map 5
MCB Camp Lejeune
North Carolina

AGVIO
CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\Mainside\Figure_3-6_Building_of_Interest_Mainside_Map6.mxd6.mxd



Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

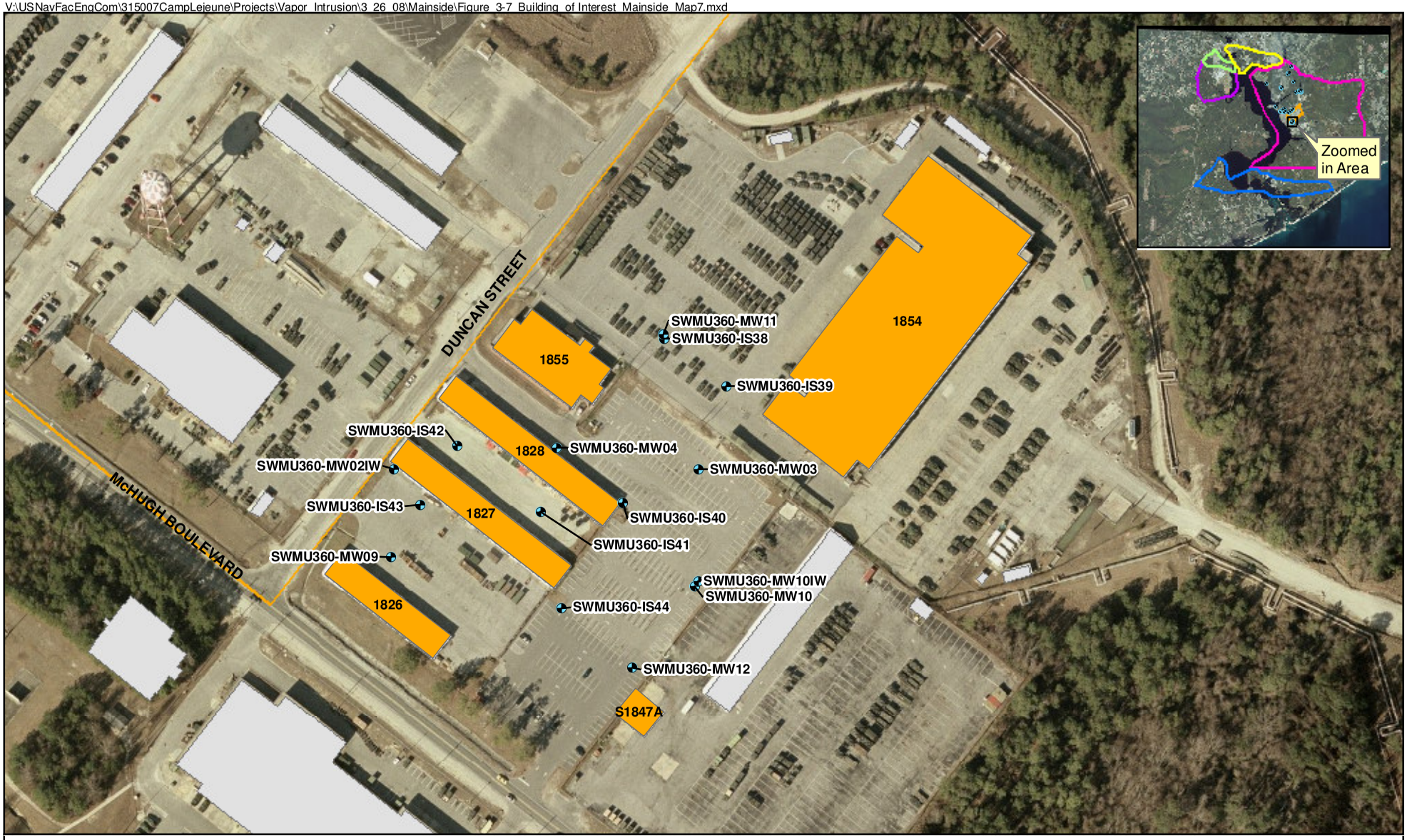
N

0 150 300 600 Feet

Figure 3-6
Buildings of Interest - Mainside Map 6
MCB Camp Lejeune
North Carolina

AGVIO
CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\Mainside\Figure_3-7_Building_of_Interest_Mainside_Map7.mxd



Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

N

0 100 200 400 Feet

Figure 3-7
Buildings of Interest - Mainside Map 7
MCB Camp Lejeune
North Carolina

AGVIO CH2M HILL

\\APHRODITE\PROJ\USNAVFACENGCOM\315007CAMPLEJEUNE\PROJECTS\VAPOR_INTRUSION\3_26-07\Mainside\Figure_3-8_Building_of_Interest_Mainside_Map8.mxd

Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

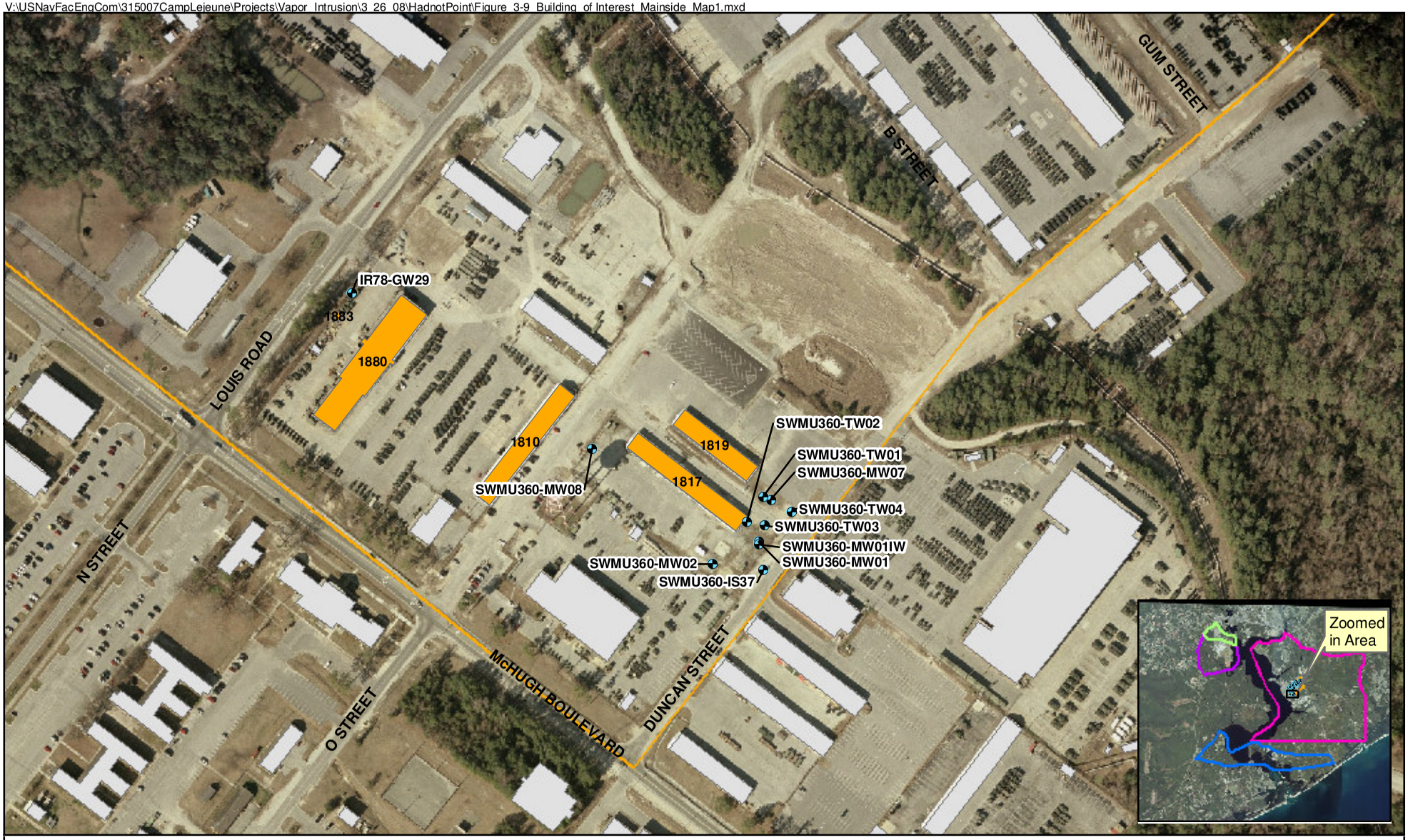
N

0 100 200 400 Feet

Figure 3-8
Buildings of Interest - Mainside Map 8
MCB Camp Lejeune
North Carolina

AGVIO CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\HadnotPoint\Figure_3-9_Building_of_Interest_Mainside_Map1.mxd



Legend

- Monitoring Well with exceedances
- Buildings within100ft of Monitoring Wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

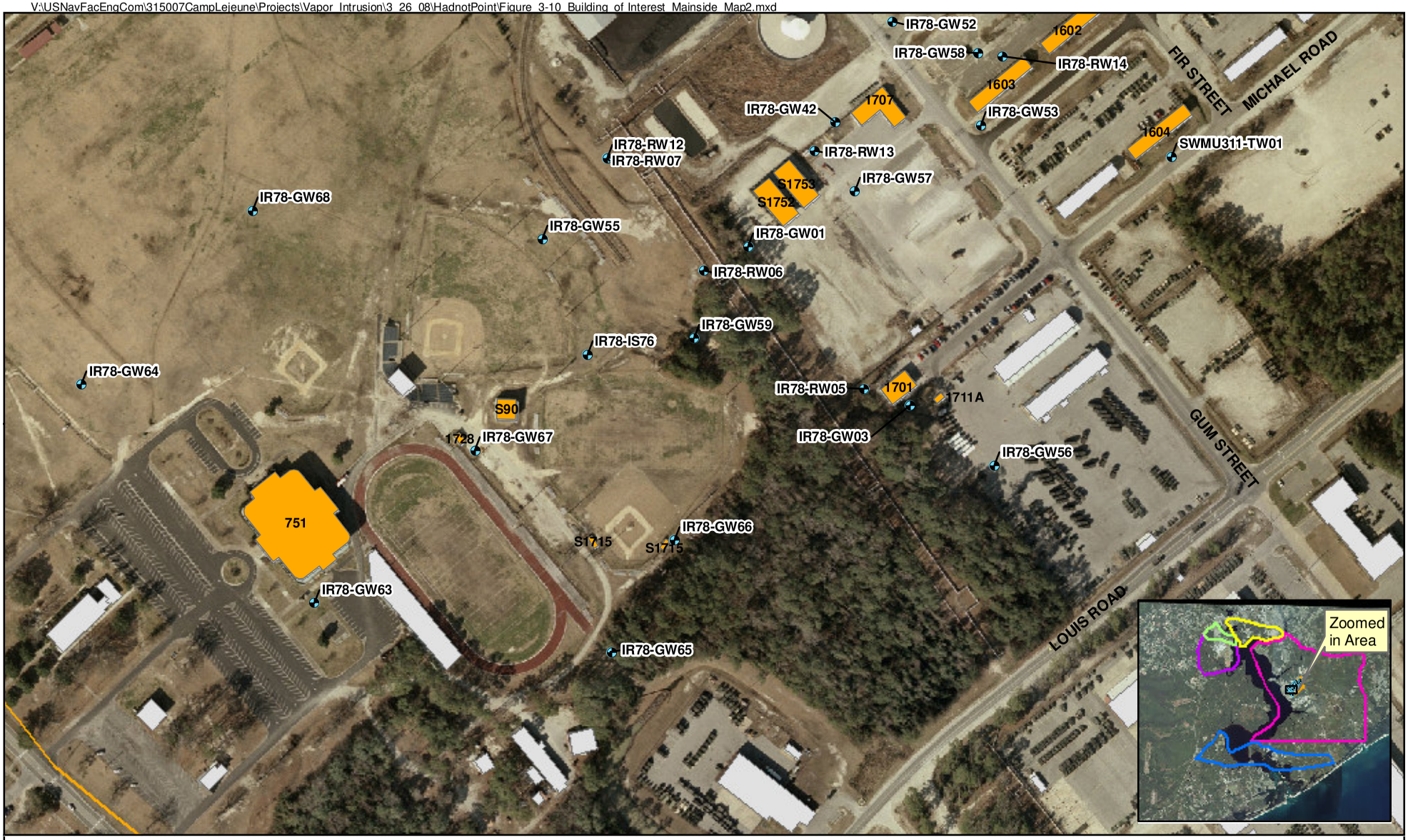
N

0 150 300 600 Feet

Figure 3-9
Buildings of Interest - Hadnot Point Map 1
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\HadnotPoint\Figure_3-10_Building_of_Interest_Mainside_Map2.mxd



Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

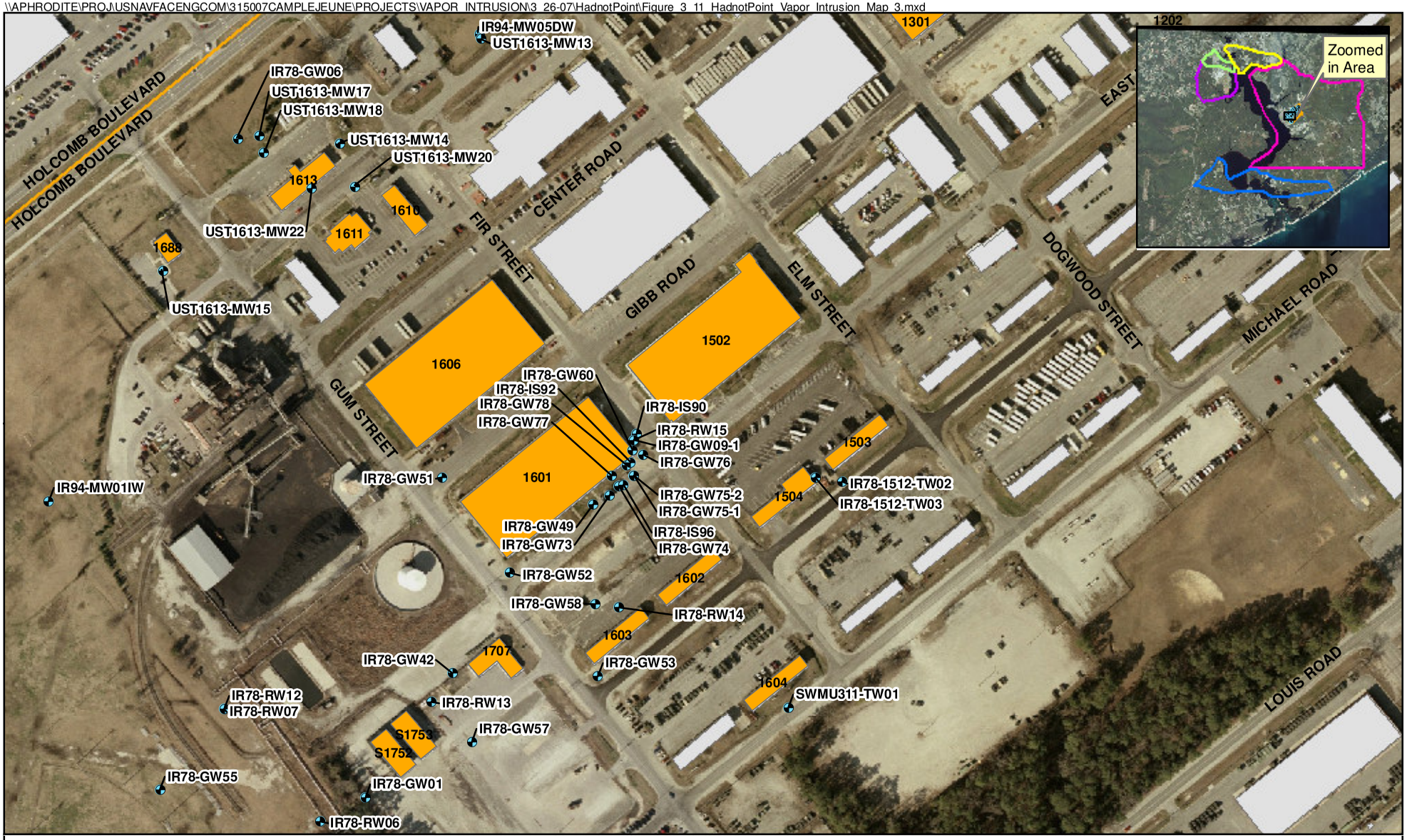
N

0 150 300 600 Feet

Figure 3-10
Buildings of Interest - Hadnot Point Map 2
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

\\APHRODITE\PROJ\USNAVFACENGCOM\315007CAMPLEJEUNE\PROJECTS\VAPOR_INTRUSION\3_26-07\HadnotPoint\Figure_3_11_HadnotPoint_Vapor_Intrusion_Map_3.mxd



Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

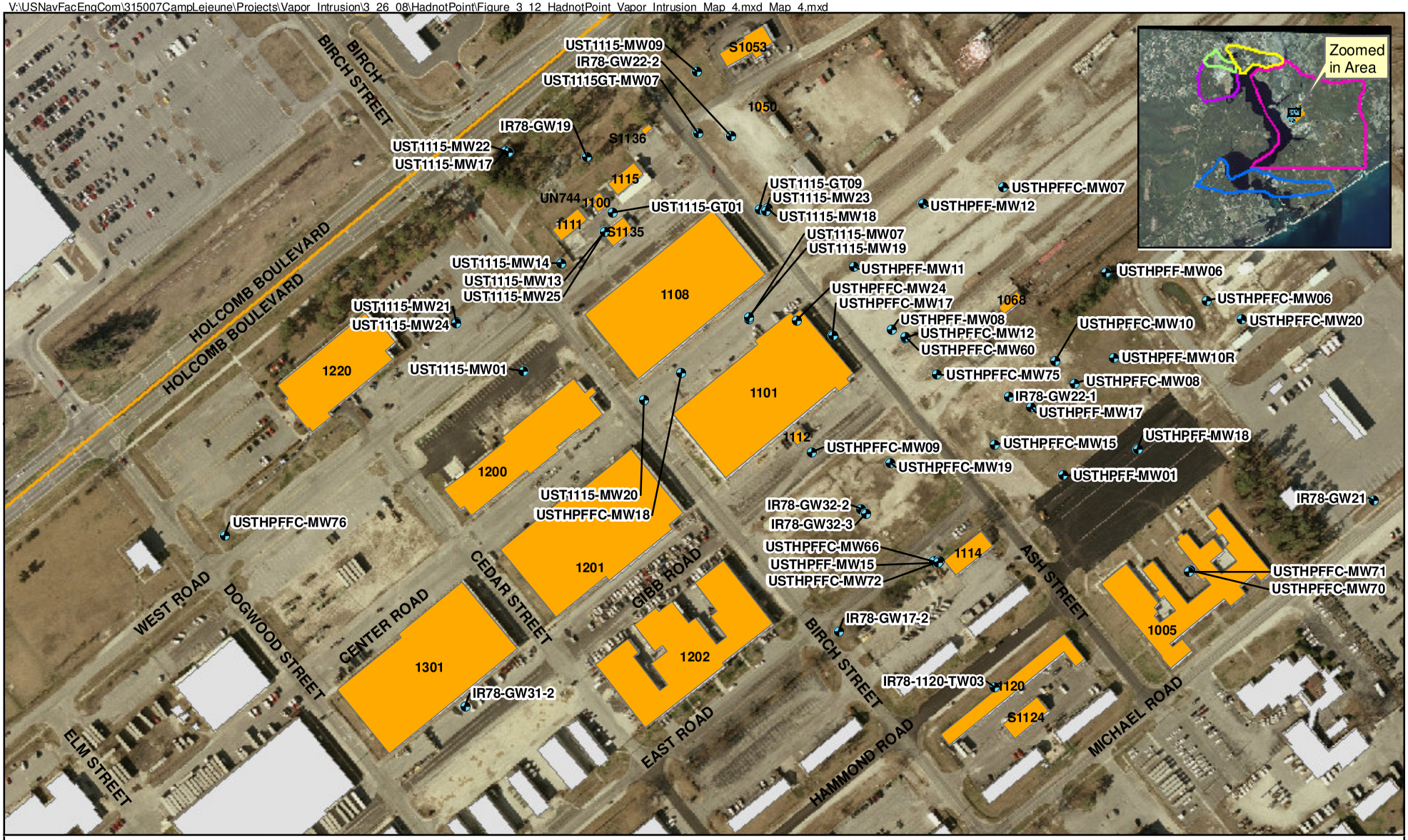
N

0 150 300 600 Feet

Figure 3-11
Buildings of Interest - Hadnot Point Map 3
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\HadnotPoint\Figure_3_12_HadnotPoint_Vapor_Intrusion_Map_4.mxd Map_4.mxd



Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

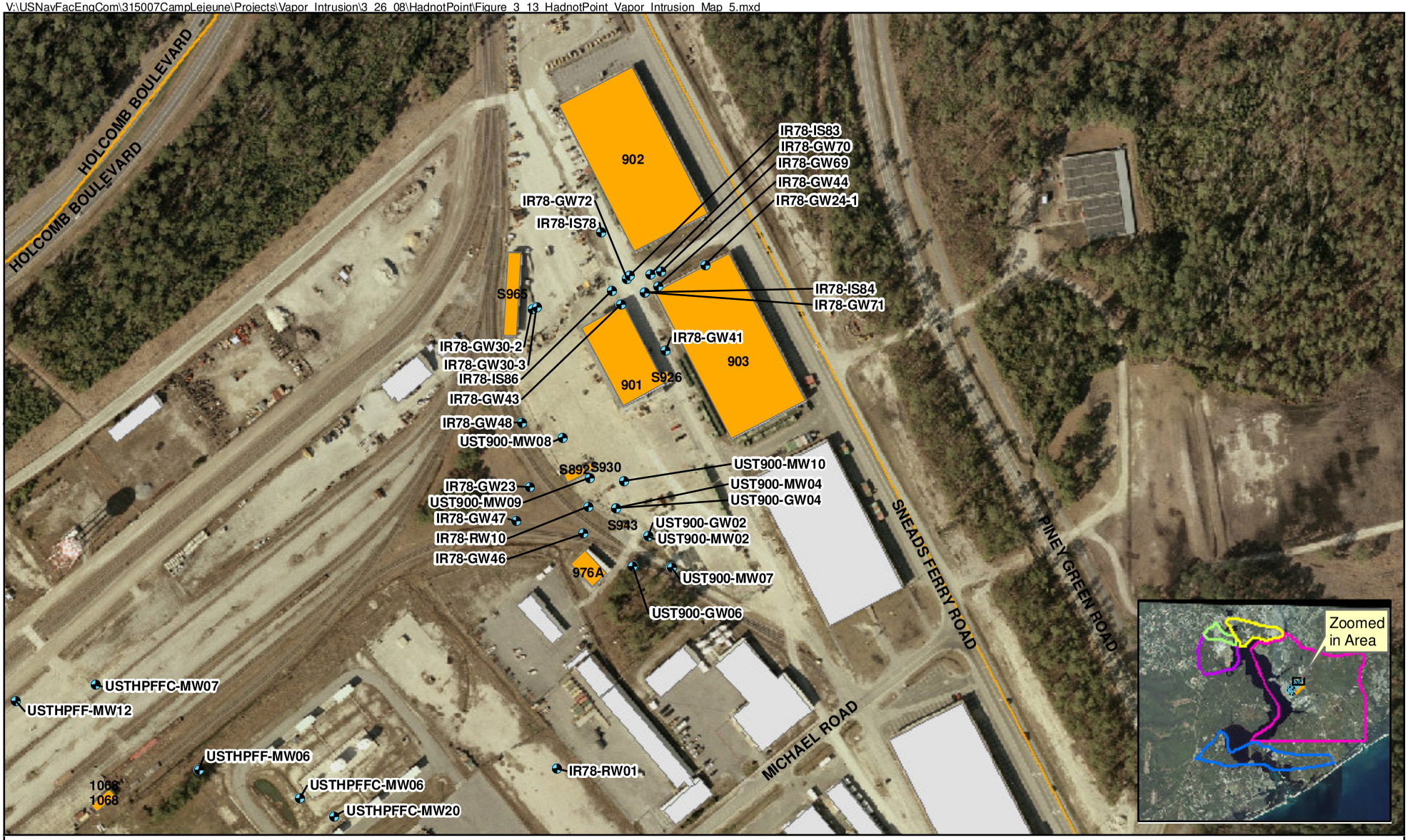
N

0 150 300 600 Feet

Figure 3-12
Buildings of Interest Hadnot Point Map 4
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\HadnotPoint\Figure_3_13_HadnotPoint_Vapor_Intrusion_Map_5.mxd



Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

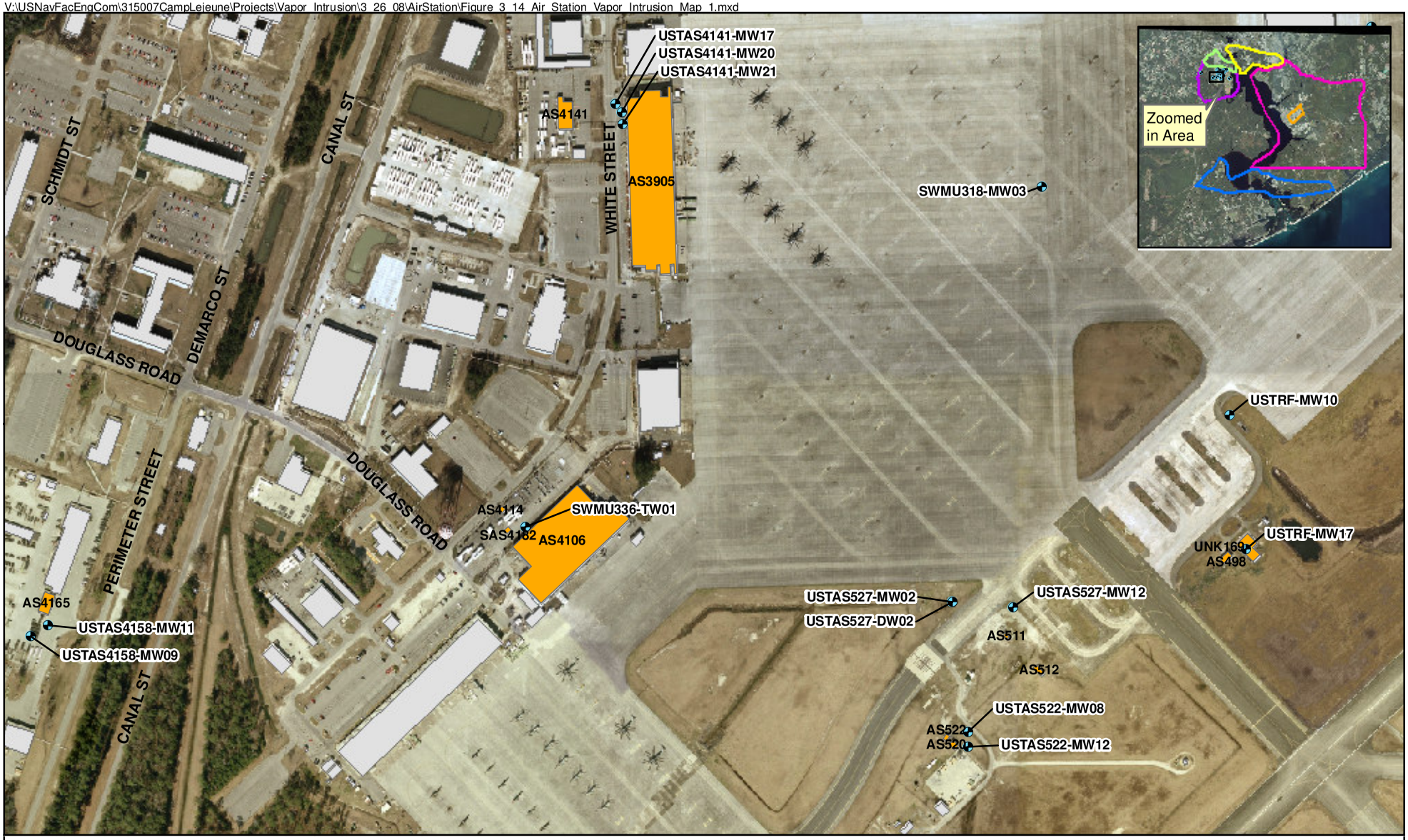
N

0 150 300 600 Feet

Figure 3-13
Buildings of Interest - Hadnot Point Map 5
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\AirStation\Figure_3_14_Air_Station_Vapor_Intrusion_Map_1.mxd



Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

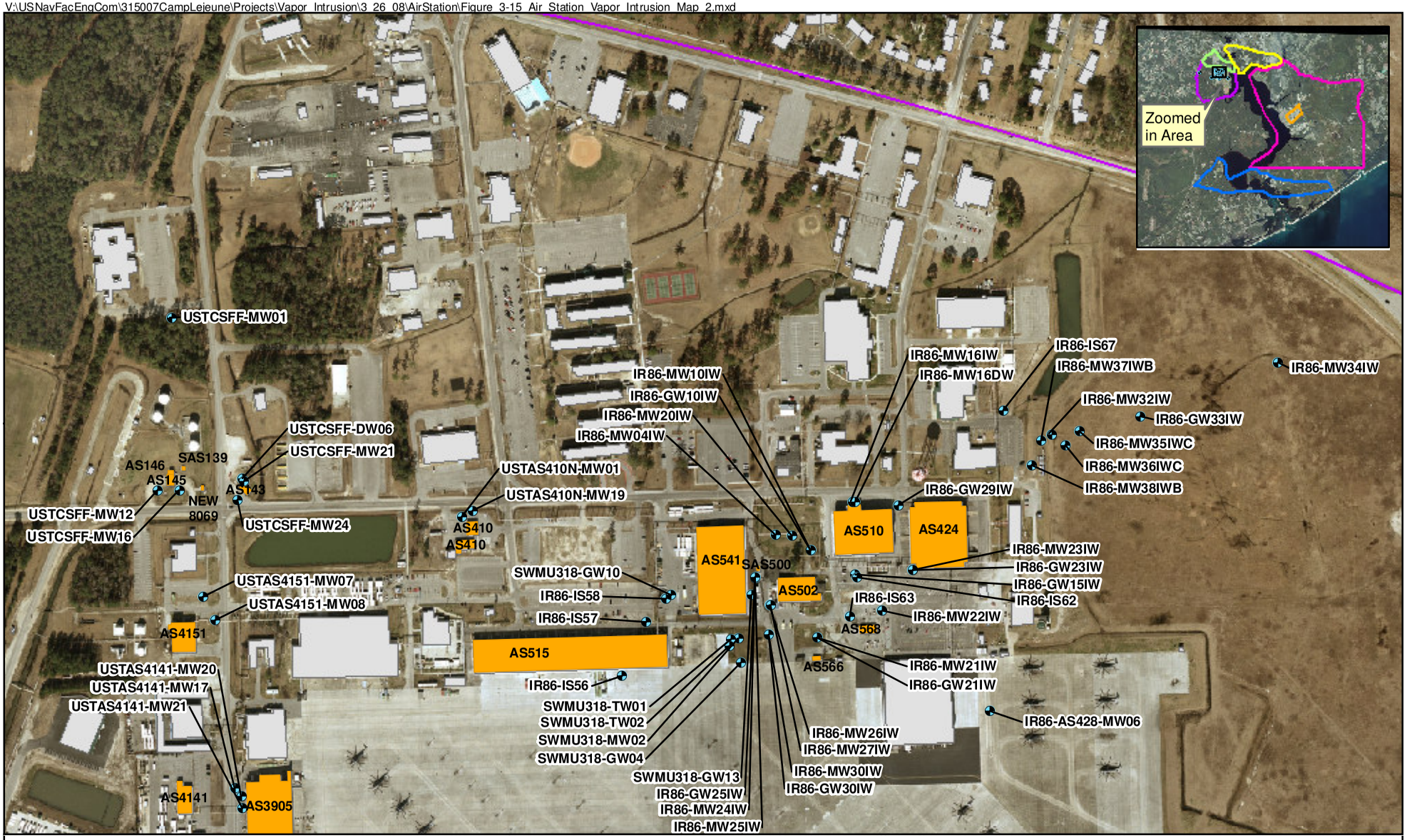
N

0 250 500 1,000 Feet

Figure 3-14
Buildings of Interest - Air Station Map1
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\AirStation\Figure_3-15_Air_Station_Vapor_Intrusion_Map_2.mxd



Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

N

0 250 500 1,000 Feet

Figure 3-15
Buildings of Interest - Air Station Map 2
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\AirStation\Figure_3-16_Air_Station_Vapor_Intrusion_Map_3.mxd

Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

N

0 250 500 1,000 Feet

Figure 3-16
Buildings of Interest - Air Station Map 3
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\CourthouseBay\Figure_3-17_Courthouse_Bay_Vapor_Intrusion_Map_1.mxd

Legend

- Monitoring Well with exceedances
- Buildings within100ft of Monitoring Wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

N

0 200 400 800 Feet

Figure 3-17
Buildings of Interest - Courthouse Bay Map 1
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\CourthouseBay\Figure_3-18_Courthouse_Bay_Vapor_Intrusion_Map_2.mxd

Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

N

0 200 400 800 Feet

Figure 3-18
Buildings of Interest - Courthouse Bay Map 2
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\CampGeiger\Figure_3-19_Camp_Griger_Vapor_Intrusion_Map_1.mxd

Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

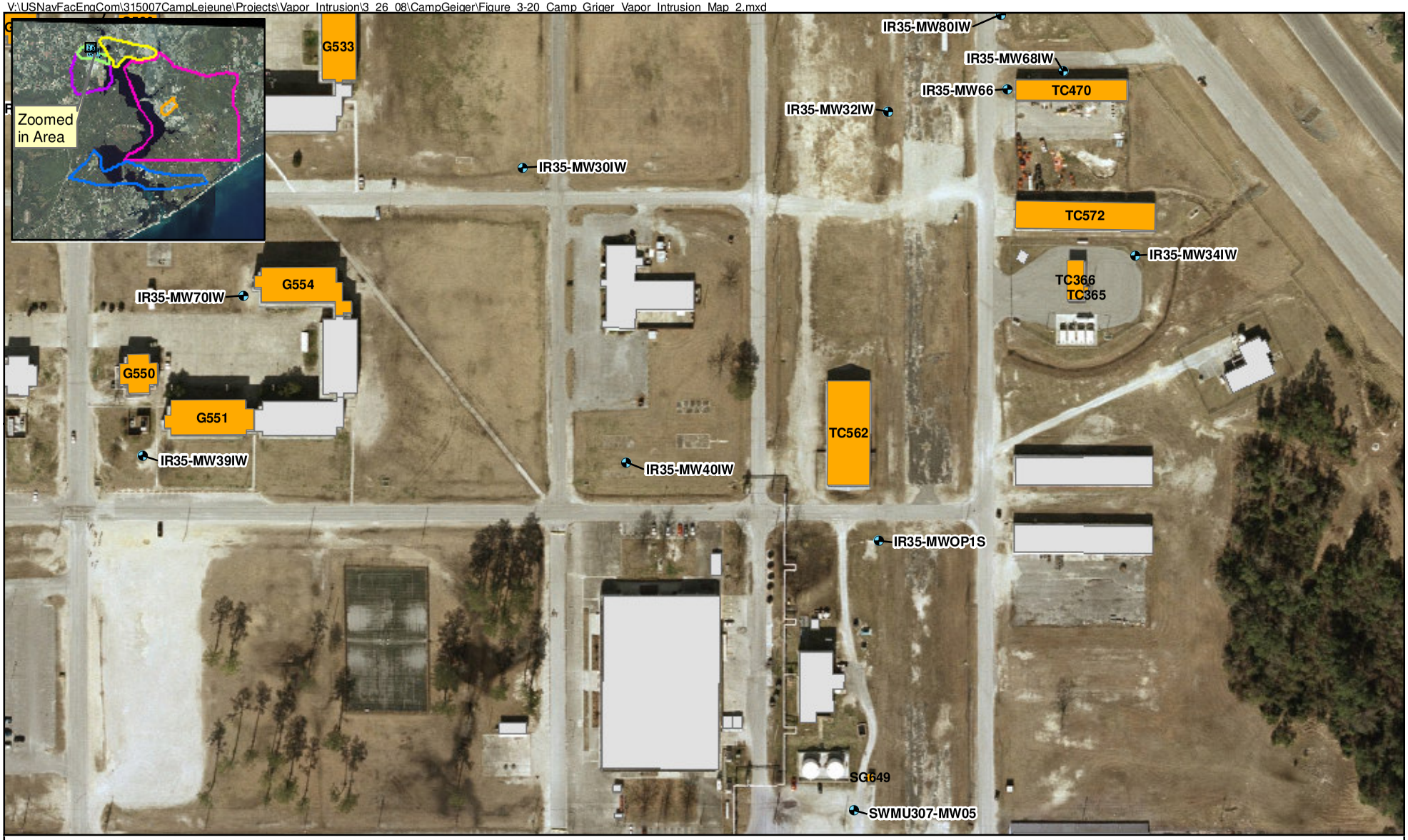
N

0 100 200 400 Feet

Figure 3-19
Buildings of Interest - Camp Geiger Map 1
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\CampGeiger\Figure_3-20_Camp_Griger_Vapor_Intrusion_Map_2.mxd



Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

N

0 100 200 400 Feet

Figure 3-20
Buildings of Interest - Camp Geiger Map 2
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\CampGeiger\Figure_3-21_Camp_Griger_Vapor_Intrusion_Map_3.mxd

Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

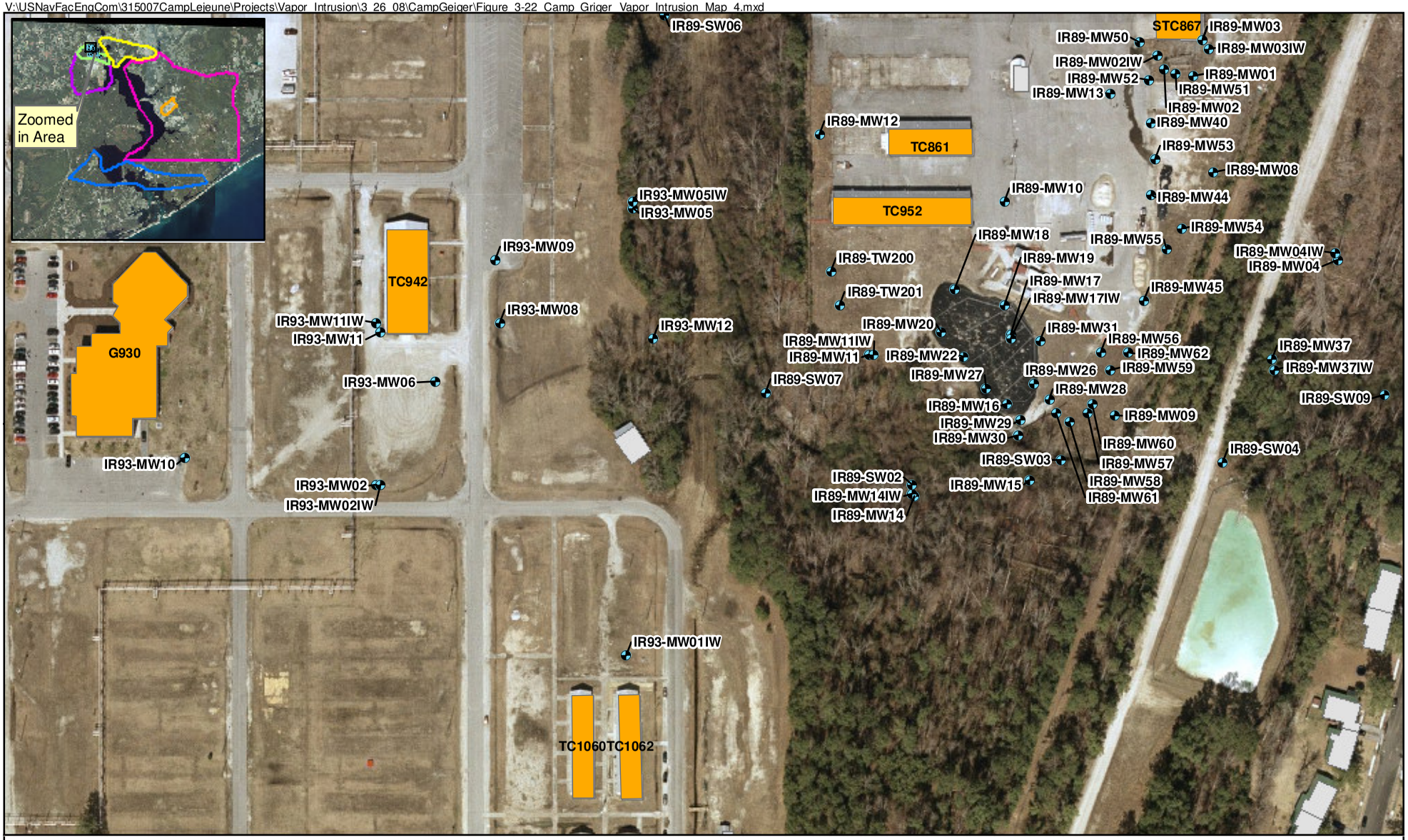
N

0 100 200 400 Feet

Figure 3-21
Buildings of Interest - Camp Geiger Map 3
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\CampGeiger\Figure_3-22_Camp_Griger_Vapor_Intrusion_Map_4.mxd



Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

N

0 100 200 400 Feet

Figure 3-22
Buildings of Interest - Camp Geiger Map 4
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\TarrawaTerrace\Figure_3-23_Camp_Tarrawa_Terrace_Intrusion_Map_1.mxd

Legend

- Monitoring Well with exceedances
- Buildings within 100ft of NCGWQS of wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

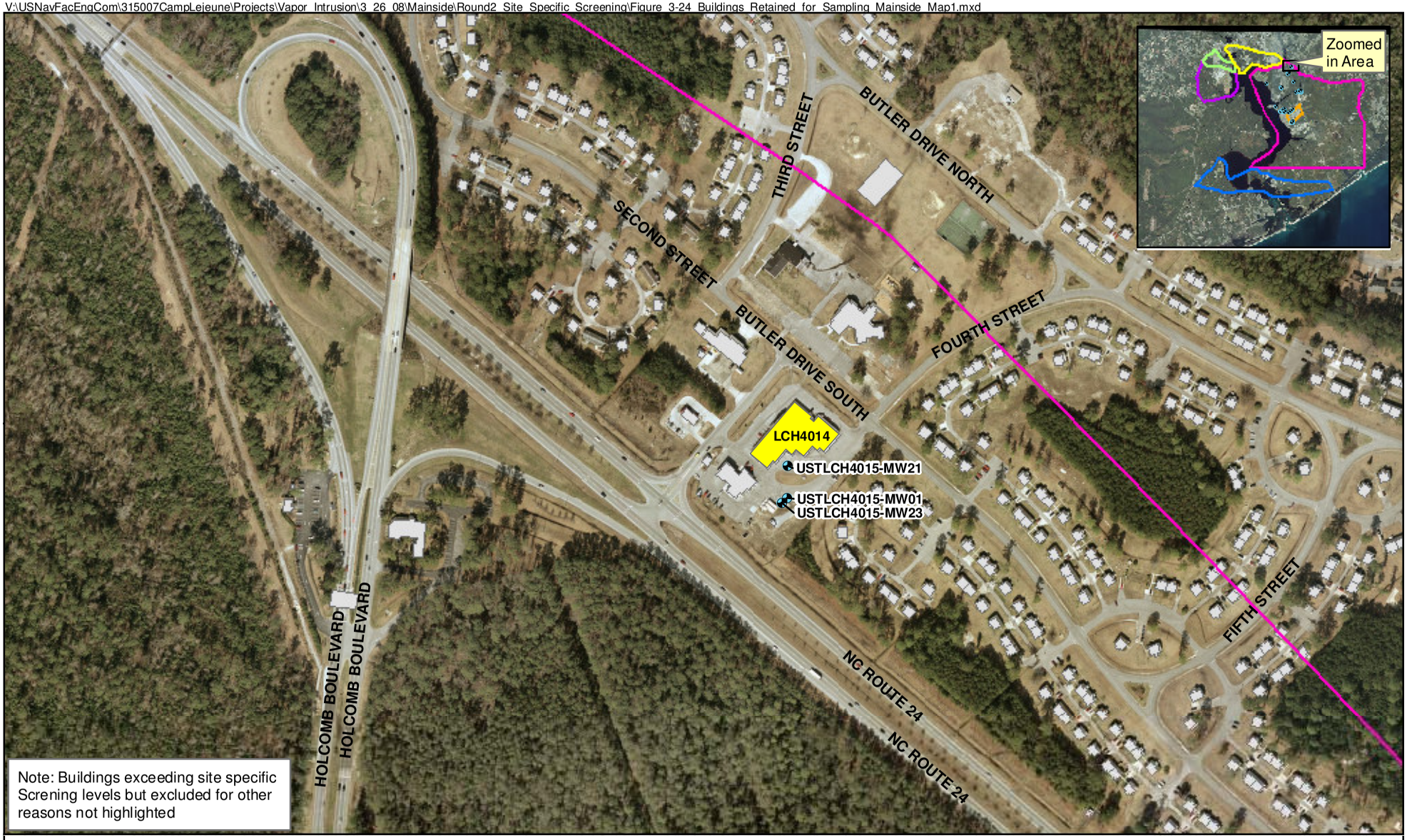
N

0 50 100 200 Feet

Figure 3-23
Buildings of Interest Tarrawa Terrace Map 1
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\Mainside\Round2_Site_Specific_Screening\Figure_3-24_Buildings_Retained_for_Sampling_Mainside_Map1.mxd



Legend

- Monitoring Well with exceedances
- Buildings within100ft of Monitoring Wells exceeding small building criteria
- Buildings within100ft of Monitoring Wells exceeding large building criteria
- Retained due to free product or system
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

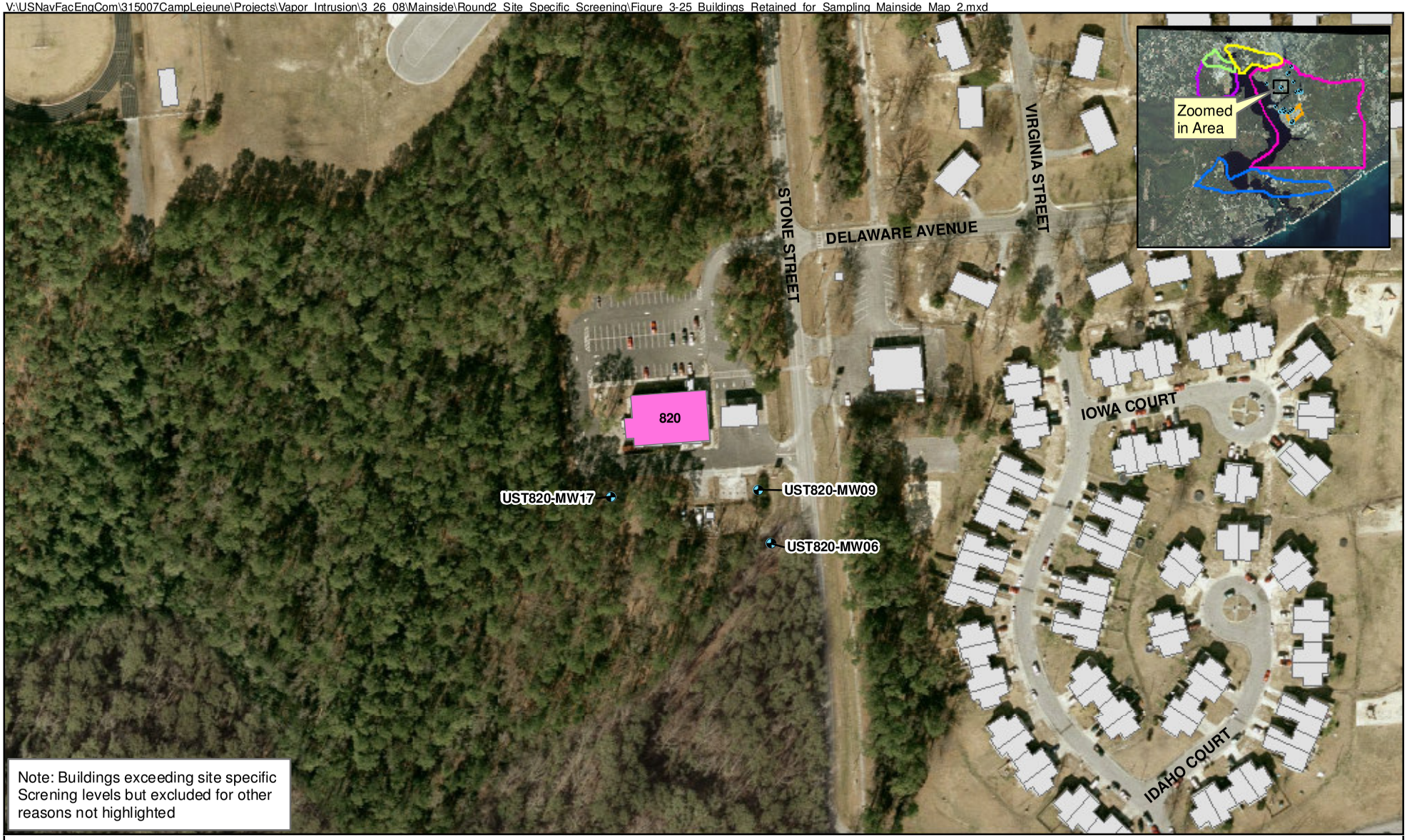
N

0 200 400 800 Feet

Figure 3-24
Buildings Retained for Sampling - Mainside Map 1
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\Mainside\Round2_Site_Specific_Screening\Figure_3-25_Buildings_Retained_for_Sampling_Mainside_Map_2.mxd



Note: Buildings exceeding site specific Screning levels but excluded for other reasons not highlighted

Legend

- Monitoring Well with exceedances
- Buildings within100ft of Monitoring Wells exceeding small building criteria
- Buildings within100ft of Monitoring Wells exceeding large building criteria
- Retained due to free product or system
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

N

0 100 200 400 Feet

Figure 3-25
Buildings retained for Sampling - Mainside Map 2
MCB Camp Lejeune
North Carolina

AGVIO CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\Mainside\Round2_Site_Specific_Screening\Figure_3-26_Buildings_Retained_for_Sampling_Mainside_Map_3.mxd

Legend

- Monitoring Well with exceedances
- Buildings within100ft of Monitoring Wells exceeding small building criteria
- Buildings within100ft of Monitoring Wells exceeding large building criteria
- Retained due to free product or system
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

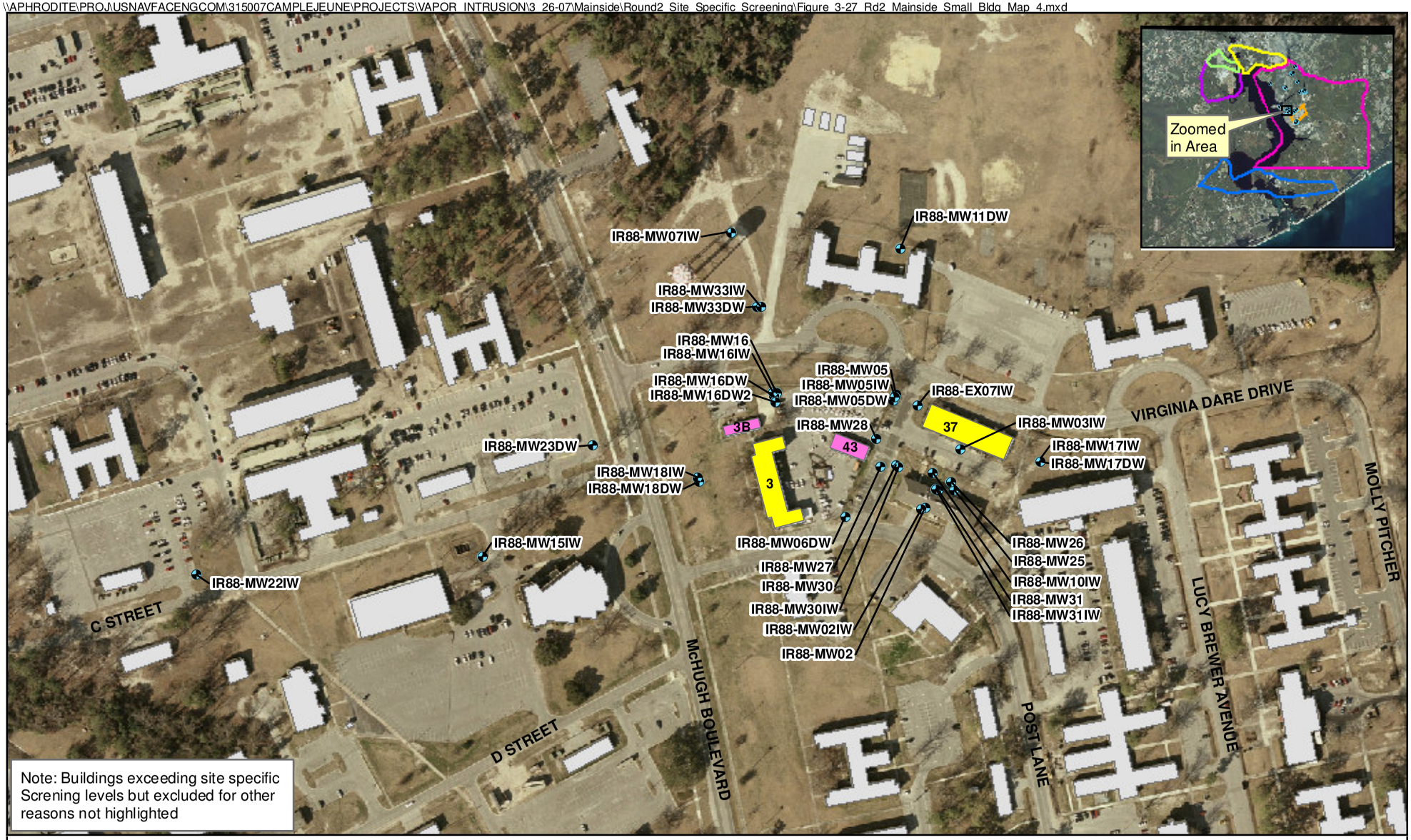
N

0 50 100 200 Feet

Figure 3-26
Buildings Retained for Sampling - Mainside Map 3
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

\\APHRODITE\PROJ\USNAVFACENGCOM\315007CAMPLEJEUNE\PROJECTS\VAPOR_INTRUSION\3_26-07\Mainside\Round2_Site_Specific_Screening\Figure_3-27_Rd2_Mainside_Small_Bldg_Map_4.mxd



Legend

- Monitoring Well with exceedances
- Buildings within100ft of Monitoring Wells exceeding small building criteria
- Buildings within100ft of Monitoring Wells exceeding large building criteria
- Retained due to free product or system
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

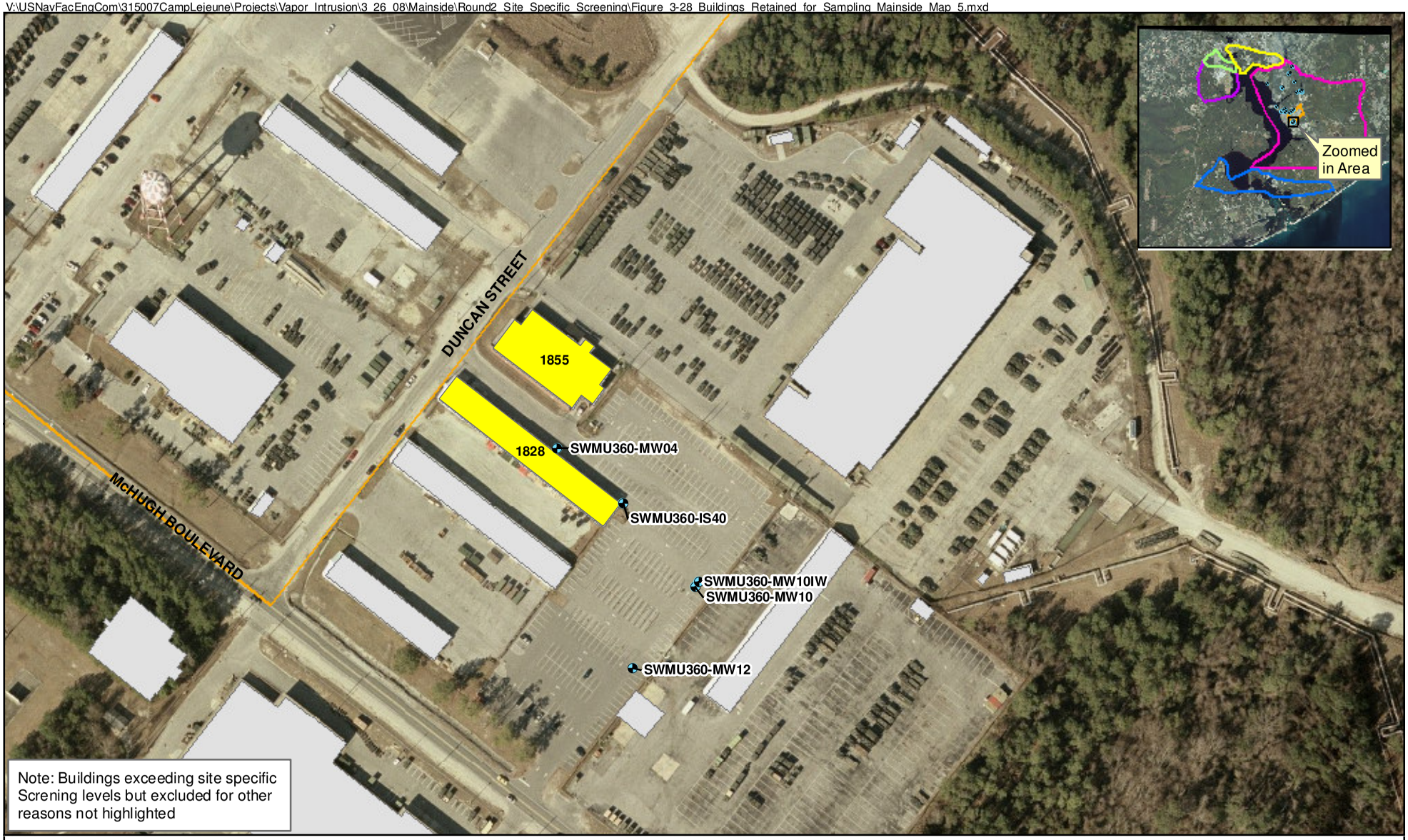
N

0 150 300 600 Feet

Figure 3-27
Buildings Retained for Sampling - Mainside Map 4
MCB Camp Lejeune
North Carolina

AGVIO
CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\Mainside\Round2_Site_Specific_Screening\Figure_3-28_Buildings_Retained_for_Sampling_Mainside_Map_5.mxd



Legend

- Monitoring Well with exceedances
- Buildings within100ft of Monitoring Wells exceeding small building criteria
- Buildings within100ft of Monitoring Wells exceeding large building criteria
- Retained due to free product or system
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

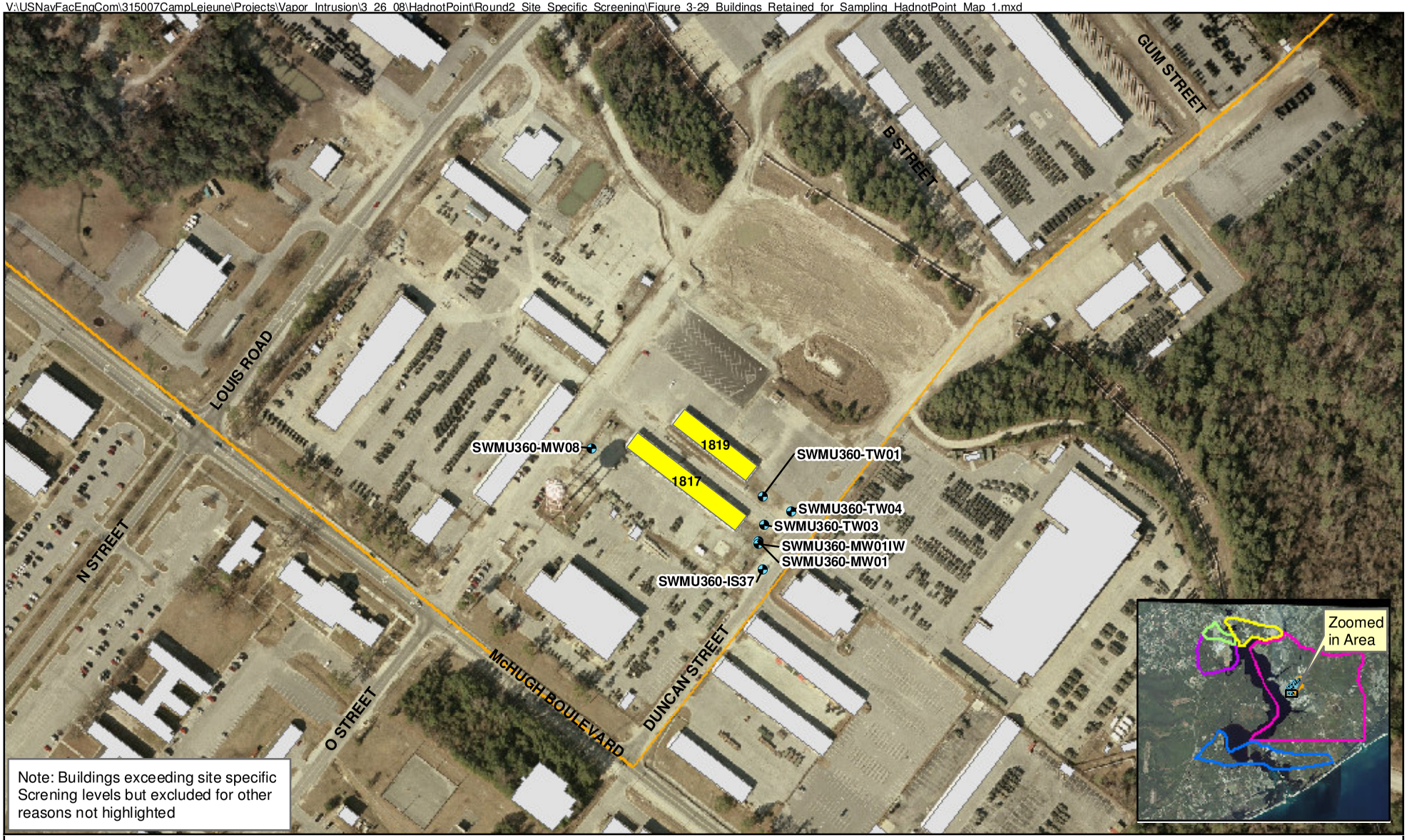
N

0 100 200 400 Feet

Figure 3-28
Buildings Retained for Sampling - Mainside Map 5
MCB Camp Lejeune
North Carolina

AGVIO CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\HadnotPoint\Round2_Site_Specific_Screening\Figure_3-29_Buildings_Retained_for_Sampling_HadnotPoint_Map_1.mxd



Legend

- Monitoring Well with exceedances
- Buildings within100ft of Monitoring Wells exceeding small building criteria
- Buildings within100ft of Monitoring Wells exceeding large building criteria
- Retained due to free product or system
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

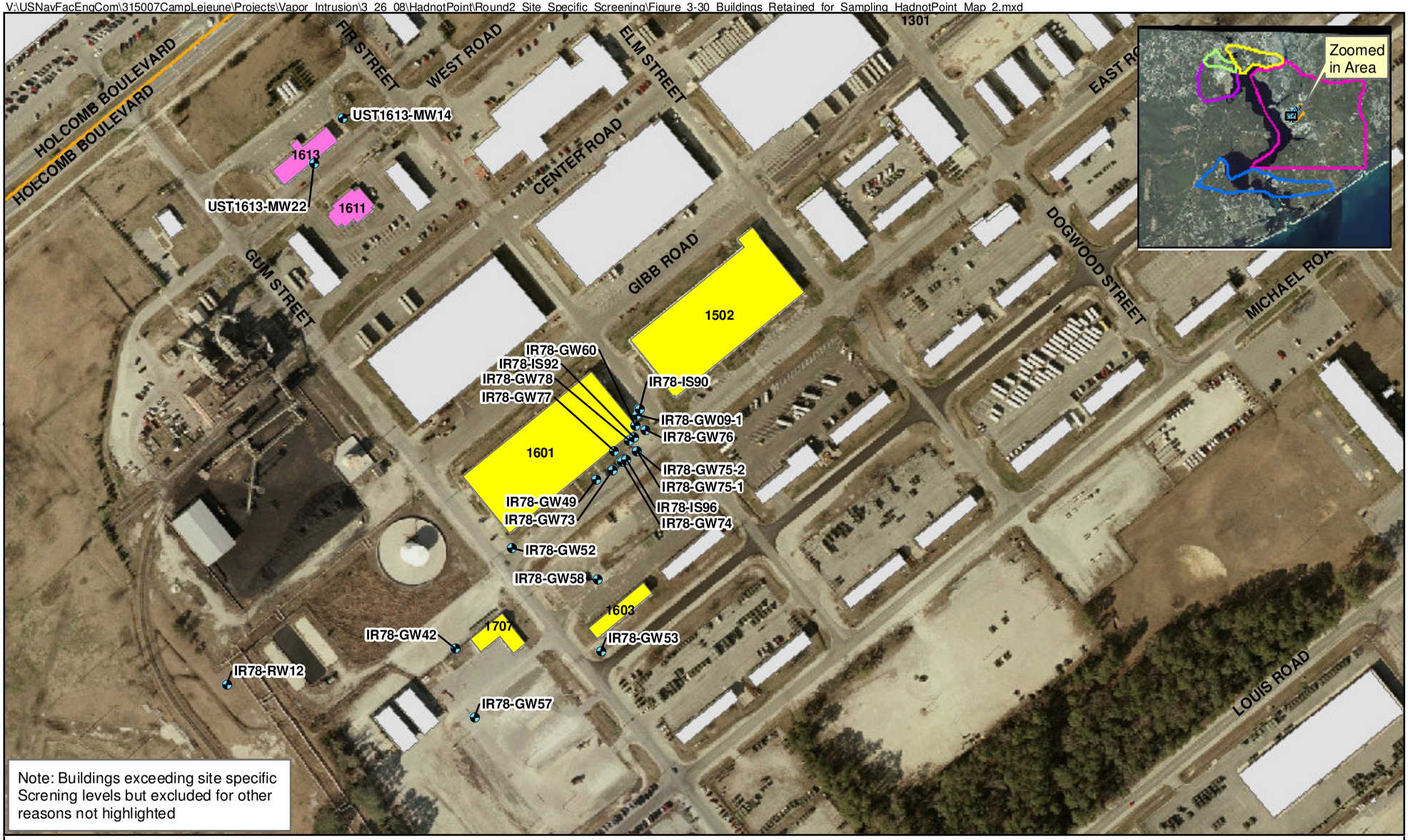
N

0 150 300 600 Feet

Figure 3-29
Buildings Retained for Sampling - Hadnot Point Map 1
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\HadnotPoint\Round2_Site_Specific_Screening\Figure_3-30_Buildings_Retained_for_Sampling_HadnotPoint_Map_2.mxd



Legend

- Monitoring Well with exceedances
- Buildings within100ft of Monitoring Wells exceeding small building criteria
- Buildings within100ft of Monitoring Wells exceeding large building criteria
- Retained due to free product or system
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

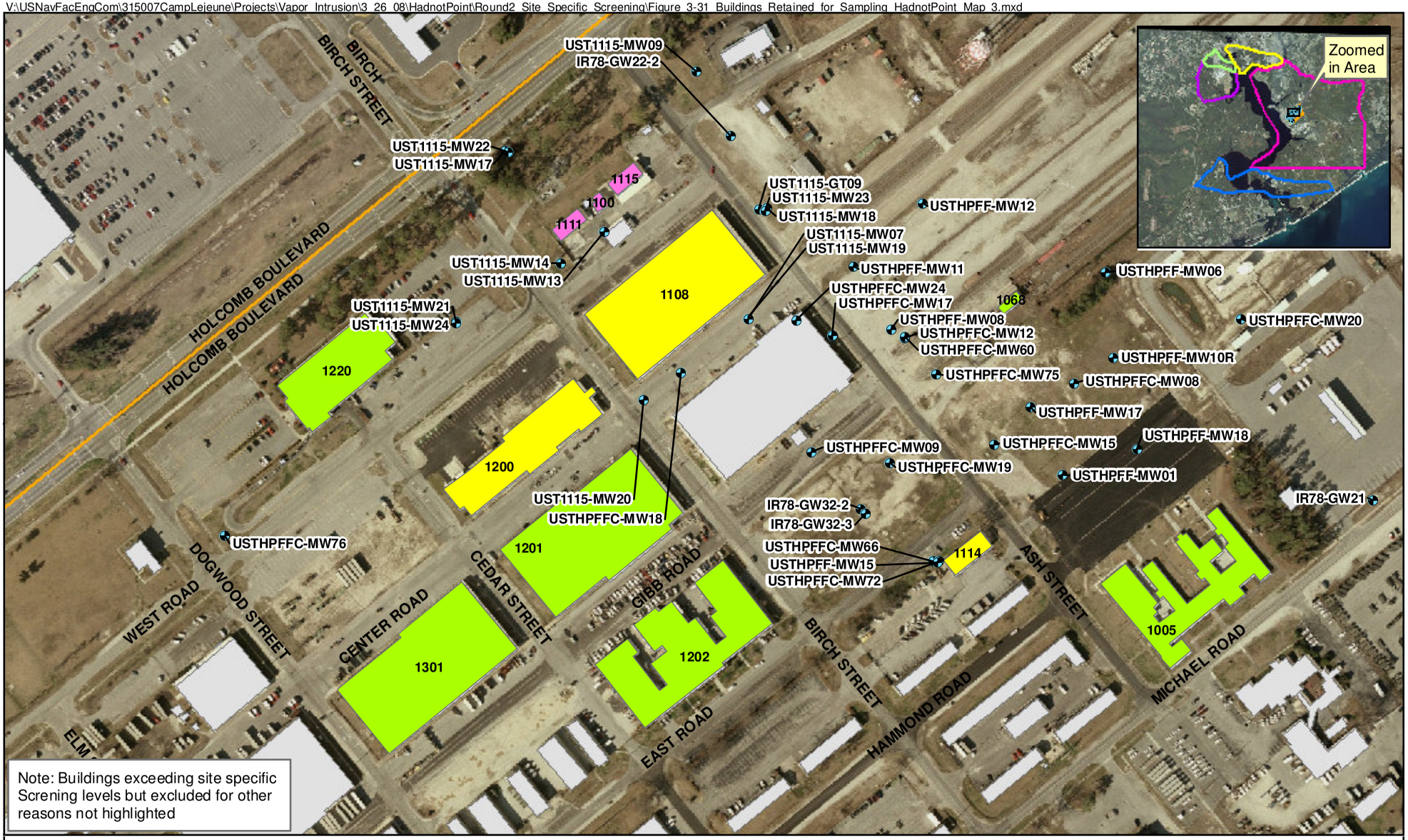
N

0 150 300 600 Feet

Figure 3-30
Buildings Retained for Sampling - Hadnot Point Map 2
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\HadnotPoint\Round2_Site_Specific_Screening\Figure_3-31_Buildings_Retained_for_Sampling_HadnotPoint_Map_3.mxd



Note: Buildings exceeding site specific Screning levels but excluded for other reasons not highlighted

Legend

- Monitoring Well with exceedances
- Buildings within100ft of Monitoring Wells exceeding small building criteria
- Buildings within100ft of Monitoring Wells exceeding large building criteria
- Retained due to free product or system
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

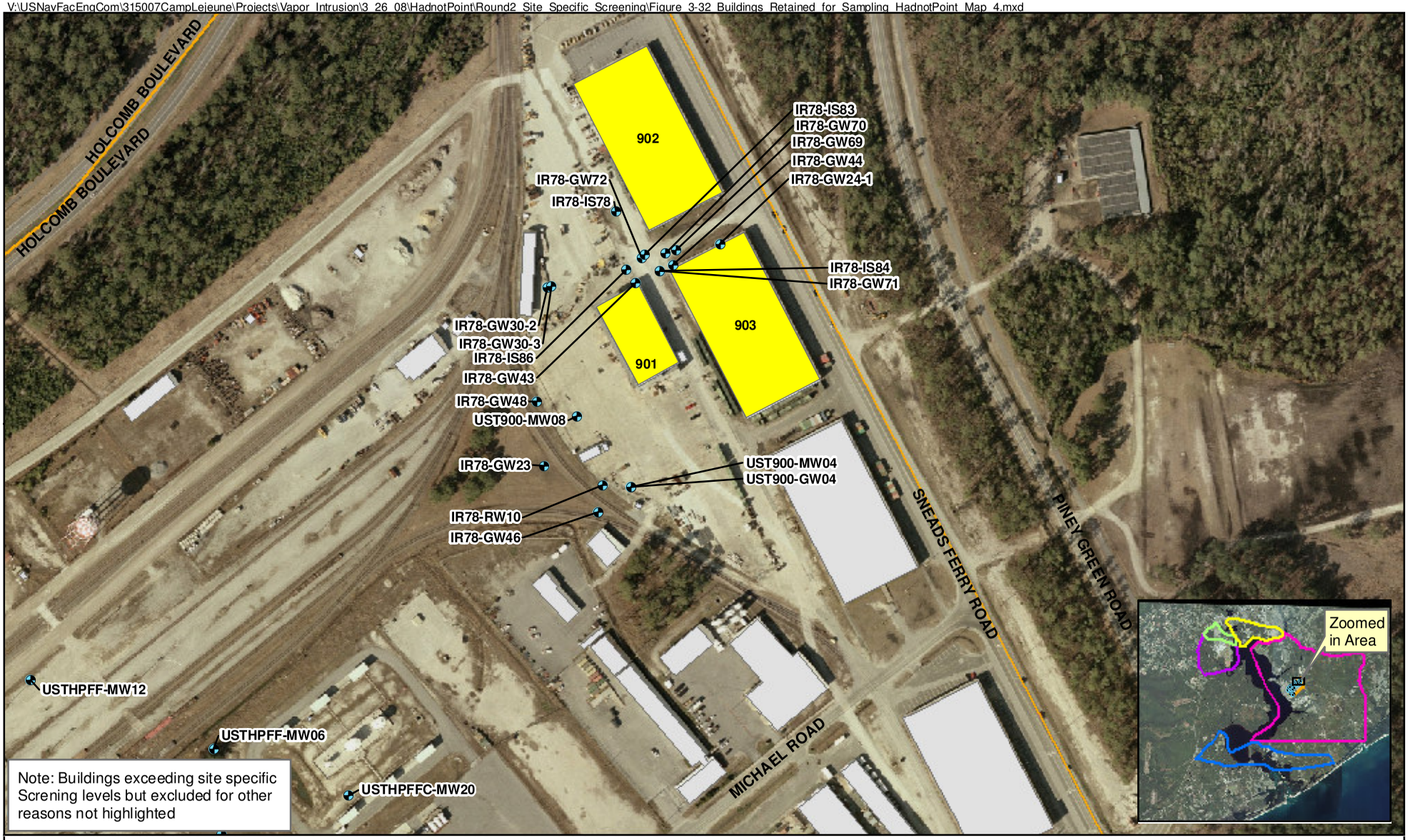
N

0 150 300 600 Feet

Figure 3-31
Buildings Retained for Sampling - Hadnot Point Map 3
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\HadnotPoint\Round2_Site_Specific_Screening\Figure_3-32_Buildings_Retained_for_Sampling_HadnotPoint_Map_4.mxd



Note: Buildings exceeding site specific Screning levels but excluded for other reasons not highlighted

Legend

- Monitoring Well with exceedances
- Buildings within100ft of Monitoring Wells exceeding small building criteria
- Buildings within100ft of Monitoring Wells exceeding large building criteria
- Retained due to free product or system
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

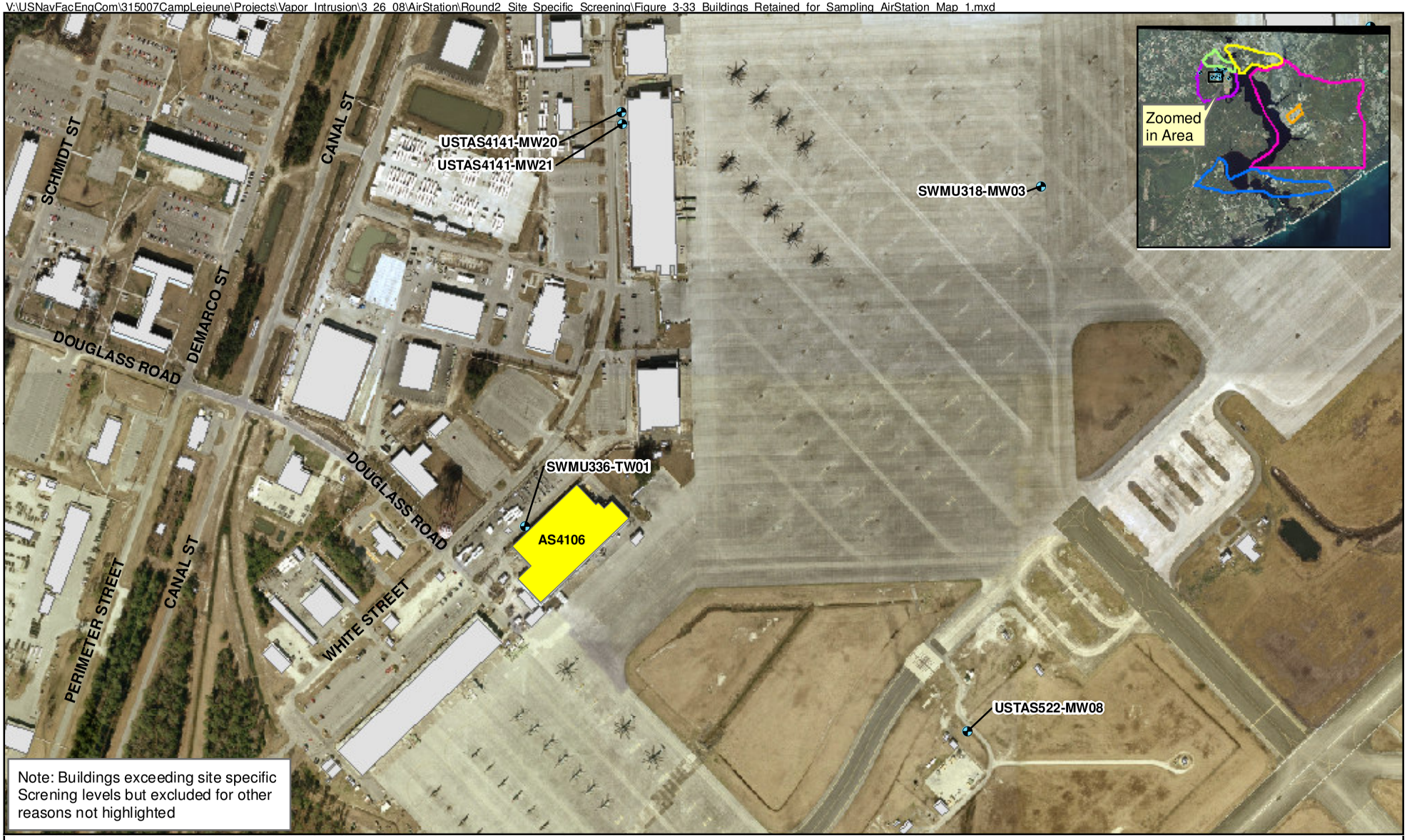
N

0 150 300 600 Feet

AGVIQ CH2M HILL

Figure 3-32
Buildings Retained for Sampling - Hadnot Point Map 4
MCB Camp Lejeune
North Carolina

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\AirStation\Round2_Site_Specific_Screening\Figure_3-33_Buildings_Retained_for_Sampling_AirStation_Map_1.mxd



Legend

- Monitoring Well with exceedances
- Buildings within100ft of Monitoring Wells exceeding small building criteria
- Buildings within100ft of Monitoring Wells exceeding large building criteria
- Retained due to free product or system
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

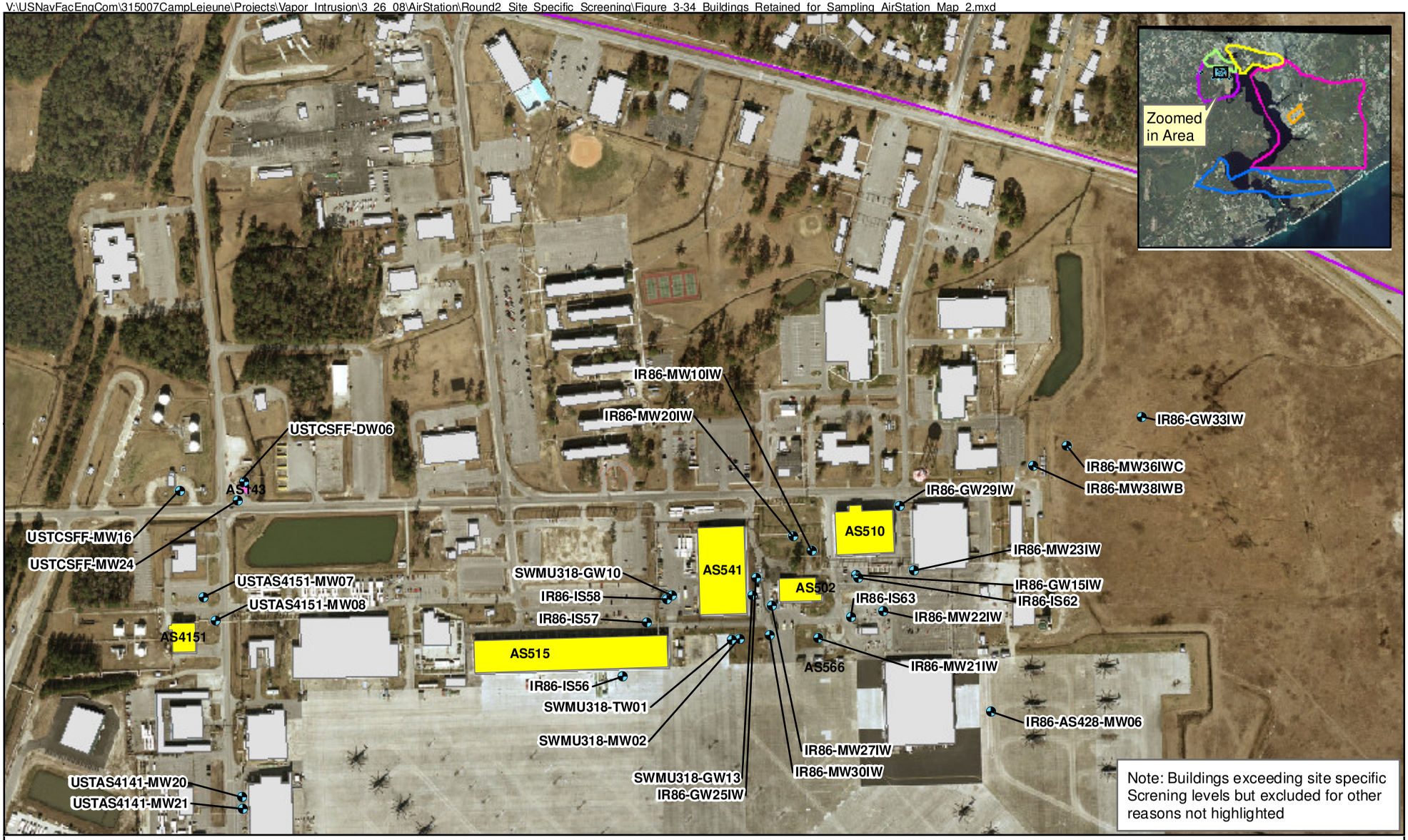
N

0 250 500 1,000 Feet

Figure 3-33
Buildings Retained for Sampling - Air Station Map 1
MCB Camp Lejeune
North Carolina

AGVIO CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\AirStation\Round2_Site_Specific_Screening\Figure_3-34_Buildings_Retained_for_Sampling_AirStation_Map_2.mxd



Legend

- Monitoring Well with exceedances
- Buildings within100ft of Monitoring Wells exceeding small building criteria
- Buildings within100ft of Monitoring Wells exceeding large building criteria
- Retained due to free product or system
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

N

0 250 500 1,000 Feet

Figure 3-34
Buildings Retained for Sampling - Air Station Map 2
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\CourthouseBay\Round2_Site_Specific_Screening\Figure_3-35_Buildings_Retained_for_Sampling_CourthouseBay_Map_1.mxd

Note: Buildings exceeding site specific Screning levels but excluded for other reasons not highlighted

Legend

- Monitoring Well with exceedances
- Buildings within100ft of Monitoring Wells exceeding small building criteria
- Buildings within100ft of Monitoring Wells exceeding large building criteria
- Retained due to free product or system
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

N

0 200 400 800 Feet

Figure 3-35
Buildings Retained for Sampling - Courthouse Bay Map 1
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\CampGeiger\Round2_Site_Specific_Screening\Figure_3-36_Buildings_Retained_for_Sampling_CampGeiger_Map_1.mxd

Legend

- Monitoring Well with exceedances
- Buildings within100ft of Monitoring Wells exceeding small building criteria
- Buildings within100ft of Monitoring Wells exceeding large building criteria
- Retained due to free product or system
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

N

0 100 200 400 Feet

Figure 3-36
Buildings Retained for Sampling - Camp Geiger Map 1
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\CampGeiger\Round2_Site_Specific_Screening\Figure_3-37_Buildings_Retained_for_Sampling_CampGeiger_Map_2.mxd

Legend

- Monitoring Well with exceedances
- Buildings within100ft of Monitoring Wells exceeding small building criteria
- Buildings within100ft of Monitoring Wells exceeding large building criteria
- Retained due to free product or system
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

N

0 100 200 400 Feet

Figure 3-37
Buildings Retained for Sampling - Camp Geiger Map 2
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

V:\USNavFacEngCom\315007CampLejeune\Projects\Vapor_Intrusion\3_26_08\CampGeiger\Round2_Site_Specific_Screening\Figure_3-38_Buildings_Retained_for_Sampling_CampGeiger_Map_3.mxd

Legend

- Monitoring Well with exceedances
- Buildings within100ft of Monitoring Wells exceeding small building criteria
- Buildings within100ft of Monitoring Wells exceeding large building criteria
- Retained due to free product or system
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

N

0 100 200 400 Feet

Figure 3-38
Buildings Retained for Sampling - Camp Geiger Map 3
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

SECTION 4

Additional Data Requirements

Buildings of interest were identified for further evaluation of potential vapor intrusion using a tiered process in accordance with USEPA Guidance as detailed in Section 3. A preliminary CSM of the vapor intrusion pathway was developed for each building retained for sampling to determine the location and type of additional data needed. These preliminary CSMs were developed from existing site data (see Section 2) and from the information gathered during the preliminary building surveys (Tables 3-3 to 3-8).

In general, a CSM for vapor intrusion pathway evaluation describes potential contaminant sources, potential migration pathways, and potential human receptors under current and/or future building uses. For this evaluation, only current land use has been considered. The exposure route for vapor intrusion is the inhalation of contaminants in indoor air.

VOCs migrate following concentration gradients from source areas of high concentration to surrounding areas of lower concentration by diffusion. If a nearby building is negatively pressurized in relation to the subsurface soil, soil gas will be pulled into the building through openings in the slab by diffusion, advection, and convection. Subsurface conditions influence the ability for soil gas transport though the subsurface and the rate of transport. The extent of depressurization and the amount of openings in the buildings are also factors in determining the presence/magnitude of vapor intrusion.

The preliminary CSMs that were developed for each building address the following building and site characteristics which are significant to the vapor intrusion pathway:

- **Size**—The indoor air volume is determined by the dimensions of the building. Contaminated soil gas entering a building with a large indoor air volume will be more diluted than in a building with a small indoor air volume.
- **Construction Materials**—This determines how tightly the building envelope is sealed and affects the rate of outdoor air exchange.
- **Crawl Space or Basement**—The presence of a basement or crawl space reduces the distance from the building to the subsurface contamination. Also, if there is a crawl space it will not be possible to collect subslab samples.
- **Doors, Windows and/or Loading Docks**—These features increase outdoor air exchange.
- **Use and Occupancy**—This determines the potential human receptors. For this evaluation, the barracks are considered to have a use consistent with industrial use due to their size and the duration of exposure.
- **Depth to Groundwater**—The depth to groundwater determines the size of the vadose zone, and when the potential source of VOCs is groundwater, it also determines the travel distance for soil gas from the contaminant source to building slab.

- **Groundwater Flow Direction**—A contaminant source in groundwater can be either transported away from or towards a building depending on the groundwater flow direction.
- **Soil type**—The presence of finer grained soils such as clay in the vadose zone reduces the effective porosity of the soil, therefore reducing the amount of soil gas and the diffusion of VOCs through soil compared to coarser grained soils such as sand and gravel

The preliminary CSMs were developed with limited building information that could be obtained through available plans and drawings, and from "windshield" surveys. The condition of the slab and the heating, ventilating, and air conditioning (HVAC) system, and the presence of underground utilities, have not been assessed at this time. During field data collection, additional building information will be collected for buildings requiring more extensive evaluation of potential vapor intrusion pathways. The additional information and analytical data will be used to refine the CSMs.

Based on the preliminary CSMs, buildings were grouped for sampling and DQOs were developed for use in determining proposed sample types and locations. The CSMs, DQOs, and proposed sample types and locations are presented by area of the Base below.

4.1 Mainside

4.1.1 CSMs

One IR site with four buildings, two RCRA sites with a total of three buildings, and two UST sites with a total of two buildings were identified in the Mainside area for further evaluation. CSMs developed for the identified buildings are described below by Site. The site-specific screening levels for Mainside are presented in Table 3-30.

Site 88

Site 88, the former Base Dry Cleaning Facility (former Building 25), was operated as a dry cleaning facility beginning in the 1940s. The dry cleaning operations ceased in January 2004, and the building was demolished to slab in August 2004. PCE and its degradation products are the primary site contaminants. Within Site 88, Buildings 3, 3B, 37, and 43 were retained for further evaluation (Figure 3-26).

Building 3 Building 3 is a 2 story brick and mortar building constructed slab on grade, approximately 150 feet long by 35 feet wide. The building has 7 doors, 1 double door, and 56 windows. It is used as the Project Management Office (PMO) Headquarters and is typically occupied by more than 50 people. The building is surrounded by a grassy area to the west and impermeable surfaces including roads and a parking lot to the east.

Building 3 is classified as a large industrial building for this evaluation. It is located within 100 ft of one shallow monitoring well (IR88-GW16) which has exceedance of the site-specific screening criteria for large buildings for PCE (5.49 µg/L) at 55 µg/L. The depth to groundwater at this well is approximately 8 ft. Shallow groundwater flows to the south, toward the building.

Based on the available information, there may be a vapor intrusion pathway present at Building 3 and collection of additional data is proposed (Table 4-1 and Figure 4-5).

Building 3B Building 3B is a one story brick and mortar building constructed slab on grade, approximately 60 ft long by 12 ft wide. Its use is PMO operations and storage. The building has three doors and seven windows and is typically occupied by less than five people. Building 3B is surrounded by a grassy area to the south and west, and impermeable parking lots and roads to the north and east.

Building 3B is classified as a small industrial building for this evaluation. It is located within 100 ft of one shallow monitoring well (IR88-GW16) which has exceedance of the site-specific screening criteria for small industrial buildings for PCE (4.17 µg/L) at 55 µg/L. The depth to groundwater at this well is approximately 8 ft. Shallow groundwater flows to the south, toward the building.

Based on the available information, there may be a vapor intrusion pathway present at Building 3B and collection of additional data is proposed (Table 4-1 and Figure 4-5).

Building 37 Building 37 is a 1.5 story brick and mortar building constructed slab on grade, approximately 180 ft long by 30 ft wide. Its use is confidential, but is reportedly consistent with commercial use. The building has 6 doors and 35 windows. Building 37 is surrounded by an impermeable parking lot to the south and east, and by an impermeable road to the north and west.

Building 37 is classified as a large industrial building for this evaluation. Building 37 is located within 100 ft of three monitoring wells which have exceedances of the site-specific screening for large buildings (Table 4-2).

TABLE 4-2
Building 37 Screening Criteria Exceedances

Well ID	PCE (µg/L)
Screening Criteria (Table 3-30)	*5.49*
IR88-MW05	800
IR88-MW25	3,700
IR88-MW26	400

The depth to groundwater in the vicinity of Building 37 is approximately 8 ft. Groundwater contamination in the shallow aquifer from Site 88 flows to the northwest, cross-gradient of the building.

Based on the available information, there may be a vapor intrusion pathway present at Building 37 and collection of additional data is proposed (Table 4-1 and Figure 4-5).

Building 43 Building 43 is a one story brick and mortar building constructed slab on grade, approximately 40 ft long by 20 ft wide. Its use is military police operations and military police motor pool. The building has three doors and 14 windows and is typically occupied by less than 15 people. Building 43 is surrounded by impermeable surfaces including a parking lot and a road.

Building 43 is classified as a small industrial building for this evaluation. It is located within 100 ft of three shallow monitoring wells which have exceedances of the site-specific screening criteria for large buildings (Table 4-3).

TABLE 4-3
Building 43 Screening Criteria Exceedances

Well ID	Benzene (µg/L)	PCE (µg/L)	TCE (µg/L)	cis-1,2 DCE (µg/L)
Screening Criteria (Table 3-30)	*8.65*	*4.17*	*20.0*	*1,320*
IR88-MW27	-	500	590	30,000
IR88-MW28	-	2,400	130	-
IR88-MW30	10	-	-	-

The depth to groundwater in the vicinity of Building 43 is approximately 10 ft. Shallow groundwater flows to the southwest, toward the building.

Based on the available information, there may be a vapor intrusion pathway present at Building 43 and collection of additional data is proposed (Table 4-1 and Figure 4-5).

SWMU 118

SWMU 118 has been identified as a former 1,000-gallon UST and fuel line at the Gottschalk Marina of MCB Camp Lejeune. The UST, historically used for storing and supplying fuels for the marina, was removed in July 2005. Elevated gasoline range organics were reported in a soil sample collected adjacent to the fuel line and near Building S195 (gazebo) during tank removal. Building 728 was the only building within the vicinity of SWMU 118 to be retained for further evaluation (Figure 3-25).

Building 728 Building 728 is a 2 story cinder block and wood building that is approximately 30 ft long by 30 ft wide. The building has 18 windows and two doors. It is used as a nautical gift shop and is typically occupied by less than 10 people.

Building 728 is classified as a small industrial building for this evaluation. It is located within 100 ft of one shallow monitoring well (SWMU118-TW01) which has exceedances of the site-specific screening criteria for small buildings for benzene (8.65 µg/L) at 13,000 µg/L. Groundwater flows north/northwest toward Wallace Creek, away from Building 728.

Based on the available information, there may be a vapor intrusion pathway present at Building 728 and collection of additional data is proposed (Table 4-1 and Figure 4-4).

SWMU 360

SWMU 360 was a former 300 gallon waste oil underground storage tank (UST) near Building 1817. The UST was removed in July 1997. The results of a Limited Site Assessment (LSA) revealed chlorinated solvents, primarily PCE and TCE, in soil and groundwater. Within the vicinity of SWMU 360, buildings 1828 and 1855 were retained for further evaluation (Figure 3-27).

Building 1828 Building 1828 is a 1.5 story corrugated steel building constructed slab on grade, approximately 300 ft long by 45 ft wide with two doors and five large double warehouse doors. Its use is food service and combat logistics regiment operations. Building 1828 is surrounded by an impervious parking lot and road.

Building 1828 is classified as a large industrial building for this evaluation. Building 1828 is located within 100 ft of one shallow monitoring well (SWMU360-MW04) which has exceedances of the site-specific screening criteria for large industrial buildings for PCE (5.49 µg/L) at 13 µg/L. The depth to groundwater at SWMU-MW04 is approximately 20 feet. Shallow groundwater flows to the southeast, away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building 1828 and collection of additional data is proposed (Table 4-1 and Figure 4-6).

Building 1855 Building 1855 is a two story brick and mortar building constructed slab on grade, approximately 175 ft long by 80 ft wide. The building has four doors, a loading dock, and six windows. It is used as the Second Tank Battalion (2d Tank Bn), Second Marine Division (2d MARDIV) Headquarters and is typically occupied by 13 to 15 people.

Building 1855 is classified as a large industrial building for this evaluation. Building 1855 is located within 100 ft of one shallow monitoring well (SWMU360-MW04) which has exceedances of the site-specific screening criteria for large industrial buildings for PCE (5.49 µg/L) at 13 µg/L. The depth to groundwater at SWMU360-MW04 is approximately 20 ft. Shallow groundwater flows to the southeast, away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building 1828 and collection of additional data is proposed (Table 4-1 and Figure 4-6).

Site 820

Building 820 is located in the Berkley Manor residential area of MCB Camp Lejeune. Building 820 is currently an active Marine Corps Exchange gas station. Four USTs are located south of the building, three 10,000-gallon gasoline USTs and one 10,000-gallon diesel UST. The USTs were upgraded in 1995. Petroleum hydrocarbons are the primary site contaminants. Building 820 is the only building within Site 820 retained for further evaluation (Figure 3-24).

Building 820 Building 820 is a one story brick and mortar building constructed slab on grade, approximately 80 ft long by 80 ft wide, and serves as a gas station. The building has a glass front, two double doors, a door for unloading, and is typically occupied by less than 10 people. Building 820 is surrounded by impermeable surfaces including a parking lot and a road.

Building 820 is classified as a large industrial building for this evaluation. Building 820 is located within 100 ft of one shallow monitoring well (UST820-MW17) which has exceedances of the site-specific screening criteria for large industrial building for benzene (11.9 µg/L) at 53.4 µg/L. The depth to groundwater in this well is approximately 13 ft. Shallow groundwater flows to the southwest, towards the building.

Based on the available information, there may be a vapor intrusion pathway present at Building 820 and collection of additional data is proposed (Table 4-1 and Figure 4-3).

UST LCH-4015

Building LCH-4015 consists of the community center building (LCH-4014), former fueling and maintenance area (LCH-4015, removed), Marine Corps Exchange Convenience Store (LCH-4034), and the former fuel tank farm. A former AST system began operation in 1945 at the site. The primary site contaminants are petroleum hydrocarbons. Building LCH-4014 is the only building with the UST LCH-4015 site retained for further evaluation (Figure 3-23).

Building LCH-4014 Building LCH-4014 is a one story brick and mortar building constructed slab on grade, approximately 80 ft long by 50 ft wide. It serves as a gas station and convenience store. The building has 2 doors and 2 windows and is typically occupied buy less than 10 people. Building LCH-4014 is surrounded by impermeable surfaces on all sides.

Building LCH-4014 is classified as a large building for this evaluation. Building LCH-4014 is located within 100 ft of one shallow monitoring well (USTLCH4015-MW21) which has exceedances of the site-specific screening criteria for large industrial buildings for benzene (11.9 µg/L) at 21.0 µg/L. The depth to groundwater at USTLCH4015-MW21 is approximately 11 feet. Shallow groundwater flows to the southeast, away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building LCH-4014 and collection of additional data is proposed (Table 4-1 and Figure 4-2).

4.1.2 DQOs

Based on the CSMs presented above, DQOs for Mainside were developed for use in selecting sample types and locations. These DQOs are presented in Table 4-4.

TABLE 4-4
Data Quality Objectives—Mainside

Step 1: Statement of Problem	Groundwater within Mainside has been impacted by chlorinated VOCs, specifically PCE, TCE, and their daughter products, and petroleum-related VOCs, including benzene. One or more of these compounds are present above site specific screening levels in shallow groundwater within 100 ft of the buildings included in this evaluation. Additional data are required to determine whether VOCs in groundwater near these buildings represent potential vapor intrusion pathways that require further investigation.
Step 2: Identify the Decision	Additional exterior data (e.g., soil gas, groundwater), in conjunction with existing data, will provide information to determine whether subsurface contamination requires further investigation. For some buildings, specifically those within 100 ft of an AS system, or buildings within 100 ft of identified free product, subslab and/or indoor air sampling will be conducted.
Step 3: Inputs to Decisions	The preliminary CSMs developed for the buildings were used to determine additional data requirements. For the purposes of this evaluation, all buildings within Mainside are classified as industrial use buildings. Large buildings are defined as 150 to 300 ft long by 30 to 80 ft wide. Small buildings are defined as 10 to 75 ft long by 10 to 30 ft wide. Existing VOC data in exceedance of site-specific screening levels in shallow groundwater within 100 ft of each building were used, as summarized in Section 3 and the CSMs above. An offsite or mobile laboratory will be contracted to perform sample analysis. The subcontracted laboratory will use the appropriate analytical methods to reach the project specific analytical requirements.

Step 4: Study Boundaries	The Mainside area, aboard MCB Camp Lejeune, North Carolina, is generally defined as the Base property south of NC Route 24 and east of Courthouse Bay, excluding the areas defined as Hadnot Point and Courthouse Bay. Study boundaries are defined as 100 lateral feet around each building.
Step 5: Decision Rules	The decision logic for selecting sampling locations is provided as Figure 4-1 and is summarized below. For buildings within 100 ft of shallow monitoring wells containing VOCs, depth-specific groundwater samples (within the top five feet of the aquifer) will be collected at locations adjacent to buildings to determine whether VOC concentrations greater than site specific screening levels developed using the J&E model extend beneath the building. Sample locations will be based toward the highest concentrations from current data. Groundwater samples will not be collected where the water table is present at depths less than 5 ft bgs. In this case, subslab and potentially indoor air samples will be collected from the building being evaluated. The results of the groundwater sample analysis will be compared to the site-specific screening levels developed using the J&E model. Soil gas samples will be collected adjacent to buildings exceeding site-specific screening levels. Where groundwater samples are also being collected, the soil gas samples will be collected co-located with the groundwater samples. As with groundwater samples, soil gas samples will not be collected in areas where the groundwater table is present at depths less than 5 ft bgs. In this case, subslab and potentially indoor air samples will be collected from the building being evaluated. Where applicable, site-specific soil gas screening levels will be developed. Results from the soil gas samples will be compared to site-specific screening levels and/or Region IX Preliminary Remediation Goals (PRGs) for ambient air quality standards using an appropriate attenuation factor. That attenuation factor will be identified from USEPA's recently developed attenuation factors database. If free product is present within 100 ft of a building, as indicated by the observation of nonaqueous phase liquid (NAPL), or suspected based on the exceedance of 1 percent of a compound's solubility (see Table 4-5), then subslab and/or indoor air samples within the building being evaluated. Subslab and/or indoor air samples will also be collected within buildings located within 100 ft of an air sparge or biopulsing system. The subslab and/or indoor air sample results will be compared to Region IX PRGs for ambient air quality standards. Additional data will not be collected within buildings where existing soil gas or indoor air data is available, or a mitigation system is currently in place. For these buildings, existing data will be used in the evaluation. If subslab and/or indoor air data confirm that VOC concentrations exceed site-specific screening levels and/or Region IX PRGs for ambient air quality standards, additional investigation and/or mitigation measures may be recommended.
Step 6: Limits of Decision Errors	The probability of sampling and measurement errors at any site under investigation necessitates the development of sampling guidelines. Field errors are minimized by having each member of the field team follow the same standard operating procedures (SOPs) for sampling. QC samples, including duplicates, matrix spikes, matrix spike duplicates, equipment blanks, and field blanks, are used to verify the data's accuracy and precision. When a QC sample is outside of the established control limits, the data will be qualified and field corrective action implemented when applicable (such as when field duplicates are outside established control limits). Further, when subslab and.or indoor air samples are collected, ambient air QC samples will also be collected. A building survey will be conducted to identify chemicals stored or used within the building. This will ensure that concentrations detected in indoor air and or/sub-slab air samples are indicative of vapor intrusion from groundwater

Step 7: Optimize the Sampling Design	The sampling design objective is to assess the potential for vapor intrusion to result in risks to building occupants. The results of the evaluation will be used to determine whether additional investigation/risk assessment is required. Refer to Figure 4-1 for the decision logic used to optimize the sampling design.

4.1.3 Proposed Sample Locations

Based on the CSMs and DQOs provided above, 11 groundwater samples, 14 soil gas samples, six subslab, and six indoor air sample locations are proposed in the Mainside area, as summarized on Table 4-1 and shown on Figures 4-2 through 4-6.

4.2 Hadnot Point

4.2.1 CSMs

One IR site with seven buildings, one RCRA sites with two buildings, and two UST sites with a total of 13 buildings were identified in the Hadnot Point area for further evaluation. CSMs developed for the identified buildings are described below by Site. The site-specific screening levels for Hadnot Point are presented in Table 3-31.

Site 78

Site 78 is comprised of maintenance shops, warehouses, painting shops, printing shops, auto body shops, and other small industrial facilities. The majority of the site area is paved (e.g., roadways, parking lots, loading dock areas, and storage lots); however, there are many small lawn areas associated with individual buildings within the site and along lengthy stretches of roadways. Recreational ball fields and a parade ground are located in the southwest corner of the site. Due to the industrial nature of the Site, many spills and leaks have occurred over the years. Site 78 is divided into two primary sections based on the two main contaminant sources (see Section 2.2.2). The northern plume is located east of Cedar Street, extending from the vicinity of Buildings 901 and 903 to the fuel farm. The southern plume appears to originate in the vicinity of Buildings 1502, 1601, and 1602.

Site 78 North Buildings 901, 902, and 903 are located within the northern portion of Site 78 (Figure 3-31). This plume contained solvent contamination (e.g., TCE) and low-levels of fuel-related contamination (BTEX).

Building 901 It is a two story corrugated steel and fiberglass building constructed slab on grade, approximately 200 feet long by 50 feet wide. The building use is unknown but it is typically occupied by less than 20 people. The building has 4 single doors, 6 warehouse rollup doors, and approximately 100 windows. The building is surrounded by impermeable surfaces including parking lots, roads, and other buildings.

Building 901 is classified as a large industrial building for this evaluation. It is located within 100 feet of seven shallow monitoring wells which have exceedances of the site-specific screening criteria for large buildings (Table 4-6).

TABLE 4-6
Building 901 Screening Criteria Exceedances

Well ID	VC (µg/L)
Screening Criteria (Table 3-31)	*2.53*
IR78-GW43	110
IR78-GW44	650
IR78-GW70	1,700
IR78-GW71	570
IR78-GW72	250
IR78-IS84	240
IR78-IS86	120

The depth to groundwater in these wells is approximately 11 ft bgs. Shallow groundwater flows to the west, towards the building.

Based on the available information, there may be a vapor intrusion pathway present at Building 901 and collection of additional data is proposed (Table 4-7 and Figure 4-8).

Building 902 Building 902 is a 1.5 story brick and mortar building constructed slab on grade, approximately 350 ft long by 100 ft wide. The building is used by contractors for construction vehicle maintenance and is typically occupied by less than 25 people. The building has two single doors, seven to eight warehouse doors, and approximately 38 windows. The building is surrounded by impermeable surfaces including parking lots and roads.

Building 902 is classified as a large industrial building for this evaluation. It is located within 100 ft of ten shallow monitoring wells which have exceedances of the site-specific screening criteria for large buildings (Table 4-8).

TABLE 4-8
Building 902 Screening Criteria Exceedances

Well ID	Xylene (µg/L)	TCE (µg/L)	VC (µg/L)
Screening Criteria (Table 3-31)	*4,860*	*35.5*	*2.53*
IR78-GW24-1	-	-	4.0
IR78-GW44	-	-	650
IR78-GW69	-	-	840
IR78-GW70	-	-	1,700
IR78-GW71	-	-	570
IR78-GW72	-	-	250
IR78-IS78	7,200	2,500	-
IR78-IS83	-	-	140
IR78-IS84	-	-	240
IR78-IS86	-	-	120

The depth to groundwater in these wells is approximately 11 ft bgs. Shallow groundwater flows to the west, away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building 902 and collection of additional data is proposed (Table 4-7 and Figure 4-8).

Building 903 Building 903 is a 1.5 story brick and mortar building constructed slab on grade, approximately 350 ft long by 100 ft wide. The building is used by the Second Marine Expeditionary Force (II MEF) as a tire changing facility and is typically occupied by less than 25 people. The building has 11 sliding warehouse doors, 36 windows, and full loading docks in the front and back of the building. The building is surrounded by impermeable surface including parking lots and roads.

Building 903 is classified as a large industrial building for this evaluation. It is located within 100 ft of ten shallow monitoring wells which have exceedances of the site-specific screening criteria for large buildings (Table 4-9).

TABLE 4-9
Building 903 Screening Criteria Exceedances

Well ID	VC (µg/L)
Screening Criteria (Table 3-31)	*2.53*
IR78-GW24-1	4.0
IR78-GW43	110
IR78-GW44	650
IR78-GW69	840
IR78-GW70	1,700
IR78-GW71	570
IR78-GW72	250
IR78-IS83	140
IR78-IS84	240
IR78-IS86	120

The depth to groundwater in these wells is approximately 11 ft bgs. Shallow groundwater flows to the west, away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building 903 and collection of additional data is proposed (Table 4-7 and Figure 4-8).

Site 78 South Buildings 1502, 1601, 1603, and 1707 are located within the southern portion of Site 78 (Figure 3-29). The CSMs for these building are presented below.

Building 1502 Building 1502 is located within southern portion of Site 78. It is a two story cinder block and mortar building constructed slab on grade, approximately 350 ft long by 100 ft wide. The building use is base motor transport and is typically occupied by 21 government employees and 12 maintenance contractors. The building has four single doors, one double door, four warehouse doors, and many windows. The building is surrounded by impermeable surfaces including parking lots, roads, and other buildings.

Building 1502 is classified as a large industrial building for this evaluation. It is located within 100 ft of four shallow monitoring wells which have exceedances of site-specific screening criteria for large buildings (Table 4-10).

TABLE 4-10
Building 1502 Screening Criteria Exceedances

Well ID	TCE (µg/L)	VC (µg/L)
Screening Criteria (Table 3-31)	*35.5*	*2.53*
IR78-GW09-1	72	-
IR78-GW60	1,900	-
IR78-GW76	1,800	4,300
IR78-IS90	92	-

The depth to groundwater in these wells ranges from approximately 11 to 13 ft bgs. Shallow groundwater flows to the southwest, away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building 1502 and collection of additional data is proposed (Table 4-7 and Figure 4-9).

Building 1601 Building 1601 is a two story cinder block and mortar building constructed slab on grade, approximately 350 ft long by 100 ft wide. The northeastern portion is used by the [spell out here] (MCSC) nuclear biological chemical to store equipment. The southwestern portion is utilized to store equipment for civilian government employee testing. The building is typically occupied by less than 50 people with about 250 people coming in and out of the building each day. The building has four single doors, one double door, four rollup warehouse doors, and many windows. The building is surrounded by impermeable surfaces including parking lots and roads.

Building 1601 is classified as a large industrial building for this evaluation. It is located within 100 ft of 14 shallow monitoring wells which have exceedances of the site-specific screening criteria for large buildings (Table 4-11).

TABLE 4-11
Building 1601 Screening Criteria Exceedances

Well ID	Benzene (µg/L)	Xylene (µg/L)	1,1,2-TCA (µg/L)	PCE (µg/L)	TCE µg/L)	Cis-1,2-DCE (µg/L)	VC (µg/L)
Screening Criteria (Table 3-31)	*15.8*	*4,860*	*50.3*	*7.19*	*35.5*	*2,300*	*2.53*
IR78-GW09-1	-	-	-	-	72	-	-
IR78-GW49	-	-	-	57	-	-	-
IR78-GW52	-	-	-	-	49	4,300	1,200
IR78-GW60	-	-	-	-	1,900	-	-
IR78-GW73	-	-	-	-	-	7,100	-
IR78-GW74	-	-	-	-	-	7,000	-
IR78-GW75-1	-	-	-	-	560	-	-
IR78-GW75-2	-	-	-	-	-	11,000	-
IR78-GW76	-	-	-	-	1,800	4,300	-
IR78-GW77	-	-	-	-	160	-	-

IR78-GW78	-	-	-	-	50	-	-
IR78-IS90	-	-	-	-	92	-	-
IR78-IS92	110	8,500	200	-	-	-	-
IR78-IS96	390	-	-	-	-	-	-

The depth to groundwater in these wells ranges from approximately 11 to 14 ft bgs. Shallow groundwater flows to the southwest, towards the building.

Based on the available information, there may be a vapor intrusion pathway present at Building 1601 and collection of additional data is proposed (Table 4-7 and Figure 4-9).

Building 1603 Building 1603 is located within the southern section of Site 78. It is a one story cinder block and mortar building constructed slab on grade, approximately 125 ft long by 30 ft wide. The building has three single doors, three rollup doors, and nine windows. The building is used by the 10th Marines Survey and Meteorological Team and typically occupies less than 15 people. The building is surrounded by impermeable surfaces including parking lots, roads, and buildings.

Building 1603 is classified as a large industrial building for this evaluation. It is located within 100 feet of two shallow monitoring wells which exceed the site-specific screening criteria for large buildings (Table 4-12).

TABLE 4-12
Building 1603 Screening Criteria Exceedances

Well ID	Benzene (µg/L)
Screening Criteria (Table 3-31)	*15.8*
IR78-GW53	160
IR78-GW58	150

The average depth to water in these wells is approximately 16 ft bgs. Shallow groundwater flows to the southwest, away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building 1603 and collection of additional data is proposed (Table 4-7 and Figure 4-9).

Building 1707 Building 1707 is a one story cinder block and mortar building constructed slab on grade, approximately 100 ft long by 100 ft wide. The building is used by the 2d MARDIV motor transportation and typically occupies less than 10 people. The building has three single doors and nine windows. The building is surrounded by impermeable surfaces including parking lots and roads.

Building 1707 is classified as a large industrial building for this evaluation. It is located within 100 ft of one shallow monitoring well, IR78-MW42, which exceeded the site-specific screening criteria for large buildings for TCE (35.5 µg/L) at 160 µg/L and VC (2.53 µg/L) at 220 µg/L. The depth to groundwater in IR78-MW42 is approximately 18 ft bgs. Shallow groundwater flows to the southwest away from the building.

Building 1707 is located within the boundary of Munitions Response Program (MRP) Site UXO-8; therefore, the potential exists for the presence of munitions and explosives of concern (MEC) at this location. As a result, MEC avoidance will be practiced for intrusive activities conducted within the Site UXO-8 boundary. Details of MEC avoidance are provided in the HASP (Appendix C).

Based on the available information, there may be a vapor intrusion pathway present at Building 1707 and collection of additional data is proposed (Table 4-7 and Figure 4-9).

SWMU 360

SWMU 360 was a former 300 gallon waste oil UST near Building 1817s. Buildings 1819 and 1810 (located within Mainside) are also located in the vicinity of SWMU 360. The UST was removed in July of 1997. The results of a Limited Site Assessment revealed chlorinated solvents, primarily PCE and TCE, in soil and groundwater. Within SWMU 360, Buildings 1817 and 1819 were retained for further evaluation (Figure 3-28).

Building 1817 Building 1817 is a 1.5 story corrugated steel building constructed slab on grade, approximately 250 ft long by 25 ft wide. The northwest portion of the building is used by the 8th Communication Battalion (8th Comm Bn) Support Company as a CST platoon. The southeast portion of the building is used by the 8th Comm Bn as the Hazardous Materials Consolidation Center. There are approximately 30 people who work in the building. The building has three single doors and six double warehouse doors.

Building 1817 is classified as a large industrial building for this evaluation. It is located within 100 ft of six shallow monitoring wells which have exceedances of the Hadnot Point site-specific screening criteria for large industrial buildings as shown in Table 4-13.

TABLE 4-13
Building 1817 Screening Criteria Exceedances

Well ID	PCE (µg/L)	TCE (µg/L)	VC (µg/L)
Screening Criteria (Table 3-31)	*7.19*	*35.5*	*2.53*
SWMU360-IS37	180	54	-
SWMU360-MW01	100	-	-
SWMU360-MW08	-	-	2.8
SWMU360-TW01	89	-	-
SWMU360-TW03	27	-	-
SWMU360-TW04	-	75	-

The depth to groundwater in these wells ranges from approximately 19 to 21 ft bgs. Shallow groundwater flows to the southeast, away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building 1817 and collection of additional data is proposed (Table 4-7 and Figure 4-7).

Building 1819 Building 1819 is located northeast of Building 1817 within the vicinity of SWMU 360. It is a 1.5 story corrugated steel building constructed slab on grade, approximately 250 ft long by 25 ft wide. The building has two single doors and four double

warehouse doors. The northwest portion of the building is used by the 8th Comm Bn Support Company as storage. The southeast portion of the building is used by the Tank Battalion as storage. It is typically occupied by less than five people. The building is surrounded by impermeable surfaces, including parking lots, roads, and other buildings.

Building 1819 is classified as a large industrial building for this evaluation. It is located within 100 ft of two shallow monitoring wells which have exceedances of the site-specific screening criteria for large buildings (Table 4-14).

TABLE 4-14
Building 1819 Screening Criteria Exceedances

Well ID	PCE (µg/L)
Screening Criteria (Table 3-31)	*7.19*
SWMU360-TW01	89
SWMU360-TW03	27

The depth to groundwater in these wells ranges from approximately 19 to 21 feet bgs. Shallow groundwater flows to the southeast, away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building 1819 and collection of additional data is proposed (Table 4-7 and Figure 4-7).

Building 1613 Site

Building 1613 is a MCCS located in Hadnot Point. The former UST system consisted of four gasoline tanks located on the northeast side of Building 1613. In the early 1990s, free phase and dissolved phase gasoline compounds were investigated at the site. In 1998, an AS/SVE system was installed and operated for 6 years. The system was permanently shut down in 2004. Buildings retained for evaluation in the vicinity of the Building 1613 Site include Building 1611 and Building 1613 (Figure 3-29).

Building 1611 Building 1611 is a one story brick building constructed slab on grade, approximately 50 ft long by 50 ft wide. The building has seven doors and 13 windows. The building is used for vehicle maintenance by the Central Service Station and typically occupies less than ten people.

Building 1611 is classified as a small industrial building for this evaluation. It is located within 100 ft of one shallow monitoring well, UST1613-MW22, which exceeds the site-specific screening criteria for small buildings for benzene (9.96 µg/L), with a concentration of 18.7 µg/L. The depth to water in this well is approximately 14 ft bgs. Shallow groundwater flows to the southwest, away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building 1611 and collection of additional data is proposed (Table 4-7 and Figure 4-9).

Building 1613 Building 1613 is a one story brick building constructed slab on grade, approximately 30 ft long by 15 t wide. The building has four doors, two windows, and a 50-

ft overhang on each side. It is utilized as a gas station and car rental office. The building typically occupies less than eight people.

Building 1613 is classified as a small industrial building for this evaluation. It is located within 100 feet of one shallow monitoring well, UST1613-MW22, which exceeds the site-specific screening criteria for small buildings for benzene (9.96 µg/L), with a concentration of 18.7 µg/L. The depth to water in this well is approximately 14 ft bgs. Shallow groundwater flows to the southwest, away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building 1613 and collection of additional data is proposed (Table 4-7 and Figure 4-9).

HPFF

The former HPFF area and the former USTs associated with Building 1115 are located between Site 78 North and Site 78 South. Free product has been observed and dissolved-phase contamination has migrated from the source areas. Buildings identified for further evaluation within HPFF include Buildings 1005, 1068, 1108, 1111, 1114, 1115, 1200, 1201, 1202, 1220, and 1301 (Figure 3-30).

To remediate the environmental impacts caused by the HPFF and the former Building 1115 USTs, AS/SVE systems were installed in conjunction with a bio-pulse wellfield. These systems are located in an area which extends approximately 400 ft north of Holcomb Boulevard and is bound by Michael Road to the south, Dogwood Street to the west and the Vehicle Ready Fuel Storage facility and Temporary Fuel Farm, off Michael Road to the east. The extent of these systems is shown in Figure 2-39. The bio-pulse well configuration is shown in Figure 2-40.

Building 1005 Building 1005 is a one story mortar building constructed slab on grade, approximately 300 ft long by 200 ft wide. The building has approximately 10 doors and 70 windows. The building is utilized for the Public Works and Resident Officer in Charge of Construction (ROICC) offices and is occupied by approximately 100 people. The building is surrounded by a grassy area to the northeast and by impermeable surfaces, including parking lots, roads, and other buildings, to the south and northwest.

Building 1005 is classified as a large industrial building for this evaluation. There are no shallow monitoring wells containing groundwater concentration exceeding site-specific criteria located within 100 ft of the building; however, Building 1005 is located within 100 ft of the extent of the bio-pulse system impact area.

Based on the available information, there may be a vapor intrusion pathway present at Building 1005 and collection of additional data is proposed (Table 4-7 and Figure 4-10).

Building 1068 Building 1068 is located slightly northeast of the HPFF area. It is a one story concrete slab and brick building, approximately 75 ft long by 40 ft wide. The building has 11 windows, one door, and a scale for rail cars in the front. The building is used as the railroad car traffic management office and is typically occupied by less than five people. The building is surrounded by impermeable surfaces, including parking lots, roads, and other buildings.

Building 1068 is classified as a large industrial building for this evaluation. Free product, in the form of light nonaqueous phase liquid (LNAPL), has been observed in monitoring well USTHPFF-MW16R, which is located within 100 feet of Building 1068.

Based on the available information, there may be a vapor intrusion pathway present at Building 1068 and collection of additional data is proposed (Table 4-7 and Figure 4-10).

Building 1108 Building 1108 is a two story cinder block and mortar building constructed slab on grade, approximately 350 ft long by 100 ft wide. The building has 11 single doors, 3 large warehouse doors, and 64 windows. It is used as a retail warehouse and it typically occupied by less than 50 people. The building is surrounded by impermeable surfaces, including parking lots, roads, and other buildings.

Building 1108 is classified as a large industrial building for this evaluation. It is located within 100 ft of seven shallow monitoring wells which have exceedances of the site-specific screening criteria for large buildings (Table 4-15).

TABLE 4-15
Building 1108 Screening Criteria Exceedances

Well ID	Benzene (µg/L)	Xylene (µg/L)	1,2-DCA (µg/L)
Screening Criteria (Table 3-31)	*15.8*	*4,860*	*24.6*
UST1115-GT09	21.4	-	-
UST1115-MW07	6,230	-	-
UST1115-MW18	-	-	86.7
UST1115-MW20	18,700	-	91.3
UST1115-MW23	-	-	330
USTHPFFC-MW18	12,300	10,600	-
USTHPFFC-MW24	470	-	-

The depth to water in these wells ranges from 10 to 11 ft bgs. Shallow groundwater flows to the west, towards the building.

As a result of the vapor intrusion issues observed in Building 1108 and the proximity to both the AS/SVE systems and the bio-pulse system, an ASD system was installed. FID readings are collected in this building three times a week to monitor the system's effectiveness.

Based on the available information, there may be a vapor intrusion pathway present at Building 1108 and collection of additional data is proposed (Table 4-7 and Figure 4-10).

Building 1100 Building 1100 is located in the vicinity of the former USTs associated with Building 1115. It is a one story cinder block and mortar building constructed slab on grade, approximately 20 ft long by 20 ft wide. The building has three single doors and nine windows. It is used as MCCS recreational offices. The building is surrounded by a grassy area to the north and impermeable surfaces, including parking lots, roads, and other buildings, to the south, west, and east.

Building 1100 is classified as a small industrial building for this evaluation. It is located within 100 ft of two monitoring wells which have exceedances of site-specific screening criteria for small buildings (Table 4-16).

TABLE 4-16
Building 1100 Screening Criteria Exceedances

Well ID	Benzene (µg/L)	1,2-DCA (µg/L)
Screening Criteria (Table 3-31)	*9.96*	*14.6*
UST1115-MW13	78.5	25.2
UST1115-MW14	170	-

The depth to water in these wells is approximately 9 ft bgs. Shallow groundwater flows to the west, towards the building. Further, Building 1111 is located within 100 ft of the Northwest AS/SVE system and is within the extent of the bio-pulse system impact area.

Based on the available information, there may be a vapor intrusion pathway present at Building 1111 and collection of additional data is proposed (Table 4-7 and Figure 4-10).

Building 1111 Building 1111 is located in the vicinity of the former USTs associated with Building 1115. It is a one story cinder block and mortar building constructed slab on grade, approximately 25 ft long by 20 ft wide. The building has two single doors, three warehouse rollup doors, and ten windows. It is used as storage for the MCCS recreational equipment and is typically occupied by less than three people. The building is surrounded by a grassy area to the north and west and impermeable surfaces, including parking lots, roads, and other buildings, to the south and east.

Building 1111 is classified as a small industrial building for this evaluation. It is located within 100 ft of two monitoring wells which have exceedances of site-specific screening criteria for small buildings (Table 4-17).

TABLE 4-17
Building 1111 Screening Criteria Exceedances

Well ID	Benzene (µg/L)	1,2-DCA (µg/L)
Screening Criteria (Table 3-31)	*9.96*	*14.6*
UST1115-MW13	78.5	25.2
UST1115-MW14	170	-

The depth to water in these wells is approximately 9 ft bgs. Shallow groundwater flows to the west, towards the building. Further, Building 1111 is located within 100 ft of the Northwest AS/SVE system and is within the extent of the bio-pulse system impact area.

Based on the available information, there may be a vapor intrusion pathway present at Building 1111 and collection of additional data is proposed (Table 4-7 and Figure 4-10).

Building 1114 Building 1114 is located in the HPFF area. It is a one story steel warehouse constructed slab on grade, approximately 100 ft long by 50 ft wide. The building has two single doors, two rollup warehouse doors, and no windows. The building is utilized for storage and base telephone operations. The building is occupied by approximately 20 government employees. The building is surrounded by impermeable surfaces, including parking lots, roads, and other buildings.

Building 1114 is classified as a large industrial building for this evaluation. It is located within 100 ft of three shallow monitoring wells which have exceedances of site-specific screening criteria for large buildings (Table 4-18).

TABLE 4-18
Building 1114 Screening Criteria Exceedances

Well ID	Benzene (µg/L)	Xylene (µg/L)
Screening Criteria (Table 3-31)	*15.8*	*4,860*
USTHPFFC-MW66	3,830	-
USTHPFFC-MW72	16,800	8,290
USTHPFF-MW15	561	16,900

Further, Building 1114 is located within 100 ft of the Southeast AS/SVE system and is within the extent of the bio-pulse system impact area. Additionally, free product, in the form of LNAPL, has been observed in the vicinity of Building 1114 during previous investigations.

Based on the available information, there may be a vapor intrusion pathway present at Building 1114 and collection of additional data is proposed (Table 4-7 and Figure 4-10).

Building 1115 As described above, Building 1115 is the location of the former fleet service and refueling area and seven former USTs. It is a one story cinder block and mortar building constructed slab on grade, approximately 25 ft long by 20 ft wide. The building has three single doors and ten windows. The building is currently used for MCCS recreational equipment rentals and its occupancy varies seasonably. The building is surrounded by a grassy area to the north and impermeable surfaces, including parking lots, roads, and other buildings, to the south.

Building 1115 is classified as a small industrial building for this evaluation. It is located within 100 feet of one monitoring well, which has exceedances of the site-specific screening criteria for small buildings for benzene (9.96 µg/L) at a concentration of 78.5 µg/L and 1,2-DCA (14.6 µg/L) at a concentration of 25.2 µg/L. Further, Building 1115 is located within 100 feet of the Northwest AS/SVE system and is within the extent of the bio-pulse system impact area.

Based on the available information, there may be a vapor intrusion pathway present at Building 1115 and collection of additional data is proposed (Table 4-7 and Figure 4-10).

Building 1200 Building 1200 is located within the HPFF area. It is a one story cinder block and mortar building constructed slab on grade, approximately 350 ft long by 35 ft wide. The building has five single doors, three double doors, and a total of nine windows. The

northeast half of the building is utilized as a thrift shop and the southwest half of the building is headquarters for II MEF. The building is typically occupied by less than 35 people. The building is surrounded by impermeable surfaces, including parking lots, roads, and other buildings.

Building 1200 is classified as a large industrial building for this evaluation. It is located within 100 ft of one shallow monitoring well, UST1115-MW20, which has exceedances of the site-specific screening criteria for large buildings, including benzene (15.8 µg/L) at a concentration of 18,700 µg/L and 1,2-DCA (24.6 µg/L) at a concentration of 91.3 µg/L. Further, Building 1200 is located within 100 ft of both the Northwest and Southeast AS/SVE systems and is within the extent of the bio-pulse system impact area.

As a result, an ASD system was installed to provide vapor intrusion protection in Building 1200. FID readings are collected in this building three times a week to monitor the effectiveness of the ASD system.

Based on the available information, there may be a vapor intrusion pathway present at Building 1115 and collection of additional data is proposed (Table 4-7 and Figure 4-10).

Building 1201 Building 1201 is located within the HPFF area. It is a one story concrete building constructed slab on grade, approximately 300 feet long by 100 feet wide. The building has 13 double doors, one large sliding door, and 16 windows and is utilized by Base Maintenance. It is typically occupied by less than 25 people.

Building 1201 is classified as a large industrial building for this evaluation. There are no monitoring wells containing groundwater concentrations exceeding site-specific screening levels located within 100 ft of the building; however, Building 1201 is located within 100 ft of the Southeast AS/SVE system and is within the extent of the bio-pulse system impact area.

As a result of the proximity to the AS/SVE system, an ASD system was installed to provide vapor intrusion protection in Building 1201. FID readings are collected in this building three times a week to monitor the effectiveness of the ASD system.

Based on the available information, there may be a vapor intrusion pathway present at Building 1201 and collection of additional data is proposed (Table 4-7 and Figure 4-10).

Building 1202 Building 1202 is a two story cinder block building constructed slab on grade, approximately 400 ft long by 150 feet wide. The building has seven doors and approximately 80 windows. The building is utilized as office and storage space for Lejeune Support Services and typically occupies less than 80 people.

Building 1202 is classified as a large industrial building for this evaluation. There are no shallow monitoring wells containing groundwater concentrations exceeding site-specific screening levels located within 100 ft of the building; however, Building 1202 is located within 100 feet of the Southeast AS/SVE system and is within the extent of the bio-pulse system impact area.

As a result of the proximity to the AS/SVE system, an ASD system was installed to provide vapor intrusion protection in Building 1202. FID readings are collected in this building three times a week to monitor the effectiveness of the ASD system.

Based on the available information, there may be a vapor intrusion pathway present at Building 1202 and collection of additional data is proposed (Table 4-7 and Figure 4-10).

Building 1220 Building 1220 is a one story cinder block building constructed slab on grade, approximately 100 ft long by 100 ft wide. The building has one single door, two double doors, 12 long windows, and two drive through windows. The building is utilized as a fast-food restaurant (Burger King) and occupies up to 100 people, depending on the time of day.

Building 1220 is classified as a large industrial building for this evaluation. There are no shallow monitoring wells containing groundwater concentrations exceeding site-specific screening levels located within 100 ft of the building; however, Building 1220 is located within the extent of the bio-pulse system impact area.

Based on the available information, there may be a vapor intrusion pathway present at Building 1220 and collection of additional data is proposed (Table 4-7 and Figure 4-10).

Building 1301 Building 1301 is a one story concrete building constructed slab on grade, approximately 400 feet long by 100 ft wide. The building has two single doors, four steel loading doors, ten large double doors and nine windows. The building is utilized as supply for the Command Element 22nd Marine Expeditionary Unit (22nd MEU) and is occupied by approximately 20 people.

Building 1301 is classified as a large industrial building for this evaluation. There are no shallow monitoring wells containing groundwater concentrations exceeding site-specific screening levels located within 100 ft of the building; however, Building 1301 is located within the extent of the bio-pulse system impact area. As a result, an ASD system was installed to provide vapor intrusion protection in building 1301. FID readings are collected in this building three times a week to monitor effectiveness of the ASD system.

Based on the available information, there may be a vapor intrusion pathway present at Building 1301 and collection of additional data is proposed (Table 4-7 and Figure 4-10).

4.2.2 Data Quality Objectives

Based on the CSMs presented above, DQOs for Hadnot Point were developed for use in selecting sample types and locations. These DQOs are presented in Table 4-19.

TABLE 4-19
Data Quality Objectives—Hadnot Point Industrial Area

Step 1: Statement of Problem	Groundwater within Hadnot Point has been impacted by chlorinated VOCs, specifically PCE, TCE, and their daughter products, and petroleum-related VOCs, including BTEX. One or more of these compounds are present above site specific screening levels in shallow groundwater within 100 ft of the buildings included in this evaluation. Additional data are required to determine whether VOCs in groundwater near these buildings represent potential vapor intrusion pathways that require further investigation.
Step 2: Identify the Decision	Additional exterior data (e.g., soil gas, groundwater), in conjunction with existing data, will provide information to determine whether subsurface contamination requires further investigation. For some buildings, specifically those within 100 ft of an AS system, or buildings within 100 ft of identified free product, subslab and/or indoor air sampling will be conducted.

Step 3: Inputs to Decisions	The CSMs developed for the buildings were used to determine additional data requirements. For the purposes of this evaluation, all buildings within Hadnot Point are classified as industrial use buildings. Large buildings are defined as 100 to 350 ft long by 25 to 100 ft wide. Small buildings are defined as 15 to 60 ft long by 10 to 50 ft wide. VOCs in exceedance of site-specific screening levels in shallow groundwater within 100 ft of each building, as summarized in Section 3 and the CSMs above. An offsite or mobile laboratory will be contracted to perform sample analysis. The subcontracted laboratory will use the appropriate analytical methods to reach the project specific analytical requirements.
Step 4: Study Boundaries	Hadnot Point is bound by Holcomb Boulevard, McHugh Boulevard/Main Service Road, Duncan Street, and Sneads Ferry Road, aboard MCB Camp Lejeune, North Carolina. Study boundaries are defined as 100 lateral feet around each building.
Step 5: Decision Rules	The decision logic for selecting sampling locations is provided as Figure 4-1 and is summarized below. For buildings within 100 ft of shallow monitoring wells containing VOCs, depth-specific groundwater samples (within the top five feet of the aquifer) will be collected at locations adjacent to buildings to determine whether VOC concentrations greater than site specific screening levels developed using the J&E model extend beneath the building. Sample locations will be based toward the highest concentrations from current data. Groundwater samples will not be collected where the water table is present at depths less than 5 ft bgs. In this case, subslab and potentially indoor air samples will be collected from the building being evaluated. The results of the groundwater sample analysis will be compared to the site-specific screening levels developed using the J&E model. Soil gas samples will be collected adjacent to buildings exceeding site-specific screening levels. Where groundwater samples are also being collected, the soil gas samples will be collected co-located with the groundwater samples. As with groundwater samples, soil gas samples will not be collected in areas where the groundwater table is present at depths less than 5 ft bgs. In this case, subslab and potentially indoor air samples will be collected from the building being evaluated. Where applicable, site-specific soil gas screening levels will be developed. Results from the soil gas samples will be compared to site-specific screening levels and/or Region IX PRGs for ambient air quality standards using an appropriate attenuation factor. That attenuation factor will be identified from USEPA's recently developed attenuation factors database. If free product is present within 100 ft of a building, as indicated by the observation of NAPL, or suspected based on the exceedance of 1 percent of a compound's solubility (see Table 4-5), then subslab and/or indoor air samples within the building being evaluated. Subslab and/or indoor air samples will also be collected within buildings located within 100 ft of an AS or biopulsing system. The subslab and/or indoor air sample results will be compared to Region IX PRGs for ambient air quality standards. Additional data will not be collected within buildings where existing soil gas or indoor air data is available, or a mitigation system is currently in place. For these buildings, existing data will be used in the evaluation. If subslab and/or indoor air data confirm that VOC concentrations exceed site-specific screening levels and/or Region IX PRGs for ambient air quality standards, additional investigation and/or mitigation measures may be recommended.
Step 6: Limits of Decision Errors	The probability of sampling and measurement errors at any site under investigation necessitates the development of sampling guidelines. Field errors are minimized by having each member of the field team follow the same SOPs for sampling. QC samples, including duplicates, matrix spikes, matrix spike duplicates, equipment blanks, and field blanks, are used to verify the data's accuracy and precision. When a QC sample is outside of the established control limits, the data will be qualified and field corrective action implemented when applicable (such as when field duplicates are outside established control limits). Further, when subslab and.or indoor air samples are collected, ambient air QC samples will also be collected. A building survey will be conducted to identify chemicals stored or used within the building. This will ensure that concentrations detected in indoor air and or/sub-slab air samples are indicative of vapor intrusion from groundwater.

Step 7: Optimize the Sampling Design	The sampling design objective is to assess the potential for vapor intrusion to result in risks to building occupants. The results of the evaluation will be used to determine whether additional investigation/risk assessment is required. Refer to Figure 4-1 for the decision logic used to optimize the sampling design.

4.2.3 Proposed Sample Locations

Based on the CSMs and DQOs provided above, 21 groundwater, 21 soil gas, 15 subslab, and 15 indoor air sample locations are proposed in Hadnot Point, as summarized on Table 4-7 and shown on Figures 4-7 through 4-10.

4.3 Air Station

4.3.1 CSMs

One IR site with four buildings, one RCRA site with one building, and one UST site with two buildings were identified in the Air Station area for further evaluation. CSMs developed for the identified buildings are described below by Site. The site-specific screening levels for Air Station are presented in Table 3-32.

Site 86

Historically, the extent of Site 86, formerly the AST Area, was defined as the southwest corner of the intersection of Foster and Campbell Streets. During site investigations, PCE and its daughter products were discovered in the vicinity of Site 86. The MCB Camp Lejeune Tier I Partnering Team (August 2006) expanded the boundaries of Site 86 in August 2006.

As a result, Site 86 is roughly bounded by White Street to the west, Davis Street to the north, an open field to the east, and the flight line to the south. The flight line at MCB Camp Lejeune, constructed with a tarmac cover, has been in service since 1951. Over time, the surrounding area has been developed to provide support for aircraft and personnel. Major features within Site 86 include the Former Aircraft Wash Rack AS513; an aircraft washing area (referred to as the "bird bath"); SWMUs 303 and 318, former steel ASTs and an OWS, respectively; aircraft hangars; and other air station support buildings. Most of Site 86 is developed with buildings and is paved. Buildings AS502, AS510, AS515, and AS541 within Site 86 were retained for further evaluation (Figure 3-33).

Building AS502 Building AS502 is a one-story cinder block constructed slab on grade building approximately 115 ft long by 100 ft wide. The building has eight tall rollup doors, seven windows, and two doors. The building is used as an emergency crash rescue response center and a fire station and is typically occupied by less than 15 people. The building is surrounded by impermeable surfaces including parking lots, roads, and other buildings.

Building AS502 is classified as a large industrial building for this evaluation. It is located within 100 ft of two monitoring wells which have exceedances of the site-specific screening criteria for large industrial buildings (Table 4-20).

TABLE 4-20
Building AS502 Screening Criteria Exceedances

Well ID	PCE (µg/L)	TCE (µg/L)	VC (µg/L)
Screening Criteria (Table 3-32)	*7.69*	*38.5*	*2.86*
IR86-MW27IW	-	160	12
IR86-MW10IW	64	39	21

The depth to groundwater in these wells ranges from approximately 6 to 11 ft bgs. Shallow groundwater flows to the northeast away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building AS502 and collection of additional data is proposed (Table 4-21 and Figure 4-12).

Building AS510 Building AS510 is a one story cinder block constructed slab on grade building approximately 150 ft long by 180 ft wide. The building has five bays and eight double doors. The building is used as a training facility and is typically occupied by less than 100 people. The building is surrounded by impermeable surfaces including parking lots, roads, and other buildings.

Building AS510 is classified as a large industrial building for this evaluation. It is located within 100 ft of one monitoring well (IR86-MW10IW) which has an exceedance of the site-specific screening criteria for large industrial buildings for PCE (7.69 µg/L), TCE (38.5 µg/L) at 39 µg/L, and VC (7.69 µg/L) at 64 µg/L.

The depth to groundwater in well IR86-MW10IW is approximately six feet bgs. Shallow groundwater flows to the northeast away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building AS510 and collection of additional data is proposed (Table 4-21 and Figure 4-12).

Building AS515 Building AS515 is a one-story cinder block building constructed slab on grade approximately 450 ft long by 100 ft wide. The building has a steel front with panels that slide open and 27 doors, three roll up doors, and two long windows. The building is used as an aircraft hanger and is typically occupied by less than 100 people. The building is surrounded by impermeable surfaces including parking lots, roads, and other buildings.

Building AS515 is classified as a large industrial building for this evaluation. It is located within 100 ft of two monitoring wells which have exceedances of the site-specific screening criteria for large industrial buildings (Table 4-22).

TABLE 4-22
Building AS515 Screening Criteria Exceedances

Well ID	Benzene (µg/L)	VC (µg/L)
Screening Criteria (Table 3-32)	*17.4*	*2.86*
IR86-IS56	140	5.2
IR86-IS57	-	5.3

The depth to groundwater in the vicinity of Building AS515 ranges from 6 to 9 ft bgs. Shallow groundwater flows to the northeast away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building AS515 and collection of additional data is proposed (Table 4-21 and Figure 4-12).

Building AS541 Building AS541 is a one-story concrete cinder block building constructed slab on grade approximately 270 ft long by 50 ft wide. The building has six doors, and seven steel bay doors. The building is used as a marine aviation logistic center and is typically occupied by ten people. The building is surrounded by impermeable surfaces including parking lots, roads, and other buildings.

Building AS541 is classified as a large industrial building for this evaluation. It is located within 100 ft of four monitoring wells which have exceedances of the site-specific screening criteria for large industrial buildings (Table 4-23).

TABLE 4-23
Building AS541 Screening Criteria Exceedances

Well ID	TCE (µg/L)	VC (µg/L)	Benzene (µg/L)
Screening Criteria (Table 3-32)	*38.5*	*2.86*	*17.4*
IR86-MW27IW	160	12	-
SWMU318-MW02	79	14	29
SWMU318-GW10	1,200	140	-
SWMU318-GW13	57	-	-

The depth to groundwater in these wells is approximately 5 ft bgs. Shallow groundwater flows to the northeast away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building AS541 and collection of additional data is proposed (Table 4-21 and Figure 4-12).

SWMU 366

SWMU 336 is the site of a former paint stripping vat within Building AS4106. PCE is the primary site contaminant in groundwater. Building AS4106 is the only building within SWMU 366 retained for further evaluation (Figure 3-32).

Building AS4106 Building AS4106 is a one-story cinder block building, approximately 290 ft long by 120 ft wide. The building has 12 rollup doors (large doors for helicopter entrance), and 10 single doors. The building is used as an aircraft hanger and is typically occupied by less than 100 people. The building is surrounded by impermeable surfaces including parking lots, roads, other buildings and tarmac.

Building AS4106 is classified as a large industrial building for this evaluation. It is located within 100 ft of one monitoring well (SWMU336-TW01) which has an exceedance of the site-specific screening criteria for large industrial buildings for PCE (7.69 µg/L) at a concentration of 27.0 µg/L.

The depth to groundwater in SWMU336-TW01 is approximately 12 ft bgs. Shallow groundwater flows to the east away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building AS4106 and collection of additional data is proposed (Table 4-21 and Figure 4-11).

UST-CSFF

CSFF is located aboard MCAS New River near the intersection of Campbell and White Streets. The site is separated into two areas: one located at the fuel farm and Building AS-143 and the other approximately 500 feet south near Building AS-4151. Within the UST-CSFF site, two buildings were retained for further evaluation: AS143 and AS4151 (Figure 3-33).

Building AS143 Building AS143 is a one-story concrete masonry building approximately 35 ft long by 20 ft wide. The building has three doors and six windows. The building is used as a gas station and base fuel office and is typically occupied by less than five people. The building is surrounded by impermeable surfaces such as parking lots and roads to the north and is surrounded by permeable surfaces such as grass and surface water to the south.

Building AS143 is classified as a small industrial building for this evaluation. It is located within 100 ft of two monitoring wells which have exceedances of the site-specific screening criteria for small industrial buildings (Table 4-24).

TABLE 4-24
Building AS143 Screening Criteria Exceedances

Well ID	Benzene (µg/L)
Screening Criteria (Table 3-32)	*8.70*
USTCSFF-MW21	273
USTCSFF-MW24	248

The depth to groundwater in these wells ranges from approximately 14 to 16 ft bgs. Shallow groundwater flows to the southeast away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building AS143 and collection of additional data is proposed (Table 4-21 and Figure 4-12).

Building AS4151 Building AS4151 is a one-story cinder block building, approximately 70 ft long by 70 ft wide. The building has four single doors, four rollup doors, and two windows. The building is used as a steam plant and is typically occupied by less than five people. The building is surrounded by impermeable surfaces including parking lots, roads, and other buildings.

Building AS4151 is classified as a small industrial building for this evaluation. It is located within 100 ft of two monitoring wells which have exceedances of the site-specific screening criteria for small industrial buildings (Table 4-25).

TABLE 4-25
Building AS4151 Screening Criteria Exceedances

Well ID	Benzene (µg/L)
Screening Criteria (Table 3-32)	8.7
USTAS4151-MW07	29.8
USTAS4151-MW08	52.7

The depth to groundwater in these wells ranges from approximately 14 to 16 ft bgs. Shallow groundwater flows to the east away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building AS4151 and collection of additional data is proposed (Table 4-21 and Figure 4-12).

4.3.2 DQOs

Based on the CSMs presented above, DQOs for Air Station were developed for use in selecting sample types and locations. These DQOs are presented in Table 4-26.

TABLE 4-26
Data Quality Objectives—Air Station

Step 1: Statement of Problem	Groundwater within the Air Station has been impacted by chlorinated VOCs, specifically PCE, TCE, and their daughter products, and petroleum-related VOCs, including benzene. One or more of these compounds are present above site specific screening levels in shallow groundwater within 100 ft of the buildings included in this evaluation. Additional data are required to determine whether VOCs in groundwater near these buildings represent potential vapor intrusion pathways that require further investigation.
Step 2: Identify the Decision	Additional exterior data (e.g., soil gas, groundwater), in conjunction with existing data, will provide information to determine whether subsurface contamination requires further investigation. For some buildings, specifically those within 100 ft of an AS system, or buildings within 100 ft of identified free product, subslab and/or indoor air sampling will be conducted.
Step 3: Inputs to Decisions	The CSMs developed for the buildings were used to determine additional data requirements. For the purposes of this evaluation, all buildings within the Air Station are classified as industrial use buildings. Large buildings are defined as 115 to 450 ft long by 50 to 180 ft wide. Small buildings are defined as 5 to 70 ft long by 5 to 70 ft wide. VOCs in exceedance of site-specific screening levels in shallow groundwater within 100 ft of each building, as summarized in Section 3 and the CSMs above. An offsite or mobile laboratory will be contracted to perform sample analysis. The subcontracted laboratory will use the appropriate analytical methods to reach the project specific analytical requirements.
Step 4: Study Boundaries	The Air Station area, aboard MCB Camp Lejeune, North Carolina, is generally defined as the Base property south of Curtis Road, west of Courthouse Bay, and east of Highway 17. Study boundaries are defined as 100 lateral feet around each building.

Step 5: Decision Rules	The decision logic for selecting sampling locations is provided as Figure 4-1 and is summarized below. For buildings within 100 ft of shallow monitoring wells containing VOCs, depth-specific groundwater samples (within the top five feet of the aquifer) will be collected at locations adjacent to buildings to determine whether VOC concentrations greater than site specific screening levels developed using the J&E model extend beneath the building. Sample locations will be based toward the highest concentrations from current data. Groundwater samples will not be collected where the water table is present at depths less than 5 ft bgs. In this case, subslab and potentially indoor air samples will be collected from the building being evaluated. The results of the groundwater sample analysis will be compared to the site-specific screening levels developed using the J&E model. Soil gas samples will be collected adjacent to buildings exceeding site-specific screening levels. Where groundwater samples are also being collected, the soil gas samples will be collected co-located with the groundwater samples. As with groundwater samples, soil gas samples will not be collected in areas where the groundwater table is present at depths less than 5 ft bgs. In this case, subslab and potentially indoor air samples will be collected from the building being evaluated. Where applicable, site-specific soil gas screening levels will be developed. Results from the soil gas samples will be compared to site-specific screening levels and/or Region IX PRGs for ambient air quality standards using an appropriate attenuation factor. That attenuation factor will be identified from USEPA's recently developed attenuation factors database. If free product is present within 100 ft of a building, as indicated by the observation of NAPL, or suspected based on the exceedance of 1 percent of a compound's solubility (see Table 4-5), then subslab and/or indoor air samples within the building being evaluated. Subslab and/or indoor air samples will also be collected within buildings located within 100 ft of an air sparge or biopulsing system. The subslab and/or indoor air sample results will be compared to Region IX PRGs for ambient air quality standards. Additional data will not be collected within buildings where existing soil gas or indoor air data is available, or a mitigation system is currently in place. For these buildings, existing data will be used in the evaluation. If subslab and/or indoor air data confirm that VOC concentrations exceed site-specific screening levels and/or Region IX PRGs for ambient air quality standards, additional investigation and/or mitigation measures may be recommended.
Step 6: Limits of Decision Errors	The probability of sampling and measurement errors at any site under investigation necessitates the development of sampling guidelines. Field errors are minimized by having each member of the field team follow the same SOPs for sampling. QC samples, including duplicates, matrix spikes, matrix spike duplicates, equipment blanks, and field blanks, are used to verify the data's accuracy and precision. When a QC sample is outside of the established control limits, the data will be qualified and field corrective action implemented when applicable (such as when field duplicates are outside established control limits). Further, when subslab and.or indoor air samples are collected, ambient air QC samples will also be collected. A building survey will be conducted to identify chemicals stored or used within the building. This will ensure that concentrations detected in indoor air and or/sub-slab air samples are indicative of vapor intrusion from groundwater.
Step 7: Optimize the Sampling Design	The sampling design objective is to assess the potential for vapor intrusion to result in risks to building occupants. The results of the evaluation will be used to determine whether additional investigation/risk assessment is required. Refer to Figure 4-1 for the decision logic used to optimize the sampling design.

4.3.3 Proposed Sample Locations

Based on the CSMs and DQOs provided above, 14 groundwater and 14 soil gas sample locations are proposed at the Air Station, as summarized on Table 4-21 and shown on Figures 4-11 through 4-12.

4.4 Courthouse Bay

4.4.1 CSM

One IR site with one building was identified in the Courthouse Bay area for further evaluation. The CSM developed for the identified building is described below by Site. The site-specific screening levels for Courthouse Bay are presented in Table 3-33.

Site 73

The Amphibious Vehicle Maintenance Facility (Site 73) began operations in 1946 and is still active. Site 73 consists of numerous buildings, ASTs, USTs, vehicle wash racks and OWSs. Building A47 is the only building within Site 73 to be retained for further evaluation (Figure 3-34).

Building A47 Building A47 is a two-story cinder block building constructed slab on grade approximately 400 ft long by 200 ft wide. The building has 28 bay doors, 10 single doors, and 12 long windows. The building is used as an amphibious vehicle maintenance area and is typically occupied by 50 to 300 people. The building is surrounded by impermeable surfaces such as parking lots and roads.

Building A47 is classified as a large industrial building for this evaluation. It is located within 100 ft of one monitoring well (IR73-MW27) which has an exceedance of the site-specific screening criteria for large industrial buildings for TCE (49.1 µg/L) at 190 µg/L. The depth to groundwater in this well is approximately 3 ft bgs. Shallow groundwater flows to the southeast away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building A47 and collection of additional data is proposed (Table 4-27 and Figure 4-13).

4.4.2 DQOs

Based on the CSM presented above, DQOs for Courthouse Bay were developed for use in selecting sample types and locations. These DQOs are presented in Table 4-28.

TABLE 4-28
Data Quality Objectives—Courthouse Bay

Step 1: Statement of Problem	Groundwater within Courthouse Bay has been impacted by chlorinated VOCs, specifically TCE, and its daughter products. One or more of these compounds are present above site specific screening levels in shallow groundwater within 100 ft of the buildings included in this evaluation. Additional data are required to determine whether VOCs in groundwater near these buildings represent potential vapor intrusion pathways that require further investigation.
Step 2: Identify the Decision	Additional exterior data (e.g., soil gas, groundwater), in conjunction with existing data, will provide information to determine whether subsurface contamination requires further investigation. For some buildings, specifically those within 100 ft of an air sparge system, or buildings within 100 ft of identified free product, subslab and/or indoor air sampling will be conducted.

Step 3: Inputs to Decisions	The CSMs developed for the buildings were used to determine additional data requirements. For the purposes of this evaluation, all buildings within Courthouse Bay are classified as industrial use buildings. Large buildings are defined as 200 to 530 ft long by 100 to 207 ft wide. One building was defined as small at 105 ft long by49 ft wide. VOCs in exceedance of site-specific screening levels in shallow groundwater within 100 ft of each building, as summarized in Section 3 and the CSMs above. An offsite or mobile laboratory will be contracted to perform sample analysis. The subcontracted laboratory will use the appropriate analytical methods to reach the project specific analytical requirements.
Step 4: Study Boundaries	Courthouse Bay, aboard MCB Camp Lejeune, North Carolina, is generally defined as the southernmost Base property, spanning both sides of Courthouse Bay. Study boundaries are defined as 100 lateral feet around each building.
Step 5: Decision Rules	The decision logic for selecting sampling locations is provided as Figure 4-1 and is summarized below. For buildings within 100 ft of shallow monitoring wells containing VOCs, depth-specific groundwater samples (within the top five feet of the aquifer) will be collected at locations adjacent to buildings to determine whether VOC concentrations greater than site specific screening levels developed using the J&E model extend beneath the building. Sample locations will be based toward the highest concentrations from current data. Groundwater samples will not be collected where the water table is present at depths less than 5 ft bgs. In this case, subslab and potentially indoor air samples will be collected from the building being evaluated. The results of the groundwater sample analysis will be compared to the site-specific screening levels developed using the J&E model. Soil gas samples will be collected adjacent to buildings exceeding site-specific screening levels. Where groundwater samples are also being collected, the soil gas samples will be collected co-located with the groundwater samples. As with groundwater samples, soil gas samples will not be collected in areas where the groundwater table is present at depths less than 5 ft bgs. In this case, subslab and potentially indoor air samples will be collected from the building being evaluated. Where applicable, site-specific soil gas screening levels will be developed. Results from the soil gas samples will be compared to site-specific screening levels and/or Region IX PRGs for ambient air quality standards using an appropriate attenuation factor. That attenuation factor will be identified from USEPA's recently developed attenuation factors database. If free product is present within 100 ft of a building, as indicated by the observation of NAPL, or suspected based on the exceedance of 1 percent of a compound's solubility (see Table 4-5), then subslab and/or indoor air samples within the building being evaluated. Subslab and/or indoor air samples will also be collected within buildings located within 100 ft of an AS or biopulsing system. The subslab and/or indoor air sample results will be compared to Region IX PRGs for ambient air quality standards. Additional data will not be collected within buildings where existing soil gas or indoor air data is available, or a mitigation system is currently in place. For these buildings, existing data will be used in the evaluation. If subslab and/or indoor air data confirm that VOC concentrations exceed site-specific screening levels and/or Region IX PRGs for ambient air quality standards, additional investigation and/or mitigation measures may be recommended.
Step 6: Limits of Decision Errors	The probability of sampling and measurement errors at any site under investigation necessitates the development of sampling guidelines. Field errors are minimized by having each member of the field team follow the same SOPs for sampling. QC samples, including duplicates, matrix spikes, matrix spike duplicates, equipment blanks, and field blanks, are used to verify the data's accuracy and precision. When a QC sample is outside of the established control limits, the data will be qualified and field corrective action implemented when applicable (such as when field duplicates are outside established control limits). Further, when subslab and.or indoor air samples are collected, ambient air QC samples will also be collected. A building survey will be conducted to identify chemicals stored or used within the building. This will ensure that concentrations detected in indoor air and or/sub-slab air samples are indicative of vapor intrusion from groundwater.

Step 7: Optimize the Sampling Design	The sampling design objective is to assess the potential for vapor intrusion to result in risks to building occupants. The results of the evaluation will be used to determine whether additional investigation/risk assessment is required. Refer to Figure 4-1 for the decision logic used to optimize the sampling design.

4.4.3 Proposed Sample Locations

Based on the CSMs and DQOs provided above, sampling of four existing subslab sample probes is proposed at Courthouse Bay, as summarized on Table 4-27 and shown on Figure 4-13.

4.5 Camp Geiger

4.5.1 CSMs

Three IR sites with a total of nine buildings were identified in the Camp Geiger area for further evaluation. CSMs developed for the identified buildings are described below by Site. The site-specific screening levels for Camp Geiger are presented in Table 3-34.

Site 35

Site 35, formerly the Camp Geiger Area Fuel Farm, is located within Camp Geiger, in the northwest portion of the Base. Site 35 primarily refers to five 15,000-gallon ASTs, underground fuel transmission lines, a pump house, a fuel unloading pad, an oil water separator, and a distribution island. Buildings G480, G521, G530, G531, G532, and G533 were retained for further evaluation within Site 35 (Figure 3-35).

Building G480 Building G480 is a one-story brick building constructed slab grade, and is approximately 200 ft long by 75 ft wide. The building has 13 windows and 11 doors. Building G480 is classified as a restricted area used for storage and is typically occupied by approximately 50 people. The building is surrounded by impermeable surfaces including roads and a parking lot on each side.

Building G480 has been retained for further evaluation based on the observance of LNAPL in monitoring well 35-MW67 during recent investigations. Historical potentiometric surfaces in the area indicate shallow groundwater flows to the northeast, away the building.

Based on the available information, there may be a vapor intrusion pathway present at Building G480 and collection of additional data is proposed (Table 4-29 and Figure 4-14).

Building G521 Building G521 is a three-story brick building constructed slab on grade, and is approximately 150 ft long by 75 ft wide. The building has 66 windows, 9 doors, and stairs on each side. Building G521 is used as barracks for the School of Infantry and typically houses more than 100 residents. The building is surrounded by impermeable surfaces including a parking lot and an additional building to the south and west, and by a grassy area to the north and east.

Building G521 is classified as a large industrial building for this evaluation. It is located within 100 ft of one temporary monitoring well (IR35-IS213) which has exceedance of the site-specific screening criteria for large buildings of benzene (12.8 µg/L) at 21 µg/L.

Historical potentiometric surface maps indicate shallow groundwater flows to the northeast away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building G521 and collection of additional data is proposed (Table 4-29 and Figure 4-14).

Building G530 Building G530 is a two-story brick building constructed slab on grade, and is approximately 40 feet long by 70 feet wide. The building has 20 ft continuous windows on each side, two doors, and vents at the base. Building G530 is used as barracks for the School of Infantry and typically houses more than 100 residents. The building is surrounded by impermeable surfaces including a parking lot the south and east, and by a grassy area to the north and west.

Building G530 is classified as a large industrial building for this evaluation. It is located within 100 ft of one temporary monitoring well (IR35-IS218) which has exceedance of the site-specific screening criteria for large buildings for benzene (12.8 µg/L) at 17 µg/L.

Historical potentiometric surfaces in the area indicate shallow groundwater flows to the northeast away the building.

Based on the available information, there may be a vapor intrusion pathway present at Building G530 and collection of additional data is proposed (Table 4-29 and Figure 4-14).

Building G531 Building G531 is a two-story brick building constructed slab on grade, and is approximately 150 feet long by 75 feet wide. The building has 66 windows, nine doors, and stairs on each side. Building G531 is used as barracks for the School of Infantry and typically houses more than 100 residents. The building is surrounded by impermeable surfaces including a parking lot and adjacent building the south and east, and by a grassy area to the north and west.

Building G531 is classified as a large industrial building for this evaluation. It is located within 100 ft of two monitoring wells which has exceedance of the site-specific screening criteria for large buildings (Table 4-30).

TABLE 4-30
Building G531 Screening Criteria Exceedances

Well ID	Benzene (µg/L)	VC (µg/L)
Screening Criteria (Table 3-34)	*12.8*	*2.06*
IR35-IS218	17	-
IR35-IS219	-	6.9

Historical potentiometric surfaces in the area indicate shallow groundwater flows to the northeast away the building.

Based on the available information, there may be a vapor intrusion pathway present at Building G531 and collection of additional data is proposed (Table 4-30 and Figure 4-14).

Building G532 Building G532 is a two-story brick building constructed slab on grade, and is approximately 150 ft long by 75 ft wide. The building has 66 windows, nine doors, and

stairs on each side. Building G532 is used as barracks for the School of Infantry and typically houses more than 100 residents. The building is surrounded by impermeable surfaces including a parking lot the south, a building to the west and a grassy area to the north and east.

Building G532 is classified as a large industrial building for this evaluation. It is located within 100 ft of two monitoring wells which has exceedance of the site-specific screening criteria for large buildings (Table 4-31).

TABLE 4-31
Building G532 Screening Criteria Exceedances

Well ID	Benzene (µg/L)	VC (µg/L)
Screening Criteria (Table 3-34)	*12.8*	*2.06*
IR35-MW29	20	-
IR35-IS219	-	6.9

The depth to groundwater in these wells is approximately 8 ft. Shallow groundwater flows south, away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building G532and collection of additional data is proposed (Table 4-29 and Figure 4-14).

Building G533 Building G533 is a two-story brick building constructed slab on grade, and is approximately 150 ft long by 75 ft wide. The building has 66 windows, 9 doors, and stairs on each side. Building G533 is used as barracks for the School of Infantry and typically houses more than 100 residents. The building is surrounded by impermeable surfaces including a parking lot to the west, buildings to the south and north and, and a grassy area to the east.

Building G533 is classified as a large industrial building for this evaluation. It is located within 100 ft of one monitoring well (IR35-MW29) which has exceedance of the site-specific screening criteria for large buildings for benzene (12.8 µg/L) at 20 µg/L. The depth to groundwater in this well is approximately 8 ft. Shallow groundwater flows to the south, away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building G533 and collection of additional data is proposed (Table 4-29 and Figure 4-14).

Site 89

Site 89, the former DRMO, is located within Camp Geiger. Historical records for Site 89 indicate that the Base Motor Pool operated on site until approximately 1988. The Base Motor Pool, while located at Site 89, reportedly used solvents (acetone, TCE, and MEK) for parts cleaning. After 1988, the site was used as the DRMO by DLA until 2000. The facility was used as a storage yard for items such as scrap and surplus metal, electronic equipment, vehicles, and rubber tires. Within Site 89, Buildings TC860 and TC864 were retained for further evaluation (Figure 3-36).

Building TC860 Building TC860 is a one-story steel building constructed slab on grade, and is approximately 200 ft long by 100 ft wide. The building has eight doors, eight windows, and

an additional building attached measuring 50 ft long by 20 ft wide. Building TC860 is used as a student check in and office administration building with occupancy ranging between 20 and 80 people. The building is surrounded by impermeable surfaces including a parking lot and roads to the north, south, and west, and by a grassy area to the east.

Building TC860 is classified as a large industrial building for this evaluation. It is located within 100 ft of one monitoring well (IR89-MW43) which has exceedance of the site-specific screening criteria for large buildings for PCE (5.82 µg/L) and TCE (28.7 µg/L) at 7.82 µg/L and 280 µg/L respectively. Further, soil gas samples were collected in conjunction with an air sparging treatability study conducted in 2007. The depth to groundwater in this well is approximately 5 ft. Shallow groundwater flows to the west away from the building. During the AS pilot study conducted in 2007, constituents of potential concern were detected near Building TC860 in soil gas samples collected from IR89-SV01 and IR89-SV02, as summarized in Table 4-32.

TABLE 4-32
Maximum COPC Detections During Air Sparging Pilot Study

COPC (ppbv)	IR89-SV01	IR89-SV02
Benzene	13.7	0.364
1,1-DCE	22.1	11.5
Cis-1,2-DCE	648	244
1,1,2,2-PCA	ND	74
PCE	295	602
TCE	8,370	7,230
VC	2.09	3.46

ppbv = parts per billion by volume

Based on the available information, there may be a vapor intrusion pathway present at Building TC860 and collection of additional data is proposed (Table 4-29 and Figure 4-15).

Building TC864 Building TC864 is a one-story steel building constructed slab on grade, and is approximately 150 ft long by 50 ft wide. The building has 11 windows, three double doors, one single door, and four bay doors. Building TC864 is used as student gear staging area with a typical occupancy of less than 40 people. The building is surrounded by impermeable surfaces including a parking lot and roads on all sides.

Building TC864 is classified as a large industrial building for this evaluation. It is located within 100 ft of three monitoring wells which has exceedance of the site-specific screening criteria for large buildings (Table 4-33).

TABLE 4-33
Building TC864 Screening Criteria Exceedances

Well ID	PCE (µg/L)	TCE (µg/L)
Screening Criteria (Table 3-34)	*5.82*	*28.7*
IR89-MW32	-	74
IR89-MW43	7.8	280
IR89-MW48A	-	45

The depth to groundwater in these wells is approximately 5 ft. Shallow groundwater flows to the west, away from the building. During the AS pilot study conducted in 2007, COPCs were detected near Building TC864 in soil gas samples collected from IR89-SV03, as summarized in Table 4-34.

TABLE 4-34
Maximum COPC Detections During Air Sparging Pilot Study

COPC (ppbv)	IR89-SV03
Benzene	10.1
1,1-DCE	96
Cis-1,2-DCE	4,340
1,1,2,2-PCA	10.4
PCE	406
TCE	13,800
VC	126

ppbv = parts per billion by volume

Based on the available information, there may be a vapor intrusion pathway present at Building TC864 and collection of additional data is proposed (Table 4-29 and Figure 4-15).

Site 93

Site 93 is located within Camp Geiger immediately west of Site 89. The buildings in this portion of Camp Geiger were constructed during the Korean War and currently function as classrooms, barracks, and supply rooms for the Marine Infantry School. Historical records indicate that a 550-gallon UST storing waste oil was previously located on Site 93. Building G930 is the only building retained for further evaluation within Site 93 (Figure 3-37).

Building G930 Building G930 is a two-story brick building constructed on a concrete slab, and is approximately 200 ft long by 200 ft wide. The building has 32 windows and four doors. Building G930 is used as a gymnasium with varying occupancy. The building is surrounded by impermeable surfaces including a parking lot and roads to the south and west, and a grassy area to the north and east.

Building G930 is classified as a large industrial building for this evaluation. It is located within 100 ft of one monitoring well (IR93-MW10) which has exceedance of the site-specific screening criteria for large buildings for PCE (5.82 µg/L) at 26 µg/L. The depth to groundwater at IR93-MW10 is approximately 5 feet. Shallow groundwater flows to the northeast, away from the building.

Based on the available information, there may be a vapor intrusion pathway present at Building G930 and collection of additional data is proposed (Table 4-29 and Figure 4-16).

4.5.2 DQOs

Based on the CSMs presented above, DQOs for Camp Geiger were developed for use in selecting sample types and locations. These DQOs are presented in Table 4-35.

TABLE 4-35
Data Quality Objectives—Camp Geiger

Step 1: Statement of Problem	Groundwater within Camp Geiger has been impacted by chlorinated VOCs, specifically PCE, TCE, and their daughter products, and petroleum-related VOCs, including benzene. One or more of these compounds are present above site specific screening levels in shallow groundwater within 100 ft of the buildings included in this evaluation. Additional data are required to determine whether VOCs in groundwater near these buildings represent potential vapor intrusion pathways that require further investigation.
Step 2: Identify the Decision	Additional exterior data (e.g., soil gas, groundwater), in conjunction with existing data, will provide information to determine whether subsurface contamination requires further investigation. For some buildings, specifically those within 100 ft of an air sparge system, or buildings within 100 ft of identified free product, subslab and/or indoor air sampling will be conducted.
Step 3: Inputs to Decisions	The CSMs developed for the buildings were used to determine additional data requirements. For the purposes of this evaluation, all buildings within Camp Geiger are classified as industrial use buildings. Large buildings are defined as 100 to 200 ft long by 50 to 200 ft wide. Small buildings are defined as 10 to 50 ft long by 10 to 50 ft wide. VOCs in exceedance of site-specific screening levels in shallow groundwater within 100 ft of each building, as summarized in Section 2 and the CSMs above. An offsite or mobile laboratory will be contracted to perform sample analysis. The subcontracted laboratory will use the appropriate analytical methods to reach the project specific analytical requirements.
Step 4: Study Boundaries	Camp Geiger, aboard MCB Camp Lejeune, North Carolina, is generally defined as the Base property north of Curtis Road, east of Highway 17, south of NC Route 24 and west of Courthouse Bay. Study boundaries are defined as 100 lateral feet around each building.
Step 5: Decision Rules	The decision logic for selecting sampling locations is provided as Figure 4-1 and is summarized below. For buildings within 100 ft of shallow monitoring wells containing VOCs, depth-specific groundwater samples (within the top five feet of the aquifer) will be collected at locations adjacent to buildings to determine whether VOC concentrations greater than site specific screening levels developed using the J&E model extend beneath the building. Sample locations will be based toward the highest concentrations from current data. Groundwater samples will not be collected where the water table is present at depths less than 5 ft bgs. In this case, subslab and potentially indoor air samples will be collected from the building being evaluated. The results of the groundwater sample analysis will be compared to the site-specific screening levels developed using the J&E model. Soil gas samples will be collected adjacent to buildings exceeding site-specific screening levels. Where groundwater samples are also being collected, the soil gas samples will be collected co-located with the groundwater samples. As with groundwater samples, soil gas samples will not be collected in areas where the groundwater table is present at depths less than 5 ft bgs. In this case, subslab and potentially indoor air samples will be collected from the building being evaluated. Where applicable, site-specific soil gas screening levels will be developed. Results from the soil gas samples will be compared to site-specific screening levels and/or Region IX PRGs for ambient air quality standards using an appropriate attenuation factor. That attenuation factor will be identified from USEPA's recently developed attenuation factors database. If free product is present within 100 ft of a building, as indicated by the observation of NAPL, or suspected based on the exceedance of 1 percent of a compound's solubility (see Table 4-5), then subslab and/or indoor air samples within the building being evaluated. Subslab and/or indoor air samples will also be collected within buildings located within 100 ft of an air sparge or biopulsing system. The subslab and/or indoor air sample results will be compared to Region IX PRGs for ambient air quality standards. Additional data will not be collected within buildings where existing soil gas or indoor air data is available, or a mitigation system is currently in place. For these buildings, existing data will be used in the evaluation.

	If subslab and/or indoor air data confirm that VOC concentrations exceed site-specific screening levels and/or Region IX PRGs for ambient air quality standards, additional investigation and/or mitigation measures may be recommended.
Step 6: Limits of Decision Errors	The probability of sampling and measurement errors at any site under investigation necessitates the development of sampling guidelines. Field errors are minimized by having each member of the field team follow the same SOPs for sampling. QC samples, including duplicates, matrix spikes, matrix spike duplicates, equipment blanks, and field blanks, are used to verify the data's accuracy and precision. When a QC sample is outside of the established control limits, the data will be qualified and field corrective action implemented when applicable (such as when field duplicates are outside established control limits). Further, when subslab and.or indoor air samples are collected, ambient air QC samples will also be collected. A building survey will be conducted to identify chemicals stored or used within the building. This will ensure that concentrations detected in indoor air and or/sub-slab air samples are indicative of vapor intrusion from groundwater.
Step 7: Optimize the Sampling Design	The sampling design objective is to assess the potential for vapor intrusion to result in risks to building occupants. The results of the evaluation will be used to determine whether additional investigation/risk assessment is required. Refer to Figure 4-1 for the decision logic used to optimize the sampling design.

4.5.3 Proposed Sample Locations

Based on the CSMs and DQOs provided above, nine groundwater, 12 soil gas, six subslab, and six indoor air sample locations are proposed at Camp Geiger, as summarized on Table 4-29 and shown on Figures 4-14 through 4-16.

4.6 Summary

A total of 50 buildings were selected for sampling across the Base. CSMs were developed for each of these buildings and DQOs were developed by Base area. The proposed sample types and locations were selected based on the CSMs and DQOs. The number and types of proposed samples are summarized by Base area in Table 4-36 and the locations are shown on Figures 4-2 to 4-16.

TABLE 4-36
Summary of Proposed Samples

	Groundwater	Soil Gas	Subslab	Indoor Air
Mainside	11	14	6	6
Hadnot Point	21	21	15	15
Air Station	14	14	0	0
Courthouse Bay	0	0	4	0
Camp Geiger	9	12	6	6
TOTAL	**55**	**61**	**30**	**26**

Subslab and indoor air samples are currently proposed only for buildings where free product and/or an air sparge or biopulsing system is present. Although only collecting subslab vapor samples beneath buildings within 100 ft of free product and/or an air sparge or biopulsing system is an option, concurrent indoor and subslab sampling is recommended at these buildings in order to begin obtaining data which can be used to develop empirically based and building-specific subslab-to-indoor air attenuation factors. This is important

given the potential for stakeholders to question the validity of the input assumptions used to derive J&E based subslab-to-indoor air screening values. During data evaluation (discussed in Section 5), site-specific small and large building-specific input parameters will be used in the J&E transport model to the extent feasible. However, the potential for significant (orders of magnitude in some cases) uncertainties associated with the J&E model are generally recognized by regulators and other stakeholders. Concurrent indoor air and subslab sampling results at these select buildings will help to begin validate model assumptions and address these and other uncertainties.

Sample collection and analysis will be performed in accordance with the FSP (Appendix A) and the HSP (Appendix C).

TABLE 4-1
Mainside Building Summary and Sampling Plan
Vapor Intrusion Work Plan
MCB Camp Lejeune, North Carolina

Building/Group ID	VOCs in Exceedance of Site-Specific Screening Criteria	Depth to Groundwater (ft bgs)	Number of Groundwater Samples	Number of Soil Gas Samples	Number of Subslab Samples	Number of Indoor Air Samples
LCH-4015 LCH-4014	Benzene	11	0	0	2	2
Site 820 820	Benzene	13	0	0	2	2
SWMU 118 728	Benzene	NA	0	0	2	2
Site 88 3 3B 37 43	Benzene, PCE, TCE, Cis 1,2-DCE	8-10	7	10	0	0
SWMU 360 1828 1855	PCE	20	4	4	0	0
TOTAL			**11**	**14**	**6**	**6**

Notes:
NA - not available

TABLE 4-5
Solubility of Contaminants of Concern
Vapor Intrusion Work Plan
MCB Camp Lejeune, North Carolina

Chemical	Water Solubility (µg/L)	1% of Solubility (µg/L)
Volatile Organic Compounds		
Benzene	1,770,000 (4)	17,700
Bromoform	3,100,000	31,000
Cis-1,2-Dichloroethene	3,500,000 (1)	35,000
1,1,2,2-Tetrachloroethane	2,962,000 (2)	29,620
1,2-Dichloroethane	8,310,000 (4)	83,100
Tetrachloroethene	150,000 (3)	1,500
1,1,2-Trichloroethane	4,400,000 (2)	44,000
Trichloroethene	1,100,000 (3)	11,000
Vinyl Chloride	1,100,000 (2)	11,000
o-Xylene	221,000 (4)	2,210
m-Xylene	162,700 (4)	1,627
p-Xylene	189,000 (4)	1,890

Data sources:
(1) United States Environmental Protection Agency. October 1990. *Subsurface Contamination Reference Guide.*
(2) Montgomery, John H. 1996. Groundwater Chemicals Desk Reference. Second Edition.
(3) Montgomery and Welkom. 1989. Groundwater Chemicals Desk Reference. Volume 1.
(4) Richard Watts. 1998. Hazardous Wastes: Sources, Pathways, and Receptors.

TABLE 4-7
Hadnot Point Building Summary and Sampling Plan
Vapor Intrusion Work Plan
MCB Camp Lejeune, North Carolina

Building/Group ID	VOCs in Exceedance of Site-Specific Screening Criteria	Depth to Groundwater (ft bgs)	Number of Groundwater Samples	Number of Soil Gas Samples	Number of Subslab Samples	Number of Indoor Air Samples
SWMU 360 1817 1819	PCE, TCE, and Vinyl Chloride	19 - 21	3	3	0	0
Site 78 North 901 902 903	Xylene, TCE, and Vinyl Chloride	11	6	6	0	0
Site 78 South 1502 1601	Benzene, Xylene, 1,1,2-TCA, PCE, TCE, Cis-1,2-DCE, and Vinyl Chloride	11 - 14	5	5	0	0
Site 78 South 1603	Benzene	16	2	2	0	0
Site 78 South 1707	TCE and Vinyl Chloride	18	2	2	0	0
Building 1613 1611 1613	Benzene	14	3	3	0	0
Hadnot Point Fuel Farm 1005	None	NA	0	0	1	1
Hadnot Point Fuel Farm 1068	Observation of LNAPL	NA	0	0	1	1
Hadnot Point Fuel Farm 1111 1115	Benzene and 1,2-DCA	NA	0	0	2	2
Hadnot Point Fuel Farm 1108 1200	Benzene, Xylene, and 1,2-DCA	NA	0	0	2	2
Hadnot Point Fuel Farm 1201 1202 1301	None (in vicinity of air sparge / bio-pulse systems)	NA	0	0	5	5
Hadnot Point Fuel Farm 1220	None	NA	0	0	1	1
Hadnot Point Fuel Farm 1114	Benzene, Xylene, and Observation of LNAPL	NA	0	0	1	1
TOTAL			**21**	**21**	**13**	**13**

Notes:
NA - not available

TABLE 4-21
Air Station Building Summary and Sampling Plan
Vapor Intrusion Work Plan
MCB Camp Lejeune, North Carolina

Building/Group ID	VOCs in Exceedance of Site-Specific Screening Criteria	Depth to Groundwater (ft bgs)	Number of Groundwater Samples	Number of Soil Gas Samples	Number of Subslab Samples	Number of Indoor Air Samples
SWMU 366 AS4106	PCE	12	2	2	0	0
USTCSFF AS4151 AS143	Benzene	14 -16	2	2	0	0
Site 86 AS515 AS541 AS502 AS424 AS510	Benzene, PCE, TCE, Vinyl Chloride	5-11	10	10	0	0
TOTAL			**14**	**14**	**0**	**0**

TABLE 4-27
Courthouse Bay Building Summary and Sampling Plan
Vapor Intrusion Work Plan
MCB Camp Lejeune, North Carolina

Building/Group ID	VOCs in Exceedance of Site-Specific Screening Criteria	Depth to Groundwater (ft bgs)	Number of Groundwater Samples	Number of Soil Gas Samples	Number of Subslab Samples	Number of Indoor Air Samples
Site 73 A47	TCE and Vinyl Chloride	5	0	0	4	0
TOTAL			**0**	**0**	**4**	**0**

TABLE 4-29
Camp Geiger Building Summary and Sampling Plan
Vapor Intrusion Work Plan
MCB Camp Lejeune, North Carolina

Building/Group ID	VOCs in Exceedance of Site-Specific Screening Criteria	Depth to Groundwater (ft bgs)	Number of Groundwater Samples	Number of Soil Gas Samples	Number of Subslab Samples	Number of Indoor Air Samples
Site 35 G480	Benzene, Vinyl Chloride and observance of LNAPL	NA	0	0	2	2
Site 35 G521 G530 G531 G532 G533	Benzene and Vinyl Chloride	8	6	6	0	0
Site 89 TC860 TC864	PCE and TCE	5	0	3	4	4
Site 93 G930	PCE	5	3	3	0	0
TOTAL			**9**	**12**	**6**	**6**

Notes:
NA - not available

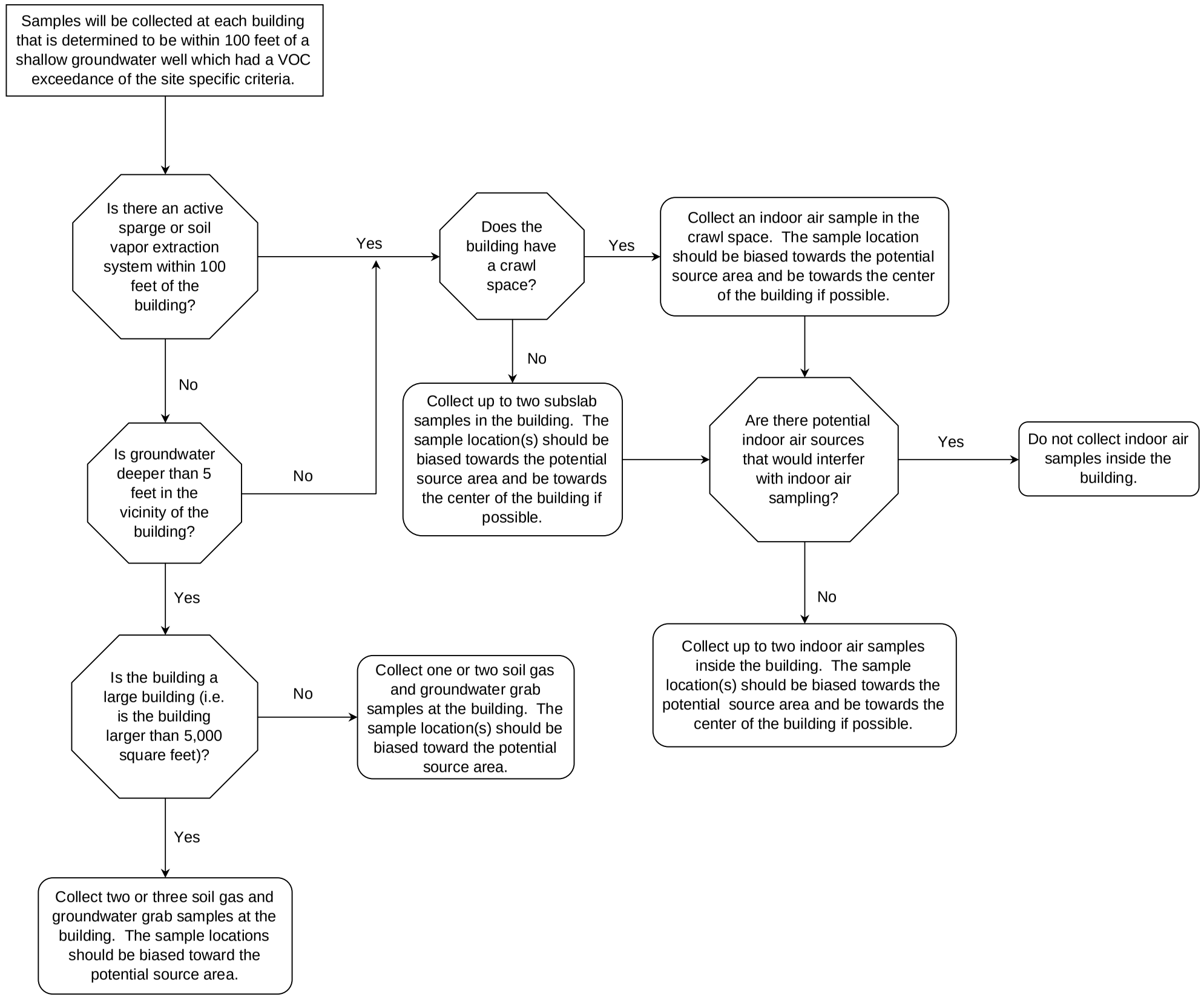


FIGURE 4-1
Field Investigation Decision Logic
MCB Camp Lejeune, North Carolina

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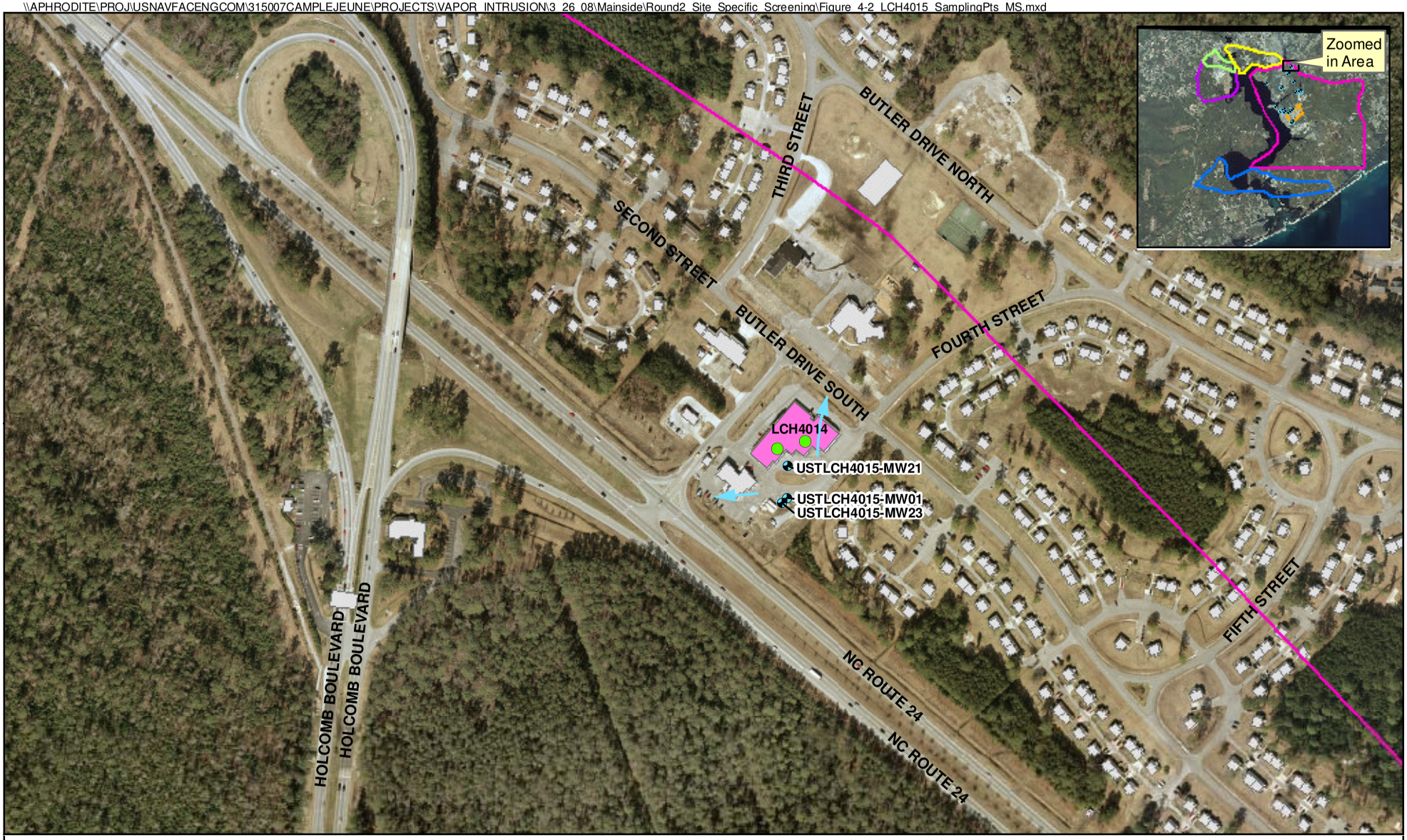


Legend

- Monitoring Well with exceedances
- Proposed Subslab/ Indoor Air Sample Locations
- Shallow Groundwater Flow
- Buildings Selected for Further Evaluation
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

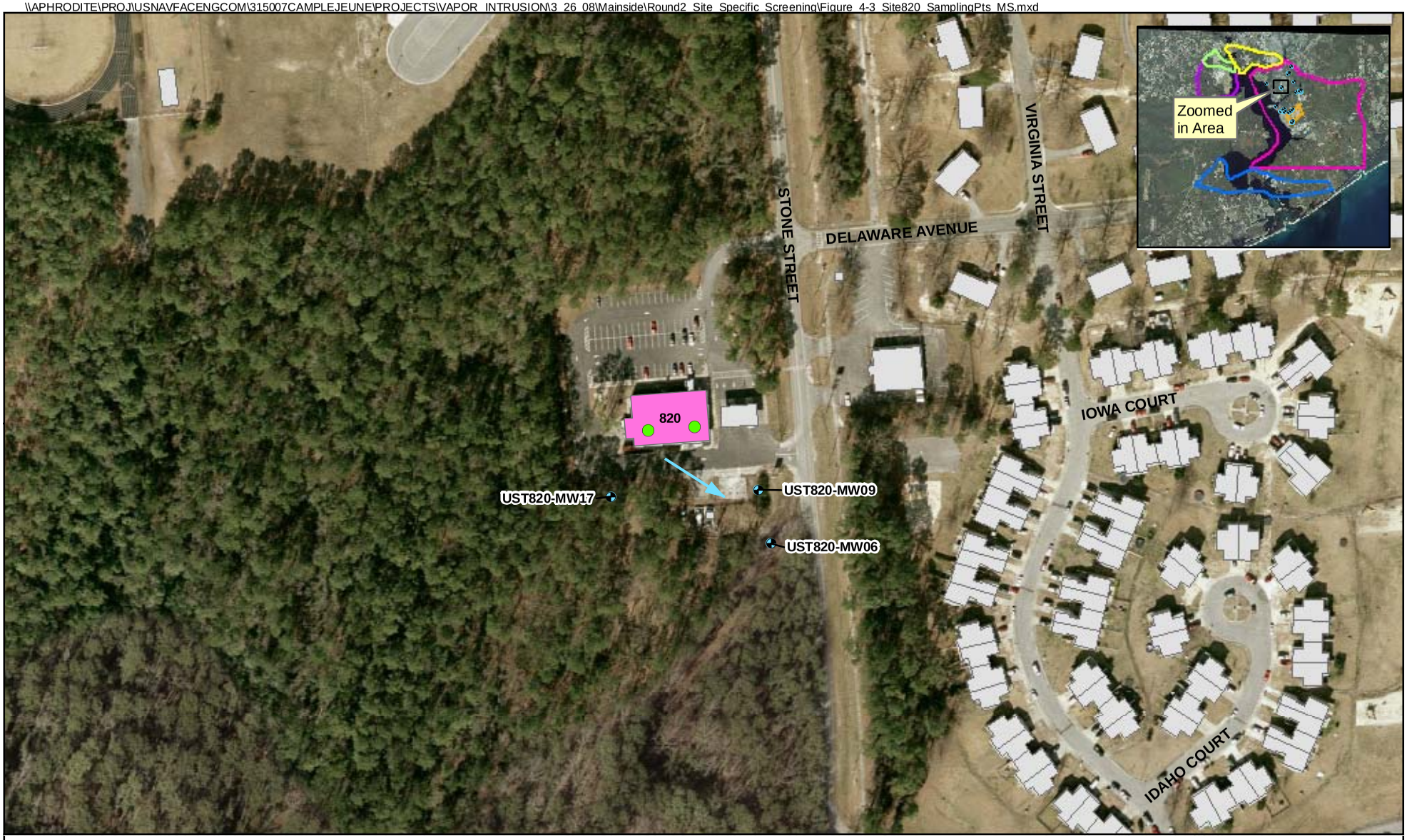
N

0 200 400 800 Feet

Figure 4-2
LCH-4015 Sampling Locations
Vapor Intrusion Work Plan
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

\\APHRODITE\PROJ\USNAVFACENGCOM\315007CAMPLEJEUNE\PROJECTS\VAPOR_INTRUSION\3_26_08\Mainside\Round2_Site_Specific_Screening\Figure_4-3_Site820_SamplingPts_MS.mxd



Legend

- Monitoring Well with exceedances
- Proposed Subslab and Indoor Air Sample Locations
- Shallow Groundwater Flow
- Buildings Selected for Further Evaluation
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

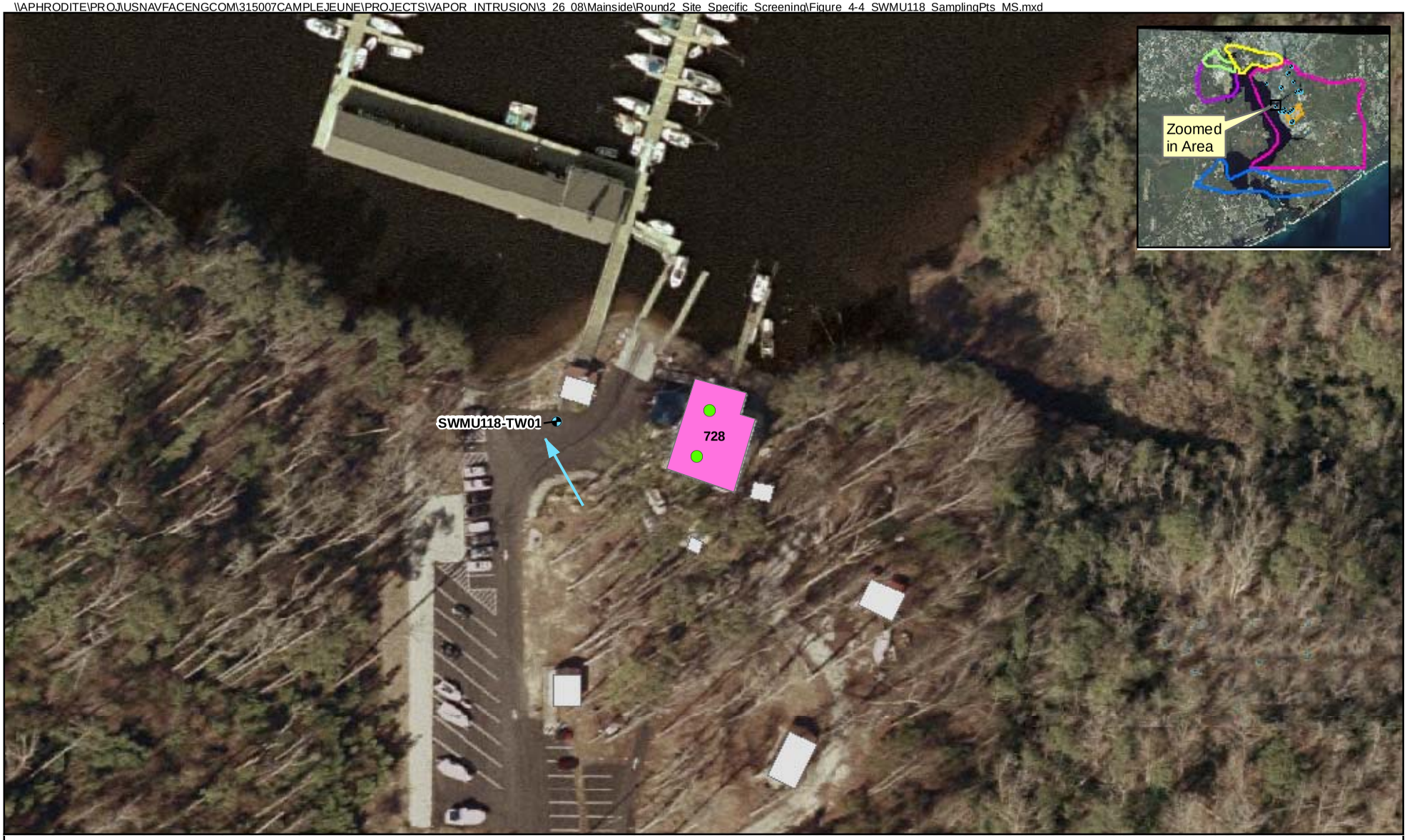
N

0 100 200 400 Feet

Figure 4-3
Site 820 Sampling Locations
Vapor Intrusion Work Plan
MCB Camp Lejeune
North Carolina

AGVIO CH2M HILL

\\APHRODITE\PROJ\USNAVFACENGCOM\315007CAMPLEJEUNE\PROJECTS\VAPOR_INTRUSION\3_26_08\Mainside\Round2_Site_Specific_Screening\Figure_4-4_SWMU118_SamplingPts_MS.mxd



Legend

- Monitoring Well with exceedances
- Proposed Subslab and Indoor Air Sample Locations
- Shallow Groundwater Flow
- Buildings Selected for Further Evaluation
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

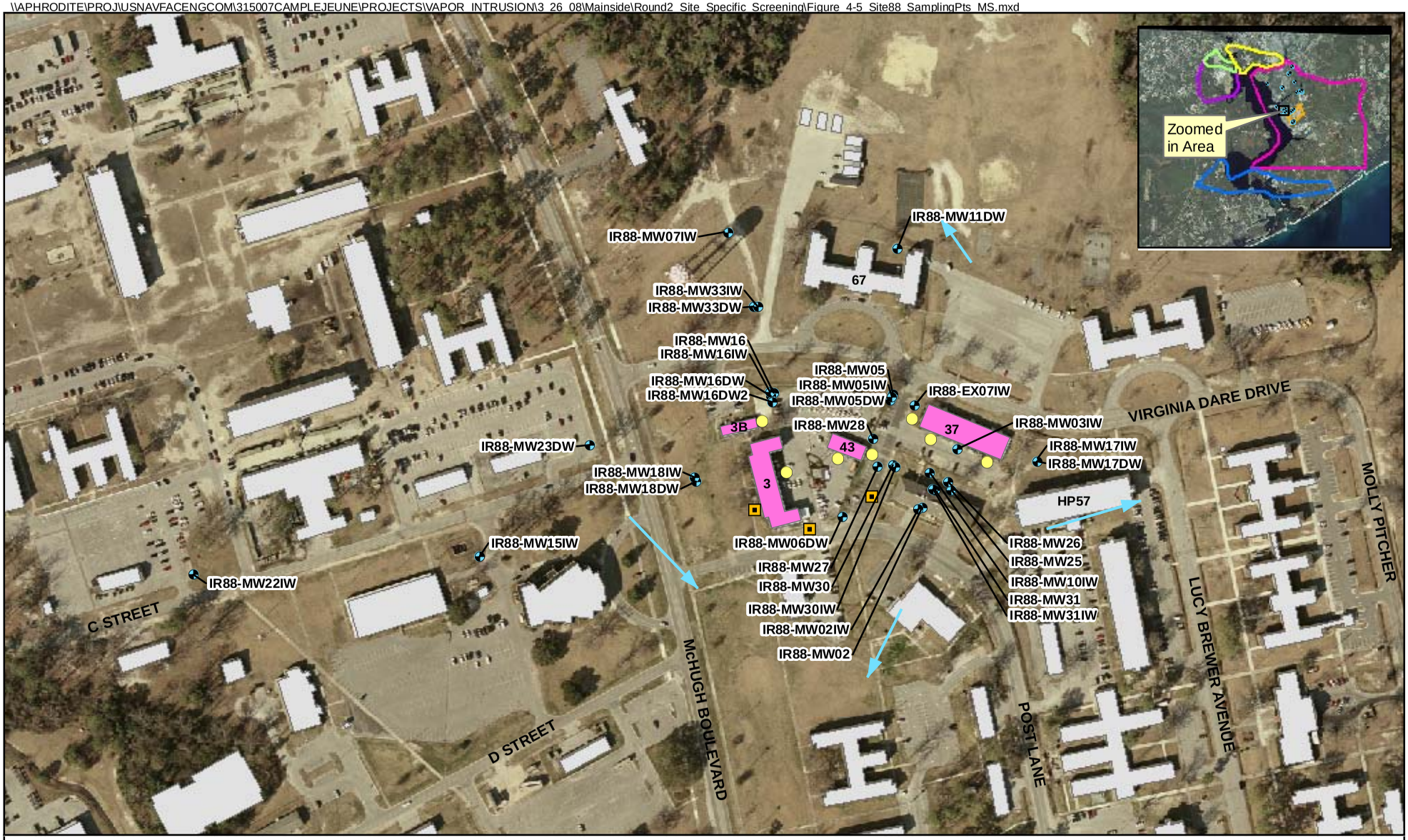
N

0 50 100 200 Feet

Figure 4-4
SWMU 118 Sampling Locations
Vapor Intrusion Work Plan
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

\\APHRODITE\PROJ\USNAVFACENGCOM\315007CAMPLEJEUNE\PROJECTS\VAPOR_INTRUSION\3_26_08\Mainside\Round2_Site_Specific_Screening\Figure_4-5_Site88_SamplingPts_MS.mxd



Legend

- Monitoring Well with exceedances
- Existing Soil Gas Sample Locations
- Proposed Groundwater and Soil Gas Sample Locations
- Shallow Groundwater Flow
- Buildings Selected for Further Evaluation
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

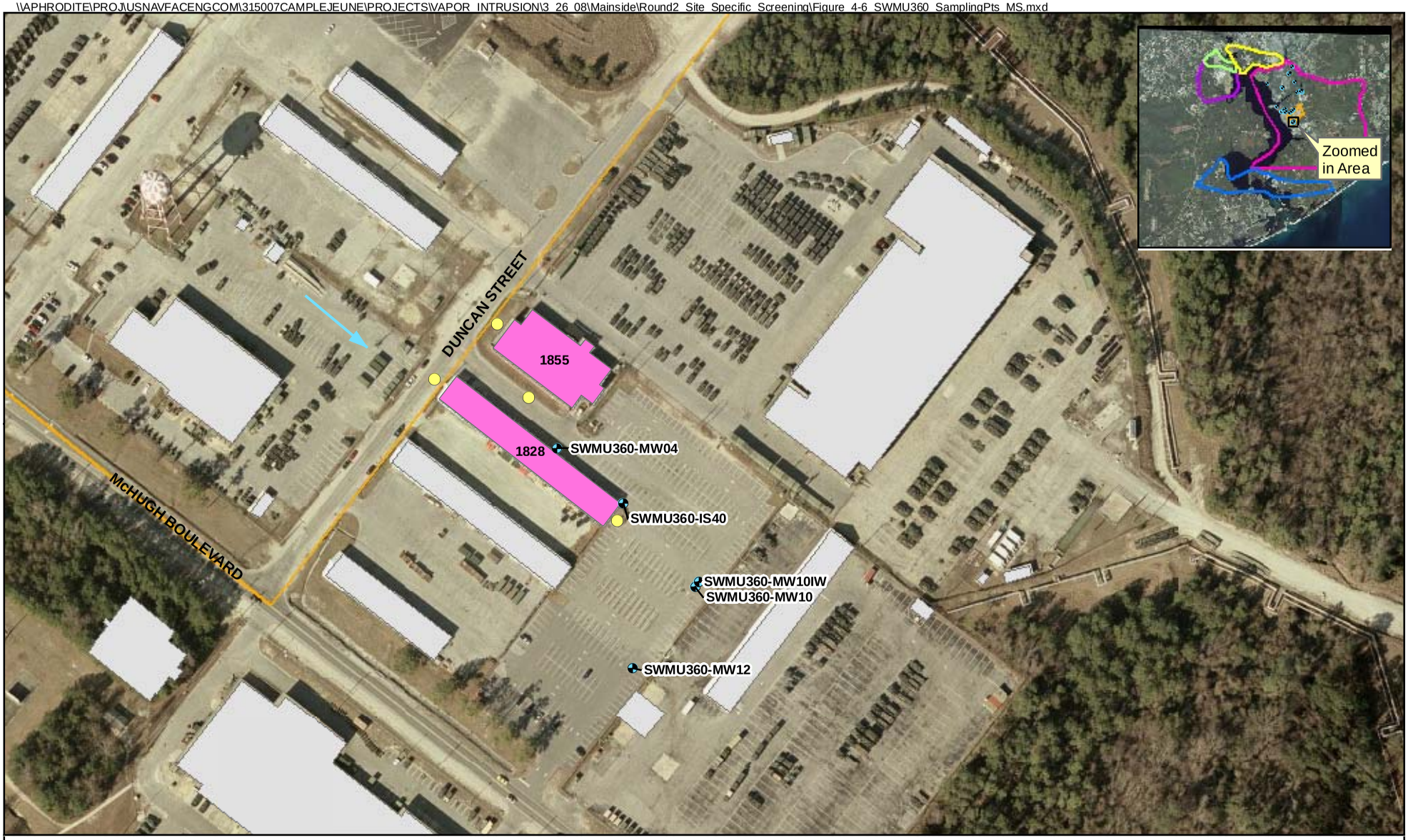
N

0 150 300 600 Feet

Figure 4-5
Site 88 Sampling Locations
Vapor Intrusion Work Plan
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

\\APHRODITE\PROJ\USNAVFACENGCOM\315007CAMPLEJEUNE\PROJECTS\VAPOR_INTRUSION\3_26_08\Mainside\Round2_Site_Specific_Screening\Figure_4-6_SWMU360_SamplingPts_MS.mxd



Legend

- Monitoring Well with exceedances
- Proposed Groundwater and Soil Gas Sample Locations
- Shallow Groundwater Flow
- Buildings Selected for Further Evaluation
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

N

0 100 200 400 Feet

Figure 4-6
Mainside SWMU 360 Sampling Locations
Vapor Intrusion Work Plan
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

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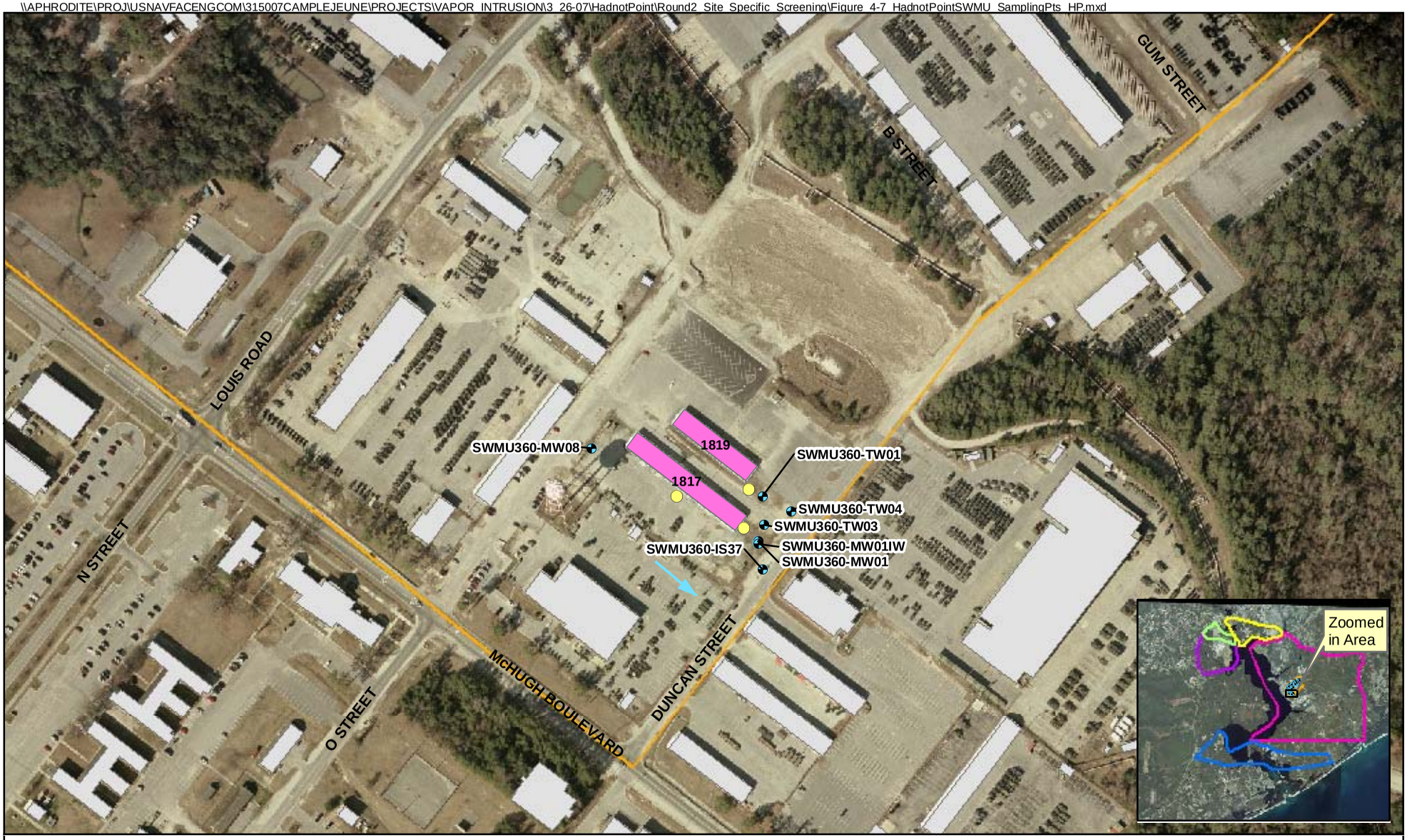


Legend

- Monitoring Well with exceedances
- Proposed Groundwater and Soil Gas Sample Locations
- Shallow Groundwater Flow
- Buildings Selected for Further Evaluation
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

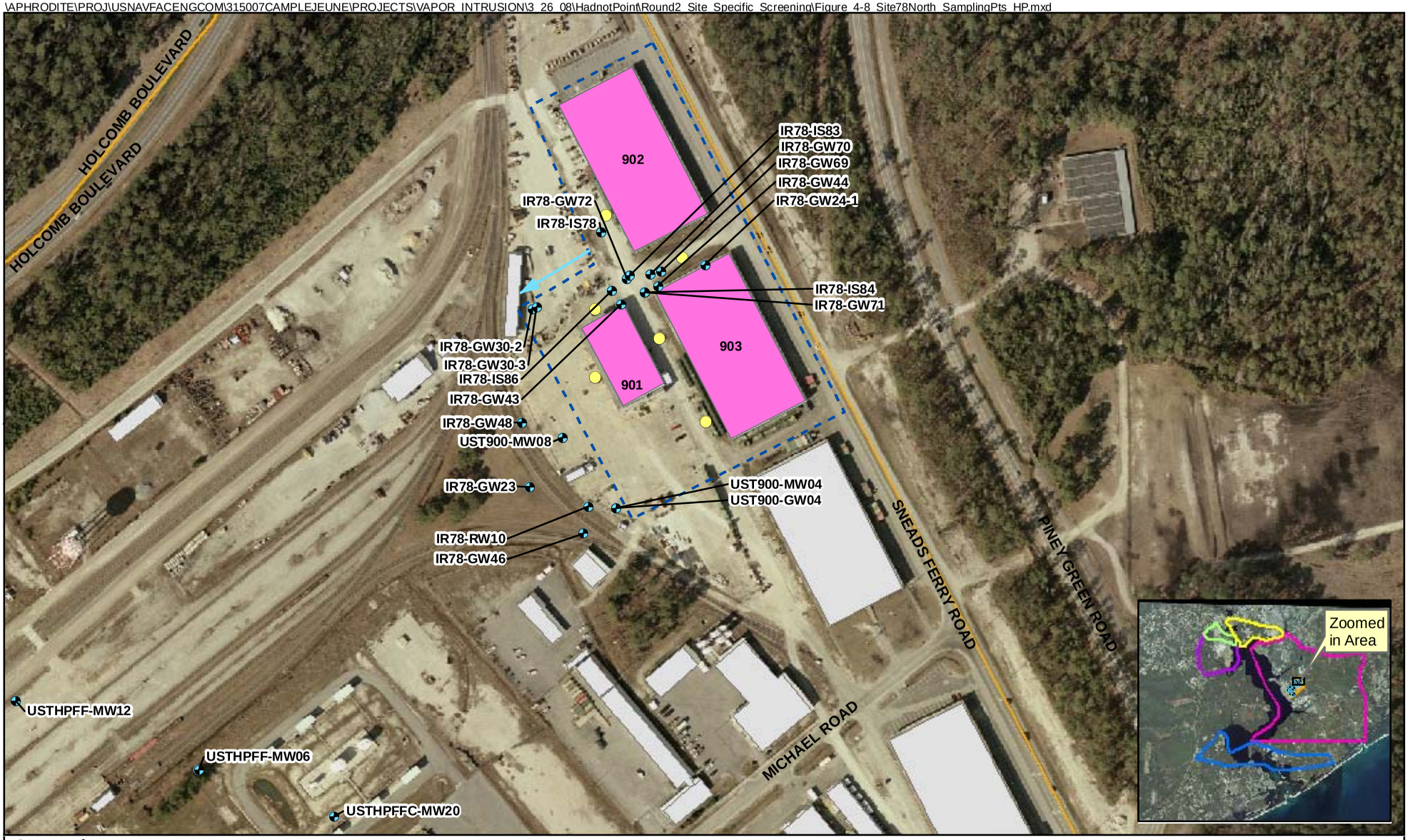
N

0 150 300 600 Feet

Figure 4-7
Hadnot Point SWMU 360 Sampling Locations
Vapor Intrusion Work Plan
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

\APHRODITE\PROJ\USNAVFACENGCOM\315007CAMPLEJEUNE\PROJECTS\VAPOR_INTRUSION\3_26_08\HadnotPoint\Round2_Site_Specific_Screening\Figure_4-8_Site78North_SamplingPts_HP.mxd



Legend

- Monitoring Well with exceedances
- Proposed Groundwater and Soil Gas Sample Locations
- Shallow Groundwater Flow
- Buildings Selected for Further Evaluation
- Buildings Grouped for Sampling Analysis
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

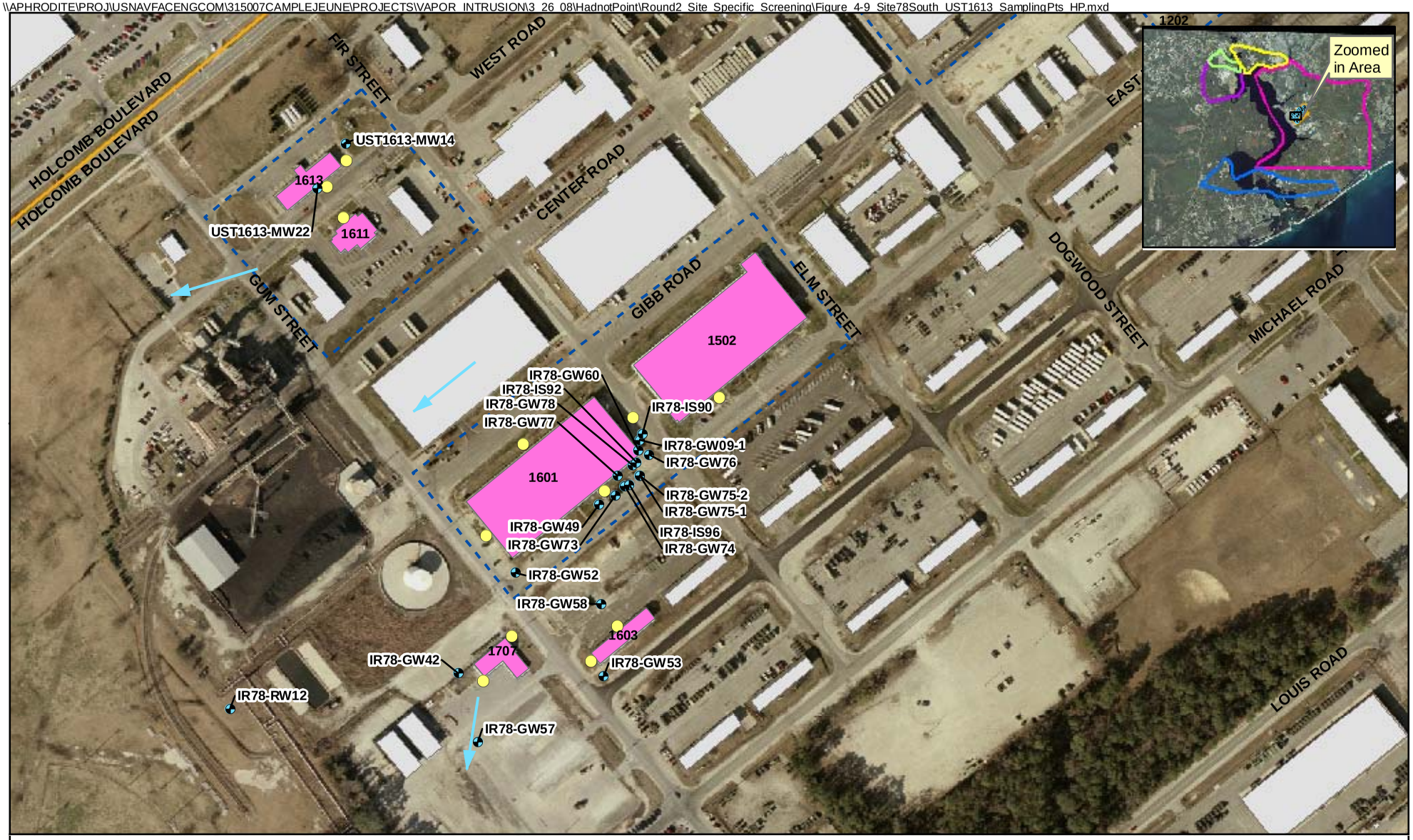
N

0 150 300 600 Feet

Figure 4-8
Site 78 North Sampling Locations
Vapor Intrusion Work Plan
MCB Camp Lejeune
North Carolina

AGVIO
CH2M HILL

\\APHRODITE\PROJ\USNAVFACENGCOM\315007CAMPLEJEUNE\PROJECTS\VAPOR_INTRUSION\3_26_08\HadnotPoint\Round2_Site_Specific_Screening\Figure_4-9_Site78South_UST1613_SamplingPts_HP.mxd



Legend

- Monitoring Well with exceedances
- Proposed Groundwater and Soil Gas Sample Locations
- Shallow Groundwater Flow
- Buildings Grouped for Sampling Analysis
- Buildings Selected for Further Evaluation
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

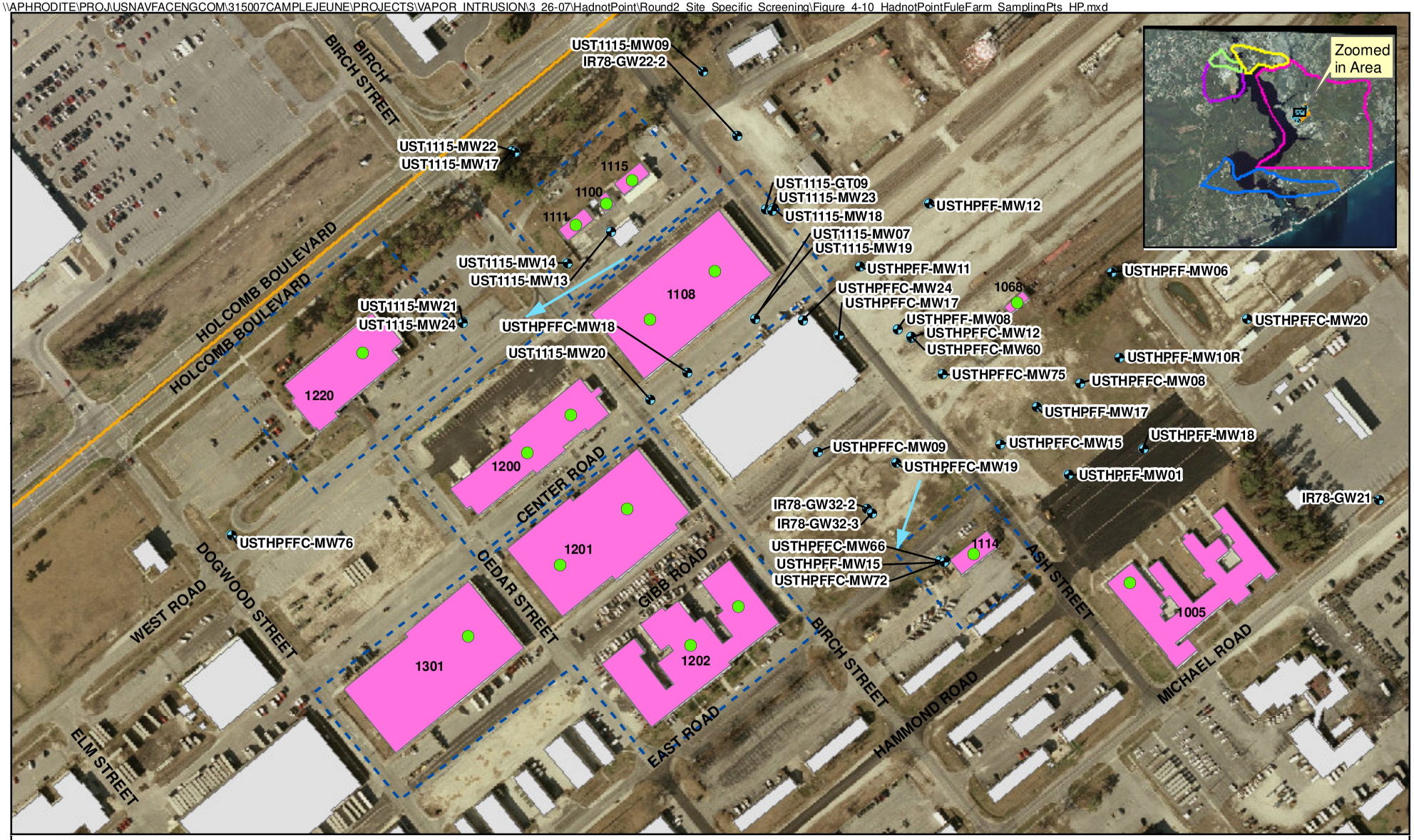
N

0 150 300 600 Feet

Figure 4-9
Site 78 South/UST1613 Sampling Locations
Vapor Intrusion Work Plan
MCB Camp Lejeune
North Carolina

AGVIO CH2M HILL

\\APHRODITE\PROJ\USNAVFACENGCOM\315007CAMPLEJEUNE\PROJECTS\VAPOR_INTRUSION\3_26-07\HadnotPoint\Round2_Site_Specific_Screening\Figure_4-10_HadnotPointFuleFarm_SamplingPts_HP.mxd



Legend

- Monitoring Well with exceedances
- Proposed Subslab and Indoor Air Sample Locations
- Shallow Groundwater Flow
- Buildings Grouped for Sampling Analysis
- Buildings Selected for Further Evaluation
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

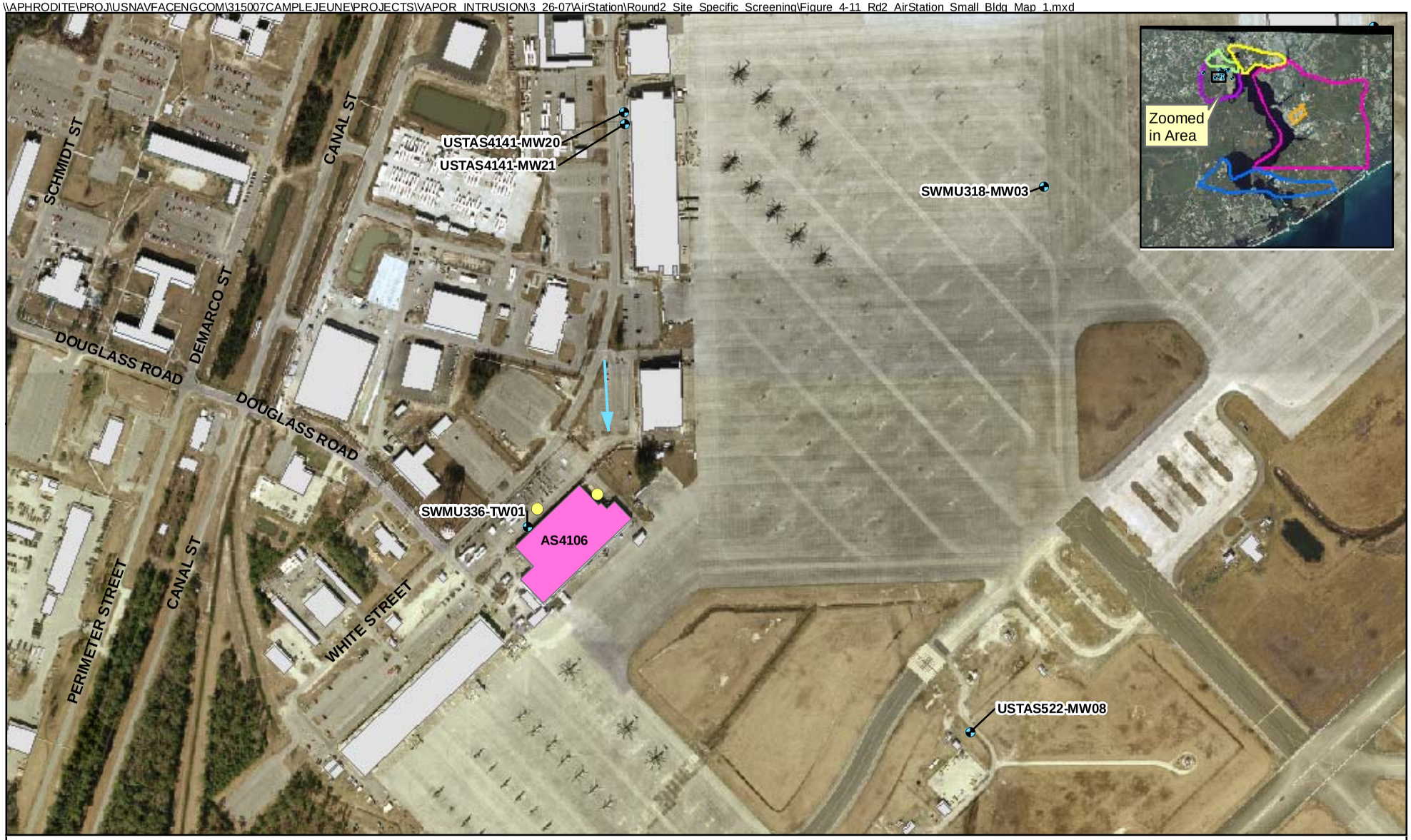
N

0 150 300 600 Feet

Figure 4-10
Hadnot Point Fuel Farm Sampling Locations
Vapor Intrusion Work Plan
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

\\APHRODITE\PROJ\USNAVFACENGCOM\315007CAMPLEJEUNE\PROJECTS\VAPOR_INTRUSION\3_26-07\AirStation\Round2_Site_Specific_Screening\Figure_4-11_Rd2_AirStation_Small_Bldg_Map_1.mxd



Legend

- Monitoring Well with exceedances
- Proposed Groundwater and Soil Gas Sample Locations
- Shallow Groundwater Flow
- Buildings within100ft of Monitoring Wells
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

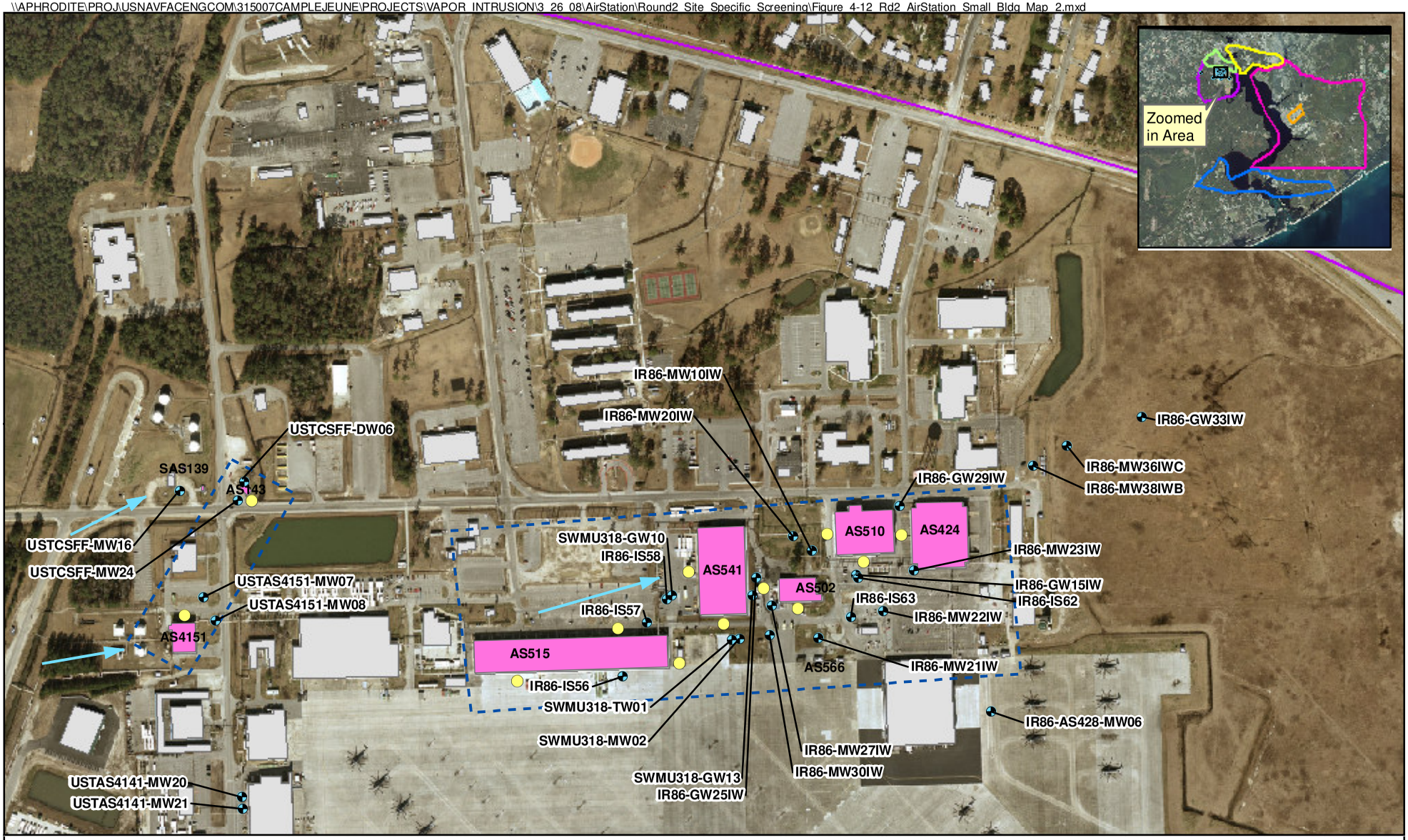
N

0 250 500 1,000 Feet

Figure 4-11
SWMU 336 Sampling Locations
Vapor Intrusion Work Plan
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

\\APHRODITE\PROJ\USNAVFACENGCOM\315007CAMPLEJEUNE\PROJECTS\VAPOR_INTRUSION\3_26_08\AirStation\Round2_Site_Specific_Screening\Figure_4-12_Rd2_AirStation_Small_Bldg_Map_2.mxd



Legend

- Monitoring Well with exceedances
- Proposed Groundwater and Soil Gas Sample Locations
- Shallow Groundwater Flow
- Buildings within100ft of Monitoring Wells
- Buildings Grouped for Sampling Analysis
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

N

0 250 500 1,000 Feet

Figure 4-12
Site 86/USTCSFF Sample Locations
Vapor Intrusion Work Plan
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

\\APHRODITE\PROJ\USNAVFACENGCOM\315007CAMPLEJEUNE\PROJECTS\VAPOR_INTRUSION\3_26_08\CourthouseBay\Round2_Site_Specific_Screening\Figure_4-13_Site73_SamplingPts_CB.mxd

Legend

- Monitoring Well with exceedances
- Existing Subslab Sample Locations
- Shallow Groundwater Flow
- Buildings Selected for Further Evaluation
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

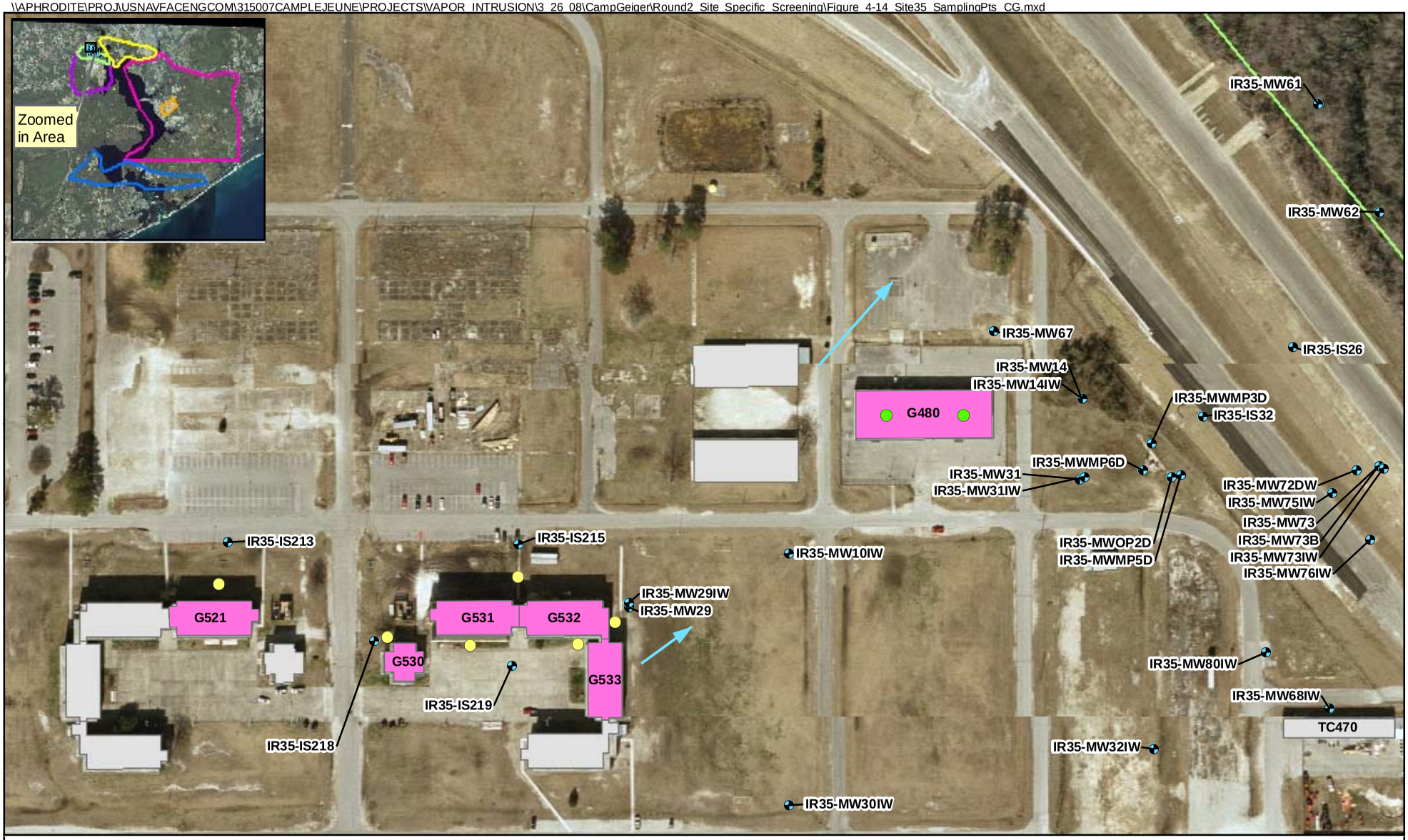
N

0 200 400 800 Feet

Figure 4-13
Courthouse Bay Sampling Locations
Vapor Intrusion Work Plan
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

\\APHRODITE\PROJ\USNAVFACENGCOM\315007CAMPLEJEUNE\PROJECTS\VAPOR_INTRUSION\3_26_08\CampGeiger\Round2_Site_Specific_Screening\Figure_4-14_Site35_SamplingPts_CG.mxd



Legend

- Monitoring Well with exceedances
- Proposed Subslab and Indoor Air Sample Locations
- Proposed Groundwater and Soil Gas Sample Locations
- Shallow Groundwater Flow
- Buildings Selected for Further Evaluation
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

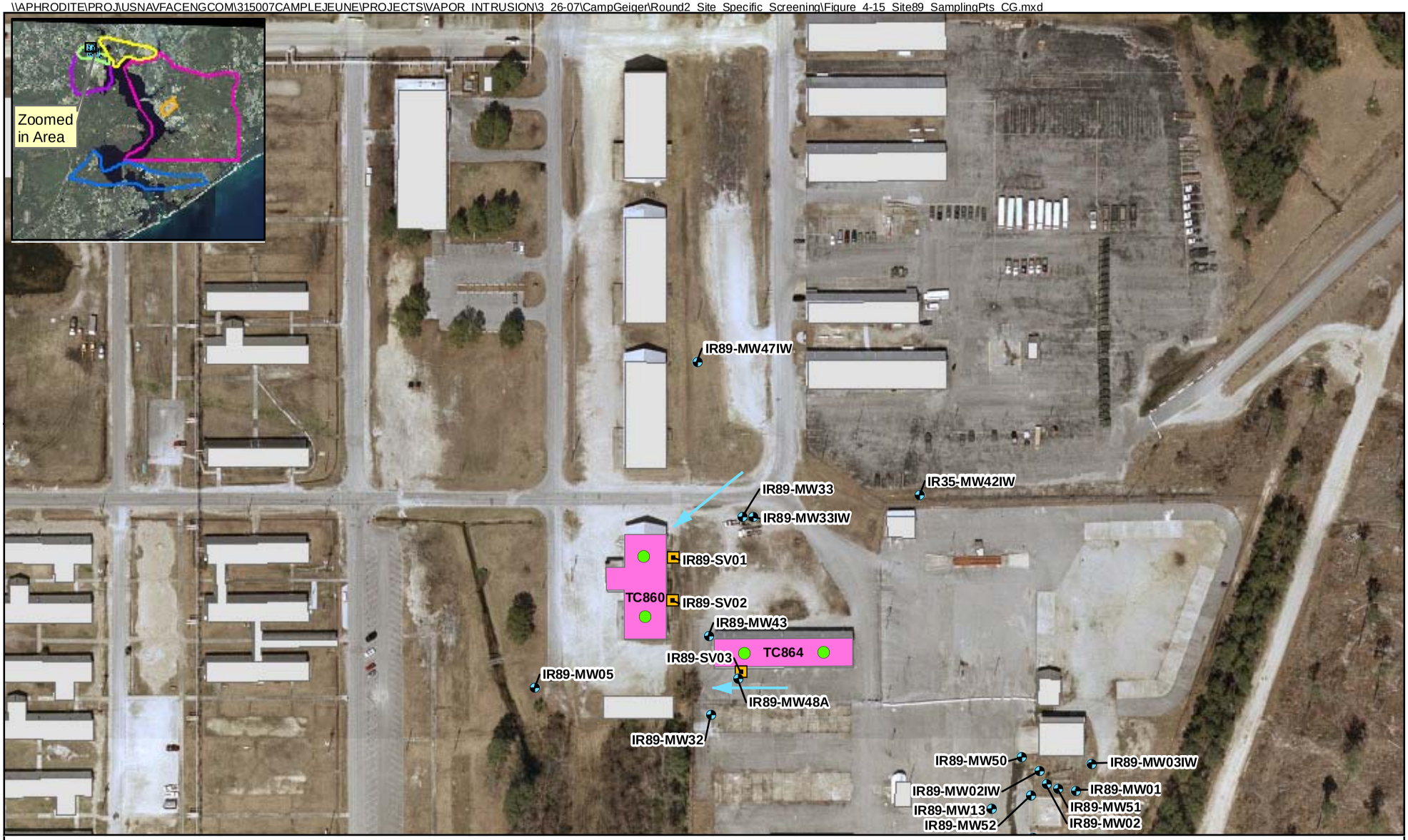
N

0 100 200 Feet

Figure 4-14
Site 35 Sampling Locations
Vapor Intrusion Work Plan
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

\\APHRODITE\PROJ\USNAVFACENGCOM\315007CAMPLEJEUNE\PROJECTS\VAPOR_INTRUSION\3_26-07\CampGeiger\Round2_Site_Specific_Screening\Figure_4-15_Site89_SamplingPts_CG.mxd



Legend

- Monitoring Well with exceedances
- Existing Soil Gas Sample Locations
- Proposed Subslab and Indoor Air Sample Locations
- Shallow Groundwater Flow
- Buildings Selected for Further Evaluation
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

N

0 100 200 400 Feet

Figure 4-15
Site 89 Sampling Locations
Vapor Intrusion Work Plan
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

\\APHRODITE\PROJ\USNAVFACENGCOM\315007CAMPLEJEUNE\PROJECTS\VAPOR_INTRUSION\3_26_08\CampGeiger\Round2_Site_Specific_Screening\Figure_4-16_Site93_SamplingPts_CG.mxd

Legend

- Monitoring Well with exceedances
- Proposed Groundwater and Soil Gas Sample Locations
- Shallow Groundwater Flow
- Air Station
- Camp Geiger
- Courthouse Bay
- Hadnot Point
- Mainside
- Tarawa Terrace

N

0 100 200 400 Feet

Figure 4-16
Site 93 Sampling Locations
Vapor Intrusion Work Plan
MCB Camp Lejeune
North Carolina

AGVIQ CH2M HILL

SECTION 5

Risk Evaluation and Reporting

The groundwater, soil vapor, subslab and indoor air data collected during this preliminary vapor intrusion evaluation will be validated (see Appendix B for validation methods) and will undergo evaluation to identify buildings where potential vapor intrusion pathways might be present, and also to identify additional buildings that might warrant investigation for vapor intrusion during future sampling events. The results from this data evaluation will be used to refine the conceptual site models for the buildings investigated, and to determine if additional data collection is needed to confirm the presence or absence of potential vapor intrusion pathways. In addition, the data evaluation will be used to support recommendations to take mitigation measures for selected buildings, if appropriate.

5.1 Risk Evaluation

The primary tools that will be used for the risk evaluation will be consistent with the data evaluation approach outlined in the ITRC, 2007 guidance document (ITRC, 2007). The evaluation approach is outlined in Figure 5-1 and will include the following:

- Comparison to screening levels, including site-specific screening levels appropriate for specific media. For groundwater, these include site-specific screening levels generated from the Johnson and Ettinger model; for indoor air sampling results, these include the USEPA Region IX PRGs adjusted for an indoor worker scenario; for soil gas, these include screening levels calculated from ambient air PRGs using an appropriate attenuation factor. That attenuation factor will be identified from the following:
  - USEPA's recently developed attenuation factors database (USEPA, 2008) if comparable buildings and data are available and applicable; and/or
  - Predictive J&E modeling using input parameters consistent with those used to develop the groundwater screening values Listed in Section 3.
- Comparison of site data with refined groundwater- and soil gas-to-indoor air screening levels. Site and building-specific data will be used for the following J&E input parameters:
  - SCS soil type and the corresponding soil properties recommended in USEPA (2002); and
  - The length, width, and height of individual buildings.

  All other J&E input parameters will be consistent with values from Section 3. If additional information is collected from the building, such as ventilation or pressure differential measurements, that information may be used to further refine the predictive modeling.

- Evaluation of multiple lines of evidence will include examination of concentration trends and potential spatial correlations between groundwater, soil gas and, if available, subslab and indoor air sampling data. Indoor air sampling results will be compared with ambient background sampling results, to assess if concentration detected might be from existing ambient air sources. In addition, potential indoor sources identified during the pre-sampling building survey will be used to flag indoor and/or subslab vapor results and will be considered during the vapor intrusion assessment. As necessary, building characteristics will be examined in further detail to identify the presence of conditions that might promote the occurrence of vapor intrusion. If needed, the ratio of constituents in groundwater, soil gas, subslab, and/or indoor air will be evaluated to help identify potential vapor intrusion contributions or to screen out background sources. If the ratios of constituents (including ratios to potential marker chemicals) differ significantly between groundwater, soil gas, subslab, and/or indoor air, this would suggest subsurface volatilization is not responsible for all of the measured levels.

In addition to the analytical data, data collected in the field will be used to refine the CSMs for the buildings of interest which require further vapor intrusion evaluation. If the sample data indicates that no further action is required at a building of interest the CSM for that building will not be updated.

The following field data will be evaluated:

- The soil boring logs generated during field sampling and previous investigations will be evaluated to determine the subsurface conditions in the vicinity of the buildings of interest.
- The groundwater field data will be evaluated to determine the hydrogeologic conditions adjacent to the buildings of interest.
- The utility location and visual utility survey information will be used to determine the location of underground utilities in the vicinity of the buildings of interest which may act as preferential pathways for soil gas. If the results of the utility evaluation indicate a utility corridor is acting as a preferential pathway, the utility will be traced to determine whether this pathway may impact additional buildings. If appropriate, the additional buildings will be recommended for evaluation.
- The building survey information (e.g., HVAC system, slab condition) will be added to the building condition information.

5.2 Reporting

A comprehensive report will be prepared to document the results of this preliminary vapor intrusion evaluation. The report will include results of the field investigation and sample analysis and the risk evaluation. In addition, the summary report will include the building inventory, analytical results and comparison to screening levels, GIS maps showing sampling and building locations, and revised CSMs (as appropriate).

The lines of evidence used to determine whether a vapor intrusion risk is present within the buildings of interest will be presented. Buildings where no current unacceptable risk is

found to building occupants exists will be removed from the buildings of interest list. Recommendations for further action (e.g. additional sampling, further risk assessment, and/or mitigation) will be made if the evaluation concludes further actions are required for the remaining buildings of interest.

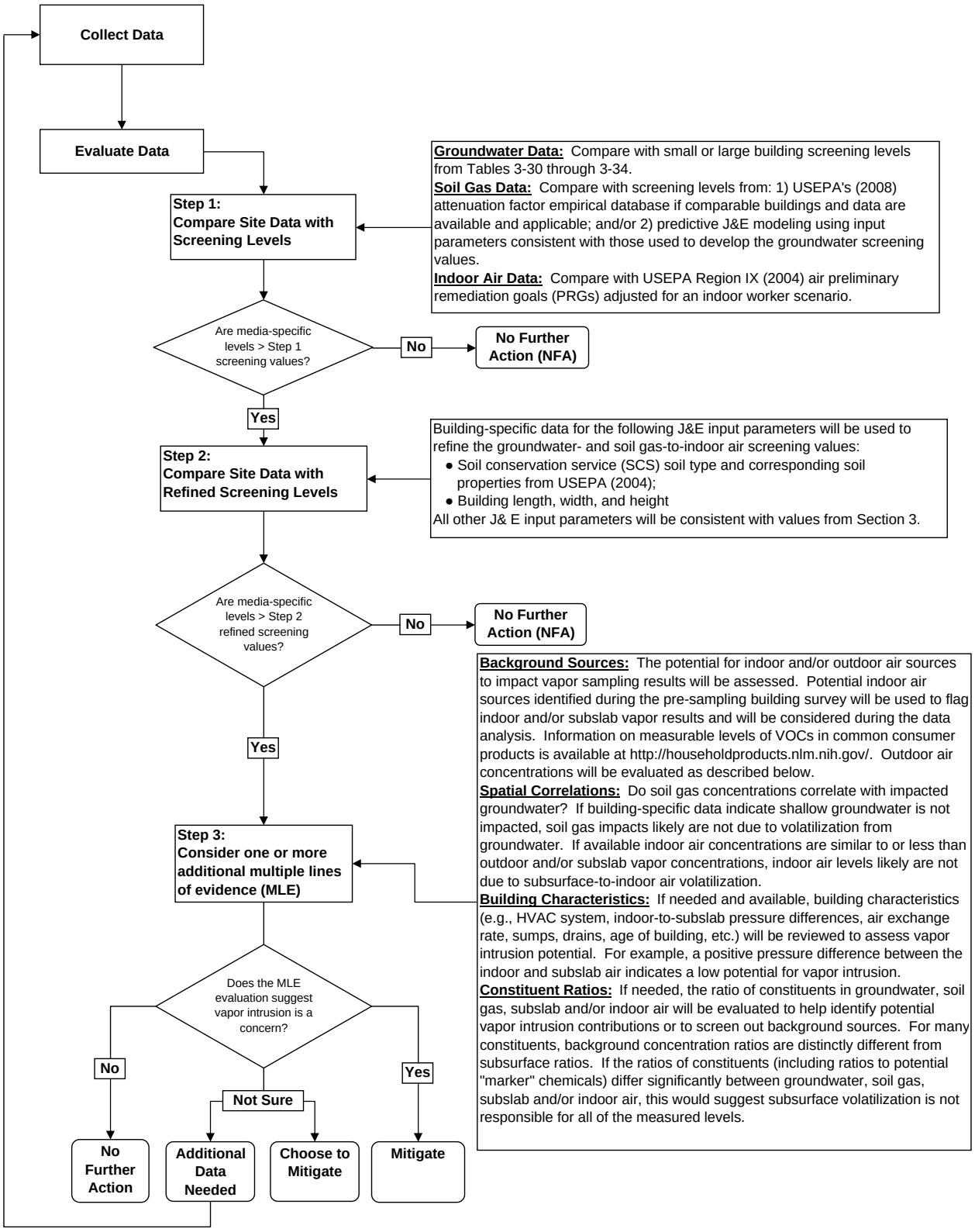


FIGURE 5-1
Risk Evaluation Strategy (adapted from ITRC [2007])
MCB Camp Lejeune, North Carolina

SECTION 6

Schedule

The proposed schedule for completion of field sampling, data evaluation and reporting is included as Appendix D. Field sampling is expected to begin in June 2008. A draft of the summary report is scheduled for submission in November 2008.

SECTION 7

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Appendix A
Field Sampling Plan

Appendix A
Field Sampling Plan

Camp Lejeune Vapor Intrusion Evaluation

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Lists of Attachments

CH2M HILL SOP #1	Standard Operating Procedure for Direct Push Groundwater Sample Collection
CH2M HILL SOP #2	Standard Operating Procedure for the Installation of Shallow Soil Gas Sampling Probes in Conjunction with Indoor Vapor Intrusion Assessments (PRT Soil Gas Probes)
CH2M HILL SOP #3	Standard Operating Procedure for the Collection of Soil Gas Samples from Soil Gas Probes (GeoProbe System - PRT) using Summa™ Canisters and a Helium Leak Check
CH2M HILL SOP #4	Standard Operating Procedure for the Collection of Sub-Slab Vapor Samples Using Summa™ Canisters
CH2M HILL SOP #5	Standard Operating Procedure for Integrated Ambient or Indoor Air for Trace VOCs by Method TO-14/15 (Summa™ canister)

SECTION 1

Introduction

1.1 Introduction

This Field Sampling Plan (FSP) describes in detail the sampling methods and procedures to be used during the vapor intrusion evaluation that is being performed for the Marine Corps Base (MCB), Camp Lejeune.

The vapor intrusion evaluation process is presented in the Camp Lejeune Vapor Intrusion Evaluation Work Plan to which this FSP is an appendix. Existing groundwater data was evaluated to determine the location of wells that had exceedances of site specific screening criteria from 2002 to 2007. Buildings of interest were selected based on the presence of monitoring wells within 100 feet containing exceedances of site-specific screening criteria and the presence of free product and/or remedial systems such as air sparging or biopulsing which can increase the risk of vapor intrusion. Additional sample data will be collected at each identified building of interest in order to further evaluate the potential vapor intrusion pathway at each building.

This FSP is to be used in conjunction with the Master Project Plans, which include the Master Work Plan, Master Sampling and Analysis Plan (SAP), Master Quality Assurance Project Plan (QAPP), Master Waste Management Plan (WMP) and Master Health and Safety Plan (HASP) (CH2M HILL, 2008). The Master Project Plans will be referenced to the greatest extent possible. A project-specific HASP has been developed for the vapor intrusion evaluation field work and is provided as Appendix C of the Work Plan.

1.2 Sampling Objectives

The main objective of the field sampling is to determine if VOC contamination could potentially migrate into buildings at Camp Lejeune via the vapor intrusion pathway. Additional data, including groundwater, soil gas, subslab, and/or indoor air data, will be collected to augment existing data for use in evaluation of the vapor intrusion pathway at each building of interest. The specific data quality objectives developed for each area are provided in Section 4 of the work plan.

SECTION 2

Field Sampling Procedures

Field sampling procedures for sampling activities to be conducted in support of the vapor intrusion evaluation are described in the following subsections. Sampling activities will be conducted in accordance with CH2M HILL SOPs (provided in Attachments 1 – 5), and the Master Project Plans (CH2M HILL, 2008). Sample handling procedures are described in Section 3. The number of field samples, quality assurance/quality control (QA/QC) samples, the analytical parameters, and the analytical methods are summarized on Table 2-1.

The sampling logic used in selecting sample locations is discussed in Section 4 of the Draft Work Plan and proposed sample locations are shown on Figures 4-2 through 4-16 of the work plan.

2.1 Groundwater Sampling

Groundwater sampling will be performed in accordance with the attached SOP #1 – Standard Operating Procedure for Direct Push Groundwater Sample Collection. Groundwater samples will be collected using the Geoprobe® Screen Point Sampler [stainless-steel retractable screen attached to the direct push technology (DPT) rods]. To determine the sample depth, 5- to 10-ft soil cores will be collected at each location using a Geoprobe Macro-Core® Sampler with polyvinyl chloride (PVC), or polyethylene terephalate glycol (PETG) liners. The soil cores will be logged to record lithology and determine the depth of the water table. The soil boring log form provided in Attachment 1 of the Master SAP (CH2M HILL, 2008) will be used to record the soil core information.

At each selected DPT groundwater sample location, the groundwater sampling device will be pushed to the desired sample interval. Since the groundwater at the top of the aquifer is most representative of VOC concentrations that may volatilize and pass through the vadose zone, the sample interval will be the top one foot of the water table. If there is not sufficient volume to collect a groundwater sample within the one-foot interval, then the exposed portion of the screen should be increased at one-foot intervals, thus drawing groundwater from a larger vertical interval. The screen length can be increased up to 4 ft if there is significant difficulty collecting a sample.

The groundwater samples will be collected directly through the screen following low-flow sampling protocol using a peristaltic pump and disposable Teflon™ tubing. Field indicator parameters (turbidity, temperature, specific conductance, pH, Eh, and DO) will be measured with a water quality meter (Horiba U-22 or YSI 600 equipped with a flow through cell) and recorded. A groundwater sample will be attempted within approximately 5 minutes of low-flow purging, regardless of the observed turbidity. Groundwater collected from the DPT is considered to be representative of groundwater in that sample interval and should not need significant purging. The groundwater samples will be submitted to a fixed-based laboratory for analysis following USEPA Method SW-8260 for TCL VOCs (Table 2-1).

2.2 Soil Gas Sampling

Temporary soil gas sample probes will be installed in accordance with the attached SOP #2 - Standard Operating Procedure for the Installation of Shallow Soil Gas Sampling Probes in Conjunction with Indoor Vapor Intrusion Assessments (PRT Soil Gas Probes) and will be sampled in accordance with the attached SOP #3 - Standard Operating Procedure for the Collection of Soil Gas Samples from Soil Gas Probes (GeoProbe System - PRT) using Summa™ Canisters and a Helium Leak Check. Temporary soil gas sample probes will be installed in locations around the buildings of interest using a Geoprobe® post-run tubing (PRT) system. Soil gas samples will be co-located with the groundwater samples described in Section 2.2. The soil gas probe screen interval will be one foot long and the bottom of the screen will be located one foot above the water table but will not be collected at depths less than 5 feet below ground surface in accordance with EPA's draft vapor intrusion guidance (USEPA, 2002). Collection of soil gas samples may not be feasible at all of the proposed sample locations due to either a shallow water table or the presence of clay in the sample interval. In these locations the groundwater grab sample data collected will be used for the vapor intrusion evaluation in lieu of soil gas data.

The basic PRT system consists of an expendable PRT drive point (tip), PRT point holder and assembly, hollow drive rod, drive point popper, PRT tubing adapter, Teflon™ tubing, and various O-rings used to create a gas-tight seal at connection points (for example, at drive rods, PRT point holder, point, etc.).

A helium leak check will be performed prior to sampling to ensure the probe was installed correctly. The probe will be purged with a sampling manifold (consisting of stainless steel Swagelok® gas tight valves and fittings and Teflon tubing) and an air pump. Three probe volumes of soil gas will be purged at 200 mL/min into a Tedlar bag. A multi-gas meter will be used to collect field measurements of VOCs, oxygen, carbon monoxide, methane and hydrogen sulfide. Soil gas samples will be collected in 6-L Summa™ canisters equipped with flow controllers. The flow controllers will regulate the sample collection rate to 200 mL/min which will result in a sample collection period of 30 minutes. The soil gas samples will be submitted to a fixed-based laboratory for analysis following USEPA Method TO-15 for VOCs (Table 2-1).

2.3 Building Survey

A building survey will be performed at each existing building at the base prior to indoor air or subslab sampling activities. The CH2M HILL field team will document building conditions which are pertinent to vapor intrusion which were not captured during the preliminary building survey. Such items include the location of underground utilities which may serve as preferential pathways, the type and typical operation of the HVAC system, and the condition of the slab. Chemical products stored and activities performed within the buildings surveyed which may be sources of VOCs in indoor air (i.e., dry cleaned clothing, solvents, cleaning products, etc.) will also be documented. This information will be obtained by visual inspection and by holding discussions with base personnel. The gathered information will be documented on the attached Building Survey Form (Figure 2-1).

Based on the results of the building survey, subslab and indoor air sampling locations may

be adjusted in the field. Subslab and indoor air sampling locations will be biased toward identified utility corridors which may act as preferential pathways.

2.4 Subslab Soil Gas Sampling

Subslab soil gas samples will be collected in accordance with the attached SOP #4 - Standard Operating Procedure for the Collection of Sub-Slab Vapor Samples Using Summa™ Canisters. Subslab probes will be installed in the building foundation at appropriate locations; in the center of the building and away from underground water, sewer, heating, or electrical lines. The subslab probes will consist of stainless steel Swagelok® gas tight fittings (a length of one-quarter-inch stainless steel tubing [not to extend below the slab], a probe union, a sampling union and a probe cap). The probes will be installed by drilling through the building foundation with a rotary hammer drill and securing the probe in place with Portland cement into the hole so that it is flush with the foundation. The cement will be allowed to dry for 24 hours. A helium leak check will be performed prior to sampling to ensure the probe was installed correctly. The probe will be purged with a sampling manifold (consisting of stainless steel Swagelok® gas tight valves and fittings and Teflon tubing) and an air pump. Two liters of subslab soil gas will be purged at 200 ml/min into a Tedlar bag. A multi-gas meter will be used to collect field measurements of VOCs, oxygen, carbon monoxide, methane and hydrogen sulfide. Subslab soil gas samples will be collected in Summa™ canisters equipped with flow controllers. The flow controllers will regulate the sample collection rate to 200 mL/min which will result in a sample collection period of 30 minutes. The subslab soil gas samples will be submitted to a fixed-based laboratory for analysis following USEPA Method TO-15 for VOCs (Table 2-1).

2.5 Indoor Air Sampling

Indoor air samples will be collected in accordance with the attached SOP #5 - Standard Operating Procedure for Integrated Ambient or Indoor Air for Trace VOCs by Method TO-14/15 (Summa™ canister). Indoor air samples will be collected will be collected at appropriate locations on the first floor towards in the center of the building. Indoor air samples will be collected over a 24 hour period in Summa™ canisters equipped with flow controllers. The Summa™ canister will be placed at the sampling location, turned on and left undisturbed for 24 hours. The Summa™ canister will be checked after 20 hours to ensure that the canister pressure does not reach zero. The indoor air samples will be submitted to a fixed-based laboratory for analysis following USEPA Method TO-15 for VOCs (Table 2-1).

2.6 Outdoor Air Sampling

Outdoor air samples will be collected in accordance with the attached SOP #5 - Standard Operating Procedure for Integrated Ambient or Indoor Air for Trace VOCs by Method TO-14/15 (Summa™ canister). Outdoor air samples will be collected in conjunction with indoor air samples. One outdoor air sample will be collected in each investigation area where indoor air sampling occurs. The outdoor air samples will be placed in secure locations and will be secured to a fence or other structure with a chain and padlock. Outdoor air samples

will be collected over a 24 hour period in Summa™ canisters equipped with flow controllers. The Summa™ canister will be placed at the sampling location, turned on and left undisturbed for 24 hours. The Summa™ canister will be checked after 20 hours to ensure that the canister pressure does not reach zero. The outdoor air samples will be submitted to a fixed-based laboratory for analysis following USEPA Method TO-15 for VOCs (Table 2-1).

2.7 Quality Control Samples

The following QA/QC samples will be collected/prepared during the field activities to ensure precision, accuracy, representativeness, completeness, and comparability:

- Equipment rinsate blanks (all media except air)
- Trip blanks (all media except air)
- Field blanks (all media except air)
- Field duplicates
- Matrix Spike/Matrix Spike Duplicates (MS/MSDs) (all media except air)

Equipment rinsate blanks will be collected by running laboratory-supplied de-ionized water over/through the sampling equipment and placing it into the appropriate sample containers for laboratory analyses. Equipment rinsate blanks will be collected from selected disposable sampling equipment (i.e., roll of tubing, stainless steel spoon, etc.); one equipment rinsate blank will be collected each day for reusable sampling equipment. The results will be used to verify that the sampling equipment has not contributed to contamination of the samples.

One field blank will be collected from each source of water used in decontamination. The field blanks will be collected by pouring the water from the original container or spigot directly into the sample bottle set. Field blanks will not be collected in dusty environments. The results will be used to verify that the water used in decontamination has not contributed to contamination of the samples.

Field duplicate samples will consist of one unique sample, split into two aliquots, and analyzed independently. Duplicate soil samples analyzed for parameters other than VOCs will be homogenized and split. Samples for VOC analyses will not be mixed, but select segments of the soil will be collected. Duplicate water samples will be collected simultaneously. The duplicate samples will be analyzed to verify the reproducibility of the laboratory results and degree of variability of reported concentrations. Duplicate samples will be collected at a frequency of 10 percent; the samples will be taken from locations anticipated to be contaminated.

MS/MSD samples will be prepared in the field to address aliquoting reproducibility and to provide information on matrix reproducibility otherwise unobtainable from samples reported below analytically reproducible and statistically valid levels. MS/MSD samples will be prepared at a frequency of 5 percent for each group of samples of a similar matrix; the samples will be taken from locations anticipated to be contaminated.

2.8 General Field Procedures

2.8.1 Health and Safety

CH2M HILL and its subcontractors will abide by the project-specific health and safety plan (HASP) presented in Appendix C of the Work Plan and the Master HASP (CH2M HILL, 2008) as well as Occupational Safety and Health Administration (OSHA) regulations.

General topics covered in the HASP include: site location and scope of work, safety and health risk analysis, field team organization and responsibilities, air monitoring, personal protective equipment, site control measures, decontamination procedures, emergency response plan, and employee training and medical monitoring. The HASP will be kept onsite during all field activities and a copy will be maintained in the project files.

2.8.2 Underground Utilities

All underground utilities, including electric lines, gas lines, and communication lines, will be identified before starting drilling and other subsurface work. The State Agency Call Before You Dig service will be contacted to assist with the identification of utilities coming into the property. A separate utilities subcontractor will be procured to ensure the accuracy of the utility markings. No intrusive activities will be initiated until the utility clearance has been completed.

2.8.3 Sample Location Surveying

Groundwater and soil gas sample locations coordinates will be determined in the field using a real time kinematics (RTK) differential global positioning system (DGPS) unit in the field. Subslab soil gas and indoor air sample locations will be recorded based on hand measurements with a tape measure.

2.8.4 Field Documentation

Field Log Books

The Field Team Leader will record information pertinent to field activities in a field logbook. The front cover or first page of the field log book will list the project name, project number, and dates of use. Entries in the field log book will be made in real time, signed, and dated by the Field Team Leader at the end of each day. Unused pages or portions of pages will be lined out, dated, and initialed to prevent entry of additional information later. Field log book pages, as well as the log books themselves, will be numbered consecutively. The following information will be included in field log books:

- Date, time of specific activities, and physical location
- Weather conditions
- Names, titles, and organization of personnel onsite, names and titles of visitors, and times of visits
- Field observations; details on sampling activities, including type of sampling, time of sampling, and sample numbers; station coordinates, water depth and tidal stage at time

of sampling; a description of field tests and their results; and references to field forms used and/or type of document generated

- A detailed description of samples collected including the following information:
  - Sample identifier
  - Sample identifier of blind duplicate samples and cross-reference to corresponding field sample
  - Identification of other QA/QC samples and cross-reference to corresponding field samples
  - Identification of sampled media (soil, groundwater, soil gas, air)
  - Sample location with respect to known reference point
  - Physical description of sample location
  - Field measurements, (pH, temperature, EC, and water levels)
  - Date and time of collection
  - Sample collection method
  - Number of sample containers
  - Analytical parameters
  - Preservatives used
  - Shipping information
    - Dates and method of sample shipments
    - COC record numbers
    - FedEx air bill numbers (if necessary)
    - Sample recipient (laboratory name)
- Specific problems, including equipment malfunctions and their resolutions
- Unexpected or adverse field conditions that may inhibit the field team's ability to perform the day's activity or that may affect the accuracy of the data collected
- Decontamination and calibration of sampling equipment
- Equipment descriptions by type, model number, and serial number, and may include pH meters, conductivity (EC) meters, turbidity meter, and health and safety monitoring equipment
- Additional information may be recorded on field data sheets (Figures 2-2 through 2-6) at the discretion of the log book user.
- Standard Field Data Forms
- Standard forms will be used in addition to the field log books and provide a more detailed second record. They ensure that necessary data are recorded consistently. No blank spaces will appear on completed forms. If information requested is not applicable, the space will be marked with a dashed line or marked “N/A.” All forms are to be completed in the field and placed in the project files. The following standard field data forms will be completed as necessary:
- Soil Boring Logs will document percent recovery, soil type, color, moisture content, texture, grain size and shape, consistency, visible evidence of staining, and any other

observations. The soil descriptions will be in accordance with the ASTM D2488 and colors will be designated using the Munsell color chart.

- Groundwater Sampling Field Data Sheets will document well depth and diameter, groundwater elevations, depth to water measurements, flow rate, total volume purged, pH, temperature, conductivity, oxygen reduction potential, dissolved oxygen, turbidity, color and odor.
- Soil Gas Sampling Field Data Sheets will document the PID meter readings including VOCs, O2, H2S, CO, and LEL, purging data including screen volume, purge date and time, purge rate and volume, sample collection including sample ID, sample location, canister ID, flow controller ID, initial pressure, final pressure, sample date and time, and elapsed time.
- Building Survey Field Data Sheets will document the owner's contact information, type of building structure, age of structure, foundation type, existence of a basement, basement characteristics, HVAC system information, and the consumer products inventory.
- Subslab Soil Gas Sampling Field Data Sheets will document will document the sample ID, sample type, location of the sample, Summa™ canister ID, flow controller ID, initial pressure, final pressure, start and stop time and dates.
- Indoor Air Sampling Field Data Sheets will document the sample ID, sample type, location of the sample, Summa™ canister ID, flow controller ID, initial pressure, final pressure, start and stop time and dates.

2.8.5 Decontamination

Decontamination will be performed in accordance with Section 3.16 of the Master SAP (CH2M HILL, 2008).

All equipment shall be decontaminated by the appropriate party, either CH2M HILL field staff or the drilling contractor, using industry accepted procedures. Equipment should be deconned when there is a risk of cross-contamination between locations, depth intervals, or contaminants present.

Heavy equipment such as drill rigs and groundwater sampling equipment (augers, rods, split spoons, etc.) will be steam cleaned prior to each location. A decontamination pad will be set up to prevent run off of decontamination water and to allow for easy collection of decontamination fluids.

2.8.6 Management of Investigation-Derived Waste

Investigation-derived waste (IDW) will be managed in accordance with the Master Waste Management Plan (CH2M HILL, 2008). IDW is expected to consist of drill cuttings from the soil borings, purge water (from groundwater sampling), and decontamination fluids. Aqueous IDW will be placed in poly-tanks or 55 gallon drums, or, if low volumes are expected, in 5-gallon containers. Soil IDW generated during temporary well installation will be containerized in 55-gallon drums, which will be staged near the drilling activities. Based on existing data, IDW is expected to be non-hazardous.

The IDW will be properly disposed of by subcontractors within 90 days of generation, based on the results of the waste characterization. Disposable equipment, including personal protective equipment (PPE), poly sheeting, paper towels, and aluminum foil, will be disposed of as solid waste.

2.8.7 Borehole Abandonment

All DPT boreholes will be abandoned following NCDENR guidelines by grouting from the bottom of the boring to the ground surface. Abandonment will be completed by a NC licensed well driller.

2.8.8 Field Instrumentation

Calibration

All field screening and sampling instruments (e.g., YSI meter and photoionization detector [PID]) that require calibration before operation will be calibrated daily in accordance with the manufacturer's instructions. All instrument calibrations will be documented in the field log book for the various pieces of equipment. Instrument operating manuals will be maintained onsite by the field team.

Maintenance Procedures

Non-consumable field equipment (YSI meter, GPS unit, PID, etc.) will be obtained from CH2M HILL's warehouse or rented from an approved rental company. Maintenance of this equipment will be performed by the CH2M HILL warehouse staff or the contracted rental company. If maintenance is required on a piece of equipment, the rental company will switch out that piece of equipment so that the maintenance can be performed without delaying the field work. Basic maintenance such as changing batteries will be performed by the field team.

SECTION 3

Sample Handling and Analysis

Sample handling and analysis procedures for sampling activities to be conducted in support of the vapor intrusion evaluation are described in the following subsections. Sampling handling and analysis will be conducted in accordance with the CH2M HILL SOPs (provided in Attachments 1 – 4), and the Master Project Plans (CH2M HILL, 2008).

3.1 Sample Identification

Each analytical sample will be assigned a unique number of the following format similar to other sample numbers for MCB Camp Lejeune:

Site# - Station#/Media or QA/QC - Depth Interval

An explanation of each of these identifiers is given below.

Site#: This investigation includes samples collected from multiple sites on the base.

89 = Site 89
SWMU360 = SWMU 360

Station#: Each sample location will be identified with a unique identification number. Soil, soil gas and groundwater samples collected from the same location will have a station ID beginning with IS (In-situ sample collected by DPT). Samples will be numbered consecutively for each media type.

Media: This investigation includes the following types of media:

SB = Subsurface soil boring
GW = Groundwater
SV = Soil vapor sample
SG = Subslab soil gas sample
IA = Indoor air sample

QA/QC: D = Duplicate sample (following sample type/number)
FB = Field blank
ER = Equipment rinsate
TB = Trip blank

All MS/MSD samples will be entered in the same line as the field sample on the COC. The total number of sample containers submitted will be entered on the COC and "MS/MSD" will be indicated in the comments section.

Depth Interval: Depth indicators will be used for soil, groundwater and soil gas samples collected using direct push technology. The number will reference the depth interval of the sample:

2–3 = 2 to 3 feet bgs

Under this sample designation format, "89-IS36-GW-11-15-08C" would mean the following:

89-IS36-GW-11-15-08C	Site 89
89-IS36-GW-11-15-08C	In-situ boring location #36
89-IS36-GW-11-15-08C	Groundwater sample
89-IS36-GW-11-15-08C	Sample depth range of 11 ft to 15 ft bgs
89-IS36-GW-11-15-08C	Sampled during the *third* quarter of 2008

"89-TB071608" would mean the following:

89-TB071608	Site 89
89-TB071608	Trip Blank
89-TB071608	Sampled on July 16, 2008

This sample designation format will be followed throughout the project. Required deviations to this format in response to field conditions will be documented.

3.2 Sample Containerization and Preservation

Samples for chemical analyses will be placed into laboratory–prepared sample containers with the appropriate preservatives and stored on ice in a cooler at approximately 4° Celsius (with the exception of the air samples) until shipped to the laboratory.

Sample preservation details are presented in the Master SAP and QAPP (CH2M HILL, 2008). The type of container used for each sampling effort, as well as a summary of preservation requirements is described in the Master QAPP (CH2M HILL, 2008).

3.3 Chain-of-Custody

The chain of custody (COC) procedures detailed in the Master SAP and QAPP (CH2M HILL, 2008) will be followed. The COCs forms will be provided by the contracted laboratories. The COC forms will contain the following information: project number (CTO), sampler names, sample numbers, number of containers, methods of preservation, date and time of sample collection, analysis requested, date and time of transportation to the laboratory, method of transportation, and any other information pertinent to the samples.

SECTION 4

References

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Tables

TABLE 2-1
Required Analytical Method, Sample Containers, Preservation, and Holding Times

Analyses	Analytical Method	Sample Matrix	Container [a]	Qty	Preservative [b]	Holding Time [c]
Volatile Organic Compounds	SW-846 5030B/8260B	Water	40 mL, glass	3	HCL, pH<2, cool to 4 ºC Water, Cool 4°C	14 days
Volatile Organic Compounds	TO-15	Air	1-L or 6-L Summa™ Canister	1	None	14 days

Notes:
Sample container, and volume requirements will be specified by the analytical laboratory performing the tests.
Three times the required volume should be collected for samples designated as MS/MSD samples.
a Glass containers will be sealed with Teflon®-lined screw caps.
[b] Water samples will be stored promptly at 4°C in an insulated chest.
[c] Holding times are from the time of sample collection.
Source: SW-846, third edition, Update III (June 1997).
ºC = Degrees Centigrade
HCl = Hydrochloric acid
mL = Milliliter
L = Liter

Figures

Figure 2-1
Preliminary Building Survey for Vapor Intrusion Investigation

Date: _____

Preparer: _____

Facility: _____

Address: _____

_____

_____

Contact Person: _____

Phone Number: _____

e-mail address: _____

Building Description

Building or Room Identifier: _____

Primary Activity within Building (select one):

☐ Manufacturing ☐ Storage ☐ Other

☐ Chemical processing ☐ Chemical Storage

☐ Administrative ☐ Instrumentation/Control

Notes: _____

_____

_____

Approximate floor space _____

Number of floors _____

Multi-room building ☐ or Single room ☐

Ceiling height _____

Aboveground Construction ☐ Wood ☐ Concrete

☐ Brick ☐ Cinderblock

☐ Other _____

Floor plan attached? ☐ Yes ☐ No

Notes: _____

Evaluation of Potential Conduits from Soil

Floor/foundation description (check all that apply)

☐ Wood ☐ Concrete ☐ Elevated above grade?
☐ Below grade?

☐ Other _____

Expansion joints present (if concrete floor)?	☐ Yes	☐ No	☐ N/A
Are expansion joints sealed?	☐ Yes	☐ No	☐ N/A
Are sumps or floor drains present?	☐ Yes	☐ No	☐ N/A
Are basements or subsurface vaults present?	☐ Yes	☐ No	☐ N/A
Are there subsurface drainage problems?	☐ Yes	☐ No	☐ N/A

Notes: _____

Evaluation of Potential Pathways/Driving Forces

Are there locations with elevated positive or negative pressure (look for doors not opening/closing properly, perceptible airflow, audible fan noise)

Is there one air conditioning zone or multiple zones (if in a multi-room building)?

☐ Single zone ☐ Multi-zone ☐ Other _____

(building management may know; another tip-off is the presence of multiple thermostats = multiple zones)

Sources of outdoor air

☐ Mechanical (air handling unit) ☐ Doors

☐ Windows

Are windows/doors left open routinely? ☐ Yes ☐ No

Notes: _____

Evaluation of Potential Existing Chemical Sources Indoors

List principal solvent or VOC-containing products used (obtain MSDSs if available)

_____ _____

_____ _____

_____ _____

Are any of the target analytes used in this building/room?

☐ Yes ☐ No

_____ _____

_____ _____

Are pesticides used indoors for pest control? ☐ Yes ☐ No

Names of pesticide products used? _____

_____

Has there been a pesticide application within the past 6 months? ☐ Yes ☐ No

Is smoking permitted in the building? ☐ Yes ☐ No

Description of Vapor Mitigation Systems

Has a radon or vapor mitigation system been installed in this building/room? ☐ Yes ☐ No

Date of installation? _____

Type of system? ☐ Passive venting ☐ Active subslab depressurization

☐ Crack/crevice sealing ☐ Dilution ventilation control

☐ N/A

Notes: _____

Additional Notes

_____

Additional Notes

Figure 2-1
Preliminary Building Survey for Vapor Intrusion Investigation

Attachment 4

	PROJECT NUMBER	PROJECT NAME
CH2MHILL		

WELL PURGE AND SAMPLING FIELD SHEET

SITE:	DATE:
FIELD CREW:	WELL
WEATHER:	NUMBER:

PURGE VOLUME CALCULATION:

			CASING DIAMETER	GAL/FT OF CASING
WELL DEPTH (FT):				
DEPTH TO WATER (FT):	-		**2 IN.**	**0.1632**
WATER COLUMN (FT):	=	0	**4 IN.**	**0.6528**
GAL/FT OF CASING (from table at right):	x	0.1632	**6 IN.**	**1.4688**
CASING VOLUME (GALs):	=	0	**8 IN.**	**2.611**
NO. OF VOLUMES (min. 3):	x		**10 IN.**	**4.0797**
PURGE VOLUME (GAL):	=	0	**12 IN.**	**5.8748**

METHOD OF PURGING (circle one)

PUMP:	SUB., CENT., PERIST.	**OTHER:**	**BAILER** : TEFLON, SS ,OTHER:
	TIME ON:		BAILER VOL.. (gal) .25 / .33 / .75
	FLOW RATE (gpm):		REQUIRED PULLS:
	PUMP TIME (min):		VOL. PURGED (gals):
	VOL. PURGED (gals):		OTHER:

FIELD PARAMETER MEASUREMENTS Field Equipment Used: Horiba U-22

No.	Time	Volume	pH	Temperature	Conductivity	Turbidity	Other (DO; ORP)
1							
2							
3							
4							
5							
6							
7							
8							

OBSERVATIONS (circle as appropriate)

COLOR: CLEAR , AMBER , TAN , BROWN , GREY , MILKY WHITE , OTHER:

ODOR: NONE , LOW , MEDIUM , HIGH , VERY STRONG , H2S , FUEL LIKE , CHEMICAL ?, UNKNOWN

TURBIDITY: NONE , LOW , MEDIUM , HIGH , VERY TURBID. HEAVY SILTS

COMMENTS:

Please use back of sheet for sketching maps, well location notes, etc. **See back of sheet? Y / N**

SAMPLE DATA:

Sample ID Number	No. and Types of Containers	Parameters Analyzed	Laboratory	QA/QC sample? Y /N

SIGNED/SAMPLER: _____

Figure 2-3

Soil Gas Sampling Field Data Sheet

Soil Gas Point Installation

Time Installed	
Screen Depth	
Screen Volume	
Helium Leak Check Result	

Soil Gas Sample Point Purging

Purge Date	
Purge Time	
Purge Rate	
Purged Volume	

Multi Rae Readings

Total VOCs (ppm)	
O2 (%)	
H2S (ppm)	
CO (ppm)	
LEL (%)	

Soil Gas Sample Collection

Sample ID	
Sample Location	
Canister ID	
Critical Orifice or Flow Controller ID	
Pressure Gauge ID	
Initital Pressure (in. Hg)	
Sample Date	
Start Time	
End Time	
Final Pressure (in. Hg)	
Elapsed Time	

Observations:_____

_____

Figure 2-4

CH2MHILL

Indoor Vapor Intrusion Assessment
Sub-slab Vapor Field Sampling Log - Summa Canister Method

Project Info

Project Name: ..... **Project # :** .....

By: ..... **Date:** .....

Structure

Identification: .....

Address: .....

Slab Information:

☐ Concrete slab on grade (directly on top of soil) ☐ Other (describe) .....

☐ Concrete slab on gravel underlayment .....

Condition of slab .....

Type of Sub Slab Soil .....

Is water present in the soil .....

Sub-slab Probe Installation, Leak Checking, Probe Purging, & Sampling Log

	Sample location (show in diagram)	1	2	3	4
	Sample Identification (field ID)				
Probe Installation	Depth of slab (inches)				
	Depth of hole drilled (inches below slab surface)				
	Depth of installed probe (inches below slab surface)				
Manifold Leak check	Leak check (sampling manifold) - Pass/No Pass				
Probe Purge	Purge rate, cc/min.				
	Purge Start (time of day)				
	Purge vacuum, " Hg				
	Purge completed (time of day)				
Helium Leak Check (optional)	Leak check (Helium) - %				
Canister Sampling	Canister & flow controller ID (if used)				
	Initial Canister Pressure (" Hg)				
	Sampling rate, cc/min				
	Sampling period started (time of day)				
	Sampling vacuum, " Hg				
	Sampling period ended (time of day)				
	Final Canister Pressure (" Hg)				

Observations and Comments: .....

Figure 2-5

CH2M HILL

Sheet 1 of __

Indoor Air Sampling Log (Summa Canister)

Project Information

Project Name: ..... Project # : .....

By: ..... Date: .....

Sampling Data Log

Sample Location	Field ID	Canister ID	Flow Controller ID	Initial Canister Pressure ("Hg)	Initial Flow Controller Rate (ml/min)	Start Date & Time	End Data & Time	Final Pressure ("Hg)	Final Flow Controller Rate (ml/min)

Sample Location Diagram

N

Note:

Draw in outline the structure's foundation and interior walls, identify rooms, and note other defining features. Show location of canister relative to physical objects, etc.

Other Observations and Comments (note any unique circumstances): .....

Attachments

STANDARD OPERATING PROCEDURE

Direct-Push Groundwater Sample Collection

I. Purpose

To provide a general guideline for the collection of groundwater samples using direct-push (e.g., Geoprobe®) sampling methods.

II. Scope

Standard direct-push (e.g., Geoprobe®) groundwater sampling methods.

III. Equipment and Materials

- Truck-mounted hydraulic percussion hammer.
- Direct-push (e.g., Geoprobe®) sampling rods and slotted lead rod
- Polyethylene sampling tubing and stainless steel foot valve
- Pre-cleaned sample containers
- Clean latex or surgical gloves.

IV. Procedures and Guidelines

1. Decontaminate slotted lead rod and other downhole equipment in accordance with SOP *Decontamination of Personnel and Equipment*.

2. Drive slotted steel lead rod to the desired sampling depth using the truck-mounted hydraulic percussion hammer.

3. Insert the stainless steel foot valve into the end of the polyethylene sampling tubing and insert tubing through the rods.

4. Fill all sample containers, beginning with the containers for VOC analysis.

5. Remove polyethylene sampling tubing from the rods. Remove the foot valve and discard polyethylene tubing.

6. Backfill borehole at each sampling location with grout or bentonite and repair the surface with like material (bentonite, asphalt patch, concrete, etc.), as required.

V. Key Checks and Items

- Verify that the hydraulic percussion hammer is clean and in proper working order.
- Ensure that the direct-push operator thoroughly completes the decontamination process between sampling locations.
- Ensure that the slotted lead rod has been inserted to the desired sampling depth.
- Verify that the borehole made during sampling activities has been properly backfilled.

Standard Operating Procedure for the Installation of Shallow Soil Gas Sampling Probes in Conjunction with Indoor Vapor Intrusion Assessments (PRT Soil Gas Probes)

This procedure is recommended as a practical approach for the installation of Post Run Tubing (PRT) style soil gas probes where the intent is to collect shallow (5-20 feet bgs) soil vapor samples. A common use of this SOP is during indoor vapor intrusion assessments associated with sub-surface VOC contamination. This SOP should be used in conjunction with CH2M HILL's SOP: "Standard Operating Procedure for the Collection of Soil Gas Samples from Soil Gas Probes Using Summa® Canisters and a Helium Leak Check" and when its application is consistent with the projects data quality objectives. It is the responsibility of the project team to make sure this procedure meets all applicable regulatory standards and receives approval/concurrence from the leading regulatory agency for the project.

1. Gas Probe System Set-up

1.1 Prior to installation of gas probes at a given location, a utility survey must be completed, the necessary permits acquired, and in the case of private property - permission granted.

1.2 Obtain soil gas sampling probes, such as those manufactured by Geo Probe Systems, in sufficient quantity to carry out the assessment. These systems and their installation can be obtained from geo-technical firms that provide direct push installation. Their basic installation procedures can be followed as long as the details below are included.

1.3 Coordinate the hardware (i.e. size of tubing, fittings, sampling interface assembly, etc.) that mates the soil gas probe sampling line to the sampling system (i.e. Tedlar bags, Summa canisters, etc.). This step is critical to achieve a leak free system. All above ground connections should be inert gas tight compression fittings (i.e Swagelok or equal) and all sample transfer lines should be made of Teflon® tubing. Typically, all tubing and fittings should be ¼". These fittings will match up with the sampling manifold specified in the soil gas sampling SOP.

1.4 The soil gas probes must be decontaminated prior to use. Steam cleaning is the preferred method of decontamination. Once decontaminated, the probes must be shown to be free of contaminates. As a minimum, a suitably sensitive organic vapor meter should be used for this purpose. Any probe that does not pass decontamination should not be used.

1.5 To minimize decontamination efforts and the potential for cross contamination, when it is practical, all gas probe sampling lines should be replaced between uses. Alternatively, a decontamination procedure for cleaning and purging sampling lines will be carried out.

1.6 Handle and store decontaminated soil gas probes in a manner that prevents contamination.

1.7 Inspect all probe parts for wear before each use. Replace probe tips, o-rings, adapters, and probe rods as needed. New parts and parts in good working condition greatly reduce the chances of ambient air leaking into the soil gas sample and reduce the need for re-pushing probes. Ideally, the PRT expendable point holder will be one single piece (as opposed to 2 or more).

1.8 Assemble the probe as shown in figure 1. Note: A slotted drive cap may be used if the probe is assembled with the inner Teflon tube before pushing into the ground.

2. Gas Probe Installation & Removal

2.1 It is common practice to both install and remove shallow soil gas probes by the "direct push" method using a machine specifically designed for this purpose. Operation of direct push machinery shall be performed only by personnel trained in its use.

2.2 Push the probe to the desired depth and then retract 6 inches to create an annular space. It is advisable to check that the tip detached during retraction. This can be done by poking a small diameter rod down the inside of the probe. Note: Sometimes an o-ring may be used between the tip and tip holder. If so, the tip is more likely to stay attached to the holder when the probe is retracted. Since the helium leak check procedure will be utilized, it is not necessary to use an o-ring on the tip. The force of the direct push will hold the tip against the tip holder during the push. There is no need to create a leak free seal at this connection as the tip will be removed before sampling.

2.3 Attach the PRT tubing adapter to the ¼″ Teflon tubing and secure in place by wrapping the connection with about 2″ of electrical tape. (This prevents the tubing from slipping on the nipple while tightening). Double check that the o-ring on the PRT adapter is new and undamaged.

2.4 Feed the PRT tubing adapter and tubing down the probe. When it reaches the point holder, cut the tubing so that an additional 2-3 feet remains above ground.

2.5 While pushing down on the tubing, twist in a counter clockwise direction until the PRT adapter seats. Test the connection by lightly tugging on the tubing.

2.6 Install probes in a manner that creates a leak free seal between the above ground atmosphere and the probe tip while minimizing the impact on ground surface covers (i.e. asphalt, concrete, drive ways, lawns, etc.). Achieving a leak free seal may require placement of an inert sealing material (i.e. hydrated powdered bentonite) at the point where the probe penetrates into the ground surface. See Figure 2.

2.7 In the event the direct push installation technique does not work, and a pre-drilled pilot hole is needed, this procedure must be coordinated with the project engineer. Use of pre-drilled holes will require careful control as to not over drill and may also create the need for back grouting to overcome leakage from the above ground atmosphere.

2.8 Once the probe is sealed, sampling may begin. Be sure to follow the proper procedures as stated in the Soil Gas Sampling SOP, and **be sure that helium leak check procedures are employed**.

2.9 Removal of the probes is to be carried out by trained personnel using the direct push machinery. The probe will be removed in a manner that minimizes disruption of ground surface covers (i.e. asphalt, concrete, drive ways, lawns, etc.).

2.10 Replace ground surface covers and repair to original condition.

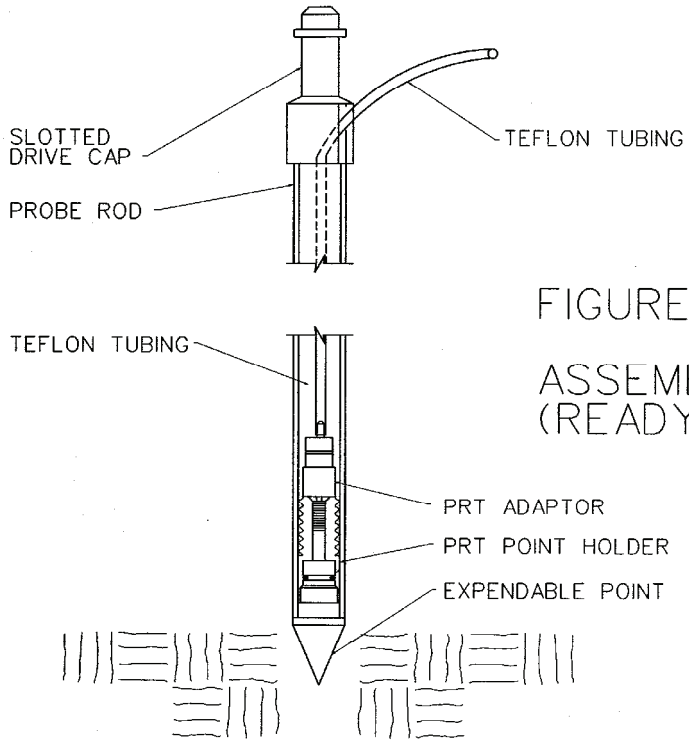


FIGURE 1

ASSEMBLED SOIL/GAS PROBE
(READY FOR INSTALLATION)

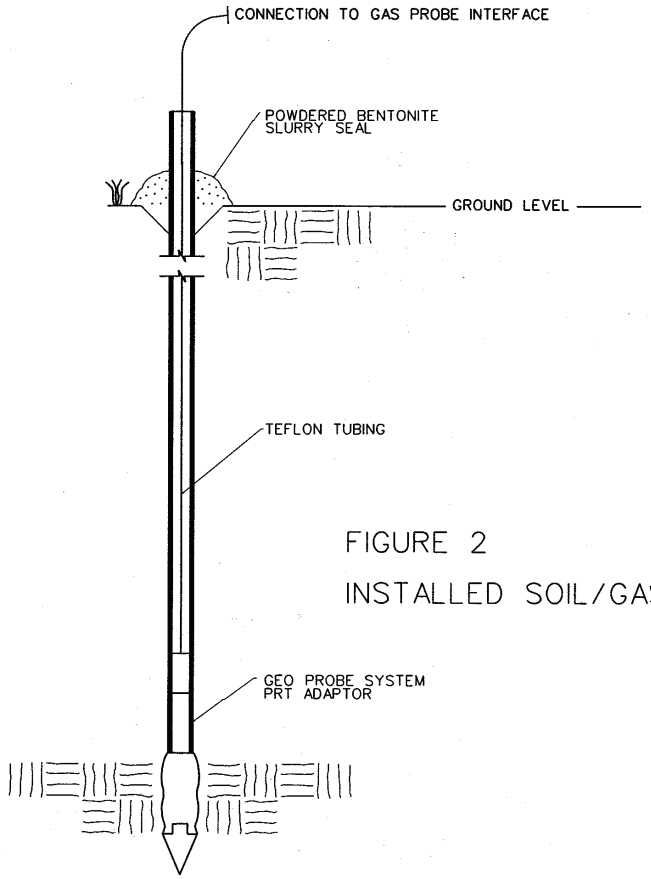


FIGURE 2

INSTALLED SOIL/GAS PROBE

Standard Operating Procedure for the Collection of Soil Gas Samples from Soil Gas Probes (GeoProbe System - PRT) using Summa™ Canisters and a Helium Leak Check

This procedure offers a practical approach for the collection of soil vapor samples from GeoProbe Systems (or equal) direct push soil gas probes (with PRT adapters) into Summa canisters. Soil gas sample integrity is verified by using a real time helium leak checking procedure. This SOP should be used in conjunction with CH2M HILL's SOP: "Standard Operating Procedure for the Installation of Shallow Soil Gas Sampling Probes" and when its application is consistent with the projects data quality objectives. It is the responsibility of the project team to make sure this procedure meets all applicable regulatory standards and receives approval/concurrence from the leading regulatory agency for the project. Only persons trained in the collection of soil gas samples should attempt this procedure.

1. System Set-up

1.1 Acquire all the necessary hardware and sampling equipment shown in Figure 1.

1.2 Assemble or obtain the necessary fittings and vacuum gauge to create a soil gas probe and sampling manifold shown in Figure 1. This manifold must be clean, free of oils, and flushed free of VOCs prior to use. Note: use only gas tight fittings such as Swagelok or equivalent. Be sure to place the helium leak check enclosure over the probe, and push the sample tubing through the hole in the cap before attaching the sampling manifold.

1.3 Adjust the purge system evacuation pump sampling rate to achieve the desired flow rate of 150 milliliters /min. This should be performed at the outlet of the vacuum pump prior to purging, either by use of a suitable flowmeter or determining the amount of time required to fill a 1 liter Tedlar bag.

1.4 Summa canisters are pre-evacuated by the laboratory. In some cases (i.e. project specific QA) the vacuum will need to be verified in the field prior to use. This is accomplished with a vacuum gauge and instructions supplied by the laboratory.

1.5 Flow controllers (if used) should come pre-set by the laboratory to sample at a pre-determined rate based on specific project requirements (see Table 1 for the most common options). Verify the flow controller flowrate setting (indicated on the tag). In some cases (i.e. project specific QA) the flowrate will need to be verified in the field prior to use. This is accomplished with a bubble meter, vacuum source, and instructions supplied by the laboratory.

2. System Leak Checking & Purging

2.1 Make sure the sampling system is assembled (as shown in Figure 1). The leak check enclosure is placed over the sample probe prior to connection of the sample line to the sampling manifold and the purge system. ***Do not connect the canister at this time***.

2.2 ***Physical Leak Check*** - Perform a leak check of the sample manifold system by:

2.2.1 Making sure the gas probe valve (valve #1) is closed and the sample valve (valve #2) is open.

2.2.2 Open the purge valve (valve #3) and start the purge pump. Verify that the flow is set to 150 ml/min.

2.2.3 Close the sample valve (valve #2) and achieve a vacuum gauge reading of 10 inches of Hg or to a vacuum that will be encountered during sampling, which ever is greater.

2.2.4 A leak free system will be evident by closing off the purge valve (valve #3), turning of the purge pump, and observing no loss of vacuum within the sampling manifold system for a period of 30 seconds. Repair any leaks prior to use.

2.2.5 Record the leak check date and time on the field sampling log.

2.3 ***System Purge and Helium Leak Check*** -A purge of the soil gas probe and sampling manifold system is required. The helium leak check procedure is also performed during this step. This is accomplished by:

2.3.1 Where the ground surface is soft, the helium leak check enclosure is pressed down slightly into the ground surface. In situations where the ground surface is hard (e.g. asphalt), apply a slight downward pressure to achieve a build up of helium in the leak check enclosure.

2.3.2 Start the flow of helium into the side of the leak check enclosure at 200 ml/min. Let the helium fill the enclosure for a couple of minutes.

2.3.3 Turn the helium leak detector on and make sure that the detector is not giving a helium reading before starting the purge. Place the probe of the helium detector in the exhaust port of the flow meter.

2.3.4 Purging is carried out by pulling soil gas through the system at a rate of between 150 milliliters /min for a time period sufficient to achieve a purge volume that equals at least 3 dead volumes (internal volume of the in ground annular space, sample line, and sampling manifold system).

2.3.5 Open the sample valve (valve #2) and the purge valve (valve #3) and start the purge pump. Verify that the flow rate is still 150 ml/min.

2.3.6 To start the soil gas probe purge, open the gas probe valve (valve #1) and close the sample valve (valve #2) at the same time, and start timing.

2.3.7 During the purge, observe the helium detector for indication of soil gas probe leakage (e.g. infiltration of ambient air into the probe). If a helium reading of >1% is observed, then the probe leak check has failed and corrective action should be taken. This includes first checking the fittings and connections and trying another purge and leak check. It may also result in removing the soil gas probe and re-installing it in a nearby location.

2.3.8 If the vacuum gauge reads >15" during the purge, then close the purge valve (valve #3) and monitor the vacuum in the manifold and probe. If there is no significant change after a minute, then there is the lack of a significant amount of soil gas and the vacuum is too great to take a soil gas sample. Several things can cause this. Consult with the project manager and take corrective action.

2.3.8.1 The soil formation is too 'tight' (i.e. high clay or moisture content). Try a different depth or location

2.3.8.2 With a GeoProbe style probe system, the expendable tip may not have released when the probe was retracted. Try retracting the probe a little further, or using a long thin rod to poke the tip loose.

2.3.8.3 If water is visible in the flexible soil gas tubing, stop the purging immediately. It is not possible to take a soil gas sample at that depth or location.

2.3.9 At the end of the pre-determined purge time (usually around a couple minutes) and after the system is verified to be leak free, close the purge valve (valve #3). Do not open it again. Doing so will result in loss of the purge integrity and requires re-purging. Turn off the helium leak detector.

2.3.10 Record the purge date, time, purge rate, leak check result, and purge volume on the field sampling log.

2.3.11 Immediately move on to the sampling phase. Little to no delay should occur between purging and sampling.

3 Sampling

3.1 The Summa canisters are certified clean and evacuated by the laboratory to near absolute zero pressure. Care should be used at all times to prevent inadvertent loss of canister vacuum. ***Never open the canister's valve unless the intent is to collect sample.***

3.2 Attach the canister to the flow controller and then connect the flow controller to the sample valve (valve #2) on the sampling manifold.

3.3 Before taking the sample, confirm that the sampling system valves are set as follows: 1) the purge valve (valve #3) is confirmed to be closed, gas probe valve (valve #1) is open, and 2) the sample valve is (valve #2) is open.

3.4 Slowly open the canister's valve approximately one full turn.

3.5 After sampling for the appropriate amount of time (determined from project instructions, see Table 1), close the sample valve (valve #2) and the canister's valve. Remove the canister from the sampling manifold.

3.6 Record the sampling date, time, canister ID, flow controller ID, and any other observation pertinent to the sampling event on the field sampling log.

3.7 Fill out all appropriate documentation (sampling forms, sample labels, chain of custody, sample tags, etc.).

3.8 Disassemble the sampling system.

4 Sample Handling and Shipping

4.1 If shipping is required, pack the sample canisters in a rigid wall shipping container such as a cooler or heavy duty cardboard box (ice is not required). Never pack the cans with other objects or materials that could cause them to be punctured or damaged.

4.2 Place a custody seal over the openings to the shipping container.

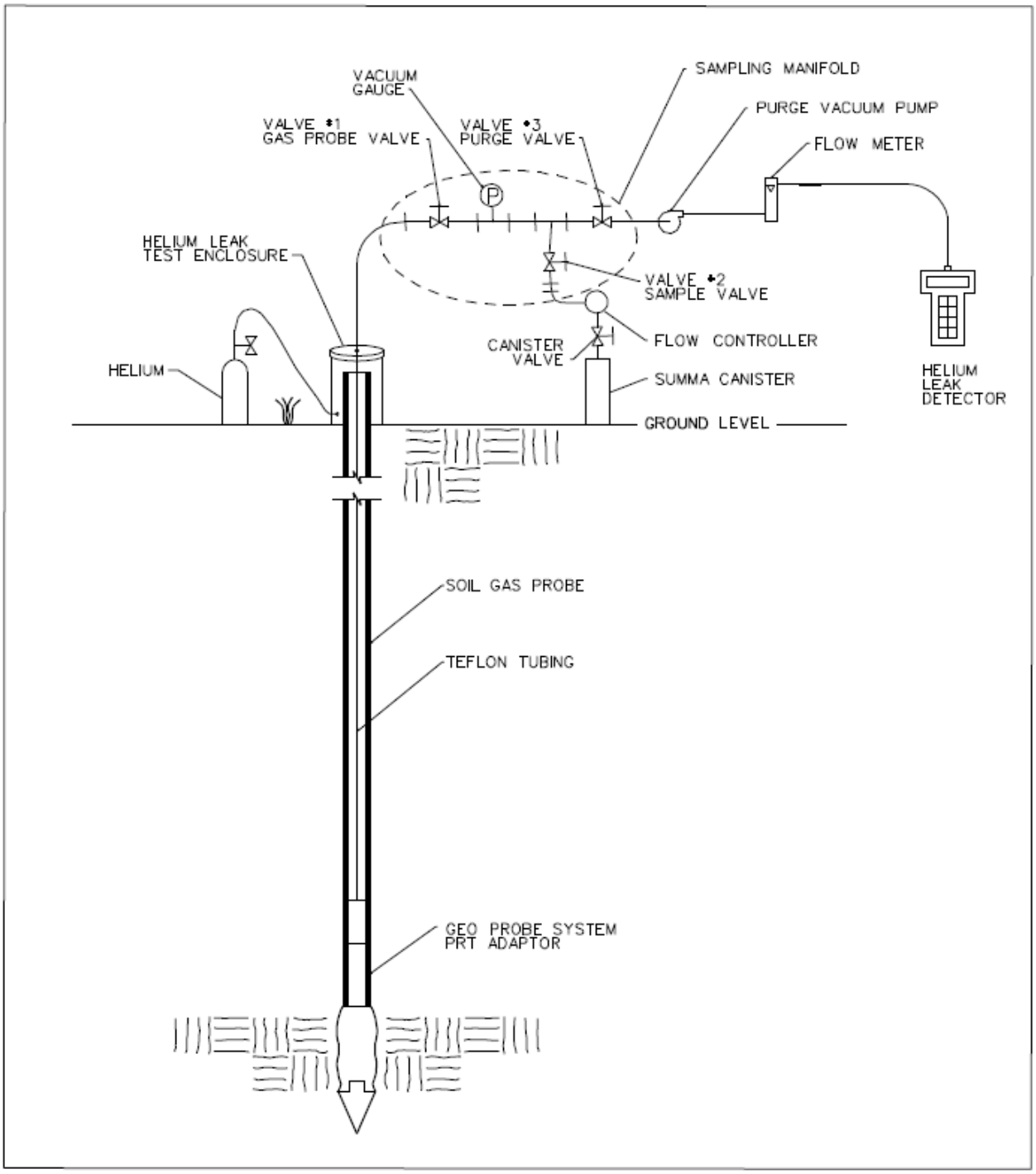
4.3 Ship immediately to the laboratory for analysis.

Table 1 – Common Sampling Rates for Soil Gas Sampling

Can Size	Length of sampling time	Sampling Flow Rate (ml/min)
6 Liter	1 hour	90
6 Liter	8 hours	11.25
6 Liter	24 hours	3.75
1 Liter	5 minutes	180
1 Liter	1 hour	15
850 ml	5 minutes	150
850 ml	1 hour	12

Figure 1

Soil Gas Sampling System



CH2MHILL *Applied Sciences Laboratory*

Indoor Vapor Intrusion Assessment
Soil Gas Sampling Field Log

Sheet _ of _

Project Info

Project Name: ..... **Project # :** .....

By: ..... **Date:** .....

Structure

Identification: .....

Address: .....

Sample Location type:

- ☐ concrete slab on grade
- ☐ concrete footing w/crawl space
- ☐ basement
- ☐ Yard or Driveway
- ☐ other (describe) .....

Soil Gas Sampling System

Probe type (describe): .....

Probe to sample interface system (describe): .....

Sample collection type: ☐ Syringe ☐ Tedlar bag ☐ Summa canister

Other info (describe other aspects) .....

Soil Gas Probe Purging & Sampling Log

Sample location (show in diagram)	1	2	3	4
Sample Identification (field ID)				
Time Installed				
Depth of installed probe (feet bgs)				
Leak check (probe/sampling interface)				
Calculated dead volume (1 purge volume), cc				
Purge rate, cc/min.				
Purge duration, min.				
Purge vacuum, " Hg				
Max PID Reading, ppmv (optional)				
Purge completed (time of day)				
Sampling period started (time of day)				
Sampling rate, cc/min				
Sampling vacuum, " Hg				
Sampling period ended (time of day)				

Observations and Comments: .....

Standard Operating Procedure for the Collection of Sub-Slab Vapor Samples Using Summa™ Canisters

This procedure describes the approach for the collection of sub slab soil vapor samples in Summa canisters. It includes instruction on probe installation, leak checking, gas sampling, and probe abandonment. This SOP should be used in conjunction with project data quality objectives. Only persons trained in the collection of soil gas samples should attempt this procedure

1.0 Materials

1.1 Probe Installation
- Hammer drill and 7/8″ or 1″ and 5/16″ or 3/8″ bits
- Vacuum cleaner ('shop vac' type or hand held)
- Probe (1/4″ stainless steel tube with Swagelock or equivalent nut and ferrule)
- Probe seal (1/8″ NPT internal wrenching plug)
- Probe union (1/4″ male Swagelock or equivalent to 1/8″ female NPT)
- Nuts and ferrules (1/4″ stainless steel Swagelock or equivalent)
- Hack saw
- Mortar consisting of Portland Cement mix, Fix-it-All, or similar
- Large Q-tips or paper towels and water
- Tongue depressor, putty knife, or similar tool
- Tape measure

1.2 Leak check
- Leak check enclosure
- Compressed helium tank (balloon grade), helium regulator, flow meter (0-500 ml/min)
- Helium detector, or equal
- (alternative) Isopropyl alcohol and paper towels

1.3 Sampling
- Sampling union (1/4″ male Swagelock or equivalent to 1/4″ male NPT)
- Vacuum pump, sampling manifold
- ¼″ Teflon tubing, rubber tubing
- Flow controller
- Summa canister (sized appropriately for sampling requirements)
- Miscellaneous fitting to connect tubing to sampling union and Summa canister)

1.4 Probe Abandonment
- Probe removal fitting
- Crowbar

1.5 Miscellaneous
- Teflon tape
- 9/16″, ½″, crescent wrench, screw driver
- Extension cord
- Timer/watch
- Tools required to cut carpet, and/or tools needed for removal of other floor coverings

2.0 Probe Installation

2.1 Locate the sampling locations in accordance with the work plan. Check with local utility companies to identify utilities coming into the building from outside. If possible, look for known or suspected utility conduits and note their location on a map or in the field log. Be sure to confirm that the sample locations will not interfere with the known

underground utilities. Also note the location of the probe, locations of significant features (walls, cracks, sumps, drains, etc), and conditions of the slab and soil.

2.2 If needed, expose the concrete by cutting the carpet or other loose floor coverings (Note: Carpet need not be removed, but rather a 'L' shape cut to expose the concrete for drilling and the leak check enclosure). Drill a 7/8" or 1" diameter hole to a depth of 1-3/4" (measured to the center of the hole) to allow room for the installation of the probe nut and probe union (See Figure 2). Remove the cuttings using a vacuum cleaner. Be careful to not compromise the integrity of the slab during drilling (i.e., cracking it), although note if this occurs. It is important that the slab and the probe hole remain air tight for sampling and that cracks are noted.

2.3 Drill a 5/16" or 3/8" diameter hole through the remainder of the slab and approx. 3" down into the sub-slab material (See Figure 3). Drilling into the sub slab material creates a void that is free of obstructions that might plug the probe during sampling. Record the total depth of the slab and the depth drilled into the sub slab material.

2.4 Once the total depth of the slab is known, be sure that the probe (1/4" stainless steel tube with Swagelock or equivalent nut and ferrule) is cut with a hacksaw so that it does not extend beyond the bottom of the slab. Attach the probe union (1/4" male Swagelock to 1/8" female NPT) to the probe and tighten. Wrap the probe seal with Teflon tape and tighten into the union. See Figure 8 for an expanded view of the probe parts.

2.5 Wet the walls of the hole using the Q-tip or moistened paper towel. This helps the mortar bond to the drilled concrete. Prepare the mortar in accordance with manufacturer's directions to a stiff consistency. Make sure that the consistency is such that the mixture will not run down the sides of the hole and potentially clog the probe or hole. Place sample probe and sample union part way into the hole as shown in Figure 4. The probe tip should be at least one inch into the smaller diameter hole, but not so far that mortar can not be easily placed in the large diameter hole around the probe fittings. It is critical that the mortar mixture does not get into either end of the probe and cause a plug. Using the tongue depressor or similar tool, apply mortar around the base of the sampling probe and sampling union such that it will be sealed once it is in place.

2.6 Fill the hole with mortar, and press the probe further into the hole until its top is flush with the floor. In doing so, slightly wiggle the probe to create good 'wetting' contact between the probe and the mortar as well as the mortar and the drilled concrete. Scrape off excess and make sure there is clear access to the probe. See Figure 5.

2.7 Let dry for 24 hours

2.8 Be sure to never leave the probe hole open to atmosphere for extended periods to minimize the effects of surface infiltration.

3.0 Manifold Assembly and leak check

3.1 Make sure the sampling system is assembled (as shown in Figure 1 or 10) by connecting the sampling manifold to the soil gas probe and the purge system. <u>Do not connect the flow controller or canister at this time</u>.

3.2 Make sure the gas probe valve (valve #1) is closed.

3.3 Open the sample valve (valve #2) and the purge valve (valve #3) and turn the vacuum pump on. Make sure that the flow meter on the vacuum pump exhaust is reading 200 ml/min. Let the pump run for 1 minute to allow purging of potential contaminants from the manifold

3.4 Now close valve #2 to achieve a vacuum gauge reading of 10 inches of mercury or to a vacuum that will be encountered during sampling, which ever is greater. Close the purge valve #3 and shut the vacuum pump off.

3.5 If the pressure in the manifold has not changed after a minute, then the manifold is considered leak free. If not, repair any leaks prior to use and re-check the manifold.

3.6 Record the leak check date and time on the field sampling log.

4.0 Probe Leak Check and Probe Purging

4.1 The sampling system needs to be leak-checked and purged before sampling. Two different methods supported by the available literature/guidance are presented. One method uses helium gas as a tracer and allows for the assessment of potential probe leak prior to sample collection. The other method uses isopropyl alcohol as a tracer and allows for the assessment of potential probe leak after sample collection and analysis. Both these methods are acceptable and are detailed below.

4.1.1 Helium leak checking technique and purge

4.1.1.1 Remove the probe seal insert, wrap the sampling union fitting threads (1/8" male NPT to ¼" male Swagelock or equivalent) with Teflon tape (wrap the NPT threads only), and tighten into the exposed probe fitting. Thread the Teflon sample tubing through the rubber grommet in the leak check enclosure from the outside, and attach the tube to the sampling union using a nut and ferrule. Slide the enclosure down so it seals on the concrete slab. Attach the other end of the sample tube to the sampling manifold. See Figure 6 and 7.

4.1.1.2 Attach tubing to the flow meter on the helium tank regulator and the other end to the enclosure. Attach the exhaust tube to the enclosure and position the other end as far away as possible to avoid detection by the helium leak detector. See figure 9.

4.1.1.3 Put the helium detector on the exhaust line from the sample pump. Make sure valve 1 is closed. Open valves 2 and 3. Turn on the sample pump and helium detector.

4.1.1.4 Open the helium tank and set the flow meter for approximately 200 ml/min. Allow it to flow for 1 minute to fill the leak check enclosure before starting the purge. Make sure that the detector is not reading any helium before starting the purge.

4.1.1.5 Two liters of sub slab gas need to be purged before sampling. The purge time is 10 minutes at a flow rate of 200 ml/min. Close valve #2 and open valve #1 simultaneously and start timing for the purge volume. During the purge, observe the helium detector for indication of probe leakage (e.g. infiltration of room air into the probe). If a reading of >5% is observed, then the probe leak check has failed, and corrective action is required – see step 4.2.2.

4.1.1.6 At the end of the purge time, close valves #1 and #3 and turn the pump off. If at any time during the purge the detector read < 5%, then the system is leak free and ready for sampling. If >5% was observed, then check the fittings and try again. If <5% cannot be achieved, then this probe must be abandoned and a new hole drilled. Be sure to record the helium leak check value on the field sheet.

4.1.1.7 Close the helium tank valve.

4.1.2 Isopropyl alcohol leak checking technique and purge

4.1.2.1 Moisten a paper towel with isopropyl alcohol. Wrap the isopropyl alcohol moistened paper towel around probe fittings at the slab surface. Note: It is important to keep the isopropyl alcohol completely away from the sample equipment and SUMMA Canister during the set up phase. The sampler must also change nitrile gloves between setting up the sample equipment and conducting the leak detection test. It is also

important to instruct the laboratory to analyze for isopropyl alcohol. If isopropyl alcohol is detected by the laboratory at a concentration greater than 5% (50,000 ppmv) then the sample is deemed to be invalid due to a leak.

4.1.2.2 Two liters of sub slab gas need to be purged before sampling. The purge time is 10 minutes at a flow rate of 200 ml/min. Close valve #2 and open valve #1 simultaneously and start timing for the purge volume.

4.1.2.3 At the end of the purge time, close valves #1 and #3 and turn the pump off.

5.0 Sampling

5.1 The Summa canister has been evacuated to near absolute zero pressure. Care should be used at all times to prevent inadvertent loss of canister vacuum. Never open the valve affixed to the canister unless the intent is to collect sample or check the pressure. Use only a canister that has been certified to be clean.

5.2 Remove the canister valve cap, attach the vacuum gauge to the canister, and open the canister valve. Record the pressure reading and close and remove the valve. The pressure in the canister should be between 28" and 30" of mercury. If not, then the canister has leaked and should not be used for sampling.

5.3 Connect the flow controller to the manifold (at valve #2) and the Summa canister to the flow controller. The port on the flow controller that reads 'HP' or 'In' should be attached to the manifold. The port that reads 'LP' or 'Out' should be attached to the canister. Use only a flow controller that has been cleaned and properly adjusted.

5.4 To take the sample, confirm valve #3 is closed, and open valves #1 and #2. Slowly open the canister valve approximately one (1) full turn, and start timing. Record the start time on the field sampling log. During the sampling period, record the lowest pressure from the manifold gauge on the field log.

5.5 There are different sample time and flow rate protocols. These are subject to project requirements.

5.5.1 5 minute sample period, 850 ml canister: The flow controller is set for 150 ml/min. For an 850 cc Summa canister, it will take 5 minutes to collect a sample.

5.5.2 24 hour sample period, 6 liter canister: The flow controller is set for 3.75 ml/min. For a 6 liter Summa canister, it will take 24 hours to collect a sample.

5.6 At the end of the time, close the sample valve (valve #2) and the valve affixed to the canister. Remove the canister from the apparatus.

5.7 Re-attach the vacuum gauge and record the final pressure. The canister should only have 750 mls of sample in it based on a 150 ml/min sampling rate for 5 minutes. This should equate to between 2" and 5" final pressure in the canister. Record the sampling date, time, canister ID, flow controller ID, and any other observation pertinent to the sampling event on the field sampling log.

5.8 Remove the gauge from the can and tighten the cap back on with a wrench. Verify that canister valve is closed.

5.9 Fill out all appropriate documentation (sampling forms, sample labels, chain of custody, sample tags, etc.).

5.10 Disconnect the sample tubing from the probe, and remove the sampling union.

6.0 Probe Abandonment

6.1 After sampling, it is critical that the probe either be removed or plugged to prevent the creation of a new pathway for vapor intrusion.

6.2 If the probe is to be used again in the future, wrap the probe seal insert with Teflon tape, and tighten it into the probe opening using a hex key until it is tight and flush with the concrete floor.

6.3 If the probe is to be removed, insert the removal fitting into the probe. Using a crow bar, remove the entire probe assembly. If the probe can not be removed in this manner, then over drill the probe with the drill and 1″ bit. Fill the hole with cement mix.

Figure 1 – Sub slab Sampling

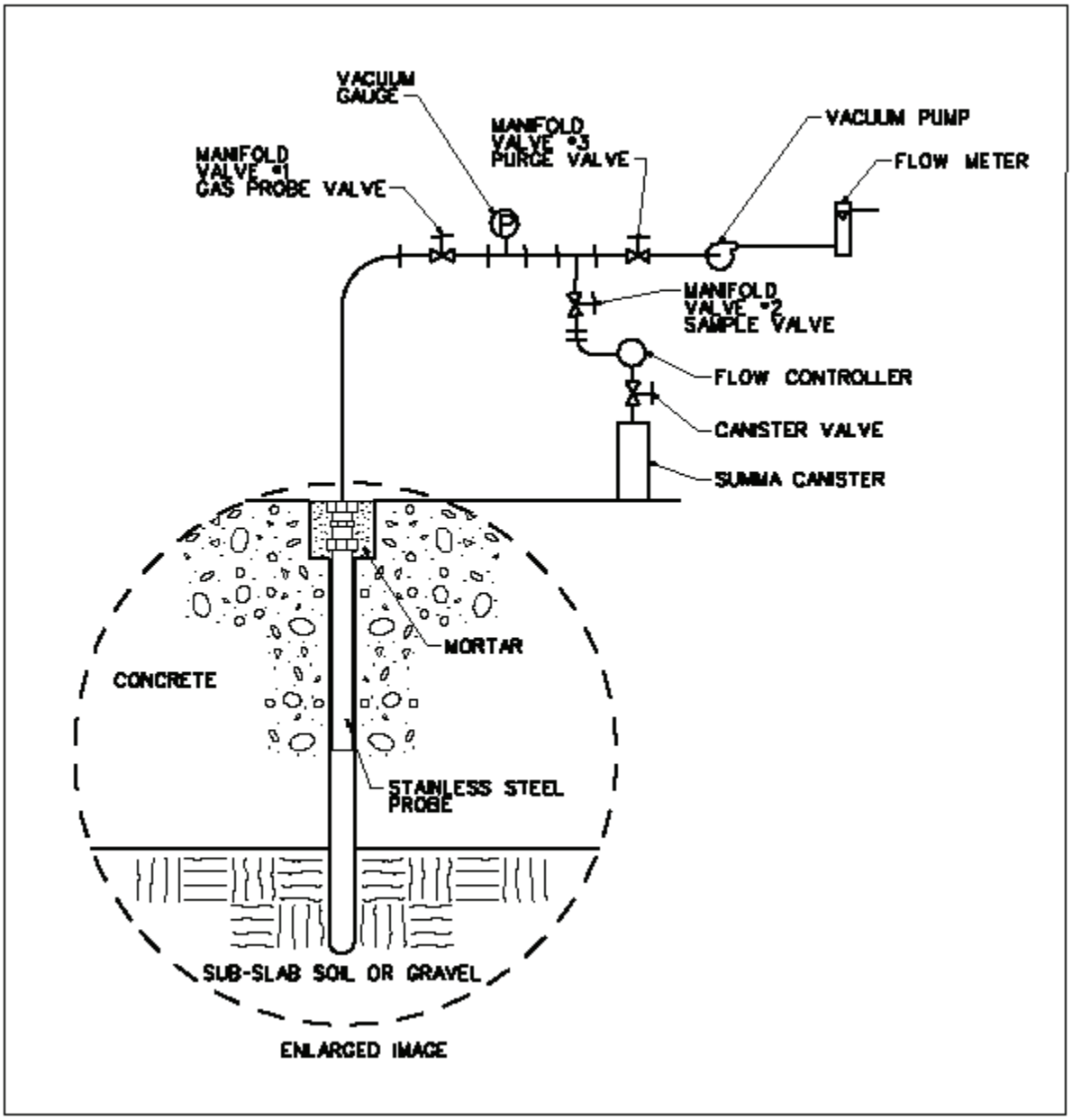


Figure 2 – Drilling 1” mortar hole to a depth of 1 ¾”

Figure 3 – Drilling 3/8” probe hole

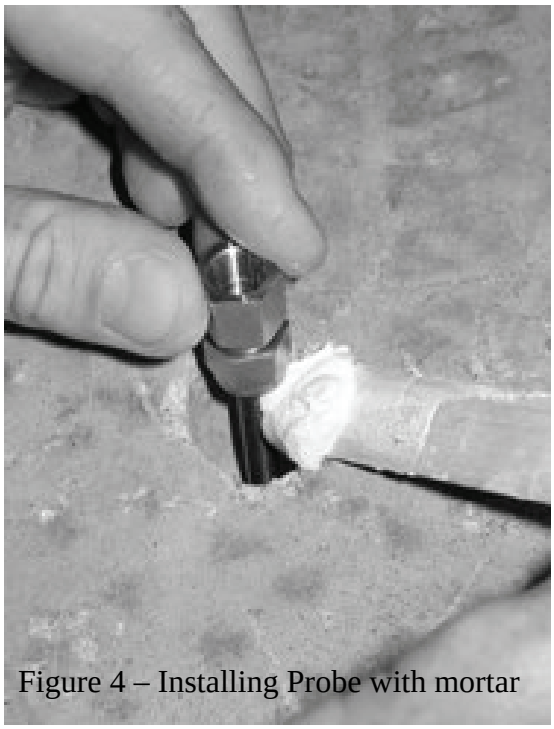


Figure 4 – Installing Probe with mortar

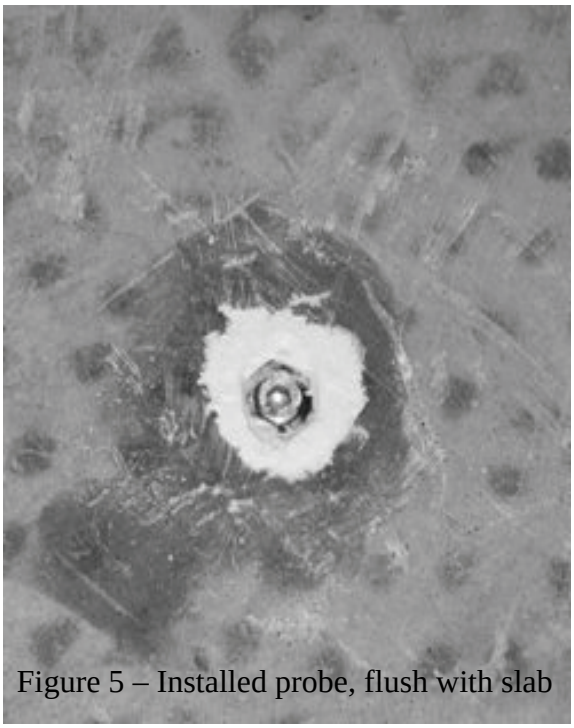


Figure 5 – Installed probe, flush with slab

Figure 6 – Installed probe with sample tube

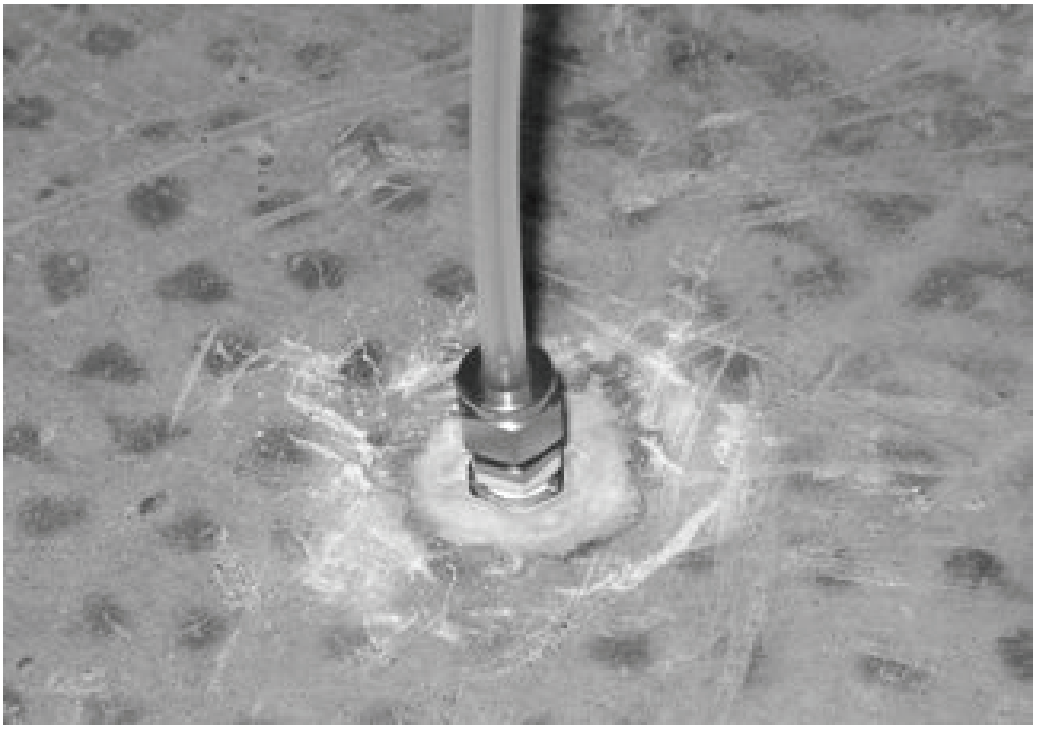
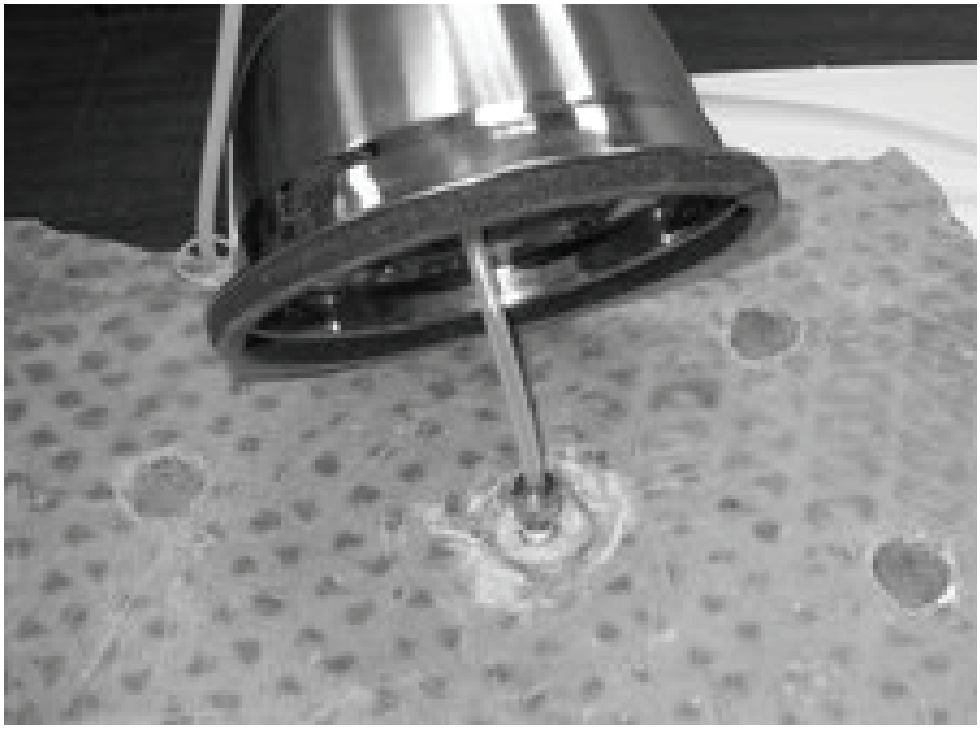


Figure 7 - Installing the helium leak check assembly



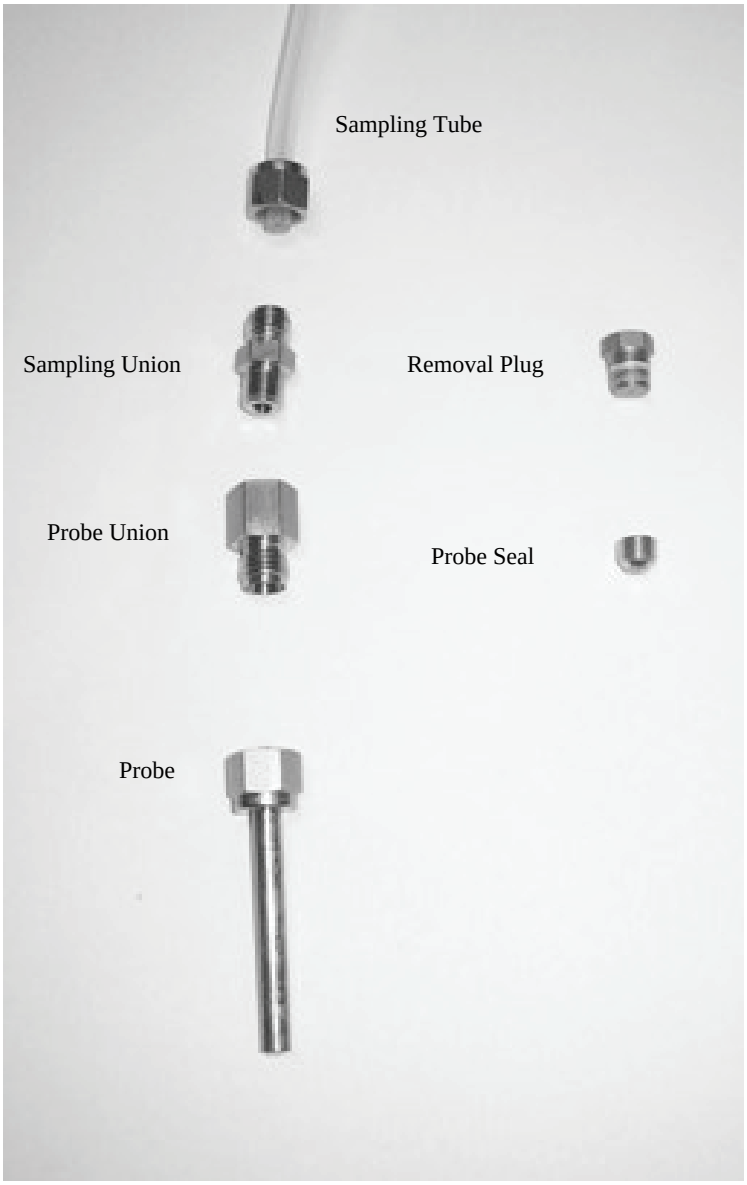


Figure 8 – Probe Parts

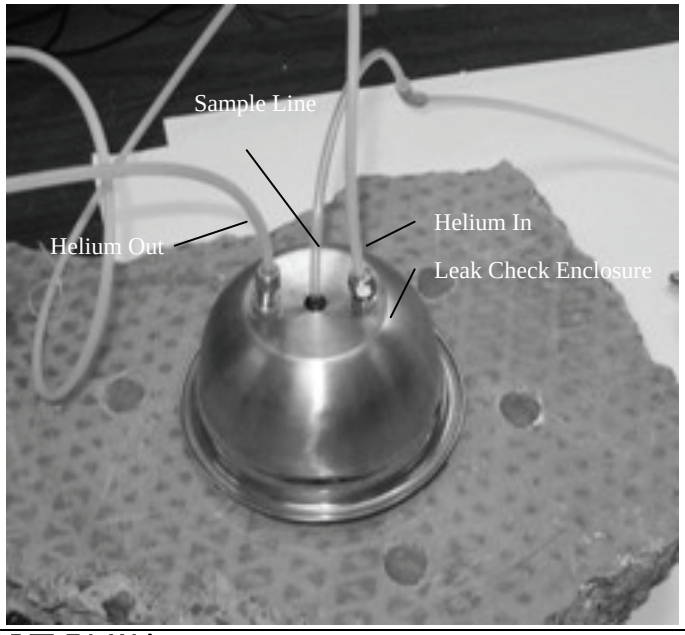
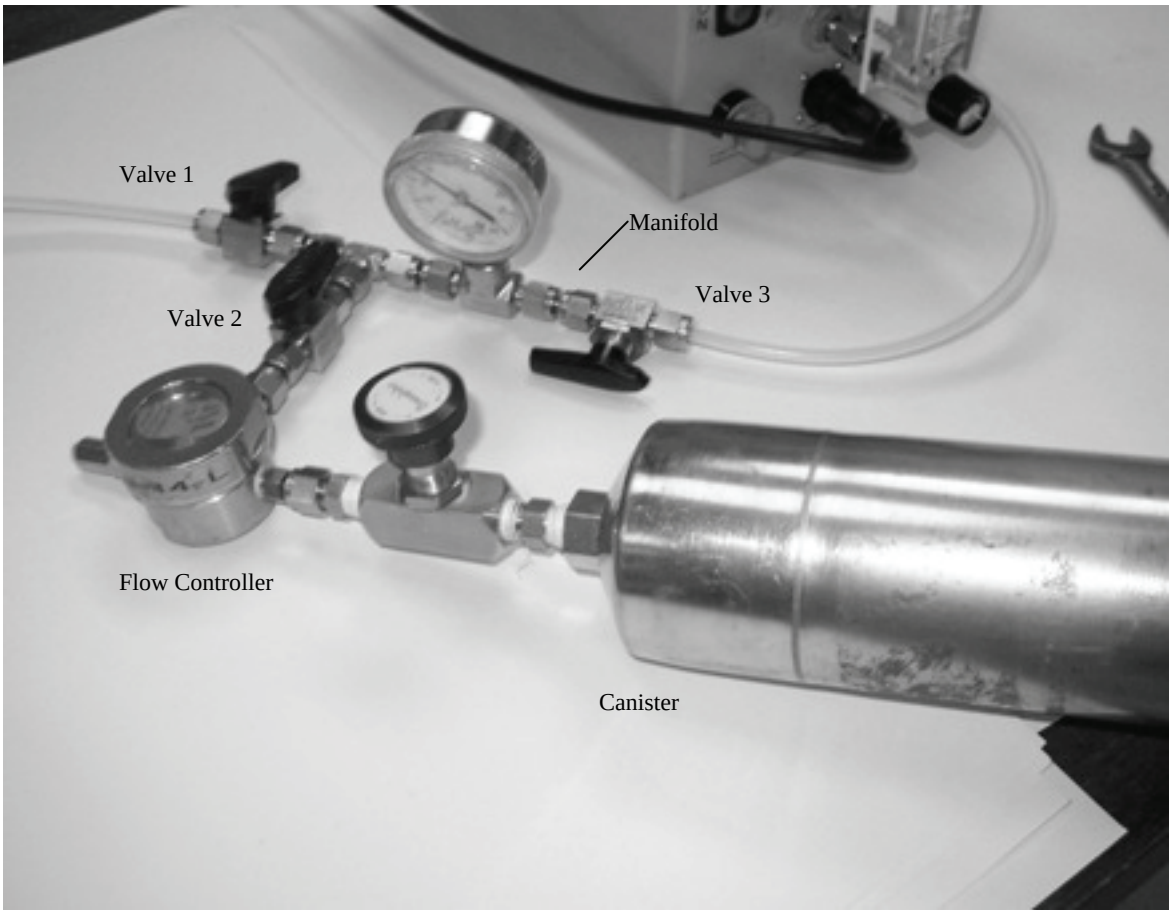


Figure 9 –Helium Leak Check Assembly

Figure 10 – Sampling Manifold



Standard Operating Procedure for Integrated Ambient or Indoor Air for Trace VOCs by Method TO-14/15 (Summa™ canister)

1 Scope and Application

1.1 This sampling method describes the procedure for collecting ambient air samples for targeted volatile organic compounds. The method presented here is based on 'clean' sampling techniques. The requirements of 'clean' sampling dictate sampling and sample handling by trained personnel.

2 Summary of Method

2.1 A sample of ambient air is withdrawn, using clean technique, from into a certified clean and evacuated Summa™ canister by virtue of a certified clean flow controller. Sample collection can be integrated over time by adjusting the flow controller. Sample periods as short as 10 minutes to as long as 24 hours can be achieved based on the size of canister used and the sampling rate selected.

3 Apparatus and Materials

3.1 Canister, Summa™ polished, certified clean, evacuated, and wrapped for shipping.

3.2 Flow controller, certified clean, set at desired sampling rate, and wrapped for shipping.

3.3 Shipping container, suitable for protection and canister during shipping.

3.4 Wrenches and screw driver (clean and free of contaminants), various sizes as needed for connecting fittings and making adjustment to the flow controller

3.5 Bubble flow meter or equivalent (clean and free of contaminants), used in the adjustment of the flow controller

3.6 Negative Pressure Gauge, oil free and clean, either installed on the canister or used externally to check canister pressure.

3.7 Zero air purge gas (UHP) and regulator to purge and clean flow controller between uses.

4 Procedure

4.1 'Clean' sampling protocols must be followed at times when handling and collecting samples. This requires care in the shipping, storage, and use of sampling equipment. Cleanliness of personnel who come in contact with the sampling equipment, no smoking, eating, or drinking, no perfumes, deodorants, clean clothing (not dry cleaned) and clean overgarments.

4.2 Inspect the canister for damage. Do not use a canister that has visible damage.

4.3 Verify that the vacuum pressure of the canister is equal to that indicated on the laboratory's evacuation tag. Do not use a canister that has leaked.

4.1.3 Remove the protective cap from the valve on the canister.

4.2.3 If using an external gauge, attach the gauge to the canister and open the valve. After taking the reading, close the canister and remove the gauge.

4.4 Verify that the flow controller is set at the desired sampling rate. If not pre-set, see the appropriate SOP for flow controller adjustment.

4.5 In the field log record the canister ID, flow controller ID, initial vacuum, desired flowrate, sample location information, and all other information pertinent to the sampling effort.

4.6 Connect the flow controller to the canister. The flow controller fitting denoted "LP" or "OUT" is connected to the canister. Tighten the fitting as to be leak free but <u>do not over tighten</u>. (A ¼ turn past snug is usually enough.)

4.7 Remove all work articles from the sampling area.

4.8 To begin sampling, slowly open the canister valve one full turn.

4.9 For canisters with built in pressure gauges, monitor the vacuum pressure change several times during the course of the selected sample period to ensure the canister is filling at the desired rate.

4.10 At the end of the sample period, close the canister valve finger tight.

4.11 Remove the flow controller and replace the protective cap on the canister valve fitting.

4.12 If using an external vacuum gauge, re-attach it, open the canister valve, and record the pressure. Then close the valve, remove the vacuum gauge, and replace the protective cap.

4.13 If the flow controller is going to be used for more than one sample collection, be sure to purge it between uses. To do this, attach the flow controller to a vacuum source and draw clean air or gas (UHP) through it for several minutes before attaching it to the canister.

4.14 Fill out all appropriate documentation (chain of custody, sample tags) and return canisters and all equipment to the laboratory in the shipping containers provided.

4.15 When packing the canisters for shipment, verify that the valve (just past finger tight) and valve caps are snug (1/4 turn past finger tight), and use sufficient clean packing to prevent the valves from rubbing against any hard surfaces.

4.16 Please do not place sticky labels or tape on any surface of the canister!

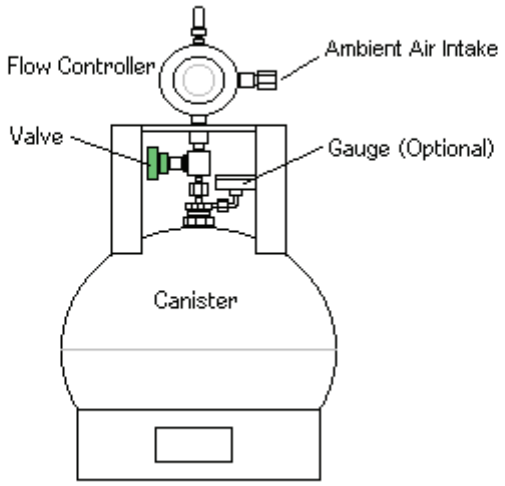
5 Quality Control

5.1 Canister supplied by the laboratory must follow the performance criteria and quality assurance prescribe in US EPA Method TO-14/15 for canister cleaning, certification of cleanliness, and leak checking. Standard operating procedures are required.

5.2 Flow controllers supplied by the laboratory must follow the performance criteria and quality assurance prescribed in US EPA Method TO-14/15 for flow controller cleaning and adjustment. Standard operating procedures are required.

FIGURE 1

Assembled Canister Sampler for Integrated Sample Collection



Appendix B
Uniform Federal Policy—
Sampling and Analysis Plan

SAP Worksheet #1 -- Title and Approval Page

(UFP-QAPP Manual Section 2.1)

Draft

SAMPLING AND ANALYSIS PLAN

(Field Sampling Plan and Quality Assurance Project Plan)

May 2, 2008

Vapor Intrusion Evaluation Work Plan

Prepared for:

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Prepared by:

Virginia Beach, Virginia

Prepared under:

AGVIQ–CH2M HILL JV 2 Program
Contract N62467-03-D-0260

Review Signatures: _____

Contractor QAM Signature
Printed Name/Title/Date
Approval Authority

Approval Signatures: _____

NAVFAC QAO/Chemist Signature
Printed Name/Title/Date
Approval Authority

Other Approval Signatures: _____

Signature

EXECUTIVE SUMMARY

Provided in Section 1 of the Work Plan

SAP Worksheets

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Acronyms

AA	Atomic Absorption
ANSI/ASQ	American National Standards Institute/American Society for Quality
ASTM	American Society for Standards and Materials
BOD	Biological Oxygen Demand
CA	Corrective Action
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CLP	Contract Laboratory Program
COC	Contaminant of Concern
CRDL	Contract-Required Detection Limit
CSM	Conceptual Site Model
CTO	Contract Task Order
CWA	Clean Water Act
DoD	Department of Defense
DCN	Document Control Number
DQI	Data Quality Indicator
DQO	Data Quality Objective
EPA	Environmental Protection Agency
FCR	Field Change Request
FS	Feasibility Study
FSP	Field Sampling Plan
GC	Gas Chromatograph
GC/MS	Gas Chromatograph/Mass Spectrometer
GIS	Geographic Information System
GPC	Gel Permeation Chromatography
GPS	Global Positioning System
GW	Ground Water
ICP	Inductively Coupled Plasma
IDQTF	Intergovernmental Data Quality Task Force
LCS	Laboratory Control Sample
LFB	Laboratory Fortified Blank
LIMS	Laboratory Information Management Systems
MARLAP	Multi-Agency Radiological Laboratory Analytical Protocols (Manual)
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
MOU	Memorandum of Understanding
MPC	Measurement Performance Criteria
MQO	Measurement Quality Objectives
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MSR	Management Systems Review
NEIC	National Enforcement Investigations Center
NIST	National Institute of Standards and Technology
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
PA/SI	Preliminary Assessment/Site Investigation
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
PCBs	Polychlorinated Biphenyls

PDF	Portable Document Format
PG	Professional Geologist
PM	Project Manager
PQOs	Project Quality Objectives
PRP	Potentially Responsible Party
PRQL	Project-Required Quantitation Limit
PT	Proficiency Testing (previously known as performance evaluation (PE) sample)
QA	Quality Assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
QL	Quantitation Limit
QMP	Quality Management Plan
QS	Quality System
QSM	Quality Systems Manual
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RIC	Reconstructed Ion Chromatogram
RPD	Relative Percent Difference
RPM	Remedial Project Manager
RTM	Remedial Technical Manager
RSD	Relative Standard Deviation
RT	Retention Time
SAP	Sampling and Analysis Plan
SD	Standard Deviation
SDG	Sample Delivery Group
SDWA	Safe Drinking Water Act
SOP	Standard Operating Procedure
SQLs	Sample Quantitation Limits
SRM	Standard Reference Material
SVOA	Semivolatile Organic Analytes
SVOC	Semivolatile Organic Compounds
SW	Surface Water
TCLP	Toxicity Characteristic Leaching Procedure
TBD	To Be Determined
TSA	Technical Systems Audit
UFP	Uniform Federal Policy
USACE	United States Army Corps of Engineers
VOA	Volatile Organic Analytes
VOC	Volatile Organic Compounds
VSP	Visual Sample Plan

SAP Worksheet #2 -- SAP Identifying Information

(UFP-QAPP Manual Section 2.2.4)

Site Name/Number: See Section 4 of the Work Plan
Operable Unit: See Section 4 of the Work Plan
Contractor Name: AGVIQ and CH2M HILL joint venture
Contract Number: TO 21
Contract Title: Plume Vapor investigation, Camp Lejeune, NC
Work Assignment Number (optional):

1. This SAP was prepared in accordance with the requirements of the *Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP)* (U.S. EPA 2005) and *EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS (U.S. EPA 2002)* . Identify any additional guidance used to prepare SAP: USEPA Draft Vapor Intrusion Guidance (November 2002) and draft Navy Draft Vapor Intrusion Guidance (February 2008)

2. Identify regulatory program: Not Applicable

3. This SAP is a project-specific SAP.

4. List dates of scoping sessions that were held:

Scoping Session	Date
Approach Memo Review	11/20/07
Hadnot Point Memo Review	4/21/08

5. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.

Title	Date
Field Sampling Plan Tarawa Terrace Elementary School	July 2007

6. List organizational partners (stakeholders) and connection with lead organization:
Navy and Marine Corps Public Health Center

7. Lead organization NAVFAC Mid-Atlantic

8. If any required SAP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:

SAP Worksheet #2 -- SAP Identifying Information (continued)

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
A. Project Management		
Documentation		
1	Title and Approval Page	**Work Plan**
2	Table of Contents SAP Identifying Information	**Work Plan TOC and Work Plan Appendix B**
3	Distribution List	**Work Plan Appendix B**
4	Project Personnel Sign-Off Sheet	**Work Plan Appendix B**
Project Organization		
5	Project Organizational Chart	**Work Plan Appendix B**
6	Communication Pathways	**Work Plan Appendix B**
7	Personnel Responsibilities and Qualifications Table	**Work Plan Appendix B**
8	Special Personnel Training Requirements Table	**Work Plan Appendix B**
Project Planning/ Problem Definition		
9	Project Planning Session Documentation (including Data Needs tables) Project Scoping Session Participants Sheet	**Work Plan Appendix B**
10	Problem Definition, Site History, and Background. Site Maps (historical and present)	**Work Plan Sections 1 and 2**
11	Site-Specific Project Quality Objectives	**Work Plan Section 4**
12	Measurement Performance Criteria Table	**Work Plan Appendix B** To be completed by selected laboratory
13	Sources of Secondary Data and Information Secondary Data Criteria and Limitations Table	**Work Plan Appendix B** To be completed by selected laboratory
14	Summary of Project Tasks	**Field Sampling Plan Section 2**
15	Reference Limits and Evaluation Table	**Work Plan Appendix B** To be completed by selected laboratory
16	Project Schedule/Timeline Table	**Work Plan Appendix D**
B. Measurement Data Acquisition		
Sampling Tasks		
17	Sampling Design and Rationale	**Work Plan Section 4 and Worksheet 15**
18	Sampling Locations and Methods/ SOP Requirements Table Sample Location Map(s)	**Work Plan Section 4 and Field Sampling Plan Section 2**
19	Analytical Methods/SOP Requirements Table	**Field Sampling Plan Table 2-1**
20	Field Quality Control Sample Summary Table	**Work Plan Appendix B**
21	Project Sampling SOP References Table Sampling SOPs	**Field Sampling Plan TOC**
22	Field Equipment Calibration, Maintenance, Testing, and Inspection Table	**Field Sampling Plan Section 2.8.8**
Analytical Tasks		
23	Analytical SOPs Analytical SOP References Table	**Work Plan Appendix B** To be completed by selected laboratory
24	Analytical Instrument Calibration Table	**Work Plan Appendix B** To be completed by selected laboratory
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	**Work Plan Appendix B** To be completed by selected laboratory

SAP Worksheet #2 -- SAP Identifying Information (continued)

Sample Collection		
26	Sample Handling System, Documentation Collection, Tracking, Archiving and Disposal Sample Handling Flow Diagram	**Work Plan Appendix B**
27	Sample Custody Requirements, Procedures/SOPs Sample Container Identification Example Chain-of-Custody Form and Seal	**Field Sampling Plan Section 3**
Quality Control Samples		
28	QC Samples Table Screening/Confirmatory Analysis Decision Tree	**Work Plan Appendix B** To be completed by selected laboratory
Data Management Tasks		
29	Project Documents and Records Table	**Work Plan Appendix B**
30	Analytical Services Table Analytical and Data Management SOPs	**Work Plan Appendix B** To be completed by selected laboratory
C. Assessment Oversight		
31	Planned Project Assessments Table Audit Checklists	**Work Plan Appendix B**
32	Assessment Findings and Corrective Action Responses Table	**Work Plan Appendix B**
33	QA Management Reports Table	**Work Plan Appendix B**
D. Data Review		
34	Verification (Step I) Process Table	**Work Plan Appendix B**
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36	Validation (Steps IIa and IIb) Summary Table	**Work Plan Appendix B**
37	Usability Assessment	**Work Plan Appendix B**

SAP Worksheet #3 -- Distribution List

(UFP-QAPP Manual Section 2.3.1)

Name of SAP Recipients	Title/Role	Organization	Telephone Number (Optional)	E-mail Address or Mailing Address
Bob Lowder	Environmental Engineer	MCB Camp Lejeune-Environmental Management Division (EMD)	(910) 451-9607	robert.a.lowder@usmc.mil
Matt Louth	Activity Manager (AM)	JV II	(757) 671-6240	matt.louth@ch2m.com
Kim Henderson	Deputy AM	JV II	(757) 671-6231	kimberly.henderson@ch2m.com
Chris Bozzini	Senior Technical Consultant	JV II	(704) 329-0073 ext. 291	christopher.bozzini@ch2m.com
Keri Hallberg	Project Manager (PM)	JV II (CH2M HILL)	(704) 329-0073 ext. 304	keri.hallberg@ch2m.com
Craig Miller	PM	JV II (AGVIQ)	(757) 213-8584	cmiller@tikigaq.com
To Be Determined (TBD)	Field Team Leader (FTL)	JV II	TBD	TBD
TBD	Field Staff	JV II	TBD	TBD
Anita Dodson	Program Chemist	JV II	757-671-6218	anita.dodson@ch2m.com
Felicia Arroyo	Environmental Information Specialist (EIS)	JV II	(757) 671-6205	felicia.arroyo@ch2m.com
TBD	Analytical Laboratory	TBD	TBD	TBD
TBD	Data Validator	TBD	TBD	TBD
TBD	IDW Subcontractor	TBD	TBD	TBD

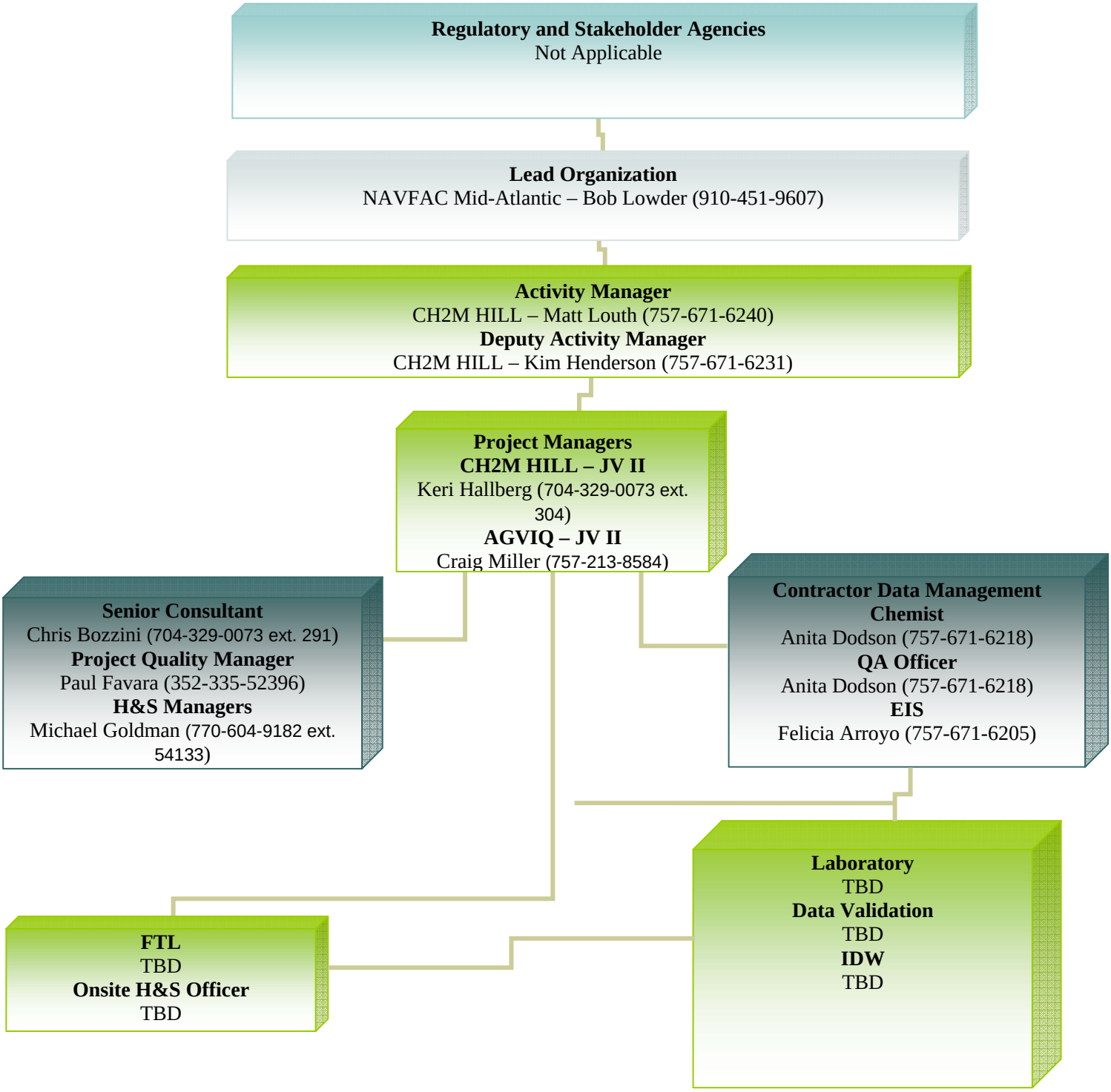
SAP Worksheet #4 -- Project Personnel Sign-Off Sheet

(UFP-QAPP Manual Section 2.3.2)

Name	Organization/Title/Role	Telephone Number (optional)	Signature/email receipt	SAP Section Reviewed	Date SAP Read
Bob Lowder	Environmental Engineer, MCB Camp Lejeune- Environmental Management Division (EMD)	(910) 451-9607	robert.a.lowder@usmc.mil		
Matt Louth	JV II - Activity Manager (AM)	(757) 671-6240	matt.louth@ch2m.com		
Chris Bozzini	JV II - Senior Technical Consultant	(704) 329-0073 ext. 291	christopher.bozzini@ch2m.com		
Keri Hallberg	JV II (CH2M HILL) - Project Manager (PM)	(704) 329-0073 ext. 304	keri.hallberg@ch2m.com		
Craig Miller	JV II (AGVIQ) - PM	(757) 213-8584	cmiller@tikigaq.com		
Kim Henderson	JV II - Deputy AM	(757) 671-6231	kimberly.henderson@ch2m.com		
Paul Favara, P.E.	JV II - Project Quality Manager	(352) 335-2396	paul.favara@ch2m.com		
Michael Goldman	JV II - Health & Safety Manager	(770) 604-9182 ext. 54133	michael.goldman@ch2m.com		
Anita Dodson	JV II – Navy Program Chemist	(757) 671-6218	anita.dodson@ch2m.com		
Felicia Arroyo	JV II - Environmental Information Specialist (EIS)	(757) 671-6205	felicia.arroyo@ch2m.com		
TBD	JV II – FTL	TBD			
TBD	JV II – Field Staff	TBD			
TBD	Analytical Laboratory				
TBD	Data Validator				
TBD	IDW Subcontractor				

SAP Worksheet #5 -- Project Organizational Chart

(UFP-QAPP Manual Section 2.4.1)



SAP Worksheet #6 -- Communication Pathways

(UFP-QAPP Manual Section 2.4.2)

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or e-mail	Procedure (timing, pathway to & from, etc.)
Communication with Navy (lead agency)	RPM	Bob Lowder	(910) 451-9607	Point of contact (POC) for the Navy; can delegate communication to other internal or external POCs. Navy will have 30 days for SAP review. Analytical results data will be presented and discussed during partnering meetings.
Communication regarding overall project status and implementation and primary POC with Navy RPM	AM	Matt Louth	757-671-6240	Forwards information and materials about the project to NAVFAC Mid-Atlantic. Oversees project and will be informed of project status by the Deputy AM Kim Henderson or PM Keri Hallberg. Analytical results will be communicated to the project team during partnering meetings.
Communication regarding overall project status and implementation and primary POC with Navy RPM	Deputy AM	Kim Henderson	757-671-6231	Perform the tasks of the AM when requested by the AM and/or when the AM is not available. When performing the roles of the AM, the Deputy AM communicates any actions taken to the AM within 24 hours of the activity.
Technical communications for project implementation, and data interpretation	Senior Consultant	Chris Bozzini	(704) 329-0073 ext. 291	The senior consultant is contacted regarding questions/issues encountered in the field and input on data interpretation, as needed. The senior consultant will have 24 hours to respond to technical field questions as necessary. Additionally, the senior consultant will review the data as necessary before partnering team discussion.
Communications regarding project management and implementation of all project phases, and primary POC with AM and Deputy AM	JV II PM	Keri Hallberg/ CH2M HILL Craig Miller/AGVIQ	(704) 329-0073 ext. 304 (757) 213-8584	All information about the project will be forwarded to the AM or the Deputy AM within 24 hours of the activity.
Health and Safety (H&S)	FTL/Onsite H&S Officer	TBD		Responsible for the adherence of team members to the site safety requirements described in the HSP. Will report H&S incidents and near misses to PM.
Reporting Laboratory Data Quality Issues	Laboratory PM	TBD	TBD	All QA/QC issues with project field samples will be reported within 2 days to the project chemist (Anita Dodson) by the laboratory.

SAP Worksheet #7 -- Personnel Responsibilities and Qualifications Table

(UFP-QAPP Manual Section 2.4.3)

Name	Title/Role	Organizational Affiliation	Responsibilities
Bob Lowder	Environmental Engineer, MCB Camp Lejeune-Environmental Management Division (EMD)	NAVFAC Mid-Atlantic	Oversees project
Matt Louth	AM	JV II	Oversees project activities
Kim Henderson	Deputy AM	JV II	Oversees project activities
Chris Bozzini	Senior Technical Consultant	JV II	Oversees project activities
Keri Hallberg	PM	JV II (CH2M HILL)	Manages project
Craig Miller	PM	JV II (AGVIQ)	Manages project
Paul Favara, P.E.	Project Quality Manager	JV II	Oversees project activities
Anita Dodson	Navy Program Chemist	JV II	Provides UFP-SAP project delivery support and performs data evaluation and QA oversight
Felicia Arroyo	EIS	JV II	Performs data management activities including sample tracking and communication with the laboratory and the data validator
TBD	FTL	JV II	Coordinates all field activities
Michael Goldman	Health & Safety Manager	JV II	Prepares HSP; manages H&S for all field activities
TBD	H&S Officer	JV II	Oversees H&S for all field activities
TBD	Laboratory PM	TBD	Responsible for ensuring proper data tracking and reporting and maintaining communication with project chemist and EIS.
TBD	Data Validation Senior Chemist	TBD	Responsible for ensuring data is validated
TBD	IDW Subcontractor	TBD	Responsible for manifest, transportation, and disposal of IDW.

SAP Worksheet #8 -- Special Personnel Training Requirements Table

(UFP-QAPP Manual Section 2.4.4)

The following table is used to identify and describe any specialized/non-routine project specific training requirements or certifications needed by personnel in order to successfully complete the project or task. OPNAV 5090.1 instructions are not considered specialized training; the OPNAV training requirements represent routine, minimum requirements that are mandatory for all DON projects. It is OK to add additional text here explaining routine training requirements. Where it is appropriate, include explanatory text discussing how specialized training will be provided and how the necessary skills will be assured and documented (training should be documented for personnel, but this documentation doesn't need to be included in SAP). For example, if the project requires confined space sampling, the sampler must be certified for confined space entry.

Project Function	Specialized Training By Title or Description of Course	Training Provider	Training Date	Personnel / Groups Receiving Training	Personnel Titles / Organizational Affiliation	Location of Training Records / Certificates[1]
Field Activities	HAZWOPER 40-hour training or 8-hour annual refresher, as appropriate	Registered training organization	Agency and subcontractor specific	FTL, field team members, site safety coordinator; onsite subcontractor; Navy representatives	Field team members and site safety coordinators from JV II; onsite subcontractor; onsite visitors from Navy	Personnel files
Field Activities	Site Safety Coordinator (SSC-HW)	Registered training organization	Subcontractor specific	Onsite H&S Officer	Onsite H&S Officer from JV II	Personnel files

[1] If training records and/or certificates are on file elsewhere, document their location in this column. If training records and/or certificates do not exist or are not available, then this should be noted.

SAP Worksheet #9 -- Project Scoping Session Participants Sheet

(UFP-QAPP Manual Section 2.5.1)

Document to the extent practicable, the dates and participants in project scoping sessions. Complete this worksheet for each project scoping session held. Identify project team members who are responsible for planning the project. The following is the generic form used for scoping meetings. NAVFAC RPMs should include meeting minutes and participant rosters in the project file and administrative record. All Correspondence (fax, e-mails etc.) and records of communication (including meetings) shall be submitted to the admin record file. If this form was not used, use the crosswalk table included in WS#2 to indicate where information about scoping sessions can be found. There may be multiple entries (tables) for this element. Text format is acceptable for this element in lieu of the table (e.g. meeting minutes) as long as the key information is included.

Project Name: Plume Vapor Investigation, Camp Lejeuene, NC Projected Date(s) of Sampling: June-July 2008 Project Manager: Keri Hallberg	Site Name: Base-wide Site Location: MCB Camp Lejeune, North Carolina

Date of Session: 11/20/2007
Scoping Session Purpose: Discuss scope and evaluation approach

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Robert Lowder	Environmental Engineer	MCB Camp Lejeune	(910) 451-9607	robert.a.lowder@usmc.mil	Base Project Manager
John Lowe	Vapor Intrusion Risk Assessment	CH2M HILL	509.438.1557	John.lowe@ch2m.com	Subject Matter Expert
Chris Bozzini	Senior Project Manager	CH2M HILL	704-329-0073 x291	Chris.bozzini@ch2m.com	Senior Technical Consultant
Kim Henderson	Deputy Activity Manager	CH2M HILL	757-671-6231	Kim.henderson@ch2m.com	Deputy Activity Manager
Keri Hallberg	Associate Project Manager	CH2M HILL	704-329-0073 x304	Keri.hallberg@ch2m.com	Project Manager
Matt Louth	Activity Manager	CH2M HILL	757-671-6240	Matt.louth@ch2m.com	Activity Manager

Comments/Decisions:

Use Table 3 of ITRC Guidance for initial screening

Navy has strong preference to resolve vapor issues using subslab sampling

Don't limit COPCs to 4, instead group COPCs

Keep deep wells in initial screening

Action Items:

Revise schedule

Consensus Decisions:

SAP Worksheet #9 -- Project Scoping Session Participants Sheet (continued)

(UFP-QAPP Manual Section 2.5.1)

Document to the extent practicable, the dates and participants in project scoping sessions. Complete this worksheet for each project scoping session held. Identify project team members who are responsible for planning the project. The following is the generic form used for scoping meetings. NAVFAC RPMs should include meeting minutes and participant rosters in the project file and administrative record. All Correspondence (fax, e-mails etc.) and records of communication (including meetings) shall be submitted to the admin record file. If this form was not used, use the crosswalk table included in WS#2 to indicate where information about scoping sessions can be found. There may be multiple entries (tables) for this element. Text format is acceptable for this element in lieu of the table (e.g. meeting minutes) as long as the key information is included.

Project Name: Plume Vapor Investigation, Camp Lejeuene, NC Projected Date(s) of Sampling: June-July 2008 Project Manager: Keri Hallberg	Site Name: Base-wide Site Location: MCB Camp Lejeune, North Carolina

Date of Session: 4/21/2008
Scoping Session Purpose: Discuss evaluation approach and NMCPHC comments on Hadnot Point Tech Memo

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Robert Lowder	Environmental Engineer	MCB Camp Lejeune	(910) 451-9607	robert.a.lowder@usmc.mil	Base Project Manager
John Lowe	Vapor Intrusion Risk Assessment	CH2M HILL	509.438.1557	John.lowe@ch2m.com	Subject Matter Expert
Loren Lund	Vapor Intrusion Risk Assessment	CH2M HILL	208.357.5351	Loren.lund@ch2m.com	Subject Matter Expert
Kim Henderson	Deputy Activity Manager	CH2M HILL	757-671-6231	Kim.henderson@ch2m.com	Deputy Activity Manager
Keri Hallberg	Associate Project Manager	CH2M HILL	704-329-0073 x304	Keri.hallberg@ch2m.com	Project Manager
Jennifer Corack		NMCPHC		Jennifer.Corack@med.navy.mil	NMCPHC Reviewer
Matt Louth	Activity Manager	CH2M HILL	757-671-6240	Matt.louth@ch2m.com	Activity Manager
Bryan Beck	RPM – Camp Lejeune	NAVFAC Mid-Atlantic	910-322-4734	bryan.k.beck@navy.mil	RPM – Camp Lejeune

Comments/Decisions:

Consider Geology when evaluating buildings

Evaluate potential preferential pathways as part of screening

List NFA sites in work plan

Evaluate only current land use

Action Items:

For non-carcinogens, divide site-specific screening level by 10 and use new screening number to identify any additional buildings

Add groundwater flow direction to sampling figures

Consensus Decisions:

SAP Worksheet #10 -- Problem Definition

(UFP-QAPP Manual Section 2.5.2)

Provided in Sections 1 and 2 of the Work Plan

SAP Worksheet #11 -- Project Quality Objectives/Systematic Planning Process Statements

(UFP-QAPP Manual Section 2.6.1)

Provided in Section 4 of the Work Plan.

SAP Worksheet #12 -- Measurement Performance Criteria Table note matrix in table entry
(UFP-QAPP Manual Section 2.6.2)

Measurement Performance Criteria Table – Field QC Samples

QC Sample	Analytical Group[1]	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Method Blank	Volatile Organics (TO-15 Air)	1 per 24 hours or 20 samples, whichever is more frequent	Contamination	No Target Compound >RL	A
Field Blanks			Contamination	No Target Compound >RL	S & A
Laboratory Control Sample		1 per 24 hours or 20 samples, whichever is more frequent	Accuracy/Bias	Non-polar analytes: 70-130%R with ≤2 within 60-140%. Polar analytes: 60-140%R with ≤2 within 45-155%.	A
Surrogates		Every sample	Accuracy/Bias	70-130%R	A
Laboratory Duplicate		1 per batch (20 samples)	Precision	RPD ≤ 25 for analytes >5x RL	S & A
Field Duplicate			Precision		S & A
Data Completeness Check			Completeness		S & A

[1]If information varies within an analytical group, separate by individual analyte.

SAP Worksheet #13 -- Secondary Data Criteria and Limitations Table

(UFP-QAPP Manual Section 2.7)

SAP Worksheet #14 -- Summary of Project Tasks

(UFP-QAPP Manual Section 2.8.1)

Provided in Section 2 of the Field Sampling Plan

SAP Worksheet #15 -- Reference Limits and Evaluation Table
(UFP-QAPP Manual Section 2.8.1)

Matrix: Water
Analytical Group: Volatile Organics 8260B

Analyte	CAS Number	Project Action Limit (ug/L)	Project Action Limit Reference[1]	Project Quantitation Limit Goal (ug/L)	Laboratory-specific[2]	
					QLs (ug/L)	MDLs (ug/L)
Acetone	67-64-1	220,000	Table 2C; EPA 2002	10	10	0.95
Benzene	71-43-2	5	Table 2C; EPA 2002	1	1	0.025
Bromodichloromethane	75-27-4	2.1	Table 2C; EPA 2002	1	1	0.065
Bromoform	75-25-2	0.0083	Table 2C; EPA 2002	1	1	0.32
Bromomethane	74-83-9	20	Table 2C; EPA 2002	2	2	0.12
2-Butanone	78-93-3	440000	Table 2C; EPA 2002	5	5	1.3
Carbon disulfide	75-15-0	560	Table 2C; EPA 2002	1	1	0.025
Carbon tetrachloride	56-23-5	5	Table 2C; EPA 2002	1	1	0.054
Chlorobenzene	108-90-7	390	Table 2C; EPA 2002	1	1	0.041

Chloroethane	75-00-3	28000	Table 2C; EPA 2002	2	2	0.13
Chloroform	67-66-3	80	Table 2C; EPA 2002	1	1	0.036
Chloromethane	74-87-3	6.7	Table 2C; EPA 2002	2	2	0.064
Dibromochloromethane	124-48-1	2.1	Table 2C; EPA 2002	1	1	0.11
1,2-Dibromo-3-chloropropane	96-12-8	33	Table 2C; EPA 2002	2	2	0.35
1,2-Dibromoethane	106-93-4	0.36	Table 2C; EPA 2002	1	1	0.094
1,2-Dichlorobenzene	95-50-1	2600	Table 2C; EPA 2002	1	1	0.036
1,3-Dichlorobenzene	541-73-1	830	Table 2C; EPA 2002	1	1	0.043
1,4-Dichlorobenzene	106-46-7	8200	Table 2C; EPA 2002	1	1	0.049
Dichlorodifluoromethane	75-71-8	14	Table 2C; EPA 2002	2	2	0.082
1,1-Dichloroethane	75-34-3	2200	Table 2C; EPA 2002	1	1	0.034
1,2-Dichloroethane	107-06-2	5	Table 2C; EPA 2002	1	1	0.043
1,1-Dichloroethene	75-35-4	190	Table 2C; EPA 2002	1	1	0.036

cis-1,2-Dichloroethene	156-59-2	210	Table 2C; EPA 2002	1	1	0.036
trans-1,2-Dichloroethene	156-60-5	180	Table 2C; EPA 2002	1	1	0.04
1,2-Dichloropropane	78-87-5	35	Table 2C; EPA 2002	1	1	0.034
cis-1,3-Dichloropropene	10061-01-5	0.84	Table 2C; EPA 2002	1	1	0.059
trans-1,3-Dichloropropene	10061-02-6	0.84	Table 2C; EPA 2002	1	1	0.056
Ethylbenzene	100-41-4	700	Table 2C; EPA 2002	1	1	0.043
Isopropylbenzene	98-82-8	8.4	Table 2C; EPA 2002	1	1	0.036
Methyl acetate	79-20-9	72500	Table 2C; EPA 2002	1	1	0.14
Methylene chloride	75-09-2	58	Table 2C; EPA 2002	2	2	0.07
Methylcyclohexane	108-87-2	710	Table 2C; EPA 2002	1	1	0.03
4-Methyl-2-pentanone	108-10-1	14000	Table 2C; EPA 2002	5	5	0.17
Methyl tert-butyl ether	1634-04-4	120000	Table 2C; EPA 2002	1	1	0.048
Styrene	100-42-5	8900	Table 2C; EPA 2002	1	1	0.038

1,1,2,2-Tetrachloroethane	79-34-5	3.3	Table 2C; EPA 2002	1	1	0.32
Tetrachloroethene	127-18-4	5	Table 2C; EPA 2002	1	1	0.051
Toluene	108-88-3	1500	Table 2C; EPA 2002	1	1	0.047
1,2,4-Trichlorobenzene	120-82-1	3400	Table 2C; EPA 2002	1	1	0.074
1,1,1-Trichloroethane	71-55-6	3100	Table 2C; EPA 2002	1	1	0.07
1,1,2-Trichloroethane	79-00-5	5	Table 2C; EPA 2002	1	1	0.079
Trichloroethene	79-01-6	5	Table 2C; EPA 2002	1	1	0.043
Trichlorofluoromethane	75-69-4	180	Table 2C; EPA 2002	2	2	0.034
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	1500	Table 2C; EPA 2002	1	1	0.036
Vinyl chloride	75-01-4	2	Table 2C; EPA 2002	1	1	0.088
o-xylene[3]	95-47-6	33000	Table 2C; EPA 2002	1	1	0.046
m&p-xylene[3]	136777-61-2	22000	Table 2C; EPA 2002	1	1	0.036

[1]List the type and source of the PAL used for each matrix specific analyte (e.g. Background, HH-MCL, HH-region III RBC, eco-WQC, eco-Region III BTAG, etc.)

[2]Laboratory-specific MDLs and QLs are limits that an individual laboratory can achieve when performing a specific analytical method. MDLs may be subject to update.

[3] o-xylene and m&p-xylene are reported in place of xylenes(total)

EPA 2002. OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance). November.

Shading represents rows where the laboratory specific QL is greater than the PAL. These compounds will be used in an effort to develop site-specific screening levels.

SAP Worksheet #15 -- Reference Limits and Evaluation Table
(UFP-QAPP Manual Section 2.8.1)

Matrix: Air
Analytical Group: Volatile Organics Method TO-15

Analyte	CAS Number	Project Action Limit (ppb(v/v)	Project Action Limit Reference[1]	Project Quantitation Limit Goal (ppb(v/v)	Laboratory-specific[2,3]	
					QLs (ppb(v/v)	MDLs (ppb(v/v)
Acetone	67-64-1	1500	Table 2C; EPA 2002	5	5	1.4
Benzene	71-43-2	0.98	Table 2C; EPA 2002	0.2	0.2	0.056
Bromodichloromethane	75-27-4	0.21	Table 2C; EPA 2002	0.2	0.2	0.044
Bromoform	75-25-2	2.1	Table 2C; EPA 2002	0.2	0.2	0.048
Bromomethane	74-83-9	13	Table 2C; EPA 2002	0.2	0.2	0.032
2-Butanone	78-93-3	3400	Table 2C; EPA 2002	1	1	0.2
Carbon disulfide	75-15-0	2200	Table 2C; EPA 2002	0.5	0.5	0.031
Carbon tetrachloride	56-23-5	0.26	Table 2C; EPA 2002	0.2	0.2	0.038
Chlorobenzene	108-90-7	130	Table 2C; EPA 2002	0.2	0.2	0.049
Chloroethane	75-00-3	38000	Table 2C; EPA 2002	0.2	0.2	0.035
Chloroform	67-66-3	0.22	Table 2C; EPA 2002	0.2	0.2	0.038
Chloromethane	74-87-3	15	Table 2C; EPA 2002	0.5	0.5	0.16
Dibromochloromethane	124-48-1	0.12	Table 2C; EPA 2002	0.2	0.2	0.042

1,2-Dibromoethane	106-93-4	0.014	Table 2C; EPA 2002	0.2	0.2	0.044
1,2-Dichlorobenzene	95-50-1	330	Table 2C; EPA 2002	0.2	0.2	0.07
1,3-Dichlorobenzene	541-73-1	170	Table 2C; EPA 2002	0.2	0.2	0.065
1,4-Dichlorobenzene	106-46-7	1300	Table 2C; EPA 2002	0.2	0.2	0.064
Dichlorodifluoromethane	75-71-8	400	Table 2C; EPA 2002	0.2	0.2	0.068
1,1-Dichloroethane	75-34-3	1200	Table 2C; EPA 2002	0.2	0.2	0.026
1,2-Dichloroethane	107-06-2	0.23	Table 2C; EPA 2002	0.2	0.2	0.047
1,1-Dichloroethene	75-35-4	500	Table 2C; EPA 2002	0.2	0.2	0.032
cis-1,2-Dichloroethene	156-59-2	88	Table 2C; EPA 2002	0.2	0.2	0.06
trans-1,2-Dichloroethene	156-60-5	180	Table 2C; EPA 2002	0.2	0.2	0.05
1,2-Dichloropropane	78-87-5	8.7	Table 2C; EPA 2002	0.2	0.2	0.052
cis-1,3-Dichloropropene	10061-01-5	1.3	Table 2C; EPA 2002	0.2	0.2	0.074
trans-1,3-Dichloropropene	10061-02-6	1.3	Table 2C; EPA 2002	0.2	0.2	0.048
Ethylbenzene	100-41-4	5.1	Table 2C; EPA 2002	0.2	0.2	0.068
Isopropylbenzene	98-82-8	810	Table 2C; EPA 2002	0.4	0.4	0.06
Methylene chloride	75-09-2	15	Table 2C; EPA 2002	0.5	0.5	0.045
4-Methyl-2-pentanone	108-10-1	200	Table 2C; EPA 2002	0.5	0.5	0.045
Methyl tert-butyl ether	1634-04-4	8300	Table 2C; EPA 2002	1	1	0.17
Styrene	100-42-5	2300	Table 2C; EPA 2002	0.2	0.2	0.058

1,1,2,2-Tetrachloroethane	79-34-5	0.48	Table 2C; EPA 2002	0.2	0.2	0.061
Tetrachloroethene	127-18-4	1.2	Table 2C; EPA 2002	0.2	0.2	0.04
Toluene	108-88-3	1100	Table 2C; EPA 2002	0.2	0.2	0.054
1,2,4-Trichlorobenzene	120-82-1	270	Table 2C; EPA 2002	1	1	0.098
1,1,1-Trichloroethane	71-55-6	4000	Table 2C; EPA 2002	0.2	0.2	0.03
1,1,2-Trichloroethane	79-00-5	0.28	Table 2C; EPA 2002	0.2	0.2	0.054
Trichloroethene	79-01-6	0.041	Table 2C; EPA 2002	0.2	0.2	0.036
Trichlorofluoromethane	75-69-4	1200	Table 2C; EPA 2002	0.2	0.2	0.024
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	39000	Table 2C; EPA 2002	0.2	0.2	0.031
Vinyl chloride	75-01-4	1.1	Table 2C; EPA 2002	0.2	0.2	0.071
o-xylene[4]	95-47-6	16000	Table 2C; EPA 2002	0.2	0.2	0.061
m&p-xylene[4]	136777-61-2	16,000	Table 2C; EPA 2002	0.4	0.4	0.12

[1]List the type and source of the PAL used for each matrix specific analyte (e.g. Background, HH-MCL, HH-region III RBC, eco-WQC, eco-Region III BTAG, etc.)

[2]Laboratory-specific MDLs and QLs are limits that an individual laboratory can achieve when performing a specific analytical method. MDLs may be subject to update.

[3] The following EPA CLP OLM04.3 Analytes are not provided in the TO-15 analysis: 1,2-Dibromo-3-chloropropane, Methyl acetate, and Methyl Cyclohexane.

[4] o-xylene and m&p-xylene are reported in place of xylenes(total)

EPA 2002. OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance). November.

SAP Worksheet #16 -- Project Schedule / Timeline Table (optional format)

(UFP-QAPP Manual Section 2.8.2)

All project workplans should include schedule information, but this information does not necessarily have to be presented in the SAP if a separate workplan is prepared. This tabular format is not mandatory. For example, project timelines created in MS Project or Gantt charts are acceptable. If the project schedule is not placed in the SAP, then provide a reference to the document or section where the project schedule can be found. Minimum requirements for project schedule: milestones, period of action, and anticipated completion date. The timeline must include a start and completion date for all project activities, as well as quality assurance assessments that will be performed during the course of the project.

Activities	Organization	Dates (MM/DD/YY)		Deliverable	Deliverable Due Date
		Anticipated Date(s) of Initiation	Anticipated Date of Completion		

SAP Worksheet #17 -- Sampling Design and Rationale

(UFP-QAPP Manual Section 3.1.1)

Provided in Section 4 of the Work Plan Section 4 and Worksheet 15

SAP Worksheet #18 -- Sampling Locations and Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Provided in Section 4 of the Work Plan and Section 2 of the Field Sampling Plan

SAP Worksheet #19 -- Analytical SOP Requirements Table
(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	Analytical and Preparation Method / SOP Reference[1]	Containers (number, size, and type)	Sample volume (units)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time[2] (preparation / analysis)
Air	Volatile Organics	KNOX-MS-0001, Rev 9	6 liter summa canister	600 ml[3]	None	30 days
Water	Volatile Organics	KNOX-MS-0015, Rev 10	40ml glass VOA vials	3x40mls[4]	<4 deg C; adjust pH <2; 0.008% $Na_2S_2O_3$[5]	7 days

[1] Refer to the Analytical SOP References table (Worksheet #23).

[2] Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted.

[3] The minimum sample size is based on a 200ml analysis allowing for sufficient sample for reanalysis. The use of calibrated flow controllers are designed to provide sufficient sample for analysis in the specified timed sampling event (e.g. 24 hour sample)

[4] Additional volume is needed for the laboratory Matrix Spike/Matrix Spike Duplicate sample analysis.

[5] Free Chlorine must be removed by the appropriate addition of $Na_2S_2O_3$. This preservation is not necessary if free chlorine is not present in the groundwater.

SAP Worksheet #20 -- Field Quality Control Sample Summary Table

(UFP-QAPP Manual Section 3.1.1)

Summarize by matrix and analytical group the number of field QC samples (initially identified on WS#12) that will be collected and sent to the laboratory. Refer to minimum requirements in the UFP-QAPP compendium or justify in text format if/when those requirements are not needed.

Matrix	Analytical Group	No. of Sampling Locations[2]	No. of Field Duplicates	No. of MS/MSDs[1]	No. of Field Blanks	No. of Equip. Blanks	No. of VOA Trip Blanks	No. of PT Samples[3]	Total No. of Samples to Lab
Groundwater	VOCs	x	x	x	x	x	x	0	
Air	VOCs	x	x	0	0	0	0	0	

[1] Although the MS/MSD is not typically considered a field QC it is included here because location determination is often established in the field.

[2] If samples will be collected at different depths at the same location, count each discrete sampling depth as a separate sampling location or station.

[3] The number of Batch or Project-specific proficiency testing (PT) samples are optional but highly recommended.

SAP Worksheet #21 -- Project Sampling SOP References Table

(UFP-QAPP Manual Section 3.1.2)

Provided in the table of contents of the Field Sampling Plan

SAP Worksheet #22 -- Field Equipment Calibration, Maintenance, Testing, and Inspection Table

(UFP-QAPP Manual Section 3.1.2.4)

Provided in Section 2.8.8 of the Field Sampling Plan Section

SAP Worksheet #23 -- Analytical SOP References Table
(UFP-QAPP Manual Section 3.2.1)

Lab SOP Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?[1] (Y/N)
KNOX-MS-0001, Rev 9	VOA Canister Analysis, KNOX-MS-0001, Revision 9	Definitive	Air, Volatile Organics	GCMS	TestAmerica Knoxville	N
KNOX-MS-0015, Rev 10	Determination of Volatile Organics by GCMS based on Method 8260B, KNOX-MS-0015, Revision 10	Definitive	Water, Volatile Organics	GCMS	TestAmerica Knoxville	N

[1] If yes, then specify the modification that has been made. Note that any analytical SOP modification made relative to project specific needs must be reviewed and approved by the Navy QAO.

SAP Worksheet #24 -- Analytical Instrument Calibration Table

(UFP-QAPP Manual Section 3.2.2)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[a]
GC/MS (SW-846 8260)	Mass scale calibration using BFB (tuning)	Verify tune every 12 hours	Ion abundance within method specified ranges as listed in SOP	Inspect system; correct problem; rerun BFB.	Analyst	KNOX-MS-0015, Revision 10
GC/MS (SW-846 8260)	Initial Calibration (ICAL) (minimum 5 point calibration)	Prior to sample analysis, after major instrument changes and when continuing calibration criteria are not met.	%RSD $\leq$30% for CCCs; SPCCs minimum avg. RF; ICAL %RSD <15%, or linear / quadratic curve $r^2 \geq 0.990$.	Inspect system; correct problem; repeat ICAL.	Analyst	KNOX-MS-0015, Revision 10
GC/MS (SW-846 8260)	Initial Calibration Verification (ICV)	After Initial Calibration; prior to sample analysis	+/-30%D from ICAL.	Inspect system; correct problem; reanalyze ICV or repeat ICAL.	Analyst	KNOX-MS-0015, Revision 10
GC/MS (SW-846 8260)	Continuing Calibration Verification (CCV)	At the beginning of each 12 hour shift.	CCV %D <20% for CCCs; SPCCs minimum avg. RF.	Inspect system; correct problem; repeat CCV. If still unacceptable, repeat ICAL.	Analyst	KNOX-MS-0015, Revision 10
GC/MS (Method TO-15)	Mass scale calibration verification using BFB (tuning)	Verify tune every 24 hours	Ion abundance within method specified ranges as listed in SOP	Inspect system; correct problem; rerun BFB.	Analyst	KNOX-MS-0001, Revision 9
GC/MS (Method TO-15)	Initial Calibration (ICAL) (minimum 5 point calibration)	Prior to sample analysis, after major instrument changes and when continuing calibration criteria are not met.	ICAL %RSD $\leq$30% with $\leq$2 analytes $\leq$40%, or linear / quadratic curve $r^2 \geq 0.990$.	Inspect system; correct problem; repeat ICAL.	Analyst	KNOX-MS-0001, Revision 9
GC/MS (Method TO-15)	Initial Calibration Verification (ICV)	After Initial Calibration; prior to sample analysis	+/-35%D from ICAL.	Inspect system; correct problem; reanalyze ICV or repeat ICAL.	Analyst	KNOX-MS-0001, Revision 9
GC/MS	Continuing Calibration	At the beginning of each 24	CCV %D $\leq$30% with $\leq$4	Inspect system; correct problem; repeat CCV. If	Analyst	KNOX-MS-0001,

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[a]
(Method TO-15)	Verification (CCV)	hour shift.	analytes ≤40%.	still unacceptable, repeat ICAL.		Revision 9

[1] Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).

[2] Name or title of responsible person may be used.

SAP Worksheet #25 -- Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table
(UFP-QAPP Manual Section 3.2.3)

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person[2]	SOP Reference[1]
GCMS (TO-15)	Clean source, change traps, replace filaments; maintain vacuum pumps	Refer to Worksheet #24	Refer to Worksheet #24	Service vacuum pumps twice per year; other maintenance as needed	Refer to Worksheet #24	Refer to Worksheet #24	Analyst	KNOX-MS-0001, Rev 9
GCMS (8260B)	Clean source, change traps, replace filaments; maintain vacuum pumps	Refer to Worksheet #24	Refer to Worksheet #24	Service vacuum pumps twice per year; other maintenance as needed	Refer to Worksheet #24	Refer to Worksheet #24	Analyst	KNOX-MS-0015, Rev 10

[1] Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).

[2] Name or title of responsible person may be used.

SAP Worksheet #26 -- Sample Handling System
(UFP-QAPP Manual Appendix A)

Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): FTL/ JV II (TBD)
Sample Packaging (Personnel/Organization): FTL/ JV II (TBD)
Coordination of Shipment (Personnel/Organization): FTL/ JV II (TBD)
Type of Shipment/Carrier: FedEx/Overnight shipment or sample courier to Analytical Laboratory (TBD)
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Analytical Laboratory (TBD)
Sample Custody and Storage (Personnel/Organization): Analytical Laboratory (TBD)
Sample Preparation (Personnel/Organization): Analytical Laboratory (TBD)
Sample Determinative Analysis (Personnel/Organization): Analytical Laboratory (TBD)
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 90 days from receipt
Sample Extract/Digestate Storage (No. of days from extraction/digestion): TBD
Biological Sample Storage (No. of days from sample collection): N/A
SAMPLE DISPOSAL
Personnel/Organization: Analytical Laboratory (TBD)
Number of Days from Analysis: 90 days from receipt

SAP Worksheet #27 – Sample Custody Requirements Table

(UFP-QAPP Manual Section 3.3.3)

Provided in Section 3 of the Field Sampling Plan

SAP Worksheet #28 -- Laboratory QC Samples Table
(UFP-QAPP Manual Section 3.4)

Matrix	Water
Analytical Group	Volatile Organics
Analytical Method / SOP Reference	EPA 8260B/KNOX-MS-0015 Rev 10

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1/Batch (20 samples)	No Target Compounds>RL; no common lab contaminants >5xRL.	If sufficient sample is available, reanalyze samples. Qualify data as needed. Report results if sample results >20x blank result or sample results ND.	Analyst / Section Supervisor	Accuracy/Bias-Contamination	No Target Compounds>RL; no common lab contaminants >5xRL.
Instrument Blank	Once per 12 hours if method blank is not run	No Target Compounds>RL; no common lab contaminants >5xRL.	If sufficient sample is available, reanalyze samples. Qualify data as needed. Report results if sample results >20x blank result or sample results ND.	Analyst / Section Supervisor	Accuracy/Bias-Contamination	No Target Compounds>RL; no common lab contaminants >5xRL.
Laboratory Control Sample	1/Batch (20 samples)	Refer to Attachment 1 for LCS control limits.	If sufficient sample is available, reanalyze samples. Qualify data as needed.	Analyst / Section Supervisor	Accuracy/Bias	Laboratory % Recovery Control Limits
Matrix Spike/Matrix Spike Duplicate	1/Batch (20 samples)	Refer to Attachment 1 for MS control limits.	Determine root cause; flag MS/MSD data; discuss in narrative.	Analyst / Section Supervisor	Accuracy/Bias/ Precision	Laboratory % Recovery / RPD Control Limits
Surrogates	Every sample	Refer to Attachment 1 for surrogate control limits.	Check calculations and instrument performance; recalculate, reanalyze.	Analyst / Section Supervisor	Accuracy/Bias	Laboratory % Recovery Control Limits

Attachment 1 TestAmerica Knoxville 8260B QC limits 06/06/08

		LCS Control Limits			MS/MSD Limits		
8260B Volatiles/ Water Matrix	**CAS Number**	**LCL**	**UCL**	**RPD**	**LCL**	**UCL**	**RPD**
Acetone	67-64-1	49	141	50	43	141	50
Benzene	71-43-2	**80**	**121**	**20**	**73**	**125**	**20**
Bromodichloromethane	75-27-4	73	127	22	57	129	22
Bromoform	75-25-2	63	141	27	49	141	27
Bromomethane	74-83-9	44	157	29	30	168	29
2-Butanone	78-93-3	61	139	37	50	143	37
Carbon disulfide	75-15-0	71	126	20	60	132	20
Carbon tetrachloride	56-23-5	66	133	29	53	133	29
Chlorobenzene	108-90-7	**80**	**121**	**20**	**71**	**125**	**20**
Chloroethane	75-00-3	61	151	20	61	151	20
Chloroform	67-66-3	76	120	20	66	122	20
Chloromethane	74-87-3	56	140	20	46	140	20
Cyclohexane	110-82-7	70	130	30	70	130	30
Dibromochloromethane	124-48-1	71	132	30	71	132	30
1,2-Dibromo-3-chloropropane	96-12-8	51	143	38	41	143	38
1,2-Dibromoethane	106-93-4	78	120	20	65	123	20
1,2-Dichlorobenzene	95-50-1	76	120	20	66	123	20
1,3-Dichlorobenzene	541-73-1	77	120	20	67	123	20
1,4-Dichlorobenzene	106-46-7	75	120	20	65	126	20
Dichlorodifluoromethane	75-71-8	48	147	25	32	151	25
1,1-Dichloroethane	75-34-3	70	127	20	68	127	20
1,2-Dichloroethane	107-06-2	71	125	20	62	126	20
1,1-Dichloroethene	75-35-4	**70**	**128**	**26**	**62**	**128**	**26**
cis-1,2-Dichloroethene	156-59-2	76	123	20	56	134	20
trans-1,2-Dichloroethene	156-60-5	75	124	20	70	124	20
1,2-Dichloropropane	78-87-5	77	122	20	72	122	20
cis-1,3-Dichloropropene	10061-01-5	69	128	24	50	130	24
trans-1,3-Dichloropropene	10061-02-6	61	132	27	42	132	27
Ethylbenzene	100-41-4	79	124	20	70	130	20
2-Hexanone	591-78-6	63	132	50	57	132	50
Isopropylbenzene	98-82-8	77	126	20	69	130	20
Methyl acetate	79-20-9	70	130	30	70	130	30
Methylene chloride	75-09-2	59	131	20	53	131	20
Methylcyclohexane	108-87-2	70	130	30	70	130	30
4-Methyl-2-pentanone	108-10-1	64	133	23	61	133	23
Methyl tert-butyl ether	1634-04-4	65	125	30	65	130	30
Styrene	100-42-5	76	127	20	69	129	20
1,1,2,2-Tetrachloroethane	79-34-5	69	128	20	65	128	20
Tetrachloroethene	127-18-4	79	126	20	66	136	20
Toluene	108-88-3	**77**	**124**	**20**	**69**	**129**	**20**
1,2,4-Trichlorobenzene	120-82-1	64	126	28	59	129	28
1,1,1-Trichloroethane	71-55-6	71	125	24	55	129	24
1,1,2-Trichloroethane	79-00-5	74	120	20	65	124	20
Trichloroethene	79-01-6	**80**	**121**	**20**	**56**	**137**	**20**
Trichlorofluoromethane	75-69-4	67	143	20	61	144	20
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	50	120	30	50	120	30
Vinyl chloride	75-01-4	72	137	21	65	139	21

o-xylene	95-47-6	76	126	20	69	129	20
m&p-xylene	136777-61-2	71	134	20	65	137	20
Bromofluorobenzene		69	126		69	126	
1,2-Dichloroethane-d4		71	127		71	127	
Toluene-d8		80	120		80	120	
Dibromofluoromethane		79	120		79	120	

Note: Xylenes(Total) has been replaced by o-xylene and m&p-xylene
Bolded analytes are used to assess batch control

SAP Worksheet #28 -- Laboratory QC Samples Table
(UFP-QAPP Manual Section 3.4)

Matrix	Water
Analytical Group	Volatile Organics
Analytical Method / SOP Reference	TO-15 / KNOX-MS-0015 Rev 10

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1 per 20 samples or 24 hr tune, whichever is more frequent	No Target Compounds>RL	If sufficient sample is available, reanalyze samples. Qualify data as needed. Report results if sample results >20x blank result or sample results ND.	Analyst / Section Supervisor	Accuracy/Bias-Contamination	No Target Compounds>RL
Laboratory Control Sample	1 per 20 samples or 24 hr tune, whichever is more frequent	Non-polar analytes: 70-130%R with ≤2 within 60-140%. Polar analytes: 60-140%R with ≤2 within 45-155%.	If sufficient sample is available, reanalyze samples. Qualify data as needed.	Analyst / Section Supervisor	Accuracy/Bias	Laboratory % Recovery Control Limits
Laboratory Duplicate	1/Batch (20 samples)	RPD ≤25 for analytes >5x RL	Determine root cause; reanalyze DUP; flag data; discuss in narrative.	Analyst / Section Supervisor	Precision	Laboratory % Recovery / RPD Control Limits
Surrogates	Every sample	70-130%R	Check calculations and instrument performance; recalculate, reanalyze.	Analyst / Section Supervisor	Accuracy/Bias	Laboratory % Recovery Control Limits

SAP Worksheet #29 -- Project Documents and Records Table

(UFP-QAPP Manual Section 3.5.1)

Document	**Where Maintained**
Field Logbook	Project Files
Sample Disposal Records	Maintained by the laboratory.
Extraction/Clean-up Records	Maintained by the laboratory.
Raw Data	Hardcopy in the full data package. Archived at project closeout.
Field Sampling Audit Checklists	Hardcopy in the project file. Archived at project closeout.
Fixed Laboratory Audit Checklists	If completed, hardcopy in the project file. Archived at project closeout.
Data Validation Reports	Electronic .pdf copies in the project file. Hardcopy stored with the data package. Archived at project closeout.
Partnering Presentations	Project Files; Meeting Minutes

SAP Worksheet #30 -- Analytical Services Table
(UFP-QAPP Manual Section 3.5.2.3)

Matrix	Analytical Group	Sample Locations/ID Number	Analytical Method	Data Package Turnaround Time	Laboratory / Organization (name and address, contact person and telephone number)	Backup Laboratory / Organization (name and address, contact person and telephone number)
Air	Volatile Organics	Camp LeJeune Sampling Area	TO-15	28 days	TestAmerica Knoxville 5815 Middlebrook Pike, Knoxville, TN 37921 Contact: John Reynolds Phone: (865) 291 3000	NA
Water	Volatile Organics	Camp LeJeune Sampling Area	8260B	28 days	TestAmerica Knoxville 5815 Middlebrook Pike, Knoxville, TN 37921 Contact: John Reynolds Phone: (865) 291 3000	NA

SAP Worksheet #31 -- Planned Project Assessments Table

(UFP-QAPP Manual Section 4.1.1)

Assessment Type	**Frequency**	**Internal or External**	**Organization Performing Assessment**	**Person(s) Responsible for Performing Assessment** (title and organizational affiliation)	**Person(s) Responsible for Responding to Assessment Findings** (title and organizational affiliation)	**Person(s) Responsible for Identifying and Implementing Corrective Actions (CA)** (title and organizational affiliation)	**Person(s) Responsible for Monitoring Effectiveness of CA** (title and organizational affiliation)
Field Performance Audit	One during sampling activities	Internal	JV II	Keri Hallberg PM JV II (CH2M HILL)	FTL JV II	Keri Hallberg PM JV II (CH2M HILL)	Keri Hallberg PM JV II (CH2M HILL)
Safe Work Observation	One during sampling activities	Internal	JV II	Site Safety Coordinator JV II	Field Team Member observed JV II	Michael Goldman H&S Manager JV II (CH2M HILL)	Site Safety Coordinator JV II

SAP Worksheet #32 -- Assessment Findings and Corrective Action Responses

(UFP-QAPP Manual Section 4.1.2)

Assessment Type	**Nature of Deficiencies Documentation**	**Individual(s) Notified of Findings** (name, title, organization)	**Timeframe of Notification**	**Nature of Corrective Action Response Documentation**	**Individual(s) Receiving Corrective Action Response** (name, title, organization)	**Timeframe for Response**
Field Performance Audit	Checklist and Written Audit Report	FTL JV II	Within one day of audit	Verbal and Memorandum	FTL JV II	Within one day of receipt of Correction Action Form
Safe Work Observation (SWO)	Safe Work Observation Form	Michael Goldman H&S Manager JV II (CH2M HILL)	Within one week of SWO.	Memorandum	Field Team Member JV II	Immediately

Worksheet #32-1—Corrective Action Form

Person initiating corrective action _____ Date _____

Description of problem and when identified: _____

_____

_____

_____

Cause of problem, if known or suspected: _____

_____

_____

Sequence of Corrective Action (CA): (including date implemented, action planned and personnel/data affected) _____

_____

_____

_____

_____

_____

_____

CA implemented by: _____ Date: _____

CA initially approved by: _____ Date: _____

Follow-up date: _____

Final CA approved by: _____ Date: _____

Information copies to:

_____

_____

_____

_____

SAP Worksheet #32-2—Field Performance Audit Checklist

Project Responsibilities

Project No.: _____ Date: _____

Project Location: _____ Signature: _____

Team Members:

Yes __ No __ 1) Is the approved work plan being followed?
Comments _____

_____

Yes __ No __ 2) Was a briefing held for project participants?
Comments _____

_____

Yes __ No __ 3) Were additional instructions given to project participants?
Comments _____

_____

Sample Collection

Yes __ No __ 1) Is there a written list of sampling locations and descriptions?
Comments _____

_____

Yes __ No __ 2) Are samples collected as stated in the Master SOPs?
Comments _____

_____

Yes __ No __ 3) Are samples collected in the type of containers specified in the work plan?
Comments _____

_____

Yes __ No __ 4) Are samples preserved as specified in the work plan?
Comments _____

_____

Yes __ No __ 5) Are the number, frequency, and type of samples collected as specified in the work plan?
Comments _____

_____

SAP Worksheet #32-2—Field Performance Audit Checklist (continued)

Yes __ No __ 6) Are quality assurance checks performed as specified in the work plan?
Comments _____

_____

Yes __ No __ 7) Are photographs taken and documented?
Comments _____

_____

Document Control

Yes __ No __ 1) Have any accountable documents been lost?
Comments _____

_____

Yes __ No __ 2) Have any accountable documents been voided?
Comments _____

_____

Yes __ No __ 3) Have any accountable documents been disposed of?
Comments _____

Yes __ No __ 4) Are the samples identified with sample tags?
Comments _____

_____

Yes __ No __ 5) Are blank and duplicate samples properly identified?
Comments _____

_____

Yes __ No __ 6) Are samples listed on a chain-of-custody record?
Comments _____

_____

Yes __ No __ 7) Is chain-of-custody documented and maintained?
Comments _____

_____

SAP Worksheet #33 -- QA Management Reports Table

(UFP QAPP Manual Section 4.2)

Type of Report	**Frequency** (daily, weekly monthly, quarterly, annually, etc.)	**Projected Delivery Date(s)**	**Person(s) Responsible for Report Preparation** (title and organizational affiliation)	**Report Recipient(s)** (title and organizational affiliation)
Field Audit Report	One during sampling activities	Submitted with Final Report	Keri Hallberg PM JV II (CH2M HILL)	Included in project files.

SAP Worksheet #34 -- Verification (Step I) Process Table

(UFP-QAPP Manual Section 5.2.1)

Verification Input	Description	Internal / External	Responsible for Verification
Planning Documents	Evidence of approval and completeness of UFP-SAP.	Internal	Chris Bozzini – JV II
CoC and shipping forms	CoC forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the CoC will be initialed by the reviewer, a copy of the CoC retained in the site file, and the original and remaining copies taped inside the cooler for shipment. See CoC SOP (on CD) for further details.	Internal	FTL – JV II TBD Felicia Arroyo – JV II
Audit Reports	Upon report completion, a copy of all audit reports will be placed in the site file. If corrective actions are required, a copy of the documented corrective action taken will be attached to the appropriate audit report in the QA site file. Periodically, and at the completion of site work, site file audit reports and corrective action forms will be reviewed internally to ensure that all appropriate corrective actions have been taken and that corrective action reports are attached. If corrective actions have not been taken, the site manager will be notified to ensure action is taken.	Internal	Anita Dodson – JV II
Field Log Notebooks	Field notes will be reviewed to ensure completeness of field data parameters, shipping information, sample collection times, etc. The logbook will also be used to document, explain, and justify all deviations from the approved work plan and UFP-SAP.	Internal	Keri Hallberg – PM JV II (CH2M HILL)
Laboratory Receipt	Upon their arrival at the laboratory, the samples will be cross-referenced against the COC records. All sample labels will be checked against the COC, and any mislabeling will be identified, investigated, and corrected. The samples will be logged in at every storage area and work station required by the designated analyses. Individual analysts will verify the completeness and accuracy of the data recorded on the forms.	Internal	Analytical Laboratory - TBD
Laboratory Data Package	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal. All received data packages will be verified externally by the third party validator. Also, the data will be verified for completeness by an EIS. A chemist will perform a data quality evaluation.	External	Felicia Arroyo – JV II Anita Dodson – JV II

SAP Worksheet #35—Validation (Steps IIa and IIb) Process Table

(UFP-QAPP Manual Section 5.2.2)

(Figure 37 UFP-QAPP Manual) (Table 9 UFP-QAPP Manual)

Step IIa / IIb[1]	Validation Input	Description	Responsible for Validation
IIb	Onsite Screening	Ensure that all field data meet Work Plan requirements for completeness and accuracy based on the field calibration records.	FTL – JV II
IIa	SOPs	Ensure that all sampling and analytical SOPs were followed.	Analytical Laboratory - TBD
IIa	Method QC Results	Ensure that all required QC samples were run and met method and/or project required limits.	Data Validation Services - TBD
IIb	Work Plan QC Sample Results	Ensure that all required Work Plan QC samples were run and met required limits.	Anita Dodson – JV II Data Validation Services - TBD
IIb	QLs	Ensure all sample results met the project quantification limit specified in the Work Plan.	Anita Dodson – JV II
IIa	Raw Data	Ten percent review of raw data to confirm laboratory calculations	Data Validation Services - TBD

[1] IIa=compliance with methods, procedures, and contracts.
IIb=comparison with measurement performance criteria in the SAP.

SAP Worksheet #36 –Analytical Data Validation (Steps IIa and IIb) Summary Table

(UFP-QAPP Manual Section 5.2.2.1)

Step IIa / IIb	Matrix	Analytical Group	Validation Criteria	Data Validator
IIa	Groundwater and air samples	Volatiles	Analytical Methods will be used to evaluate compliance to QA/QC criteria. The National Functional Guidelines will be used as an example of flagging conventions. If necessary, the laboratory SOPs may be used as well.	Data Validation Services - TBD

SAP Worksheet #37—Usability Assessment

(UFP-QAPP Manual Section 5.2.3)

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

- Non-detected site contaminants will be evaluated to ensure that project required quantitation limits in Worksheet #15 were achieved. If project quantitation limits were achieved and the verification and validation steps yielded acceptable data, then the data is considered usable.
- During verification and validation steps, data may be qualified as estimated with the following qualifiers: J or UJ. These qualifiers represent minor QC deficiencies which will not affect the usability of the data. When major QC deficiencies are encountered, data will be qualified with an R and in most cases is not considered usable for project decisions.
- For statistical comparisons non-detect values will be represented by a concentration equal to one-half the sample reporting limit. For duplicate sample results, the most conservative value will be used for project decisions.
- Analytical data will be checked to ensure the values and any qualifiers are appropriately transferred to the electronic database. These checks include comparison of hardcopy data and qualifiers to the electronic data deliverable. Once the data has been uploaded into the electronic database, another check will be performed to ensure all results were loaded accurately.
- Field and laboratory precision will be compared as relative percent difference (RPD) between the two results.

Describe the evaluative procedures used to assess overall measurement error associated with the project.

- To assess whether a sufficient quantity of acceptable data are available for decision making, the data will be reconciled with measurement performance criteria following validation and review of data quality indicator.
- If significant deviations are noted between lab and field precision the cause will be further evaluated to assess impact on decision making.

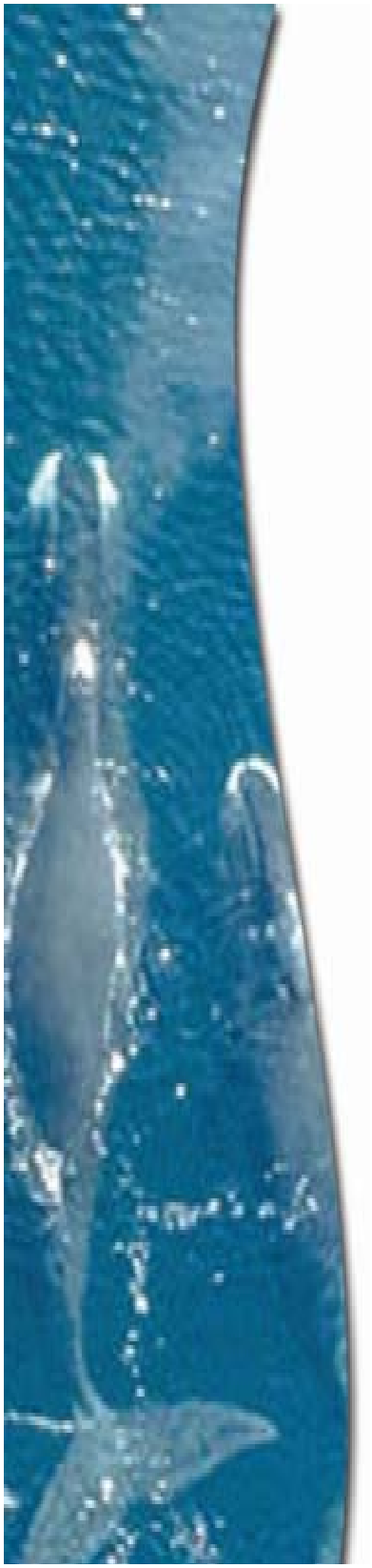
Describe the documentation that will be generated during the usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

- Data tables will be produced to reflect detected and non-detected site COCs. Data qualifiers will be reflected in the tables and discussed in the data quality evaluation.

Identify the personnel responsible for performing the usability assessment.

- The JV II Project Managers and Project Chemist with contributions from other team members as necessary.

Appendix C
Health and Safety Plan



Health and Safety Plan
Vapor Intrusion Evaluation

MCB Camp Lejeune
North Carolina
N62467-03-D-026.

Contract No N62470-03-D-026
Contract Task Order 021

Prepared for:

Department of the Navy
Naval Facilities Engineering Command
Atlantic Division

AGVIQ — CH2M HILL
Joint Venture

April 2008

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Acronyms and Abbreviations

AHA	Activity Hazard Analysis
BBLPS	Behavior Based Loss Prevention System
COCs	Constituents of Concern
CPR	Cardiopulmonary Resuscitation
DNAPL	Dense Non-Aqueous Phase Liquid
DPT	Direct Push Technology
ERA	Ecological Risk Assessment
ESC	Erosion and Sediment Controls
FA	First Aid
FS	Feasibility Study
ft	feet
GFCI	ground fault circuit interrupter
H&S	Health and Safety
HSO	Health & Safety Officer
HAZWOPER	Hazard Waste Operations
HHRA	Human Health Risk Assessment
HR	heart rate
HSM	Health and Safety Manager
HSP	Health and Safety Plan
IAS	Initial Assessment Study
IDW	Investigation Derived Waste
IRA	Interim Removal Action
IRF	Incident Report Form
JV II	AGVIQ-CH2M HILL Joint Venture III
LPO	Loss Prevention Observation
MCB	Marine Corps Base
MEC	Munitions of Explosive Concern
MSDS	Material Safety Data Sheet
NAVFAC	Naval Facilities Engineering Command
NLI	Near Loss Investigation
NTR	Navy Technical Representative
OEL	Occupational Exposure Limits
PCE	Tetrachloroethylene
POC	Point of Contact
PPE	Personal Protective Equipment
PTSP	Pre-Task Safety Plan
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RMSF	Rocky Mountain Spotted Fever
ROICC	Resident Officer in Charge of Construction
SHSO	Site Health and Safety Officer
SOP	Standard of Practice
SWO	Stop Work Order
UXO	Unexploded Ordnance
VOCs	Volatile Organic Compounds

1.0 Introduction

AGVIQ-CH2M HILL Joint Venture III (JV II) has been contracted by the United States Navy, Naval Facilities Engineering Command (NAVFAC), Mid-Atlantic Division, to perform a Non-Time Critical Removal Action (NTCRA) at the Marine Corps Base (MCB) Camp Lejeune. This work will be performed under the terms and conditions Contract Number N62470-03-D-026, Task Order 021.

All site personnel, including JV II and subcontractors, must review or be provided a detailed briefing on the contents of this Health and Safety Plan (HSP) and sign the Employee Signoff Form (**Attachment 1**). In addition, the Site Health and Safety Officer (SHSO) will provide a safety briefing for all visitors to the site.

1.1 Base Background

MCB Camp Lejeune is located in Onslow County, North Carolina. The Base covers approximately 236 square miles and is bisected by the New River, which flows in a southeasterly direction and forms a large estuary before entering the Atlantic Ocean. The southeastern border of the Base is the Atlantic Ocean shoreline. The western and northeastern boundaries are U.S. Route 17 and State Route 24, respectively. The City of Jacksonville, North Carolina borders the Base to the north.

The Base organization functions as the host command to the two Fleet Marine Force Atlantic (FMFLANT) tenant activities: Headquarters of the II Marine Expeditionary Division and the 2nd Force Service Support Group. The Base host organization's mission is to provide housing, training facilities, logistical support and administrative support for units assigned to MCB Camp Lejeune. The mission of the 6th Marine Expeditionary Brigade is to provide the Command element for a brigade-size Marine Air Ground Task Force (MAGTF). The 2nd Marine Division's mission is to execute amphibious assault operations, and other operations as may be directed, which are supported by Marine aviation and force service support units. With the aircraft wing, the Marine division provides combined arms for service with the Fleet in the seizure or defense of advanced naval bases and for the conduct of land operations essential to the prosecution of a naval campaign.

Construction of MCB Camp Lejeune began in April 1941 at the Hadnot Point Industrial Area (HPIA), where major functions of the Base are centered today. The facility was designed to be the "World's Most Complete Amphibious Training Base." The MCB Camp Lejeune complex consists of six geographical and operational locations under the jurisdiction of the Base Command. These areas include Camp Geiger, Montford Point (which includes Camp Johnson), Courthouse Bay, Mainside, the Rifle Range Area, and the Greater Sandy Run Area. Marine Corps Air Station (MCAS) New River is operationally under the control of MCAS Cherry Point. However, MCB Camp Lejeune is responsible for the facilities and the environmental management of MCAS New River.

1.2 Vapor Intrusion Evaluation Approach

The primary objective of the vapor intrusion evaluation project is to provide the Base with information on the potential for vapor intrusion issues within buildings located in close proximity to known groundwater volatile organic compound (VOC) contamination plumes. The vapor intrusion evaluation will be performed in accordance with the October 2007 Draft Navy/Marine Corps Policy on Evaluating the Vapor Intrusion Pathway. The evaluation will identify:

1. Buildings located 100 feet vertically or horizontally of a known groundwater VOC contamination plume and
2. If a complete exposure pathway exists (through a Conceptual Site Model (CSM)) for vapor intrusion of potential subsurface contamination into the buildings, and
3. Whether VOC contamination is present inside the buildings at levels that could affect building occupants.

This scope is to conduct the evaluation across five areas of the Base, as listed below:

- Mainside
- Hadnot Point
- Air Station
- Courthouse Bay
- Camp Geiger

1.2.1 Nature and Extent of Site Contamination

The primary site contaminants include benzene, cis-1-2-dichloroethylene, 1,2 dichloroethane, 1,1,2,2-tetrachloroethane, tertachloroethylene, 1,2,2-trichloroethance (TCA), trichloroethylene (TCE), trans-1,2-dichloroethylene, xylenes, vinyl chloride, vinylidene chloride (1,1-dichloroethylene). The source of the contamination is from various operating and chemical storage procedures throughout the facilities.

1.3 General Task Order Scope of Work

Groundwater sampling, soil sampling, soil vapor sampling, and indoor air sampling will be performed as appropriate at the buildings determined to have the greatest potential of vapor intrusion.

The general objectives of this Phase of the Task Order objectives include:

<u>Site Utility Survey</u>

- Utility clearance survey and obstruction location will be performed. A utility clearance survey will identify any utilities if they are present in the proposed soil sampling areas

<u>Mobilization and Site Preparations</u>

- Mobilize sampling equipment to the site including sample containers, coolers, air monitoring instruments, direct-push sampling rig and hand tools.
- Establishment temporary work areas around each sample location.

Groundwater sampling

- Use a low-flow pump to collect ground water samples from established wells.
- Collect excess water in either buckets or drum.

Soil and Soil Vapor Sampling

- Set-up direct-push sampling rig and collect soil samples and either run field soil vapor tests or use a SUMMA canister.
- Equipment decontamination will be performed with DI water collected into buckets.

Slab-Soil Vapor Sampling

- Drill a 7/8″ or 1″ diameter hole to the depth of ¾″ to create a well for Bees wax. The cuttings will be removed with a vacuum cleaner. Drill a 5/16″ or 3/8″ diameter hole through the slab and 3″ down into the sub-slab. Insert Teflon tubing and probe to the proper depth and add melted (with lighter) wax. Run the helium check. Attach to the SUMMA canister and collect sample.
- The hole will be filled with a concrete mixture.

Indoor Air Samples

- Indoor air samples will be collected with SUMMA canisters.

1.4 Health and Safety Plan Assumption Set

The assumption set for the development of this HSP is that JV II site personnel (and JV II controlled subcontractors who maybe covered by this plan), while executing their assigned tasks, will not be potentially exposed to any reported site Constituents of Concern (COCs) or Chemical Products that may be used in operational processes in excess of established Occupational Exposure Limits (OELs). This assumption is based on the following:

- The proposed engineering control measures developed for the capture and treatment of potential Volatile Organic Compound (VOC) vapor emissions that may be generated during soil mixing operations will effectively reduce or eliminate worker exposure (via inhalation) of identified site COCs to concentrations LESS THAN established OELS.
- Proper use of Air Monitoring equipment as identified in section 5.0 of this HSP and documentation/record keeping of air monitoring data collected during the execution of the task order and adherence to established Action Levels and Action Level responses defined by this HSP.

- Proper use of Personal Protective Equipment (PPE) equipment as identified in section 5.0 of this HSP.
- The outdoor site locations are in an open to the environment and well ventilated.
- Assumes site personnel shall execute proper personal hygiene practices to facilitate a negative exposure to reported site COCs from incidental exposure via dermal or ingestion routes of exposure.
- The above assumptions are accurate such that site worker personnel can execute assigned tasks utilizing up to Modified Level D PPE only, except as other wise identified in section 5.0 of this HSP.

In the event that the above assumption set is not verified, the conditions of this HSP will be re-evaluated and amended as necessary to address applicable hazards which maybe associated with identified project conditions or newly defined project tasks. In the event that recorded air monitoring data indicates that site workers are or may be exposed to site COC concentrations in excess of established OELs, work shall immediately cease until worker exposures are at acceptable levels.

1.5 HAZWOPER-Regulated Tasks

Where certain work tasks include the handling, removal, containment, investigation or other physical site management of hazardous waste/material or other regulated materials, execution of such tasks and the potential employee exposure to chemical hazards associated with these tasks may be regulated under 29CFR1910.120/29CFR1926.65. For this task order, following activities will be considered Hazardous Waste Operations (HAZWOPER)-regulated tasks because of the potential worker exposure to site contaminants:

- Groundwater Sampling
- Soil & Soil Vapor Sampling (direct-push)
- Sub-Slab Vapor Sampling (SUMMA canisters)
- Indoor Air Sampling

1.6 Non-HAZWOPER-Regulated Tasks

Under specific circumstances, the training and medical monitoring requirements of federal or state HAZWOPER regulations are not applicable. It must be demonstrated that the tasks can be performed without the possibility of exposure in order to use non-HAZWOPER-trained personnel. The following tasks are considered to be non-HAZWOPER regulated because they should not cause exposure to site constituents of concern:

- Utility Survey (Soils will NOT be disturbed).
- Mobilization and Site Preparation activities.
- Demobilization (equipment support facilities)

1.7 Hazard Analyses

The Table 1-1 summarizes the hazards associated with the project tasks. Refer to Section 3.0 for controls for the project hazards.

TABLE 1-1 ACTIVITY HAZARD ANALYSES

Potential Hazards	Project Activities						
	Utility Surveys	Mobilization & Site Preparations (non intrusive only)	Soil and Soil Vapor Sampling via Direct Push Technology	Surface Water Sampling, Groundwater Well Sampling & Monitoring	Sub-slab Vapor Sampling	Indoor Air Sampling	Demobilization. Activities
Adverse Weather	X	X	X	X	X	X	X
Biological	X	X	X	X	X	X	X
Buried Utilities	X		X				
Chainsaws/Brushcutters							
Chemical Hazard-Dermal/Inhalation			X	X	X	X	
Compressed Gas Cylinders							
Concrete and Masonry							
Cranes & Rigging							
Demolition							
Electrical Safety (HS-206)		X	X	X	X	X	X
Drilling (HS-204)			X				
Excavations (HS-307)							
Fire/Explosion Hazards				X	X	X	
Fire Prevention (HS-208)		X	X	X	X	X	X
Hand & Power Tools (HS-210)	X	X	X	X	X	X	X
Haul Truck Operations		X					X
Heat Stress/Cold Stress	X	X	X	X	X	X	X
Heavy Equipment (HS-306)		X	X				X
Housekeeping	X	X	X	X	X	X	X
Ladders & Stairs							
Lockout /Tagout							
Manual Lifting (HS-112)	X	X	X	X	X	X	X
Mechanical Guarding Hazards			X				
Material Handling Hazards		X	X				
Noise (HS-108)		X	X				X
Pinch/Struck by		X	X				
Pressure Washing/Equip Decon (HS-506)			X				
Pressurized Lines/Equipment			X				
Slips/Trips/Falls	X	X	X	X	X	X	X
Suspended Loads		X	X				
Vehicle Traffic		X	X	X	X		X
Visible Lighting	X	X	X	X	X	X	X
Welding and cutting							
Working over water							

2.0 Project Organization and Personnel

2.1 Employee Medical Surveillance and Training

The employees listed below are enrolled in a Comprehensive Health and Safety Program and meet state and federal hazardous waste operations requirements for 40-hour initial training, 3-day on-the-job experience, and 8-hour annual refresher training. Employees designated "SSC" have completed a 12-hour site safety coordinator course or equivalent, and have documented requisite field experience. An SSC with a level designation (D, C, B) equal to or greater than the level of protection being used must be present during all tasks performed in exclusion or decontamination zones. Employees designated "FA-CPR" are currently certified by the American Red Cross, or equivalent, in first aid and CPR. At least one FA-CPR designated employee must be present during all tasks performed in exclusion or decontamination zones. The employees listed below are currently active in a medical surveillance program that meets state and federal regulatory requirements for hazardous waste operations. Certain tasks (e.g., confined-space entry) and constituents of concern (e.g., lead) may require additional training and medical monitoring.

Pregnant employees are to be informed of and are to follow the procedures in SOP HSE-120, *Reproduction Protection*, including obtaining a physician's statement of the employee's ability to perform hazardous activities before being assigned fieldwork.

Employee Name	Office	Responsibility	SSC/FA-CPR
Kristi Riggs	AGVIQ	JV II Lead/SHSO/QC	SC-C, SC-HW, FA-CPR
Jennifer Simms	CH2M HILL\ORO	JV II Lead/SHSO/QC	SC-HW, FA-CPR
Rich Rathnow	CH2M HILL\ORO	JV II Health & Safety Manager	SSC-C,SSC-HW, FA-CPR

2.2 Project Safety Responsibilities

The Project Manager has the overall responsibility for this project and will ensure that the requirements of the contract are attained in a manner consistent with this HSP and other contract-specific requirements. The Project Manager will coordinate with the Site Health and Safety Officer (SHSO) to ensure that the work is completed in a manner consistent with the HSP. The SHSO will be the main contact in any on-site emergency situation and will ensure off-site emergency agencies have been contacted prior to the start of work. The Health and Safety Manager (HSM) is responsible for formulating and reviewing the HSP and ensuring that the HSP is complete and accurate. The HSM also provides technical and administrative support for the JV II Health and Safety Program and will be available for consultation when required. Each employee is responsible for personal safety as well as the safety of others in the work area.

2.2.1 Key Safety Personnel

The following individuals share responsibility for health and safety at the site:

JV II Program Manager - AGVIQ	Craig Miller	757-213-8584 757-531-6425 (cell)
JV II Deputy Program Manager – CH2MHILL	Michael Halil	904-733-9119 904-219-6277 (cell)
JV II Project Manager (overall) – AGVIQ	Keri Hallberg	704-329-0073 x304 704-975-9381 (cell)
JV II Health and Safety Manager – CH2M HILL	Richard Rathnow	865-560-2908 865-607-6734 (cell)
JV II Field Team Leader/SSHO/QC - AGVIQ	Kristi Riggs	757-544-7392 (cell)
JV II Field Team Leader/SSHO/QC - CH2M HILL	Jennifer Simms	215-640-9071 267-251-8098 (cell)

The JV II Project Manager is responsible for providing adequate resources (budget and staff) for project-specific implementation of the HS&E management process. The Project Manager has overall management responsibility for the tasks listed below. The Project Manager may explicitly delegate specific tasks to other staff, as described in sections that follow, but retains ultimate responsibility for completion of the following in accordance with this HSP.

- Include standard terms and conditions, and contract-specific HS&E roles and responsibilities in contract and subcontract agreements (including flow-down requirements to lower-tier subcontractors).
- Select safe and competent subcontractors by:
  - Obtaining, reviewing, and accepting or rejecting subcontractor pre-qualification questionnaires.
  - Ensuring that acceptable certificates of insurance, including JV II as named additional insured, are secured as a condition of subcontract award.
  - Including HS&E submittals checklist in subcontract agreements, and ensuring that appropriate site-specific safety procedures, training and medical monitoring records are reviewed and accepted prior to the start of subcontractor's field operations.
- Maintain copies of subcontracts and subcontractor certificates of insurance (including JV II as named additional insured), bond, contractors license, training and medical monitoring records, and site-specific safety procedures in the project file accessible to site personnel.
- Provide oversight of subcontractor HS&E practices per the site-specific safety plan.
- Manage the site and interface with 3rd parties in a manner consistent with our contract and subcontract agreements and the applicable standard of reasonable care.
- Ensure that the overall, job-specific, HS&E goals are fully and continuously implemented.

The Health and Safety Manager responsibilities include the following:

- Review and accept or reject subcontractor pre-qualification questionnaires that fall outside the performance range delegated to the Contracts Administrator (KA).
- Review and accept or reject subcontractor training records and site-specific safety procedures prior to start of subcontractor's field operations.
- Support the SHSO's oversight of subcontractor (and lower-tier subcontractors) HS&E practices and interfaces with on-site third parties per the HSP.

The SHSO is responsible for verifying that the project is conducted in a safe manner including the following specific obligations:

- Verify this HSP remains current and amended when project activities or conditions change.
- Verify JV II site personnel and subcontractor personnel read, or have been briefed on the contents of this HSP, and sign **Attachment 1** "Employee Signoff Form" prior to commencing field activities.
- Verify JV II site personnel and subcontractor personnel have completed any required specialty training (e.g., fall protection, confined space entry) and medical surveillance as identified in Section 3, and maintain the Subcontractor H&S Tracking Form (**Attachment 2**).
- Verify compliance with the requirements of this HSP and applicable subcontractor health and safety plan(s).
- Act as the project "Hazard Communication Coordinator" and perform the responsibilities outlined in this HSP.
- Act as the project "Emergency Coordinator" and perform the responsibilities outlined in this HSP.
- Verify that safety meetings are conducted and documented in the field logbook initially and as needed throughout the course of the project (e.g., as tasks or hazards change).
- Verify that project H&S forms and permits, found in **Attachment 3**, are being used as intended.
- Verify that Project Activity Self-Assessment Checklists, found in the SOPs referenced in this HSP, are being used as intended.
- Implement the Drug-Free Work Place Program.
- Verify that project files available to site personnel include copies of executed subcontracts and subcontractor certificates of insurance (including named additional insured), bond, contractor's license, training and medical monitoring records, and site-specific safety procedures prior to start of subcontractor's field operations.
- Manage the site and interface with third parties in a manner consistent with our contract/ subcontract agreements and the applicable standard of reasonable care.
- Coordinate with the HSM regarding JV II and subcontractor operational performance, and third-party interfaces.
- Ensure that the overall, job-specific, HS&E goals are fully and continuously implemented.

The training required for the SHSO is as follows:

- 12-hour course Site Safety Coordinator (or equivalent).
- Safety Coordinator - Hazardous Waste (or equivalent)
- 40-hour OSHA 1910.120 training course and 8 hour refresher classes (as applicable).
- First Aid and CPR
- Relevant Competent Person Courses (excavation, confined space, scaffold, fall protection, etc.)

The SHSO is responsible for coordinating with the JV II individual responsible for site operations and Project Manager, as necessary. In general, the Project Manager will contact the client. The HSM should be contacted by the SHSO as appropriate.

2.3 JV Subcontractors

Subcontractors that may be covered by this HSP, must be provided a copy, or be briefed on the contents, of this HSP prior to initiating work on this site. However, this plan does not address hazards associated with the tasks and equipment that the subcontractor has expertise in (e.g., electrical, mechanical, drilling). Subcontractors are responsible for the health and safety procedures specific to their work, and are required to submit these procedures to JV II for review before the start of field work. It is critical that Subcontractors work be performed in a manner that is consistent with applicable OSHA standards, EM 385 1-1 or other established health and safety plan(s)/protocols. The JV II SHSO should verify that subcontractor employee training, medical clearance, and fit test records are current and must monitor and enforce compliance with the established plan(s). JV II oversight does not relieve subcontractors of their responsibility for effective implementation and compliance with the established plan(s), protocols or established safety regulations.

JV II should continuously endeavor to observe subcontractors' safety performance. This goal should be reasonable, and include observing for hazards or unsafe practices that are both readily observable and occur in common work areas. JV II is not responsible for exhaustive observation for hazards and unsafe practices. In addition to this level of observation, the SHSO is responsible for confirming JV II subcontractor performance against both the subcontractor's safety plan and applicable self-assessment measures. Project Activity Self-Assessment Checklists contained in referenced Standard of Practice (SOP) are to be used by the SHSO to review subcontractor performance.

Health and safety related communications with JV II subcontractors should be conducted as follows:

- Brief subcontractors on the provisions of this plan, or request them to read the plan and then require them to sign the Employee Signoff Form included in **Attachment 1** of this HSP.
- Request subcontractor(s) to brief the project team on the hazards and precautions related to their work.
- When apparent conditions, actions or practices are observed that are not consistent with this HSP, JV II Health and Safety Program or other Health & Safety protocols, notify the subcontractor safety representative and require corrective action—the subcontractor is responsible for determining and implementing necessary controls and corrective actions.

- When identified conditions or practices/actions that are not consistent with JV II H&S policies and procedures or other applicable Health & Safety protocols are repeated or persist, notify the subcontractor safety representative and stop affected work until adequate corrective measures are implemented. See Stop Work Order (SWO) Form in **Attachment 3** of this HSP.
- When an apparent imminent danger exists, immediately remove all affected JV II employees and subcontractors, notify subcontractor safety representative, and stop affected work until adequate corrective measures are implemented (see SWO form). Notify the Project Manager and HSM as appropriate.
- Document all oral health and safety related communications in project field logbook, daily reports, or other records.

3.0 Project-Specific Hazards

Exposure to certain project specific hazards in the work place may include injury/accidents due to execution of a variety of assigned tasks or as a result of existing site conditions. This section of the HSP is provided to aid in the recognition of potential general and specific project hazards and identify procedures and practices to be implemented on the job site that may reduce or eliminate accidents/injuries and property damage that could be attributed to these hazards. All JV II personnel are required to contact the HSM or designated JV II safety representatives identified in this HSP for any questions or concerns regarding the safe execution of this task order.

The following areas/activities are not specifically covered under this HSP and must not be performed unless this HSP is amended and approved by the JV II HSM and in the case of unexploded ordnance (UXO), the Munitions Response Safety Officer.

- Areas where UXO/ Munitions and Explosives of Concern (MEC) maybe encountered.
- Activities requiring the use of scaffolding

3.1 Adverse Weather

Sudden inclement weather can rapidly encroach upon field personnel. Field crew members performing work outdoors should carry clothing appropriate for bad weather. In severe weather conditions, (i.e., high wind or electrical storms), the field crews should leave the area and find safe shelter until the weather abates and until a decision is made to resume the field activities.

Preparedness and caution are the best defenses against lightning. Many lightning deaths and injuries happen before or after a thunderstorm's peak. The site manager or SHSO shall monitor weather forecasts for predictions of electrical storms in the area. At first sight of lightning, operations shall be stopped and only resumed when conditions permit. The site manager or SHSO shall monitor weather conditions to determine when it is appropriate to resume work. The lightning safety recommendation is 30-30: Seek refuge when thunder sounds within 30 seconds after a lightning flash; and do not resume activity until 30 minutes after the last thunder clap. Some other general precautions include:

- Know where to go and how long it will take to get there. If possible, take refuge in a large building or vehicle. Do not go into a shed in an open area.
- The inclination to see trees as enormous umbrellas is the most frequent and most deadly mistake. Do not go under a large tree that is standing alone. Likewise, avoid poles, antennae and towers.
- Stay away from lakes, streams, pools, or any water.
- Stay away from railroad tracks that can carry lightning charges for long distances.
- If the area is wide open, go to a valley or ravine, but be aware of flash flooding. Do not stand on top of a hill.
- If you are caught in a level open area during an electrical storm and you feel your hair stand on end, drop to your knees, bend forward and put your hands on your knees or crouch. The idea is to make yourself less vulnerable by being as low to the ground as

possible and taking up as little ground space as possible. Lying down is dangerous, since the wet earth can conduct electricity. Do not touch the ground with your hands.

- Do not use telephones during electrical storms, except in the case of emergency.
- Review and be cognizant of the procedural requirements of the project Hurricane Preparedness Plan (HPP) included in **Attachment 12** of this HSP.

3.2 Air Compressor Operations

(Reserved)

3.3 Clearing and Grubbing - General

(Reserved)

3.4 Confined Space Entry

(Reference SOP # HSE&Q 203, Confined Space Entry)

(Reserved)

3.5 Constituents of Concern

Constituents of concern are listed in Table 3-1. Comprehensive RI Report (CH2M HILL, 2007).

TABLE 3-1
Constituents of Concern
(Refer to Project Files for more detailed contaminant information)

Constituents	Location and Maximum Concentration (ppb)	Exposure Limit in ppm (PEL)	IDLH ppm	Symptoms and Effects of Exposure	PIP[d] (eV)
Benzene	GW: 13,000 ug/L SWMU118-TW01-07B	0.1 REL, Ca	500 Ca	Eye, nose, skin, and respiratory irritation; headache; nausea; dermatitis; fatigue; giddiness; staggered gait; bone marrow depression	9.24
Cis-1,2-Dichloroethylene (as 1,2 Dichloroethylene) (DCE)	GW: 230,000 ug/L IR89-GW22-05D	200	1,000	Irritation eyes, respiratory system; central nervous system depression	9.65
1,2-Dichloroethane (Ethylene Dichloride)	GW: 33,000 ug/L IR69-GW22-05D	1 REL, Ca 2 [e]	50 Ca	CNS depression, nausea, vomiting, dermatitis, eye irritation, liver, kidney, and CNS damage; corneal opacity	11.05
1,1,2,2-Tetrachloroethane	GW: 12,000 ug/L IR89-TW20-07C	1 REL, Ca 5 PEL	100 Ca	Nausea, vomiting, abdominal pain, finger tremors, jaundice, hepatitis, liver tenderness, monocytosis, kidney damage, dermatitis	11.10

TABLE 3-1
Constituents of Concern
(Refer to Project Files for more detailed contaminant information)

Constituents	Location and Maximum Concentration (ppb)	Exposure Limit in ppm (PEL)	IDLH ppm	Symptoms and Effects of Exposure	PIP[d] (eV)
Tetrachloroethylene (Tetrachloroethene)	GW: 60,000 ug/L IR89-GW161W-07C	Ca REL 100 [e] 200 [5 min max peak in any 2 hr period] 300 [max peak]	150 Ca	Eye, nose, and throat irritation; nausea; flushed face and neck; vertigo; dizziness; sleepiness; skin redness; headache; liver damage	9.32
1,1,2-Trichloroethane (TCA)	GW: 12,000 ug/L IR89-TW20-05D	10 Ca	100 Ca	Eye and nose irritation, CNS depression, liver damage, dermatitis	11.00
Trichloroethylene (Trichloroethene, TCE)	GW: 320,000 ug/L IR89-GW18-05D	Ca REL 100 PEL 200 [e] 300 [5 min max peak in any 2 hr period]	1,000 Ca	Headache, vertigo, visual disturbance, eye and skin irritation, fatigue, giddiness, tremors, sleepiness, nausea, vomiting, dermatitis, cardiac arrhythmia, paresthesia, liver injury	9.45
Trans-1,2-Dichloroethylene	GW: 3,500 ug/L IR89-GW20-07C	200	1,000 Ca	Irritation eyes, respiratory system; central nervous system depression	9.65
Xylenes	GW: 16,800 ug/L USTHPFF-MW15	100 ppm	900	Irritated eyes, skin, nose, and throat; dizziness; excitement; drowsiness; incoherence; staggering gait; corneal vacuolization; anorexia; nausea; vomiting; abdominal pain; dermatitis	8.56
Vinyl Chloride	GW: 28,000 ug/L IR89-GW28-07B	Ca REL 1 PEL	NL Ca 5[e]	Weakness, abdominal pain, gastrointestinal bleeding, enlarged liver, pallor or cyanosis of extremities	9.99
Vinylidene Chloride (1,1-dichloroethylene)	GW: 1,600 ug/L IR89-GW22-05D	5 [f]	500[g] Ca	Eye, skin, and throat irritation; dizziness; headache; nausea; difficult breathing; liver and kidney dysfunction; pneumonitis	10.0

Footnotes:

[a] Specify sample-designation and media: SB (Soil Boring), A (Air), D (Drums), GW (Groundwater), L (Lagoon), TK (Tank), S (Surface Soil), SL (Sludge), SW (Surface Water), SD (Sediment), SG (Soil Gas)

[b] Appropriate value of PEL, REL, or TLV listed.

[c] IDLH = immediately dangerous to life and health (units are the same as specified "Exposure Limit" units for that contaminant); NL = No limit found in reference materials; CA = Potential occupational carcinogen.

[d] PIP = photoionization potential; NA = Not applicable; UK = Unknown.

e Denotes a ceiling value (15 minutes) unless otherwise identified.

f Denotes a value established by the ACGIH.

g Denotes a value established by the ACGIH and a ceiling value (15 minutes).

ppb Denotes sample concentration is in Parts per Billion unless otherwise noted.

REL = NIOSH Recommended Exposure Limit PEL = Denotes OSHA Permissible Exposure Limit unless otherwise identified.

Ca = Potential Occupational Carcinogen

3.5.1 Potential Routes of Exposure

Dermal: Contact with contaminated media. This route of exposure is minimized through proper use of PPE, as specified in Section 5.

Inhalation: Vapors and contaminated particulates. This route of exposure is minimized through proper respiratory protection and air monitoring, as specified in Sections 5 and 6, respectively.

Other: Inadvertent ingestion of contaminated media. This route should not present a concern if good hygiene practices are followed (e.g., wash hands/face before eating drinking or smoking).

Inadvertent injection of contaminated media. This route should not present a concern unless a puncture of contaminated PPE were to occur which resulted in breaking the employees skin and the resulting wound was impacted by contaminated media.

3.5.2 Respiratory Protection

(Reference SOP # HSE&Q 121, Respiratory Protection)

(Reserved)

3.6 Cranes

(Reference SOP # HSE&Q 303, Cranes)

(Reserved)

3.7 Demolition

(Reference SOP # HSE&Q 305, Demolition)

(Reserved)

3.8 Drilling

During the execution of this task order, Direct Push Technology (DPT), Hollow Stem Auger (HSA) other similar subsurface investigation techniques may be utilized to collect representative soil samples to verify baseline site COC concentrations and verify treatment performance upon the completion of soil mixing operations or for the installation of groundwater monitor wells. When these drilling operations are implemented at the site, at a minimum, the following drilling practices must be implemented.

- Prior to conducting any on-site intrusive activities, it must be verified that subsurface utilities will not be impacted by proposed site operations. See Procedures for Locating Underground Utilities in this HSP.

- PPE and air monitoring requirements shall be executed in accordance with Sections 5.0 and 6.0, respectively, of this HSP in an effort to minimize potential dermal and respiratory exposures to identified site contaminants of concern during all drilling activities. In addition, good personal hygiene practices and procedures must be maintained (see section 7.0 of this HSP).
- Drill rig inspections and maintenance and documentation of such inspections and maintenance shall be performed daily prior to the start of on-site work.
- The drill rig is not to be operated in inclement weather.
- The driller is to verify that the rig is properly leveled and stabilized (extension of stabilizers on firm ground) before raising the mast.
- Personnel should be cleared from the sides and rear of the rig before the mast is raised.
- The driller is not to drive the rig with the mast in the raised position.
- The driller must check for overhead power lines before raising the mast. A minimum distance of 10 ft between mast and overhead lines (<50 kV) is recommended. Increased separation will be required for lines greater than 50 kV. See Electric Safety in this HSP for proper separation requirements and other standard operating procedures associated with working near power transmission lines.
- Personnel should stand clear before equipment startup. Maintain eye contact with operator prior to/while approaching drill rig.
- The driller is to verify that the rig is in neutral when the operator is not at the controls.
- Become familiar with the hazards associated with the drilling method used.
- Do not wear loose-fitting clothing, watches, etc., that may get caught in moving parts.
- Do not smoke or permit other spark-producing equipment around drill rig.
- The drill rig must be equipped with a kill wire or switch and personnel associated with the drilling operation are to be informed of its location.
- For rotary air drill rigs or where other pressurized lines are associated with the drill rig, safety lashings/whip line checks, clips or other suitable restriction means should be in place on hoses/connections to prevent injury in the event connections become dislodged or hoses ruptures.
- Be aware and stand clear of heavy objects that are hoisted overhead by the drill rig.
- The driller is to verify that all machine guards are in place while the rig is in operation.
- The drill rig should be equipped with at least one fire extinguisher.
- If the drill rig comes into contact with electrical wires and becomes electrically energized, do not touch any part of the rig or any person in contact with the rig and stay as far away as possible. Notify emergency personnel immediately.

- Where it may be required to limit access and prevent inadvertent entrance of unauthorized and untrained personnel into the active drilling areas, the erection of warning tape, suitable signage, orange safety fencing or other appurtenances around the active drilling area maybe necessary.

3.9 Electrical Safety

(Reference SOP # HSE&Q 206, Electrical Safety)

Where electrical exposure hazards are possible in the work environment, the following safe work practices must be implemented.

- **Review and implement all applicable components of CH2MHILL SOP # HSE&Q-206, Electrical Safety, except where other requirements may be more stringent.**
- **Review and implement all applicable components of CH2MHILL SOP # HSE&Q-310, Lock Out Tag Out, except where other requirements may be more stringent.**
- Only qualified personnel are permitted to work on unprotected energized electrical systems.
- Do not tamper with electrical wiring and equipment unless qualified to do so. All electrical wiring and equipment must be considered energized until hazardous energy control procedures (i.e. lock-out/tag-out) are implemented.
- Inspect electrical equipment, power tools, and extension cords for damage prior to use. Do not use defective electrical equipment and remove from service.
- All temporary wiring, including extension cords and electrical power tools, must have ground fault circuit interrupters (GFCIs) installed.
- Extension cords must be:
  - Equipped with third-wire grounding.
  - Covered, elevated, or protected from damage when passing through work areas.
  - Protected from pinching if routed through doorways.
  - Not fastened with staples, hung from nails, or suspended with wire.
- Electrical power tools and equipment must be effectively grounded or double-insulated UL approved.
- Operate and maintain electric power tools and equipment according to manufacturers' instructions.
- Maintain safe clearance distances between overhead power lines and operating heavy equipment unless the power lines have been verified as being de-energized and grounded or where insulating barriers have been installed to prevent physical contact. To determine proper clearance from energized overhead electric lines, please consult the reference table below.

Nominal System Voltage	Minimum Rated Clearance

0-50 kV	10 ft
51 - 200 kV	15 ft
201 - 300 kV	20 ft
301 – 500 kV	25 ft
501 – 750 kV	35 ft
751 – 1000 kV	45 ft

- Temporary lights will not be suspended by their electric cord unless designed for suspension. Lights will be protected from accidental contact or breakage.
- Protect all electrical equipment, tools, switches, and outlets from environmental elements.

3.10 Excavation Activities

(Reference SOP # HSE&Q 307, Excavation & Trenching Safety)

(Reserved)

3.11 Fall Protection

(Reference SOP # HSE&Q 308, Fall Protection)

(Reserved)

3.12 Fire Prevention

- Be cognizant of and adhere to any specific MCB Lejeune Fire Prevention Procedures and Requirements.
- Secure a "hot work permit" from the designated MCB Lejeune Fire Department Official, when necessary. This task shall be the responsibility of the JV II individual responsible for site activities or SHSO. JV II individual responsible for site activities or SHSO shall review established MCB Lejeune hot work procedures and appropriate emergency contact requirements with the designated MCB Lejeune Fire Department and review this information with all site JV II and applicable subcontractor personnel.
- Fire extinguishers will be provided so that the travel distance from any work area to the nearest extinguisher is less than 100 feet. When 5 gallons or more of a flammable or combustible liquid is being used, an extinguisher must be within 50 feet. Extinguishers must:
  - Be maintained in a fully charged and operable condition.
  - Be visually inspected each month.
  - Undergo a maintenance check each year.
  - The area in front of extinguishers must be kept clear.

- Post “Exit” signs over exiting doors, and post “Fire Extinguisher” signs over extinguisher locations.
- Combustible materials stored outside should be at least 10 feet from any building.
- Solvent waste and oily rags must be kept in a fire-resistant, covered container until removed from the site.
- Flammable/combustible liquids must be kept in approved containers, and must be stored in an approved storage cabinet.

3.13 Flight Line Safety - General

(Reserved)

3.14 Hand and Power Tools

(Reference SOP # HSE&Q 210, Hand and Power Tools)

- **Review and implement all applicable components of CH2MHILL SOP # HSE&Q 210, Hand and Power Tools except where other requirements may be more stringent.**
- Tools will be inspected prior to use, and damaged tools will be tagged and removed from service.
- Hand tools will be used for their intended use and operated in accordance with manufacturer instructions and design limitations.
- Maintain all hand and power tools in a safe condition.
- Do not set power tools down in muddy or wet areas which may damage the tool and/or or create a potential for electric shock.
- Use PPE (such as gloves, safety glasses, earplugs, and face shields) when exposed to a hazard from a tool.
- Do not carry or lower a power tool by its cord or hose.
- Portable power tools will be plugged into GFCI-protected outlets; and
- Portable power tools will be UL listed and have a three-wire grounded plug or be double insulated.
- Disconnect tools from energy sources when they are not in use, before servicing and cleaning them, and when changing accessories (such as blades, bits, and cutters).
- Safety guards on tools must remain installed while the tool is in use and must be promptly replaced after repair or maintenance has been performed.
- Store tools properly in a place where they will not be damaged or come in contact with hazardous materials.

- If a cordless tool is connected to its recharge unit, both pieces of equipment must conform strictly with electrical standards and manufacturer's specifications.
- Tools used in an explosive environment must be rated for work in that environment (that is, intrinsically safe, spark-proof, etc.).
- When using a knife or blade tool, stroke or cut away from the body with a smooth motion. Be careful not to use excessive force that could damage the tool, the material being cut or unprotected hands.
- Working with manual and pistol-grip hand tools may involve highly repetitive movement, extended elevation, constrained postures, and/or awkward positioning of body members (for example, hand, wrist, arm, shoulder, neck, etc.). Consider alternative tool designs, improved posture, the selection of appropriate materials, changing work organization, and sequencing to prevent muscular, skeletal, repetitive motion, and cumulative trauma stressors.

3.15 Haul Trucks

(Reserved)

3.16 Heavy Equipment

(Reference SOP # HSE&Q 306, Earth Moving Equipment)

(Reserved)

3.17 Lock-Out/Tag-Out

(Reference SOP # HSE&Q 310, Lock Out Tag Out)

There maybe situations that arise where the repair or maintenance of electrical systems or pressurized process lines associated with soil mixing or water treatment systems are required. In order to control job hazards associated with the potential release of stored energy or material contained within these soil mixing or treatment system components, designated process personnel properly control of the potential release of energy that maybe be stored in these system components.

JV II personnel and subcontractors should not perform any work associated with the repair, maintenance or demobilization of soil mixing or water treatment systems until it has been determined by all applicable personnel that the electrical systems, process lines, mixers, pumps etc. are de-energized, isolated, drained (as applicable) and secured following Lock Out /Tag Out (LOTO) procedures. The following safe work practices shall be evaluated and implemented in connection with de-energizing, isolating and securing soil mixing or water treatment system components prior to performing any maintenance, repair or demobilization activities.

- **Review and implement all applicable components of CH2MHILL SOP # HSE&Q 310, Lock Out Tagout, except where other requirements may be more stringent.**

- Only qualified personnel may work on energized equipment or system components that have not been deenergized, isolated or rendered "inert" by LOTO procedures.
- When JV II controls the work, JV II must verify that subcontractors have g a written LOTO program, ensure that training on LOTO procedures has been performed and coordinate the implementation of their program with other affected subcontractors/personnel. This may include compliance with the owner or facility LOTO program.
- When JV II personnel are affected by the unexpected operation of equipment they must complete a lockout/tagout training course. Project training may also be required on site specific lockout procedures.
- Standard LOTO procedures include the following six steps:

1) notify all personnel in the affected area of the lockout/tagout,
2) shut down the equipment using normal operating controls,
3) isolate all energy sources,
4) apply individual lock and tag to each energy isolating device,
5) relieve or restrain all potentially hazardous stored or residual energy, and
6) verify that isolation and de-energization of the equipment has been accomplished. Once verified that the equipment is at the zero energy state, work may begin.

- All safe guards must be put back in place, all affected personnel notified that lockout has been removed and controls positioned in the safe mode prior to lockout removal. Only the individual who applied the lock and tag may remove them.

3.18 Machine Guarding

- Ensure that all machine guards are in place to prevent contact with drive lines, belts, chains, pinch points or any other sources of mechanical injury.
- Unplugging jammed equipment will only be performed when equipment has been shut down, all sources of energy have been isolated/secured and equipment has been locked/tagged and tested.
- Maintenance and repair of equipment that results in the removal of guards or would otherwise put anyone at risk requires lockout of that equipment prior to performing work.

3.19 Manual Lifting

(Reference SOP # HSE&Q 112, Manual Lifting)

- **Review and implement all applicable components of CH2MHILL SOP # HSE&Q 112, Manual Lifting, except where other requirements may be more stringent.**
- JV II personnel should notify supervisors or designated safety representatives of pre-existing medical conditions that may be aggravated or re-injured by lifting activities,

such that the JV II may evaluate safe operational procedures with regard to the required task.

- Proper lifting techniques (use of knees and not back) must be used when lifting any object:
  - Plan storage and staging to minimize lifting or carrying distances.
  - Split heavy loads into smaller loads.
  - Use mechanical lifting aids whenever possible.
  - Have someone assist with the lift— especially for heavy (>50 lbs.) or awkward loads. Note: If JV II personnel are not capable of lifting 50 lbs. seek assistance from a team member to split the load.
  - Make sure the path of travel is clear prior to the lift.

3.20 Noise

(Reference SOP # HSE&Q 108, Hearing Conservation Program)

Unprotected exposure to excessive noise levels may lead to gradual and permanent hearing loss. The greater the intensity of a noise and the longer a person is exposed to the noise, the greater the chance of hearing loss. A hearing loss can be permanent or temporary. After certain noise exposures, a person may experience a temporary threshold shift (hearing loss) that results in the inability to hear certain sounds. The ability to hear will usually return. However, repeated or intense noise exposure can prevent this recovery, resulting in permanent hearing loss.

Each employee is responsible for the following:

- **Review and implement all applicable components of CH2MHILL SOP # HSE&Q 108, Hearing Conservation Program, or implement other Hearing Conservation Programs may be applicable to the employee.**
- Notify the SHSO of high-noise-level areas.
- Wear hearing protection when required.
- Complete noise training and audiometric testing (as required).
- Hearing protection is required in work environments exceeding 85 dB.
- Hearing protection will be worn when operating heavy equipment and when working in close proximity to high-noise sources. At a minimum, hearing protection will be worn when the JV II personnel are engaged in or in close proximity to the following operations:
  - Subsurface investigations
  - Heavy equipment operation
  - All soil mixing operations
  - Land clearing operations
  - Operations involving air compressors and non-electrical transfer pumps

3.21 Pressure Washing Operations

Pressure washing operations may occur prior to final demobilization of re-usable materials and equipment from the site. Where pressure washing operations are required, the following safe work practices must be implemented.

- Only trained, authorized personnel may operate the high-pressure washer.
- Rinse waste from pressure washing operations must be collected and properly disposed of.
- Follow manufacturer's safety and operating instructions.
- Inspect pressure washer before use and confirm dead man switch fully operational
- The wand must always be pointed at the work area.
- The trigger should never be tied down
- Never point the wand at yourself or another worker.
- The wand must be at least 42 inches from the trigger to the tip.
- The operator must maintain good footing.
- Non-operators must remain a safe distance from the operator.
- No unauthorized attachment may be made to the unit.
- Do not modify the wand.
- All leaks or malfunctioning equipment must be repaired immediately or the unit taken out-of-service.
- Rain gear (disposal coated chemical suits for Hazwoper operations), 16-inch-high steel-toed rubber boots, safety glasses, hard hat with face shield, and inner and outer nitrile gloves should be worn, at a minimum.

3.22 Sample Handling

Sample handling, packaging, and preservation will be conducted in support of field activities to further characterize site conditions (ground or surface water, soil or sediment), verify or monitor impacts of the selected treatment technology or characterize waste materials generated during the execution of the task order. Employee safe work practices and procedures to be followed during these activities include:

- Skin contact with water, soil, sediment or debris of undetermined chemical characterization shall be avoided at all times.
- PPE and Air Monitoring requirements shall be executed in accordance with in accordance with Sections 5.0 and 6.0, respectively, of this HSP to minimize potential dermal and respiratory exposures to identified site contaminants of concern while

conducting sample collection or characterization of potentially contaminated media (soil, water, drilling fluids/cuttings, PPE, soil vapor etc.). In addition, good personal hygiene practices and procedures must be maintained (see section 7.0 of this HSP).

- Caution should be exercised when filling bottles containing acid or base preservatives. Both liquid and vapor phases of acid can cause severe burns.
- Following sample collection, sample container lids should be tightened securely to prevent any leaks, and the containers should be rinsed with clean water to ensure that they are free of chemical constituents. Sample activities, sample collection, and equipment decontamination procedures.

3.22.1 IDW Drum Handling or Sampling

During the execution of the contract, various types and quantities of Investigation Derived Waste (IDW) will be generated and may include, but not be limited to, PPE, drilling fluids/cuttings, decontamination fluids or residual materials, ground water development purge fluid/sediment. Personnel are permitted to handle and/or sample drums containing known sources investigation-derived waste (IDW) only as handling or sampling other drums (unknowns) requires a plan revision or amendment approved by the JV II HSM. The following control measures will be taken when managing drums containing IDW:

- Minimize transportation of drums or other containers with IDW.
- **Sample only labeled drums or drums known to contain IDW. Unknown drums or drums that show evidence of excessive buckling/bulging, corrosion, vapors, crystallization, unusual discoloration or other abnormalities may not be sampled without the evaluation of engineering controls, proper PPE air monitoring equipment and the use properly trained personnel familiar with the sampling of unknown drum contents.**
- Use caution when sampling bulging or swollen drums. Relieve pressure slowly and step away from the drum as pressure is being released.
- If drums contain, or potentially contain, flammable materials, use non-sparking (i.e. brass) tools to open the drum.
- Picks, chisels, and firearms may not be used to open drums.
- Reseal bung holes or plugs whenever possible.
- Avoid mixing incompatible drum contents.
- Sample drums without leaning over the drum opening.
- Transfer the content of drums using a method that minimizes contact with material.
- PPE and Air Monitoring requirements shall be executed in accordance with Sections 5.0 and 6.0, respectively, of this HSP in an effort to minimize potential dermal and respiratory exposures to identified site contaminants of concern. In addition, good personal hygiene practices and procedures must be maintained (see section 7.0 of this HSP).
- Spill-containment procedures specified in Section 8 must be appropriate for the material to be handled.

3.23 Stairways and Ladders

(Reference SOP # HSE&Q 214, Stairways and Ladders)

- **Review and implement all applicable components of CH2MHILL SOP # HSE&Q 214, Stairways and Ladders, except where other requirements may be more stringent.**
- Stairway or ladder is generally required when a break in elevation of 19 inches or greater exists.
- Personnel should avoid using both hands to carry objects while on stairways; if unavoidable, use extra precautions.
- Personnel must not use pan and skeleton metal stairs until permanent or temporary treads and landings are provided the full width and depth of each step and landing.
- Ladders must be inspected by a competent person for visible defects prior to each day's use. Defective ladders must be tagged and removed from service.
- Ladders must be used only for the purpose for which they were designed and shall not be loaded beyond their rated capacity.
- Only one person at a time shall climb on or work from an individual ladder.
- User must face the ladder when climbing; keep belt buckle between side rails
- Ladders shall not be moved, shifted, or extended while in use.
- User must use both hands to climb; use rope to raise and lower equipment and materials, as needed.
- Straight and extension ladders must be tied off to prevent displacement
- Ladders that may be displaced by work activities or traffic must be secured or barricaded
- Portable ladders must extend at least 3 feet above landing surface.
- Straight and extension ladders must be positioned at such an angle that the ladder base to the wall is one-fourth of the working length of the ladder.
- Stepladders are to be used in the fully opened and locked position.
- Users are not to stand on the top two steps of a stepladder; nor are users to sit on top or straddle a stepladder.
- Fixed ladders $\geq$ 24 feet in height must be provided with fall protection devices.
- Fall protection shall be considered when working from extension, straight, or fixed ladders greater than six feet from lower levels and both hands are needed to perform the work, or when reaching or working outside of the plane of ladder side rails.

3.24 Unknown or Unanticipated Buried Objects

Where unknown or unanticipated buried objects (i.e. drums, tanks, cylinders, munitions of explosive concern) are encountered during site operations, ongoing activities shall be immediately suspended. JV II or subcontractor personnel encountering unknown or unanticipated buried objects shall 1) secure equipment to the extent possible, without causing bodily injury, 2) evacuate the work area, 3) immediately notify the individual responsible for site operations of the encountered condition and 4) do not generate any additional disturbance or otherwise handle the buried object. The JV II individual responsible for site operations shall contact the JV II Project Manager and JV II HSM to evaluate potential hazards associated with the specific situation encountered. The project

team will then address the need for the use of special procedures, engineering controls, PPE or specialized subcontract personnel to safely mitigate the situation.

3.24.1 Munitions and Explosives of Concern

(Reference SOP # HSE&Q 610, Explosives Usage and Munitions Response)

(Reserved)

3.25 (Exposure to) Vehicular Traffic

(Reference SOP # HSE&Q 216, Traffic Control)

The following precautions must be taken when working around traffic, and in or near an area where traffic controls have been established:

- **Review and implement all applicable components of CH2MHILL SOP # HSE&Q 216, Traffic Control, except where other requirements may be more stringent.**
- Exercise caution when exiting traveled way or parking along street— avoid sudden stops, use flashers, etc.
- Park in a manner that will allow for safe exit from vehicle, and where practicable, park vehicle so that it can serve as a barrier.
- All staff working adjacent to traveled way or within work area must wear reflective/high-visibility safety vests.
- Eye protection should be worn to protect from flying debris.
- Remain aware of factors that influence traffic-related hazards and required controls— sun glare, rain, wind, flash flooding, limited sight-distance, hills, curves, guardrails, width of shoulder (i.e., breakdown lane), etc.
- Always remain aware of an escape route -- behind an established barrier, parked vehicle, guardrail, etc.
- Always pay attention to moving traffic – never assume drivers are looking out for you.
- Work as far from traveled way as possible to avoid creating confusion for drivers.
- When workers must face away from traffic, a “buddy system” should be used, where one worker is looking toward traffic.
- When working on highway projects, obtain a copy of the contractor’s traffic control plan.
- Work area should be protected by a physical barrier – such as a K-rail or Jersey barrier.
- Review traffic control devices to ensure that they are adequate to protect your work area. Traffic control devices should: 1) convey a clear meaning, 2) command respect of road users, and 3) give adequate time for proper traffic response. The adequacy of these devices is dependent on limited sight distance, proximity to ramps or intersections, restrictive width, duration of job, and traffic volume, speed, and proximity.

- Either a barrier or shadow vehicle should be positioned a considerable distance ahead of the work area. The vehicle should be equipped with a flashing arrow sign and truck-mounted crash cushion (TMCC). All vehicles within 40 feet of traffic should have an orange flashing hazard light atop the vehicle.
- Except on highways, flaggers should be used when 1) two-way traffic is reduced to using one common lane, 2) driver visibility is impaired or limited, 3) project vehicles enter or exit traffic in an unexpected manner, or 4) the use of a flagger enhances established traffic warning systems.
- Lookouts should be used when physical barriers are not available or practical. The lookout continually watches approaching traffic for signs of erratic driver behavior and warns workers. Vehicles should be parked at least 40 feet away from the work zone and traffic. Minimize the amount of time that you will have your back to oncoming traffic.

In addition to the above safe work practices, JV II personnel and JV II subcontractors shall adhere to the following procedures while operating motor vehicles or other motorized equipment on military/government facilities.

- **Always using a seat belt while driving on military/government facilities,**
- **Always observe posted speed limits, traffic signs and signals.**
- **Never using a cell phone or two way radio <u>while driving</u> on military/government facilities.**

Violating these rules may result in loss of military/government facility driving privileges.

3.26 Visible Lighting

Site work should be performed during daylight hours whenever possible. Work conducted during hours of darkness (including dusk and dawn) requires the set-up of supplemental lighting equipment. (Note: A general "rule of thumb" is that the illumination intensity must be sufficient to read a newspaper without difficulty.) . The following chart provides a reference for illumination requirements for various construction related work environments.

Illumination (Foot Candles)	Illumination (Lux)	Area of Operation
5	~ 55	General construction area lighting.
3	~ 33	General construction areas, concrete placement, excavation and waste areas, access ways, active storage areas, loading platforms, refueling, and field maintenance areas.
5	~ 55	Indoors: warehouses, corridors, hallways, and exit ways.
5	~ 55	Tunnels, shafts, and general underground work areas: (Exception: minimum of 10 foot-candles is required at tunnel and shaft heading during drilling, mucking, and scaling. Bureau of Mines approved cap lights shall be acceptable for use in the tunnel heading)
10	~ 108	General construction plant and shops (e.g., batch plants, screening plants, mechanical and electrical equipment

		rooms, carpenter shops, rigging lofts and active store rooms, mess halls and indoor toilets and workrooms.)
30	~ 323	First aid stations, infirmaries, and offices.

NOTES:

- A **footcandle** is a unit of illumination on a surface that is everywhere one foot from a point source of one candle.
- A **lux** is a unit of measurement of the intensity of light. It is equal to the illumination of a surface one meter away from a single candle.

CONVERSIONS

Foot Candles (FC) = Lux x .0929

LUX = Footcandles x 10.76 - (i.e.: 50 FC = 538 LUX)

The following safe work practices shall be considered with regard to lighting in the work place.

- Do not enter poorly lit areas without first providing portable illumination.
- Do not use non-explosion proof lighting in areas of flammable or combustible gases or liquids.

3.27 Welding or Cutting Operations

(Reference SOP # HSE&Q 314, Welding & Cutting)

(Reserved)

3.28 Working Around Material Handling Equipment

Material handling equipment such at track excavators, wheel loaders, cranes and telescopic material handlers or forklifts are likely to be utilized during all phases of site work. When working with or around material handling equipment, the following procedures shall be executed.

- Never approach operating equipment from the rear. Always make positive contact with the operator, and confirm that the operator has stopped the motion of the equipment.
- Never approach the side of operating equipment; remain outside of the swing and turning radius.
- Maintain distance from pinch points of operating equipment.
- Never turn your back on any operating equipment.
- Never climb onto operating equipment or operate subcontractor/client equipment.
- Never ride JV II/subcontractor/client equipment unless authorized to do so and unless it is designed to accommodate passengers (equipped with firmly attached passenger seat).

- Never work or walk under a suspended load.
- Never use equipment as a personnel lifts; do not ride excavator buckets, crane hook, material handling equipment forks.
- Always stay alert and maintain a safe distance from operating equipment, especially equipment on cross slopes and unstable terrain.
- JV II personnel will pull to the side of the road when encountering a forklift. Even if the forklift is not loaded with cargo, JV II personnel will still pull to the side of the road and stop until the forklift has passed.

3.28.1 Powered Industrial Trucks

(Reference HSE-309, Forklifts)

Powered Industrial Trucks (i.e. forklifts, material handlers) may be required for materials movement during project activities. Powered Industrial Trucks present the potential for damage to equipment, materials and personnel by impaling or striking personnel or materials with the fork tines. Additionally, Powered Industrial Trucks may tip if they are incorrectly loaded, driven at excessive speeds, operated with the forks too high or during excessively windy conditions.

The following rules apply whenever a forklift is used on the project:

- **Review and implement all applicable components of CH2MHILL SOP # HSE-309, Forklifts, except where other requirements may be more stringent**.
- Only trained and authorized drivers will operate Powered Industrial Trucks. Powered Industrial Truck Operators must receive training in accordance with 29 CFR 1910.178.
- A rated lifting capacity must be posted in a location readily visible to the operator.
- A Powered Industrial Truck must not be used to elevate employees unless a platform with guardrails, a back guard, and a kill switch is provided on the vehicle. When guardrails are not possible, fall arrest protection is required.
- The subcontractor operating the forklift must post and enforce a set of operating rules for forklift trucks.
- Stunt driving and horseplay are prohibited.
- Employees must not ride on the forks.
- Employees must never be permitted under the forks (unless forks are blocked).
- The driver must inspect the forklift once a shift and document this inspection.
- The operator must look in the direction of travel and must not move the vehicle until all persons are clear of the vehicle.
- Forks must be carried as low as possible.

- The operator must lower the forks, shut off the engine, and set the brakes (or block the wheels) before leaving the forklift operator's position unless maintenance or safety inspections require the forklift to be running.
- Trucks must be blocked and have brakes set when Powered Industrial Trucks are driven onto their beds.
- Extreme care must be taken when tilting elevated loads.
- Every forklift must have operable brakes capable of safely stopping it when fully loaded.
- Powered Industrial Trucks must have parking brakes and an operable horn.
- When the operator is exposed to possible falling objects, industrial trucks must be equipped with overhead protection (canopy).

3.28.2 Suspended Loads

See the information pertaining to "Suspended Loads" provided in the "Cranes" section of this HSP.

3.29 Working Above or Near Water

(Reserved)

3.30 General Hazards

3.30.1 General Practices and Housekeeping

- Good housekeeping must be maintained at all times in all project work areas.
- Common paths of travel should be established and kept free from the accumulation of materials.
- Keep access to aisles, exits, ladders, stairways, scaffolding, and emergency equipment free from obstructions.
- Provide slip-resistant surfaces, ropes, and/or other devices to be used.
- Specific areas should be designated for the proper storage of materials.
- Tools, equipment, materials, and supplies will be stored in an orderly manner.
- As work progresses, scrap and unessential materials must be neatly stored or removed from the work area.
- Containers should be provided for collecting trash and other debris and will be removed at regular intervals.
- All spills will be quickly cleaned up. Oil and grease will be cleaned from walking and working surfaces.

3.30.2 Hazard Communication

The SHSO, or designee, is to perform the following:

- Review of the Contaminant of Concern information contained this HSP.
- Complete an inventory of chemicals brought on site. See **Attachment 5** of this HSP. Give employees required chemical-specific HAZCOM training information using format included in **Attachment 5** of this HSP.
- Confirm that an inventory of chemicals brought on site is available.
- Request or confirm locations of Material Safety Data Sheets (MSDSs) from the client, contractors, and subcontractors for chemicals to which JV II employees are potentially exposed. Maintain MSDSs in this HSP (**Attachment 4**).
- Before or as the chemicals arrive on site, obtain an MSDS for each hazardous chemical.
- Label chemical containers with the identity of the chemical and with hazard warnings, and store properly.
- Store all materials properly, giving consideration to compatibility, quantity limits, secondary containment, fire prevention, and environmental conditions.

3.30.3 Shipping and Transportation of Chemical Products

Chemicals brought to the site might be defined as hazardous materials by the U.S. Department of Transportation (DOT). All staff who ship the materials or transport them by road must receive training in shipping dangerous goods. All hazardous materials that are shipped (e.g., via Federal Express) or are transported by road must be properly identified, labeled, packed, and documented by trained staff. Contact the HSM or the Equipment Coordinator for additional information.

3.30.4 Heat Stress

- It is recommended that personnel drink 16 ounces of water before beginning work. Disposable cups and water maintained at 50°F to 60°F should be available. Under severe conditions, drink 1 to 2 cups every 20 minutes, for a total of 1 to 2 gallons per day. Do not use alcohol in place of water or other nonalcoholic fluids. Decrease your intake of coffee and caffeinated soft drinks during working hours.
- Acclimate yourself by slowly increasing workloads (e.g., do not begin with extremely demanding activities).
- Use cooling devices, such as cooling vests, to aid natural body ventilation. These devices add weight, so their use should be balanced against efficiency.
- Use mobile showers or hose-down facilities to reduce body temperature and cool protective clothing.
- Conduct field activities in the early morning or evening and rotate shifts of workers, if possible.

- Avoid direct sun whenever possible, which can decrease physical efficiency and increase the probability of heat stress. Take regular breaks in a cool, shaded area. Use a wide-brim hat or an umbrella when working under direct sun for extended periods.
- Provide adequate shelter/shade to protect personnel against radiant heat (sun, flames, hot metal).
- Maintain good hygiene standards by frequently changing clothing and showering.
- Observe one another for signs of heat stress. Persons who experience signs of heat syncope, heat rash, or heat cramps should consult the SHSO to avoid progression of heat-related illness.

SYMPTOMS AND TREATMENT OF HEAT STRESS					
	Heat Syncope	**Heat Rash**	**Heat Cramps**	**Heat Exhaustion**	**Heat Stroke**
Signs and Symptoms	Sluggishness or fainting while standing erect or immobile in heat.	Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure.	Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours.	Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid thready pulse and low blood pressure; oral temperature normal or low	Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature.
Treatment	Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete.	Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.	Remove to cooler area. Rest lying down. Increase fluid intake.	Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.	Cool rapidly by soaking in cool–but not cold–water. Call ambulance, and get medical attention immediately!

3.30.5 Monitoring Heat Stress

These procedures should be considered when the ambient air temperature exceeds 70˚F, the relative humidity is high (>50 percent), or when workers exhibit symptoms of heat stress.

The heart rate (HR) should be measured by the radial pulse for 30 seconds, as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 100 beats/minute, or 20 beats/minute above resting pulse. If the HR is higher, the next work period should be shortened by 33 percent, while the length of the rest period stays the same. If the pulse rate still exceeds 100 beats/minute at the beginning of the next rest period, the work cycle should be further shortened by 33 percent. The procedure is continued until the rate is maintained below 100 beats/minute, or 20 beats/minute above resting pulse.

3.30.6 Cold Stress

- Be aware of the symptoms of cold-related disorders, and wear proper, layered clothing for the anticipated fieldwork. Appropriate rain gear is a must in cool weather.
- Consider monitoring the work conditions and adjusting the work schedule using guidelines developed by the U.S. Army (wind-chill index) and the National Safety Council (NSC).

- Wind-chill index is used to estimate the combined effect of wind and low air temperatures on exposed skin. The wind-chill index does not take into account the body part that is exposed, the level of activity, or the amount or type of clothing worn. For those reasons, it should only be used as a guideline to warn workers when they are in a situation that can cause cold-related illnesses.
- NSC Guidelines for Work and Warm-Up Schedules can be used with the wind-chill index to estimate work and warm-up schedules for fieldwork. The guidelines are not absolute; workers should be monitored for symptoms of cold-related illnesses. If symptoms are not observed, the work duration can be increased.
- Persons who experience initial signs of immersion foot, frostbite, hypothermia should consult the SHSO to avoid progression of cold-related illness.
- Observe one another for initial signs of cold-related disorders.
- Obtain and review weather forecast— be aware of predicted weather systems along with sudden drops in temperature, increase in winds, and precipitation.

SYMPTOMS AND TREATMENT OF COLD STRESS			
	Immersion (Trench) Foot	**Frostbite**	**Hypothermia**
Signs and Symptoms	Feet discolored and painful; infection and swelling present.	Blanched, white, waxy skin, but tissue resilient; tissue cold and pale.	Shivering, apathy, sleepiness; rapid drop in body temperature; glassy stare; slow pulse; slow respiration.
Treatment	Seek medical treatment immediately.	Remove victim to a warm place. Re-warm area quickly in warm–but not hot–water. Have victim drink warm fluids, but not coffee or alcohol. Do not break blisters. Elevate the injured area, and get medical attention.	Remove victim to a warm place. Have victim drink warm fluids, but not coffee or alcohol. Get medical attention.

Wind Chill Chart

Wind (mph)	Temperature (°F)																	
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

3.31 Procedures for Locating Buried Utilities

Local Utility Mark-Out Service

Name: North Carolina One Call Center (call before you dig)
Phone: (800) 632-4949 or (336) 855-5760
Website: **www2.ncocc.org/ncocc/default.htm**

Do not begin subsurface construction activities (e.g., trenching, excavation, drilling, etc.) or other ground disturbing activities until a check for underground utilities and similar obstructions has been conducted. The use of as-built drawings and utility company searches must be supplemented with a geophysical or other survey by a qualified, independent survey contractor to identify additional and undiscovered buried utilities.

Examples of the type of geophysical technologies include:

- **Ground Penetrating Radar (GPR),** which can detect pipes, including gas pipes, tanks, conduits, cables etc, both metallic and non-metallic at depths up to 30 feet depending on equipment. Sensitivity for both minimum object size and maximum depth detectable depends on equipment selected, soil conditions, etc.

- **Radio Frequency (RF),** involves inducing an RF signal in the pipe or cable and using a receiver to trace it. Some electric and telephone lines emit RF naturally and can be detected without an induced signal. This method requires knowing where the conductive utility can be accessed to induce RF field if necessary.
- **Dual RF**, a modified version of RF detection using multiple frequencies to enhance sensitivity but with similar limitations to RF
- **Ferromagnetic Detectors**, are metal detectors that will detect ferrous and non-ferrous utilities. Sensitivity is limited, e.g. a 100 mm iron disk to a depth of about one meter or a 25 mm steel paper clip to a depth of about 20 cm.
- **Electronic markers,** are emerging technologies that impart a unique electronic signature to materials such as polyethylene pipe to facilitate location and tracing after installation. Promising for future installations but not of help for most existing utilities already in place.

3.31.1 Procedure

The following procedures shall be used to identify and mark underground utilities during subsurface construction activities on the project:

- The survey subcontractor shall determine the most appropriate geophysical technique or combinations of techniques to identify the buried utilities on the project, based on the survey contractor's experience and expertise, types of utilities anticipated to be present and specific site conditions.
- The survey contractor shall employ the same geophysical techniques used on the project to identify the buried utilities, to survey the proposed path of subsurface construction work to confirm no buried utilities are present.
- Identify customer specific permit and/or procedural requirements for excavation and drilling activities. For military installations contact the Base Civil Engineer and obtain the appropriate form to begin the clearance process.
- Contact utility companies or the state/regional utility protection service at least two (2) working days prior to excavation activities to advise of the proposed work, and ask them to establish the location of the utility underground installations prior to the start of actual excavation.
- Schedule the independent survey.
- Obtain utility clearances for subsurface work on both public and private property.
- Clearances are to be in writing, signed by the party conducting the clearance.
- Underground utility locations must be physically verified by hand digging using wood or fiberglass-handled tools when any adjacent subsurface construction activity (e.g. mechanical drilling, excavating) work is expected to come within 5 feet of the marked underground system. If subsurface construction activity is within 5 feet and parallel to a

marked existing utility, the utility location must be exposed and verified by hand digging every 100 feet.

- Protect and preserve the markings of approximate locations of facilities until the markings are no longer required for safe and proper excavations. If the markings of utility locations are destroyed or removed before excavation commences or is completed, the Project Manager must notify the utility company or utility protection service to inform them that the markings have been destroyed.
- Conduct a site briefing for employees regarding the hazards associated with working near the utilities and the means by which the operation will maintain a safe working environment. Detail the method used to isolate the utility and the hazards presented by breaching the isolation.
- Monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon during drilling or change in color, texture or density during excavation that could indicate the ground has been previously disturbed).

When the client or other onsite party is responsible for determining the presence and locations of buried utilities, the JV II individual responsible for site operations shall confirm that arrangement and be available on-site to verify the location of located utilities or identified subsurface anomalies that may be in question and require further investigation measures.

3.32 Biological Hazards and Controls

The following sections provide information on potential biological hazards. Site personnel shall notify their overall supervisors and their project site supervisor of any potential allergic reactions that may occur as a result of contact with biological hazards that in the work place. If employee antidotes are required to counteract allergic reactions from biological hazard exposure, employees shall make personnel, who may be required to administer personal antidotes, aware of the location, type and quantity of antidotes needed to counteract any potential allergic reaction(s).

3.32.1 Snakes

Snakes typically are found in underbrush, tall grassy areas, near cover such as fallen logs, brush piles, rock walls, abandoned foundations, or rock ledges. They may be resting or waiting for prey. Watch where you place your hands and feet. Walk around, rather than over, fallen logs. When traveling through areas thought to contain venomous snakes, you can minimize the possibility of an encounter by using common sense. If you encounter a snake do your best to stay calm and look around as there may be other snakes. Turn around and walk away on the same path you used to approach the area. If a person is bitten by a snake, wash and immobilize the injured area, keeping it lower than the heart if possible. Seek medical attention immediately. **DO NOT apply ice, cut the wound, or apply a tourniquet**. Try to identify the type of snake: note color, size, patterns, and markings to assist medical personnel with proper treatment measures (see below – Identification of Poisonous Snakes).

Of the 37 species of snakes throughout North Carolina, six are venomous and are as follows:

1. Copperhead (throughout NC)

2. Canebrake Rattlesnake (throughout NC)

3. Eastern Diamondback Rattlesnake (Southeast NC)

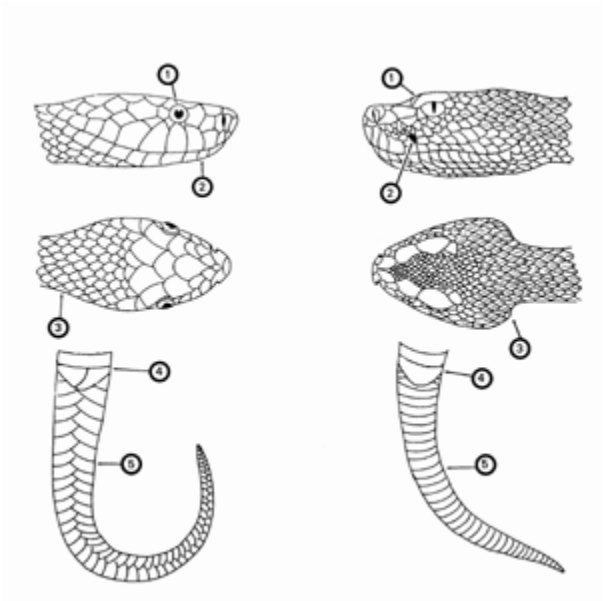
4. Pigmy Rattlesnake (Southeast NC)

5. Cottonmouth (wetland areas, Eastern NC)

6. Coral Snake (Rare, South and Southeastern NC)

Identification of Poisonous Snakes

(Major Identification Features) non-venomous snake	venomous snake
1. Round pupils	1. Eliptical pupils
2. No sensing pit	2. Sensing pit between eye and nostril
3. Head slightly wider than neck	3. Head much wider than neck
4. Divided anal plate	4. Single anal plate
5. Double row of scales on the underside of the tail	5. Single scales on the underside of the tail



3.32.2 Alligators

The habitat of the American Alligator has been reported to include coastal regions of North Carolina. As such, personnel performing field activities must be aware of the potential to encounter alligators. The following safe work practices must be followed when accessing areas that can potentially be considered a viable alligator habitat.

- Always use the buddy system.
- With a buddy, survey the area for alligators or signs of alligators prior to entering areas that can be considered potential alligator habitats.
- Maintain radio and cellular phone communications with other team members.
- Avoid approaching the edge of the creek which could potentially be within striking distance of a submerged alligator.
- If an alligator is observed in the work area or signs of alligator presence is observed (tracks, nests, eggs) evacuate the work area immediately.
- Notify the project supervisor /project manager if alligators or signs of an alligator habitat are observed.

3.32.3 Poison Ivy and Poison Sumac

Poison ivy, poison oak, and poison sumac typically are found in brush or wooded areas. They are more commonly found in moist areas or along the edges of wooded areas. Shrubs are usually 12" to 30" high, or can also be a tree-climbing vine, with triple leaflets and short, smooth hair underneath. Plants are red and dark green in Spring and Summer, with yellowing leaves anytime especially in dry areas. Leaves may achieve bright reds in Fall, but plants loses its (yellowed, then brown) leaves in Winter, leaving toxic stems. All parts of the plant remain toxic throughout the seasons.

Become familiar with the identity of these plants (see below). Wear protective clothing that covers exposed skin and clothes. Avoid contact with plants and the outside of protective clothing. If skin contacts a plant, wash the area with soap and water immediately. If the reaction is severe or worsens, seek medical attention.

Poison Ivy

Poison Sumac

Poison Oak

- Contamination with poison ivy, sumac or oak can happen through several pathways. These include
    - Direct skin contact with any part of the plant.
    - Contact with clothing that has been contaminated
    - Contact from removing shoes that have been contaminated. (your shoes are coated with oil)
    - Sitting in a vehicle that has become contaminated
    - Contact with any objects or tools that have become contaminate

- If you must work on a site with poison ivy, sumac or oak the following precautions are necessary.
    - Do not drive vehicles onto the site where it will come into contact with poison ivy, sumac or oak. Vehicles which need to work in the area, such as drill rigs or heavy equipment must be washed as soon as possible after leaving the site.
    - All tools used in the poison ivy, sumac or oak area, including those used to cut back poison oak, surveying instruments used in the area, air monitoring equipment or other test apparatus must be decontaminated before they are placed back into the site vehicle. If on-site decontamination is not possible, use plastic to wrap any tools or equipment until they can be decontaminated.
    - Personal protective equipment, including tyvek coveralls, gloves, and boot covers must be worn. PPE must be placed into plastic bags and sealed if they are not disposed immediately into a trash receptacle.
    - As soon as possible following the work, shower to remove any potential contamination. Any body part with suspected or actual exposure should be washed with "Tecnu" or other product designed for removing urushiol. If you do not have Tecnu wash with cold water. Do not take a bath, as the oils can form and invisible film on top of the water and contaminate your entire body upon exiting the bath.
    - Tecnu may also be used to decontaminate equipment.

3.32.4 Ticks

Ticks typically are in wooded areas, bushes, tall grass, and brush. Ticks are black, black and red, or brown and can be up to one-quarter inch in size. Wear tightly woven light-colored clothing with long sleeves and pant legs tucked into/taped to boots; spray **only outside** of clothing with permethrin or permanone and spray skin with only DEET; and check yourself frequently for ticks.

Hazard Control

The methods for controlling exposure to ticks include, in order of most-preferred to least:

Avoiding tick habitats and ceasing operations in heavily infested areas
Reducing tick abundance through habitat disruption or application of acracide
Personal protection through use of repellants and protective clothing
Frequent tick inspections and proper hygiene

Vaccinations are not available and preventative antibiotic treatment after a bite is generally not recommended.

Tick Removal

1. Use fine-tipped tweezers or shield your fingers with a tissue, paper towel, or nitrile gloves.

2. Grasp the tick as close to the skin surface as possible and pull upward with steady, even pressure. Do not twist or jerk the tick; this may cause the mouthparts to break off and remain in the skin. (If this happens, remove mouthparts with tweezers. Consult your healthcare provider if infection occurs.)

3. Do not squeeze, crush, or puncture the body of the tick because its fluids (saliva, hemolymph, gut contents) may contain infectious organisms. Releasing these organisms to the outside of the tick's body or into the bite area may increase the chance of infectious organism transmission.

4. Do not handle the tick with bare hands because infectious agents may enter through mucous membranes or breaks in the skin. This precaution is particularly directed to individuals who remove ticks from domestic animals with unprotected fingers. Children, elderly persons, and immunocompromised persons may be at greater risk of infection and should avoid this procedure.

5. After removing the tick, thoroughly disinfect the bite site and wash your hands with soap and water.

6. You may wish to save the tick for identification in case you become ill. Your doctor can use the information to assist in making an accurate diagnosis. Place the tick in a plastic bag and put it in your freezer. Write the date of the bite on a piece of paper with a pencil and place it in the bag.

Note: Folklore remedies such as petroleum jelly or hot matches do little to encourage a tick to detach from skin. In fact, they may make matters worse by irritating the tick and stimulating it to release additional saliva, increasing the chances of transmitting the pathogen. These methods of tick removal should be avoided. In addition, a number of tick removal devices have been marketed, but none are better than a plain set of fine tipped tweezers.

First-Aid and Medical Treatment

Tick bites should always be treated with first-aid. Clean and wash hands and disinfect the bite site after removing embedded tick. Consult a healthcare professional if infection or symptoms and effects of tick-borne illnesses are develop.

Medical treatment for tick-borne infections include antibiotics and other medical interventions. Diagnosis of specific illness involves both clinical and laboratory confirmations. Preventative antibiotic treatment in non-ill individuals who have had a recent tick bite is recommended in specific cases only.

Previously infected individuals are not conferred immunity – re-infection from future tick bites can occur even after a person has contracted a tick-borne disease.

Tick Identification

There are five varieties of hard-bodied ticks that have been associated with tick-borne pathogens. These tick varieties include:

- Deer (Black Legged) Tick (eastern and pacific varieties)
- Lone Star Tick
- Dog Tick
- Rocky Mountain Wood Tick

These varieties and their geographical locations are illustrated on the following page.

Illnesses and Signs & Symptoms

There are six notifiable tick-borne pathogens that cause human illness in the United States. These pathogens may be transmitted during a tick bite – normally hours after attachment. The illnesses, presented in approximate order of most common to least, include:

1. Lyme (bacteria)
2. RMSF (bacteria)
3. Ehrlichiosis (bacteria)
4. STARI (Southern Tick-Associated Rash Illness) (bacteria)
5. Tularemia (Rabbit Fever) (bacteria)
6. Babesia (protozoan parasite)

Symptoms will vary based on the illness, and may develop in infected individuals typically between 3 and 30 days after transmission. Some infected individuals will not become ill or may develop only mild symptoms. These illnesses present with some or all of the following signs & symptoms: fever, headache, muscle aches, stiff neck, joint aches, nausea, vomiting, abdominal pain, diarrhea, malaise, weakness, small solid, ring-like, or spotted rashes. The bite site may be red, swollen, or develop ulceration or lesions. A variety of long-term symptoms may result when untreated, including debilitating effects and death.

3.32.5 Fire Ants

Fire ants inflict a painful sting and will seriously affect your lifestyle if bitten. Fire ants look very much like ordinary house or garden ants. Fire ants are

- Small and coppery-brown in colour on the head and body, with a darker abdomen
- Come in a variety of sizes within one nest, ranging from 2mm to 6 mm. This is a distinguishing feature of fire ants
- Have nests with no obvious entry or exit holes on top of them
- Can be distinguished by their aggressive behaviour, particularly near the nest.

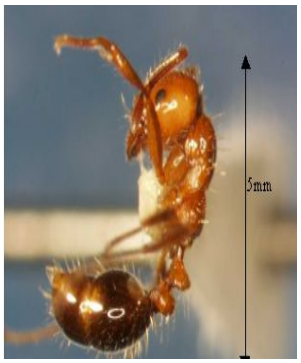
Their nests can appear as dome-shaped mounds, up to 40cm high, or can be found next to, or underneath other objects found on the ground, such as timber, logs, rocks, pavers, bricks etc. Mounds will not always be evident, but are usually found in open areas such as lawns, pastures, along roadsides and unused cropland. Mounds are rarely found in frequently cultivated areas. This species could easily be confused with the common coastal brown ant and as well as some local native ants.

Fire ants inflict a fiery sting, which causes a small blister or pustule to form at the site of each sting after several hours. The blisters become itchy while healing and are prone to infection if broken.

If you are stung by a fire ant:

- Apply a cold compress to relieve the swelling and pain.
- Gently wash the affected area with soap and water and leave the blister intact.
- People who are allergic to insect stings should seek medical attention immediately. On rare occasions, fire ant stings can cause severe acute allergic reaction (anaphylaxis)

Fire Ant



Ant Mound In Electric Box

Bites on Arm

3.32.6 Spiders - Brown Recluse

It is regarded by many as the most dangerous spider in the United States. Although North Carolina is generally not a known habitat of the brown recluse, because of interstate shipping/transportation the Brown Recluse spider can be found most anywhere in the United States. Specific reports of the recluse presenc Carolina.

Brown Recluse Spiders are usually 1 inch or larger in si as large as 3 inches. Young Brown Recluse spiders are sn Brown recluse spider bites don't always hurt right away. away. In fact, you may not know that you have been bitten until other symptoms appear. Symptoms of a brown recluse spider bite may include the following:

- Reddened skin followed by a blister that forms at the bite site.
- Mild to intense pain and itching for 2 to 8 hours following the bite.
- An open sore with a breakdown of tissue (necrosis) that develops within a few hours to 3 to 4 days following the bite and the area may become painful, itchy, hot, swollen, red and tender. An irregular ulcerous sore, caused by necrosis, will often appear that is from 1/4 inch to 10 inches in diameter. Prompt attention is the best defense against preventing the necrosis. The wound is often described as being reddish and surrounded by a bluish area with a narrow whitish separation in between the red and the blue. This gives it the famous "bull's eye" pattern. In just hours, a bite from the highly venomous Brown Recluse spider can create blisters and cause tissue damage.

Some people have a severe, systemic (whole-body) reaction to brown recluse spider bites, including the rapid destruction of red blood cells and anemia. Signs and symptoms include: Fever and chills.

- Skin rash all over the body with many tiny, flat purple and red spots.
- Nausea or vomiting.
- Joint pain.

If you think you have been bitten by a brown recluse spider:

- Remain calm. Too much excitement or movement will increase the flow of venom into the blood.
- Try to collect the spider, without being bitten, (even a mangled specimen has diagnostic value), if possible, for positive identification by a spider expert. A plastic bag, small jar, or pill vial is useful and no preservative is necessary, but rubbing alcohol helps to preserve the spider.
- Apply a cool, wet cloth to the bite or cover the bite with a cloth and apply an ice bag to the bite.
- Do not apply a tourniquet. It may cause more harm than benefit.
- Try to positively identify the spider to confirm its type.
- Seek prompt medical attention.

A brown recluse bite can be serious and will likely require immediate medical care. Seek medical attention if you believe you have been bitten by a recluse spider, especially if severe symptoms develop throughout your body or an open sore and necrosis develop. A brown recluse spider bite is diagnosed through a physical examination and questions about the bite. You should be prepared to describe the spider, where and when the bite took place, and what you were doing at the time. Your health professional will ask what your main symptoms are, when they began, and how they have developed, progressed, or changed since the bite.

3.32.7 Spiders - Widow

There are four (4) identified widow species indigenous to Southeast Regions of the United States which are as follows: the Southern Black, Northern Black, Brown and Red widows. Females range from 8-15 mm in body length; males are smaller, sometimes very small (2 mm). Most have globose, shiny abdomens that are predominantly black with red markings (although some may be pale and/or have lateral stripes), with moderately long, slender legs. These spiders are nocturnal and build a three-dimensional tangled web, often with a conical tent of dense silk in a corner where the spider hides during the day. In nature, most species are found under rocks and logs, but they readily adapt to human-altered environments, where they are most commonly found in outbuildings (sheds, barns, privies), water meter holes, nursery cans, and under any item or structure (*e.g.*, barbeque grill, slide, sand box) that has been undisturbed for a lengthy period. Formerly, most bites by black widows (almost all by female spiders) occurred in outhouses, but presently, widow bites occur most frequently when the spider is trapped against human skin, either by reaching under objects where the spider is hiding or when putting on clothing, gloves or shoes containing the spider. Widow spiders are generally very timid and only bite in self-defense when they accidentally contact humans.

Southern Widow

Red Widow

Brown Widow

Note: The northern widow is similar to the southern widow except the telltale red markings are shaped slightly different.

Bite symptoms are systemic, spreading through the lymphatic system, and usually start about 1-3 hours after the bite. The most common symptoms are intense pain, rigid abdominal muscles, muscle cramping, malaise, local sweating, nausea, vomiting, and hypertension. Other symptoms may includetremors, labored breathing, restlessness, increased blood pressure, and fever. If left untreated, widow bite symptoms usually last 3-5 days.

If bitten, remain calm, and immediately seek medical attention (contact your physician, hospital and/or poison control center). Apply an ice pack directly to the bite area to relieve swelling and pain. Try to collect the spider, without being bitten, (even a mangled specimen has diagnostic value), if possible, for positive identification by a spider expert. A plastic bag, small jar, or pill vial is useful and no preservative is necessary, but rubbing alcohol helps to preserve the spider. A hospital stay may be recommended, particularly for those with a heart condition or with health problems. A physician may administer a specific antivenin to counteract the venom or calcium gluconate to relieve pain. Calcium gluconate and/or antivenin may be administered to relieve or counteract symptoms.

3.32.8 Blood borne Pathogens

(Reference SOP HSE-202, *Bloodborne Pathogens*)

Exposure to bloodborne pathogens may occur when rendering first aid or CPR, or when coming into contact with landfill waste or waste streams containing potentially infectious material. Exposure controls and personal protective equipment (PPE) are required. Hepatitis B vaccination must be offered before the person participates in a task where exposure is a possibility.

3.32.9 Mosquito Bites

Because of the recent detection of the West Nile Virus in the Southeastern United States, it is recommended that **preventative measures** be taken to reduce the probability of being bitten by mosquitoes whenever possible. Mosquitoes are believed to be the primary source for exposure to the West Nile Virus as well as several other types of encephalitis. The following guidelines should be followed to reduce the risk of these concerns for working in areas where mosquitoes are prevalent.

- Stay indoors at dawn, dusk, and in the early evening.
- Wear long-sleeved shirts and long pants whenever you are outdoors.
- Spray clothing with repellents containing pyrethrum or DEET because mosquitoes may bite through thin clothing.

- Apply insect repellent sparingly to exposed skin. An effective repellent will contain 35% DEET (N, N-diethyl-meta-polyamide). DEET in high concentrations (greater than 35%) provides no additional protection.
- Repellents may irritate the eyes and mouth, so avoid applying repellent to the hands.
- Whenever you use an insecticide or insect repellent, be sure to read and follow the manufacturer's DIRECTIONS FOR USE, as printed on the product.

Note: Vitamin B and "ultrasonic" devices are NOT effective in preventing mosquito bites.

Symptoms of Exposure to the West Nile Virus

Most infections are mild, and symptoms include fever, headache, and body aches, occasionally with skin rash and swollen lymph glands. More severe infection may be marked by headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, paralysis, and, rarely, death.

The West Nile Virus incubation period is from 3-15 days.

If you have any questions or to report any suspicious symptoms, contact the project Health and Safety Manager.

3.32.10 Rabid Animals

Encounters with a rabid animal can lead to rabies transmission when virus from the animal's saliva, brain tissue, or spinal fluid enters open cuts or wounds in skin or mucous membranes. Therefore, not every encounter with a rabid animal is a true exposure requiring intervention. Treatment is often provided unnecessarily to people who have encountered but had no true exposure to a potentially rabid animal.

Any penetration of the skin by an animal's teeth is considered a "bite exposure". Local wound care should be performed immediately on anyone bitten by an animal. Local treatment of wounds treatment typically involves immediate and extensive washing of all bite wounds, scratches, or other sites of potential exposure for 10 minutes with soap and water is arguably the most important measure for preventing rabies following an exposure to a rabid animal. Experiments done in animals suggest that thorough and vigorous cleansing to the depth of the wound with a 20% soap solution can reduce the risk of developing rabies. Tetanus booster vaccine (Td) should be given if indicated. A health care provider should be consulted to determine whether or not other measures are necessary. When a bite exposure has been determined laboratory testing of the animal, if available, may be indicated depending upon the circumstances of the exposure (such as whether it was provoked or not) and the species involved. The risks associated bites from different animals varies from place to place. For work on this particular contract, contact with rabid dogs, cats, raccoons and rats could be possible.

"Non-bite exposures" include any scratches, abrasions, or contamination of mucous membranes by an infected animal's saliva, brain tissue, or spinal fluid. Other types of contacts (such as with the blood, urine, feces, or fur of an animal) would not by themselves be considered exposures capable of transmitting rabies even if the animal were known to be

rabid. The virus is not hardy; once dry, saliva containing rabies virus is considered non-infectious.

4.0 Behavior Based Loss Prevention System

(Reference SOP # HSE&Q 103, Behavior Based Loss Prevention System)

A Behavior Based Loss Prevention System (BBLPS) has been implemented on this project. BBLPS is a system to prevent or reduce losses using behavior-based tools and proven management techniques to focus on behaviors or acts that could lead to losses.

The four basic loss prevention tools that will be used to implement the BBLPS on this project include:

- Activity Hazard Analysis (AHA)
- Pre-Task Safety Plans (PTSP)
- Loss Prevention Observations (LPO)
- Loss and Near Loss Investigations (NLI)
- Drug Free Workplace Program (DFWP)

The Project Manager and/or JV II individual responsible for site operations are responsible for implementing the BBLPS on the project site and ensuring that project team members have received the BBLPS training prior to initiating field activities. These personnel typically delegate authority to the SHSO for the project specific implementation of the BBLPS, but the Project Manager and/or individual responsible for site operations remains accountable for its implementation. The SHSO will only oversee the subcontractor's implementation of their AHAs and PTSPs processes on the project.

Should it be determined that a JV II personnel have not received a BBLPS orientation, the Superintendent or Project Manger shall contact their designated safety representative so that this orientation can be provided. Subcontractors may not necessarily be required to receive this JV II BBLPS orientation, but shall be informed of, be covered by or separately implement the four basic loss prevention tools of the JV II BBLPS.

In an effort to provide a safe and healthy workplace for all program participants, JV II promotes and implements a Drug Free Work Place Program (DFWP). All JV II personnel must participate in and adhere to the requirements of the DFWP.

4.1 Activity Hazard Analysis

An AHA defines the activity being performed, the hazards posed, and control measures required to perform the work safely. Workers are briefed on the AHA before doing the work and their input is solicited before, during and after the performance of work to further identify the hazards posed and control measures required.

Activity Hazard Analysis will be implemented before beginning each project activity posing H&S hazards to project personnel using the AHA forms provided in **Attachment 6**. The AHA will identify the work tasks required to perform each activity, along with potential H&S hazards and recommended control measures for each work task. In addition, a listing of the equipment to be used to perform the activity, inspection requirements and training requirements for the safe operation of the equipment listed must be identified.

An AHA will be prepared for all field activities performed by JV II and subcontractors during the course of the project and should be reviewed and accepted by the Health and Safety Manager or other designated program H&S professional. The Project-Specific, General, and Biological Hazards, the Hazard Analysis Table (Table 1-1) and respective applicable JV II partner Standards of Practice (SOPs) should be used as a basis for preparing these AHAs.

JV II subcontractors will be required to provide AHAs specific to their scope of work on the project for acceptance by the SHSO. Each subcontractor will submit AHAs for their field activities, as defined in their work plan/scope of work, along with their project-specific HSP. Additions or changes in JV II or subcontractor field activities, equipment, tools or material to perform work or additional/different hazard encountered that require additional/different hazard control measures requires either a new AHA to be prepared or an existing AHA to be revised.

4.2 Pre-Task Safety Plans

Daily safety meetings are held with all project personnel in attendance to review the hazards posed and required H&S procedures/AHAs that apply for each day's project activities. The PTSPs serve the same purpose as these general assembly safety meetings, but the PTSPs are held between the crew supervisor and their work crews to focus on those hazards posed to individual work crews. At the start of each day's activities, the crew supervisor completes the PTSP, provided in **Attachment 7**, with input from the work crew, during their daily safety meeting. The day's tasks, personnel, tools and equipment that will be used to perform these tasks are listed, along with the hazards posed and required H&S procedures, as identified in the AHA. The use of PTSPs better promotes worker participation in the hazard recognition and control process, while reinforcing the task-specific hazard and required H&S procedures with the crew each day. The use of PTSPs is a common safety practice in the construction industry.

4.3 Loss Prevention Observations

Loss-Prevention Observations (LPOs) will be conducted by the JV II individual responsible for site operations/SHSO for specific work tasks or operations comparing the actual work process against established safe work procedures identified in the project-specific HSP and AHAs. LPOs are a tool to be used by supervisors to provide positive reinforcement for work practices performed correctly, while also identifying and eliminating deviations from safe work procedures that could result in a loss. The JV II individual responsible for site operations/SHSO will perform at least one LPO each week for tasks/operations addressed in the project-specific HSP or AHA. The JV II individual responsible for site operations/SHSO will complete the LPO form in **Attachment 8** for the task/operation being observed, following the process below.

4.4 Loss/Near-Loss Investigations

Loss/near-loss investigations will be performed for the all JV II and subcontractor incidents involving:

- Person injuries/illnesses and near-miss injuries
- Equipment/property damage
- Spills, leaks, regulatory violations
- Motor vehicle accidents

The causes of loss and near-loss incidents are similar, so by identifying and correcting the causes of near-loss incidents, future loss incidents may be prevented. The following is the loss/near-loss investigation process:

- Gather all relevant facts, focusing on fact-finding, not fault-finding, while answering the who, what, when, where, and how questions.
- Draw conclusions, pitting facts together into a probable scenario.
- Determine incident root cause(s), which are basic causes on why an unsafe act/ condition existed.
- Develop and implement solutions, matching all identified root causes with solutions.
- Communicate incident as a lesson learned to all project personnel.
- File follow-up on implemented corrective active action to confirm solution is appropriate.

Site Supervisors/SHSO will perform an incident investigation, as soon as practical after incident occurrence during the day of the incident, for all loss and near-loss incidents that occur on the project. Loss and near-loss incident investigations will be performed using the following incident investigation forms provided in **Attachment 9**:

- Incident Report Form (IRF) *
- Incident Investigation Form
- Root Cause Analysis Form

* For work-related injuries or illnesses to CH2MHILL personnel, Inform JV II Project Manger overall and JV II HSM contact and help Human Resources administrator complete a HITS (Hours & Incident Tracking System) Form. HITS must be completed within 24 hours of incident.

All loss and near-loss incidents involving personal injury, property damage in excess of $1,000 or near-loss incidents that could have resulted in serious consequences will be investigated by completing the incident investigation forms and submitting them to the Project Manager and HSM within 24 hours of incident occurrence. A preliminary Incident Investigation and Root Cause Analysis will be submitted to the Project Manager and HSM within 24 hours of incident occurs. The final Incident Investigation and Root Cause Analysis will be submitted after completing a comprehensive investigation of the incident.

4.5 Drug-Free Workplace Program

(Reference SOP # HSE&Q 105, Drug Free Work Place)

JV II does not tolerate illegal drugs, or any use of drugs, controlled substances, or alcohol that impairs an employees work performance or behavior. JV II has established a policy that its employees and subcontractors will not be involved in any manner with the unlawful manufacture, distribution, dispensation, possession, sale, or use of illegal drugs in the workplace. The use or possession of alcohol in the workplace is also prohibited. Any violation of these prohibitions may result in discipline or immediate discharge.

In order to remain consistent with the requirements of the Drug Free Workplace Program (DFWP), review CH2MHILL, Inc. Standard of Practice HSE 105, *Drug-Free Workplace*, for more information.

JV II reserves the right to randomly test program participants in accordance with the conditions of the DFWP.

5.0 JV II Personal Protective Equipment

Personal protective equipment (PPE) specifications are listed in Table 5-1.

Table 5-1 Personal Protective Equipment[a]

Task	Level	Body	Head	Respirator [b]
• Site Survey (Utility) Operations, where the existing ground surface of the site has NOT been disturbed. • Mobilization and Site Preparation activities (non intrusive activities only). • Indoor air monitoring. • Demobilization	D	▪ Designated and appropriate work clothes; ▪ Steel toe work boots that provide sufficient ankle support (preferably leather); ▪ Work gloves (cut resistant).; Reflective safety vest, chainsaw chaps and snake guards ▪ For land clearing Operations or as applicable to operations in wooded or grassy areas	▪ Hardhat [c] ▪ Safety glasses ▪ Hearing protection (as applicable)[d] ▪ Face Protection (as applicable - i.e. chainsaw operations)	None required
A function, identified below where potential dermal contact with site COCs is <u>limited to the hands only.</u> • Ground water well sampling. • Soil sample handling. • Equipment decontamination with DI water into a bucket. • • Removal of existing site fence • Installation or removal of ESC measures • Set-up of soil mixing equipment and materials	Modified D_1	▪ Designated and appropriate work clothes; ▪ Steel toe work boots that provide sufficient ankle support (preferable leather); ▪ Work gloves (cut resistant).; ▪ Reflective safety vest; Snake guards for as applicable to operations in wooded or grassy ▪ Inner surgical-style nitrile & outer chemical resistant nitrile gloves.	▪ Hardhat [c] ▪ Safety glasses Ear protection (as applicable) [d] ▪ Face shields(as applicable - ▪ i.e. splash hazards)	None required.
A function, identified below where potential dermal contact with site COCs is **<u>NOT</u>** limited to the hands only. • Soil sampling with Direct Push Technology (DPT) methods. • Equipment decontamination operations (pressure washer-if necessary)	Modified D_2	▪ **Coveralls:** Poly coated or uncoated Tyvek®chemical resistant disposable coveralls. **Poly c**oated will be used for exposure to liquid chemicals or other dangerous splash hazards. ▪ **Boots:** Hard toe work boots that provide sufficient ankle support (preferable leather); with outer rubber boot covers or hard toe chemically resistant rubber boots with steel shank ▪ **Gloves:** Inner & Outer surgical-style nitrile chemical-resistant nitrile gloves.	▪ Hardhat [c] ▪ Safety glasses ▪ Ear protection (as applicable) [d] ▪ Face shields (as applicable)	None required.
Contact HSM prior to implementing Level C PPE upgrade. • When required to upgrade[f].	C	▪ **Coveralls:** Polycoated Tyvek® ▪ **Boots:** Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers ▪ **Gloves:** Inner surgical-style nitrile & outer chemical resistant nitrile gloves.	▪ Hardhat [c] ▪ Splash shield [c] ▪ Spectacle inserts ▪ Ear protection (as applicable) [d]	APR, full face, MSA Ultratwin or equivalent; with GME-H cartridges or equivalent, as applicable to appropriate respiratory protection measures for specific site compounds.

Reasons for Upgrading or Downgrading Level of Protection

Upgrade[f]	Downgrade
• Request from individual performing tasks. • Change in work tasks that will increase contact or potential contact with hazardous materials. • Occurrence or likely occurrence of gas or vapor emission. • Known or suspected presence of dermal hazards. • Instrument action levels exceeded (when implemented).	• New information indicating that situation is less hazardous than originally thought. • Change in site conditions that decrease the hazard. • Change in work task that will reduce contact with hazardous materials.

[a] Modifications are as indicated. JV II will provide PPE only to JV II employees.
[b] No facial hair that would interfere with respirator fit is permitted.
[c] Hardhat and splash-shield areas are to be determined by the SHSO.
[d] Ear protection should be worn when conversations cannot be held at distances of 3 feet or less without shouting.
[e] Cartridge change-out schedule is at least every 8 hours (or one work day), except if relative humidity is > 85%, or if organic vapor measurements are > midpoint of Level C range --then at least every 4 hours.
If encountered conditions are different than those anticipated in this HSP, contact the HSM. **Where JV II personnel are required to utilize a respirator to provide respiratory protection, JV II personnel shall receive respiratory protection awareness training. Contact the HSM to receive this training, prior to utilizing any respiratory protective device.**
[f] Performing a task that requires an upgrade to a higher level of protection (e.g., Level D to Level D modified/Level C) is permitted only when the PPE requirements have been approved by the HSM, and an SHSO qualified at that level is present.

6.0 Air Monitoring/Sampling

6.1 Air Monitoring Specifications

Air Monitoring Equipment Specifications are listed in Table 6-1.

TABLE 6-1 - AIR MONITORING EQUIPMENT SPECIFICATIONS

Instrument	Tasks	Action Levels[a]	Level of Protection or Action	Frequency [b]	Calibration
Visual Inspection of the Site (nuisance dust)	Any activity that generates airborne particulate (dust) that may potentially be above the action level.	No Visible Dust	Level D, Modified D1, or D2 as identified by Table 5-1 for dermal protection	Actively during tasks	NA
		Visible Dust	Level C* *** Suspend operations, institute dust control measures (with worker protection from exposure) until visible dust is not observed. Contact the HSM before utilizing Level C PPE.**		
PID: OVM or equivalent (11.8 eV lamp or equivalent)	Any activity identified in section 1.4 of this HSP.	0 – 1 ppm (in worker BZ)	Level D, Modified D1, or D2 as identified by Table 5-1 for dermal protection	Any activity where unusual odors, vapors or fumes, discolored soil/sediment or free phase product is observed/encountered during the execution of project tasks identified in section 1.4 of this HSP or during initial start-up of tasks identified in section 1.4 of this HSP. This may also include encountering unknown or unanticipated buried objects, but only after consultation w/ the HSM.	Daily
		1 - 5 ppm (sustained 5 mins in worker BZ)	Level D, Modified Level D_1 or D_2 as identified by Table 5-1 for dermal protection and begin compound specific monitoring using Drager CMS. (See below).	Continuously until 1) level is below 1 ppm, 2) Compound specific action level is exceeded.	
		> 5 ppm (sustained 5 mins. in worker BZ)	Stop work. Evacuate area for 10 minutes and recheck BZ and work area. If levels persist, consult HSM for proper engineering controls and PPE requirements or before investigation of "unknown" conditions or working areas with ambient conditions potentially in excess of established OELs.	Continuously upon re-start of work to verify 0-1 ppm in worker BZ and until it is determined that compound specific concentrations are less than 50% of the PEL or REL	
Drager Chip Measurement System (CMS) with the following compound specific measurement chips: **Vinyl Chloride (0.3 – 10 ppm)** **Trichloroethylene (5.0 – 100 ppm)** **Perchloroethylene (5.0 – 150 ppm)** **Benzene (0.2-10)** **And for** 1,1,2,2 Tetrachloroethane Personal sampling pumps at a flow rate of 0.01 to 0.2 L/min affixed with a solid sorbent tube (coconut shell charcoal, 100 mg/50 mg) in accordance with OSHA Method 1003.	Any activity identified in section 1.4 of this HSP.	Result < 50% of Constituent PEL (in worker BZ) VC < 0.5 ppm TCE < 50.0 ppm PCE < 50.0 ppm Benzene <0.05 ppm 1,1,2,2 Tetrachloroethane < 0.5 ppm	Level D, Modified D1, or D2 as identified by Table 5-1 for dermal protection	- Initially and periodically during overburden removal operations - Initially and periodically during active soil mixing operations - When PID reading > 1 ppm and until PID reading < 1 ppm - Restart of work to verify compound specific levels are below - Prior to and during any Confined Space Entry operations	N/A
		Result >50% of Constituent PEL (in worker BZ) VC and PCA > 0.5 ppm TCE > 50.0 ppm PCE > 50.0 ppm Benzene >0.05 ppm 1,1,2,2 Tetrachloroethane > 0.5 ppm	Stop work. Evacuate area for 10 minutes and recheck BZ and work area. If levels persist, consult HSM for proper engineering controls or PPE requirements or before any investigation of "unknown" conditions. Level B PPE must be required if airborne contaminant levels of VC or PCA-1,1,2,2 Tetrachloroethane continue to exceed the action level of 0.5 ppm in the Breathing Zone		
Combustible Gas Indicator with LEL and O_2 sensors	Any activity where a potential Lower Explosive Limit or 0_2 deficient/enriched atmospheres may exist in a work environment or where PID action levels are exceeded.	0_2 19.5 – 23.5% LEL < 5%	Continue work, Follow PPE requirements as identified by Table 5-1.	When PID reading > 1 ppm and until PID reading < 1 ppm	Daily
		0_2 <19.5 or >23.5% LEL > 5%	Stop work. Evacuate area for 10 minutes and recheck BZ and work area. If levels persist, consult HSM for proper engineering controls or PPE requirements or before investigating of any "unknown" conditions.	Continuously upon re-start of work to verify action levels are not exceeded.	

[a] Action levels apply to sustained breathing-zone measurements above background.
[b] The exact frequency of monitoring depends on field conditions and is to be determined by the HSO; generally, every 5 to 15 minutes if acceptable; more frequently may be appropriate. Monitoring results should be recorded. Documentation should include instrument and calibration information, time, measurement results, personnel monitored, and place/location where measurement is taken (e.g., “Breathing Zone/MW-3”, “at surface/SB-2”, etc.).
[c] If the measured percent of O_2 is less than 10, an accurate LEL reading will not be obtained. Percent LEL and percent O_2 action levels apply only to ambient working atmospheres, and not to confined-space entry. More-stringent percent LEL and O_2 action levels are required for confined-space entry.
[d] Refer to SOP HS-10 for instructions and documentation on radiation monitoring and screening.
[e] Noise monitoring and audiometric testing also required.

REL:NIOSH Recommended Exposure Limit.

6.2 Calibration Specifications

(Refer to the respective manufacturer's instructions for proper instrument-maintenance procedures)

Air Monitoring equipment calibration specifications are listed in Table 6-2.

TABLE 6-2
Air Monitoring Equipment Calibration Specifications

Instrument	Gas	Span	Reading	Method
PID: OVM, 11.8 eV bulb	100 ppm isobutylene	RF = 1.0	100 ppm	1.5 lpm reg T-tubing/ tedlar bag
CGI w/ LEL	Mixed Gas	RF = 1.0	50 ppm	1.5 lpm reg T-tubing/ tedlar bag
CGI w/ O2	Mixed Gas	RF = 1.0	20.9 % O_2	1.5 lpm reg T-tubing/ tedlar bag or "fresh air calibration" depending on meter
Drager CMS	NA	NA	NA	Maintenance every 500 tests by manufacturer authorized technician
Personal sampling Pumps	NA	NA	NA	Calibrate pump air flow w/ rotometer to 0.01 to 0.2 L/min

7.0 Decontamination

Proper decontamination procedures will be required to ensure negative worker exposure to any identified constituents of concern or hazardous materials. Good personal hygiene practices must be exercised by JV II personnel to facilitate negative exposure. These practices include but are not limited to the following: 1) Eating, drinking, smoking and tobacco use shall only be conducted in designated areas and not in areas were there is any exposure to hazardous material/waste, flammable/combustible liquids and gases may exist and 2) wash hands and face, if applicable, before eating, drinking, smoking or using tobacco 3) shower as soon as feasible after completing field activities.

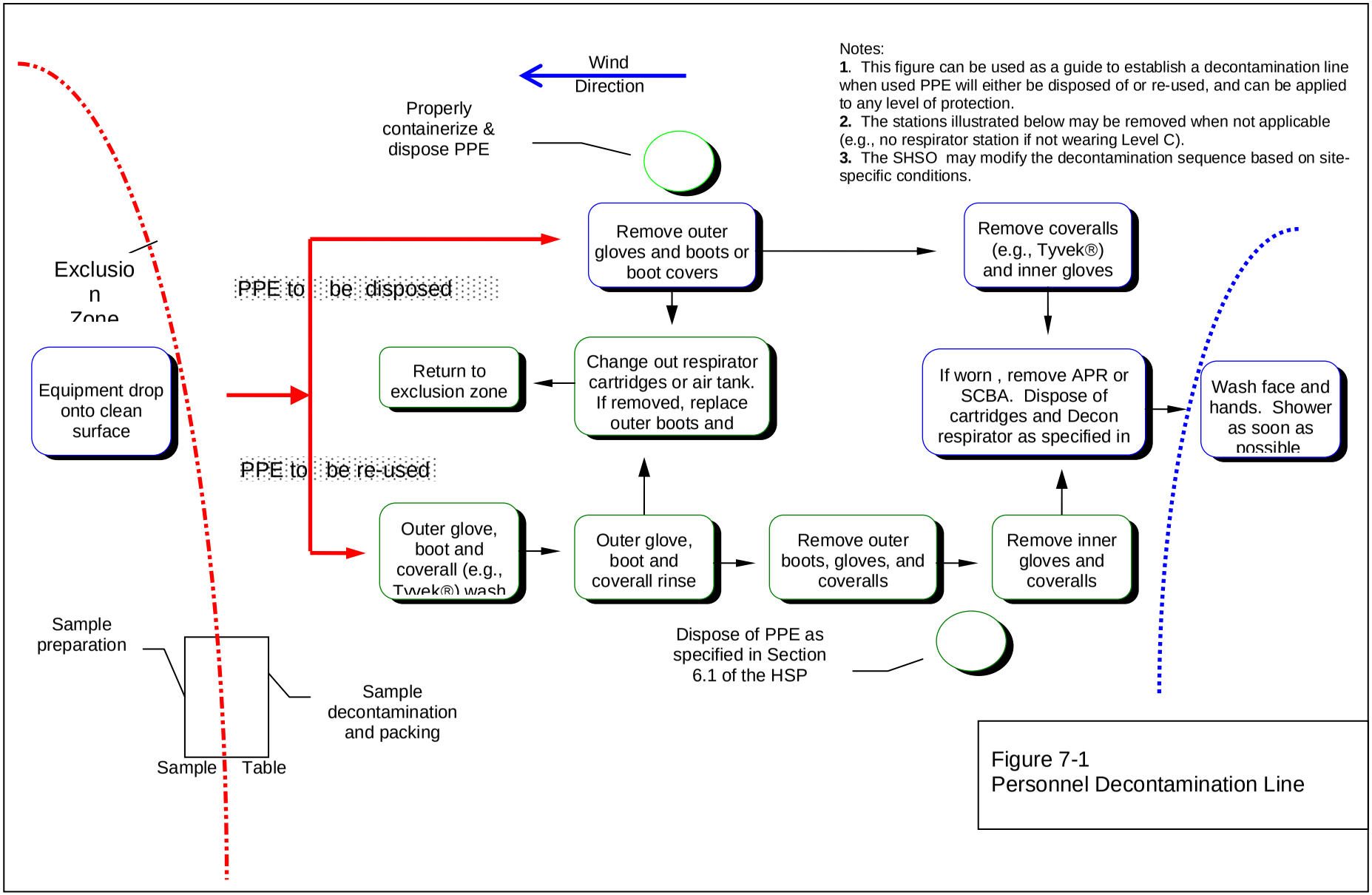
The SHSO must establish and monitor the decontamination procedures and their effectiveness. Decontamination procedures found to be ineffective will be modified by the SHSO. The SHSO must ensure that procedures are established for disposing of materials generated on the site.

7.1 Decontamination Specifications

Personnel	Sample Equipment	Heavy Equipment
• Boot wash/rinse • Glove wash/rinse • Outer-glove removal • Body-suit removal • Inner-glove removal • Respirator removal • Hand wash/rinse • Face wash/rinse • Shower ASAP • Dispose of PPE in municipal trash, or contain for disposal • Dispose of personnel rinse water to facility or sanitary sewer, or contain for offsite disposal	• Wash/rinse equipment • Solvent-rinse equipment • Contain solvent waste for offsite disposal	• Power wash • Steam clean • Dispose of equipment rinse water to facility or sanitary sewer, or contain for offsite disposal

7.2 Diagram of Personnel-Decontamination Procedures

Figure 7-1 is a flow chart of the Personnel Decontamination Line. No eating, drinking, or smoking is permitted in contaminated areas and in exclusion or decontamination zones. The SHSO should establish areas for eating, drinking, and smoking. Contact lenses are not permitted in exclusion or decontamination zones. In all cases, it is essential for workers to maintain good positive personal hygiene practices.



Notes:
1. This figure can be used as a guide to establish a decontamination line when used PPE will either be disposed of or re-used, and can be applied to any level of protection.
2. The stations illustrated below may be removed when not applicable (e.g., no respirator station if not wearing Level C).
3. The SHSO may modify the decontamination sequence based on site-specific conditions.

Figure 7-1
Personnel Decontamination Line

8.0 Spill-Containment Procedures

Sorbent material will be maintained in the support zone. Incidental spills will be contained with sorbent and disposed of properly.

8.1 Procedure for Containing/Collecting Spills

The initial response to any spill or discharge will be to protect human health and safety, and then the environment. Identification, containment, treatment, and disposal assessment will be the secondary response.

If for some reason a chemical spill is not contained within a dike or sump area, an area of isolation will be established around the spill. The size of the area will generally depend on the size of the spill and the materials involved. If the spill is large (greater than 55 gallons) and involves a tank or a pipeline rupture, an initial isolation of at least 100 ft in all directions will be used. Small spills (less than or equal to 55 gallons) or leaks from a tank or pipe will require evacuation of at least 50 ft in all directions to allow cleanup and repair and to prevent exposure. When any spill occurs, only those persons involved in overseeing or performing emergency operations will be allowed within the designated hazard area. If possible the area will be roped or otherwise blocked off.

If the spill results in the formation of a toxic vapor cloud (by reaction with surrounding materials or by outbreak of fire) and its release (due to high vapor pressures under ambient conditions), further evacuation will be enforced. In general, an area at least 500 feet wide and 1,000 feet long will be evacuated downwind if volatile materials are spilled. (Consult the DOT Emergency Response Guide for isolation distances for listed hazardous materials.)

If an incident may threaten the health or safety of the surrounding community, the public will be informed and possibly evacuated from the area. The on-site emergency coordinator will inform the proper agencies in the event this is necessary. An Emergency Contact List is provided in **Attachment 10**.

As called for in regulations developed under the comprehensive Environmental Response Compensation Liability Act of 1980 (Superfund), JV II's practice is to report a spill of a pound or more of any hazardous material for which a reportable quantity has not been established and which is listed under the Solid Waste Disposal Act, Clean Air Act, Clean Water Act, or TSCA. TSCA also follows the same practice for any substances not listed in the Acts noted above but which can be classified as a hazardous waste under Resource Conservation and Recovery Act (RCRA).

Cleanup personnel take the following measures:

- Ensure all unnecessary persons are removed from the hazard area.
- Put on protective clothing and equipment.
- If a flammable material is involved, remove all ignition sources, and use spark- and explosion-proof equipment for recovery of material.

- Remove all surrounding materials that could be especially reactive with materials in the waste. Determine the major components in the waste at the time of the spill.
- If wastes reach a storm sewer, dam the outfall by using sand, earth, sandbags, etc. Pump this material out into a temporary holding tank or drums as soon as possible.
- Place all small quantities of recovered liquid wastes (55 gallons or less) and contaminated soil into drums for incineration or removal to an approved disposal site.
- Spray the spill area with foam, if available, if volatile emissions may occur.
- Apply appropriate spill control media (e.g. clay, sand, lime, etc.) to absorb discharged liquids.
- For large spills, establish diking around leading edge of spill using booms, sand, clay or other appropriate material. If possible, use diaphragm pump to transfer discharged liquid to drums or holding tank.

9.0 Site-Control Plan

9.1 Site-Control Procedures

- Project managers and team leaders are to

  1) Evaluate and ensure worker safety in remote/secluded work areas,

  2) Confirm if potentially dangerous activities (i.e. coincidence of hunting seasons, live ordinance use, military field exercises/activities, transfer of dangerous or explosive cargo/materials, location of explosive arc zones etc.) could be occurring in or adjacent to any JV II work areas that may jeopardize worker health and safety and

  3) Reschedule field activities when potentially dangerous activities are not occurring adjacent to JV II work locations. Ensure proper two communications with workers in remote work areas. Utilize buddy system.

- **Designate an emergency evacuation route.**
- **Designate an evacuation assembly area.**
- The SHSO, or designee, will conduct a site safety briefing (see below) before starting field activities or as tasks and site conditions change.
- Topics for briefing on site safety: general discussion of Health and Safety Plan, site-specific hazards, locations of work zones, PPE requirements, equipment, special procedures, emergencies.
- The SHSO records attendance at safety briefings in a logbook and documents the topics discussed.
- Ensure that applicable JV II personnel have received the BBLPS Training
- Understand if there is a potential of being exposed to hazardous chemicals. If yes, what precautions/training are required?
- Establish support, decontamination, and exclusion zones. Delineate with flags or cones as appropriate. Support zone should be upwind of the site. Use access control at entry and exit from each work zone.
- Know how an emergency should be reported.
- Identify exact facility location and position (where possible) when contacting EMS/Fire Dispatch.
- Have readily available copy of the Hospital Route Map.
- Establish onsite communication consisting of the following:
  - Line-of-sight and hand signals
  - Air horn
  - Two-way radio or cellular telephone if available

- Establish offsite communication.
- Establish and maintain the "buddy system."
- Know how, what, when injuries/accidents are reported and treated.
- Initial air monitoring is conducted by the SHSO in appropriate level of protection.
- The SHSO or other authorized designee is to conduct periodic inspections of work practices to determine the effectiveness of this plan. Such inspections should identify site conditions or actions which are not consistent with the policies and procedures of the H&S program, report to the JV project Manager overall and JV HSM. The project team shall development and implement corrective action procedures in a timely manner.

9.2 Specific Site Control Measures

To prevent both exposure of unprotected personnel and migration of contamination, work areas and personal protective equipment requirements will be clearly identified. Many of the work areas for the general sampling activities may be a simple as placing cones around the work area. For the soil sampling activities, this HSP recommends that the area surrounding each of the work areas be divided into three (3) distinct zones; the exclusion zone (EZ), the contamination reduction zone (CRZ), and the support zone (SZ).

Only individuals who meet the requirements of 29 CFR 1910.120/29CFR1926.65 and who are authorized by the JV II individual responsible for site operations or the SHSO shall be allowed entry into the EZ and CRZ. Suitable means and methods (high visibility fencing, caution tape signage, other physical barriers) shall be employed to demarcate the EZ and CRZ boundaries at this site to prevent unauthorized entry into these controlled work zones. A CRZ for decontamination shall be established adjacent to the EZ. The SZ shall be kept free from contamination.

A typical EZ/CRZ/SZ representation is illustrated in Section 7.0 Decontamination, Figure 7-1.

9.2.1 Exclusion Zone

An EZ will be constructed to surround each work area where the greatest potential for worker exposure to identified site COCs may exist. The EZ may need to be transient as the work progresses, depending upon the type of work that is being executed. Because of potential site space limitations, the exclusion zone fencing may also include any available "permanent" perimeter fencing or other established physical barriers. Note that the term "permanent" is often used to describe the outer limits (or perimeter) of a work site or designated site area. Other temporary barriers (i.e. caution tape, high visibility construction fencing); maybe used to supplement existing permanent barriers to demarcate the EZ to identify the restricted access. Access to the EZ will be restricted to personnel wearing the prescribed level of protective equipment and meeting the training and medical criteria of this plan.

9.2.2 Contamination Reduction Zone

Each CRZ zone will be a clearly marked corridor between the EZ and the SZ. The CRZ for each area will be located immediately adjacent to the EZ This area will be identified with yellow tape, high visibility construction fencing or other suitable barriers.

The CRZ is where personnel will begin the sequential decontamination process when exiting the EZ. To prevent cross contamination and for accountability purposes, all personnel must enter and leave the EZ through the CRZ.

Contaminated personnel and equipment will exit the EZ directly to the CRZ. Each CRZ will contain a constructed decontamination stations for personnel and equipment. If possible, the CRZ will be located upwind of each EZ, however due to site constraints this may not be possible. Temporary support zones for each work area will be located adjacent to the CRZs.

9.2.3 Support Zone

Temporary support zones and staging areas will be established at the entrance of each control area. Potable water, an eye wash, and first aid supplies will be located at each temporary support zone. No hazardous or potentially hazardous materials will be allowed in the support zone unless it is in a properly labeled container that has no external contamination. Eating, drinking and smoking will only be allowed in this area, at designated locations.

Portable bathroom facilities will be located near the work areas. In addition, potable water and water and soap for hand washing will be available at the support zone, along with containers for solid waste for use by site personnel, in addition to first aid stations and administrative information.

9.3 HAZWOPER Compliance Plan

Certain parts of the site work are covered by state or federal HAZWOPER standards and therefore require training and medical monitoring. Anticipated HAZWOPER tasks (Section 1.4 or otherwise determined) might occur consecutively or concurrently with respect to non-HAZWOPER tasks. This section outlines procedures to be followed when approved activities specified in Section 1.5 do not require 24- or 40-hour training. Non-HAZWOPER-trained personnel also must be trained in accordance with all other state and federal OSHA requirements.

- In many cases, air sampling, in addition to real-time monitoring, must confirm that there is no exposure to gases or vapors before non-HAZWOPER-trained personnel are allowed on the site, or while non-HAZWOPER-trained staff are working in proximity to HAZWOPER activities. Other data (e.g., soil) also must document that there is no potential for exposure. The HSM must approve the interpretation of these data.
- When non-HAZWOPER-trained personnel are at risk of exposure, the SHSO must post the exclusion zone and inform non-HAZWOPER-trained personnel of the:
  - Nature of the existing contamination and its locations
  - Limitations of their access

  - Emergency action plan for the site

- Periodic air monitoring with direct-reading instruments conducted during regulated tasks also should be used to ensure that non-HAZWOPER-trained personnel (e.g., in an adjacent area) are not exposed to airborne contaminated media.

- When exposure is possible, non-HAZWOPER-trained personnel must be removed from the site until it can be demonstrated that there is no longer a potential for exposure to health and safety hazards.

10.0 Emergency Response Plan

10.1 Pre-Emergency Planning

(Reference SOP # HSE&Q 106, Emergency Planning)

The SHSO performs the applicable pre-emergency planning tasks before starting field activities and coordinates emergency response with JV II on-site parties, the facility, and local emergency-service providers as appropriate.

- **JV II personnel shall review and implement all applicable components of CH2MHILL SOP # HSE&Q 106 Emergency Planning, except where other requirements may be more stringent.**
- Review the facility emergency and contingency plans where applicable.
- Determine what on-site communication equipment is available (e.g., two-way radio, air horn).
- Determine what off-site communication equipment is needed (e.g., nearest telephone, cell phone).
- Confirm and post emergency telephone numbers, evacuation routes, assembly areas, and route to hospital; communicate the information to on-site personnel.
- Review changed site conditions, on-site operations, and personnel availability in relation to emergency response procedures.
- Where appropriate and acceptable to the client, inform emergency room and ambulance and emergency response teams of anticipated types of site emergencies.
- Designate one vehicle as the emergency vehicle; place hospital directions and map inside; keep keys in ignition during field activities.
- Inventory and check site emergency equipment, supplies, and potable water.
- Communicate emergency procedures for personnel injury, exposures, fires, explosions, and releases.
- Rehearse the emergency response plan before site activities begin, including driving route to hospital.
- Brief new workers on the emergency response plan.

The SHSO will evaluate emergency response actions and initiate appropriate follow-up actions.

10.2 Emergency Equipment and Supplies

The SHSO should mark the locations of emergency equipment on the site map and post the map. Equipment and locations are listed below.

Emergency Equipment and Supplies	Location
20 LB (or two 10-lb) fire extinguisher (A, B, and C classes)	Support Zone/Heavy Equipment
First aid kit	Support Zone/Field Vehicle
Eye Wash	Support & Decon Zone/Field Vehicle
Potable water	Support & Decon Zone/Field Vehicle
Bloodborne-pathogen kit	Support Zone/Field Vehicle
Additional equipment (specify): Mobile phone, 2.5 lb fire extinguisher (A, B, and C classes)	Support Zone/Field Vehicle

10.3 Incident Reporting, Investigation and Response

For any accident meeting the definition of **Recordable Occupational Injuries or Illnesses or Significant Accidents**, the Atlantic Division, NAVFAC Contracting Officer and Navy Technical Representative (NTR) will be notified by the JV II Project Manager (overall) soon as practical, **but not later than four hours after occurrence.** In the event that the overall JV Project Manager is not available, notification maybe made by the designated JV II individual responsible for site operations, but **only** after consultation with the JV II Program or Deputy Program Managers. All other incidents must be reported to Atlantic Division, NAVFAC within 24 hours of incident occurrence. Only authorized JV II personnel (Program Manager and/or Deputy Program Manager, overall JV Project Manager) may make notification to NAVFAC Atlantic Division regarding project accidents, injuries or illnesses.

In order for the incident to be assessed for reportability purposes, it is imperative that **all personal injuries, near misses, or property damage incidents involving JV II or subcontractor project personnel be reported IMMEDIATELY to the chain of command personnel identified in Section 10.7 and Attachment 10 of this HSP.** The following information shall be provided:

Date and time of incident
Project name and project number
Name and worker classification
Extent of known injuries
Level of medical attention
Injury cause
Witnesses

A written incident investigation will be performed and submitted to the HSM within 24 hours of incident occurrence by the completing the Incident Report, Near-Loss Investigation and Root Cause Analysis provided in the HSP Attachments.

In fires, explosions, or chemical releases, actions to be taken include the following:

- Shut down JV II operations and evacuate the immediate work area.
- Notify appropriate response personnel.
- Account for personnel at the designated assembly area(s).
- Assess the need for site evacuation, and evacuate the site as warranted.

Instead of implementing a work-area evacuation, note that small fires or spills posing minimal safety or health hazards may be controlled.

10.4 Emergency Medical Treatment

The procedures listed below may also be applied to non-emergency incidents. JV II employee injuries and illnesses must also be reported to the Human Resources contact in **Attachment 10**, once the notification requirements identified in Figure 10-7 have been fulfilled. If there is doubt about whether medical treatment is necessary, or if the injured person is reluctant to accept medical treatment, contact the designated medical consultant, as applicable. During non-emergencies, follow these procedures as appropriate.

- Notify appropriate emergency response authorities (e.g., 911).
- The SHSO will assume charge during a medical emergency until the ambulance arrives or until the injured person is admitted to the emergency room.
- Prevent further injury.
- Initiate first aid and CPR where feasible.
- For life threatening emergencies, get or summon medical attention immediately.
- Perform decontamination where feasible; lifesaving and first aid or medical treatment take priority.
- Make certain that the injured person is accompanied to the emergency room.
- When contacting the medical consultant, give your name and telephone number, the name of the injured person, the extent of the injury or exposure, and the name and location of the medical facility where the injured person was taken.
- Report incident as outlined in Section 10.3.
- **A map showing the route to the local hospital is shown on Figure 10-4.**
- **For CH2MHILL personnel who experience a minor non-life threatening emergency that requires medical attention, please refer to Attachment 10 for the "Emergency Nurse Instructions" and "Initial Medical Treatment Form".**

FIGURE 10-4
Hospital Route Map From Mainside

Directions to Hospital From Mainside

Onslow County Memorial Hospital, 317 Western Blvd:
Phone: 910-557-2345

Summary: 6.1 miles (12 minutes)

Mile	Instruction	For
0.0	**Depart Mainside on Camp Lejeune (North)**	**0.3 mi**
0.3	Turn RIGHT (East) onto US-17 [Ocean Hwy]	2.7 mi
2.9	Continue (East) on Ramp	142 yds
3.0	Merge onto SR-24 [Johnson Blvd] (South-East)	2.8 mi
5.8	Turn LEFT (North) onto Western Blvd	0.3 mi
6.1	**Arrive Onslow Memorial Hospital [317 Western Blvd, Jacksonville, NC 28546]**	

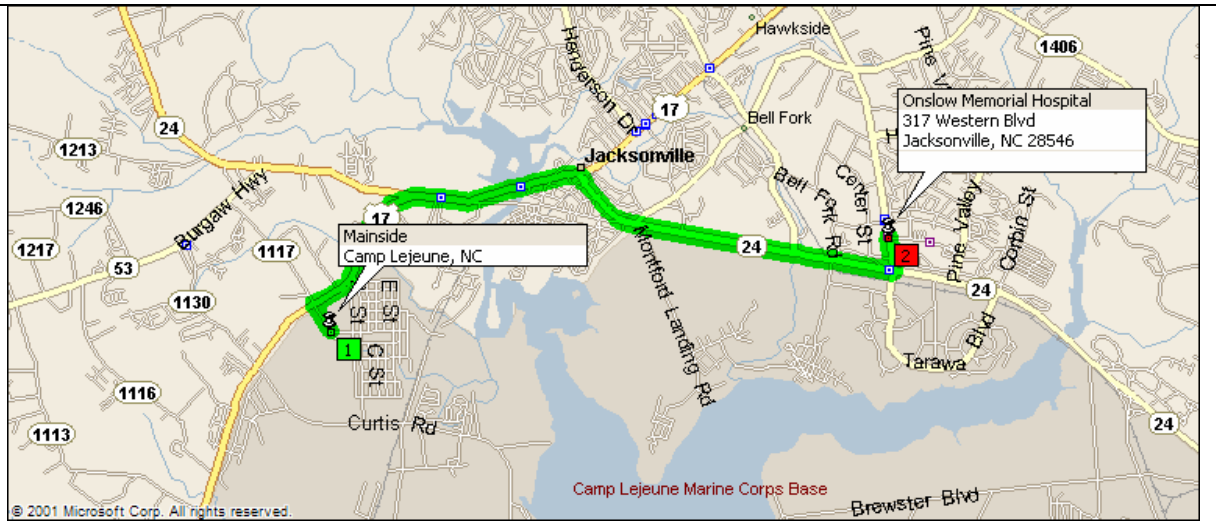


FIGURE 10-5
Hospital Route Map From Air Station

Directions to Hospital From Air Station

Onslow County Memorial Hospital, 317 Western Blvd:
Phone: 910-557-2345

Summary: 7.2 miles (15 minutes)

Mile	Instruction	For
0.0	**Depart Air Station on Curtis Rd (West)**	**0.5 mi**
0.5	Turn RIGHT (North) onto A St	1.2 mi
1.7	Turn LEFT (West) onto Camp Lejeune	120 yds
1.8	Turn RIGHT (North) onto US-17	2.3 mi
4.0	Continue (East) on Ramp	142 yds
4.1	Merge onto SR-24 [Johnson Blvd] (South-East)	2.8 mi
7.0	Turn LEFT (North) onto Western Blvd	0.3 mi
7.2	**Arrive Onslow Memorial Hospital [317 Western Blvd, Jacksonville, NC 28546]**	

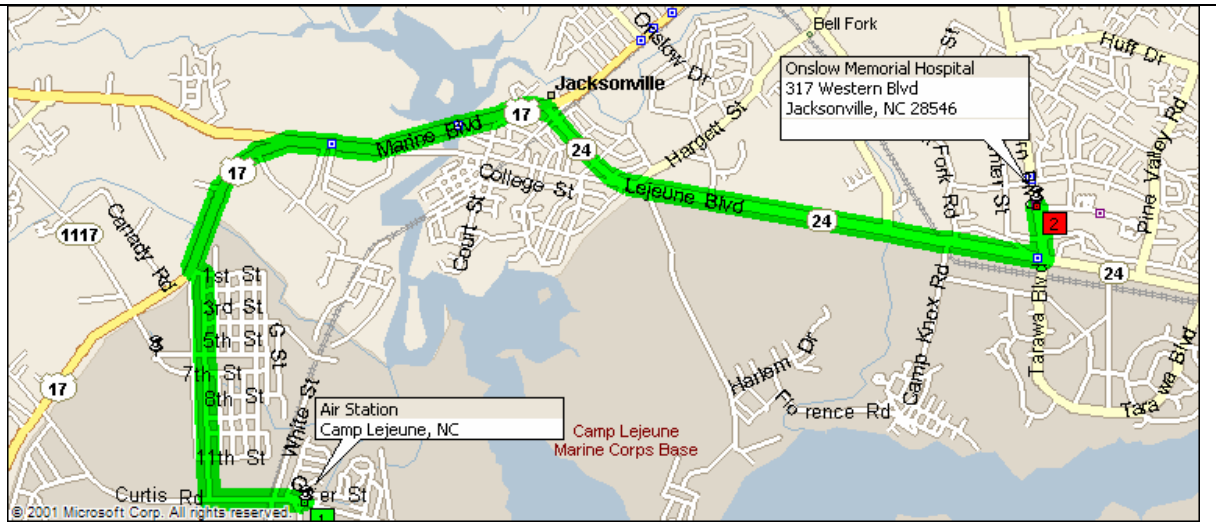


FIGURE 10-6
Hospital Route Map From Hadnot Point

Directions to Hospital From Hadnot Point

Onslow County Memorial Hospital, 317 Western Blvd:
Phone: 910-557-2345

Summary: 6.6 miles (15 minutes)

Mile	Instruction	For
0.0	**Depart Hadnot Point on Holcomb Blvd (North)**	**4.1 mi**
4.1	Bear LEFT (North-West) onto SR-24 [Freedom Way]	2.3 mi
6.4	Turn RIGHT (North) onto Western Blvd	0.3 mi
6.6	**Arrive Onslow Memorial Hospital [317 Western Blvd, Jacksonville, NC 28546]**	

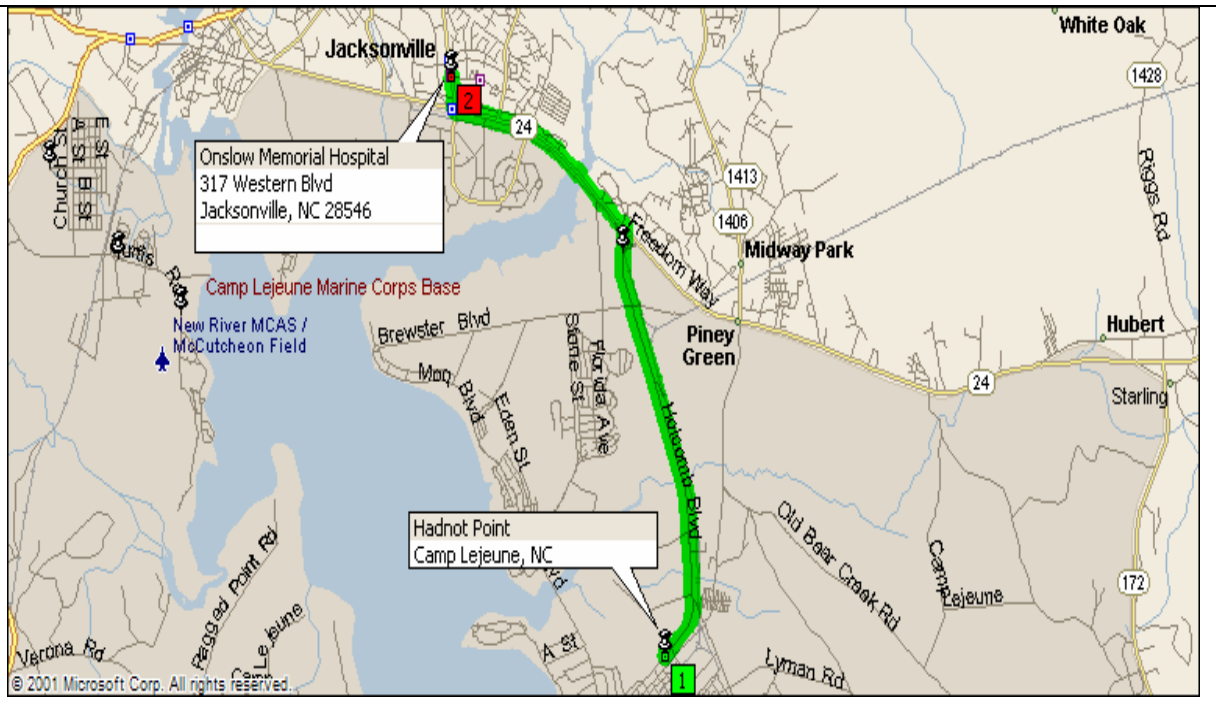


FIGURE 10-7
Hospital Route Map From Camp Geiger

Directions to Hospital From Camp Geiger

Onslow County Memorial Hospital, 317 Western Blvd:
Phone: 910-557-2345

Summary: 6.6 miles (14 minutes)

Mile	Instruction	For
0.0	**Depart Camp Geiger on 9th St (West)**	**0.3 mi**
0.3	Turn RIGHT (North) onto A St	0.8 mi
1.0	Turn LEFT (West) onto Camp Lejeune	120 yds
1.1	Turn RIGHT (North) onto US-17	2.3 mi
3.4	Continue (East) on Ramp	142 yds
3.4	Merge onto SR-24 [Johnson Blvd] (South-East)	2.8 mi
6.3	Turn LEFT (North) onto Western Blvd	0.3 mi
6.6	**Arrive Onslow Memorial Hospital [317 Western Blvd, Jacksonville, NC 28546]**	

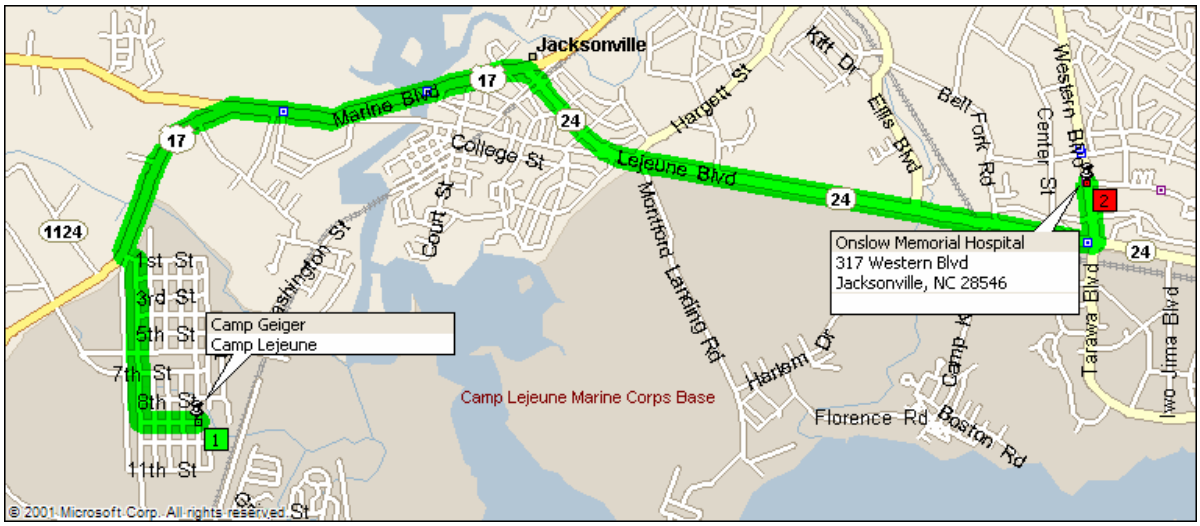


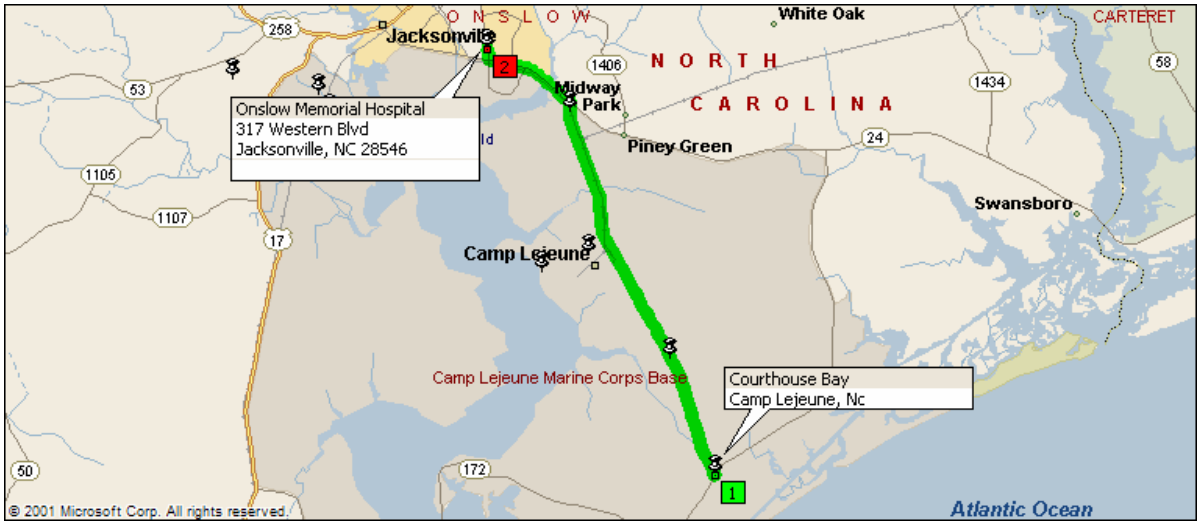
FIGURE 10-8
Hospital Route Map From Courthouse Bay

Directions to Hospital From Courthouse Bay

Onslow County Memorial Hospital, 317 Western Blvd:
Phone: 910-557-2345

Summary: 12.7 miles (30 minutes)

Mile	Instruction	For
0.0	**Depart Courthouse Bay on Local road(s) (West)**	**32 yds**
0.1	Turn RIGHT (North) onto SR-172 [Sneads Ferry Rd]	0.1 mi
0.1	Bear LEFT (North-West) onto Sneads Ferry Rd	6.6 mi
6.7	Turn RIGHT (North) onto Holcomb Blvd	3.4 mi
10.2	Bear LEFT (North-West) onto SR-24 [Freedom Way]	2.3 mi
12.5	Turn RIGHT (North) onto Western Blvd	0.3 mi
12.7	**Arrive Onslow Memorial Hospital [317 Western Blvd, Jacksonville, NC 28546]**	



10.5 Evacuation

- Evacuation routes and assembly areas (and alternative routes and assembly areas) are specified on the site map.
- Evacuation route(s) and assembly area(s) will be designated by the SHSO before work begins.
- Personnel will assemble at the assembly area(s) upon hearing the emergency signal for evacuation.
- The SHSO and a "buddy" will remain on the site after the site has been evacuated (if safe) to assist local responders and advise them of the nature and location of the incident.
- The SHSO will account for all personnel in the onsite assembly area.
- A designated person will account for personnel at alternate assembly area(s).
- The HSO will write up the incident report as soon as possible after it occurs and submit a report to the Corporate Health and Safety Manager.
- A Hurricane Preparedness Plan is included as Attachment 16 to be followed in the event of severe weather.

10.6 Evacuation Signals

Evacuation signals are listed below.

Signal	Meaning
Grasping throat with hand	Emergency-help me.
Thumbs up	OK; understood.
Grasping buddy's wrist	Leave area now.
Continuous sounding of horn	Emergency; leave site now.

10.7 Incident Notification and Reporting

- Upon any project incident (fire, spill, accident, injury/illness, near miss, property damage, death, etc.), immediately notify the Project Manager (overall) and HSM. Figure 10-7 below identifies the JV II Incident Reporting Process.
- For JV II work-related injuries or illnesses, contact the respective resources on the emergency contact list in **Attachment 10** of this HSP. For JV II incidents, the SHSO or individual responsible for site operations completes an Incident Report Form (IRF). In

some cases, this can be completed by the employee. The IRF must be completed within 24 hours of incident.

- For JV II subcontractor incidents, complete the Subcontractor Accident/Illness Report Form and submit to the HSM.
- Notify and submit reports to client as required in contract

Figure 10-9

JV II Incident Reporting Process & Chain of Command

11.0 Approval

This site-specific Health and Safety Plan has been written for use by JV II only. JV II claims no responsibility for its use by others unless that use has been specified and defined in project or contract documents. The plan is written for the specific site conditions, purposes, dates, and personnel specified and must be amended if those conditions change.

11.1 Original Plan

Prepared By: Alison Harwood, CSP **Date: April 9, 2008**

Alison Harwood

Approved By: Richard Rathnow **Date: April 23, 2008**

11.2 Revisions

Revisions Made By: **Date:**

Revisions to Plan:

Revisions Approved By: **Date:**

EMPLOYEE SIGNOFF FORM

Task Order 021 Health and Safety Plan

JV II project employees and subcontractors listed below have been provided with a copy of this Health and Safety Plan, have read or been briefed on its contents and agree to abide by its provisions.

Project Name: **Task Order:**

EMPLOYEE NAME (Please print)	**EMPLOYEE SIGNATURE**	**COMPANY**	**DATE**

Attachment 2

Subcontractor H&S Tracking Form

Subcontractor H&S Tracking Form

Project Name: **Task Number:** **Date:**

Subcontractor		Completed as Needed						Completed Within the Last 12 Months		
Name	Company	40-hour Training	8-hour Site Supervisor Training	Confined Space Entry Training	FA/CPR /BBP	Hazard Specific Training	Equipment Specific Training	Med Clearance	Fit Test	8-hour Refresher Training
		Enter "√" if Completed						Enter Date Last Completed		

22. Hazard Specific Training may include: Hazcom, asbestos, lead, fall protection, electrical, lock-out tag-out, drilling, demolition, etc.
23. Equipment Specific Training may include: Industrial (fork) truck, aerial lift, crane, portable extinguisher, respirator, scaffolding, etc.
24. Medical Clearance documents must **not** include actual medical reports. Only accept a signed physician's statement of fitness to work.

Attachment 3

Project H&S Forms/Permits

EQUIPMENT INSPECTION FORM

This form will be used to document JV II's earthmoving equipment inspections. Earthmoving equipment will be inspected each day and shift prior to use. All components will be inspected for damage and proper operation. Any component failing the inspection will be corrected prior to earthmoving equipment use. Check each box after passing inspection and initial bottom of form each day.

Equipment Name: _____ Identification #: _____ Week of: _____

INSPECTION ITEM	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sa**	**Sun**
Visual Checks							
Operating manual – present							
Controls - labeled as to their function, visible and legible, safety latches/guards present							
Tires/tracks – proper inflation/tension, not excessively worn or damaged							
Fluid levels/leaks - engine, transmission, hydraulic, radiator, swing motor and PTO oils.							
Lubrication - to the manufacturer's specifications							
Air filter gauge - gauge is not in the red zone.							
Hydraulics – no fluid leaks, connections tight, hoses, cylinders free of damage.							
Hoses/belts – held securely, not loose or rubbing, no excessive wear or crimping							
Fuel system - tank free of damage, all valves/hoses secure, no leaks							
Body & ground-engaging tools – no damage, cracks, bends, or excessive wear.							
Cylinders/articulation joints– no worn pins, loose connections or other damage.							
Roll-over protective structures (ROPS) - no damage, no cracks or bends							
Seat belt/bar – required unless operator stands or no ROPS							
Handrails, steps, platforms – clean, free from grease, oil, clear of obstructions.							
Cab glass – safety glass, clean, no cracks or visible distortion							
Mirrors – properly adjusted, no cracks or visible distortion							
Windshield wipers, fluid, and defroster - functioning							
Machine guards – present and in good condition							
1. Fire extinguisher – present and charged							
Operational Checks – check items through normal maneuvers							
Horn & back-up alarm – operating and distinguishable from surrounding noise							
Lights, directional signals, and brake lights - functioning							
Gauges/indicators – visible and working properly							
Operating controls - lift and tilt functioning properly							
Outriggers, if present – functioning properly							
Accelerator - even acceleration, does not stick							
Brakes (service & parking) - brings to complete stop, holds in fixed position							
Steering – responsive, minimal looseness							
Exhaust system – guarded if potential for contact, no signs of sparks/leaks							
Inspector's Initials							

AGVIQ-CH2MHILL Joint Venture (JV) employees who are required to operate earthmoving equipment will be evaluated and approved as qualified earthmoving equipment operators by an authorized JV Earthmoving Equipment Operator Evaluation Designated Persons (DP).

This form will be used by the DP to assess, approve, and document the qualifications of JV II employees who are required to operate earthmoving equipment.

Employee (Operator) Name: _____ Employee #: _____

Company: _____ Business Group: _____ Region: _____

Type of equipment to be operated:_____

1. Background Review

Resume and other documentation (training certificates) will be reviewed and verified with previous employers. The individual will also possess a valid driver's license. This review should take place prior to hiring.

☐ Background Review found to be adequate. Date: ___/___/____ DP initials: _____

2. Classroom Evaluation

a. Employee will read and understand the manufacturer's Equipment Operation Manual for the specific piece of equipment to be operated.
b. Employee will read and understand the CH2M HILL *Earthmoving Equipment* (HSE-306) and *Excavations* (HSE-307) Standards of Practice.
c. DP will discuss safe operating practices with the employee.
d. Employee will pass CH2M HILL written earthmoving equipment operator exam. (See Attachment 4 for exam guidelines)

☐ Classroom Evaluation successfully completed. Date: ___/___/____ DP initials: _____

3. Field Evaluation

a. Equipment Awareness, Inspection and Maintenance

The DP will observe the employee perform a daily inspection using the Earthmoving Equipment Inspection Form. The employee will demonstrate the ability to recognize deficient conditions that could affect the safe operation of the equipment. In addition, the operator will demonstrate awareness of the following:

☐ Location of vital fluid reservoirs
☐ Location of all lubrication points
☐ Proper fueling procedures
☐ Location and function of safety disabling devices (if equipped)
☐ Location and function of safety devices (fire extinguisher, back-up alarm, seat belt/bar, guards)
☐ Location of manufacturer warning labels, weight of equipment, and lift capacities labels
☐ Location and function of all gauges, indicators and controls (horn, lights, mirrors, etc.)
☐ Acceptable conditions for passing items during daily inspections
☐ Periodic maintenance requirements

b. Equipment Operation

The DP will observe the employee operating the equipment through normal maneuvers. The employee will demonstrate the ability to operate the equipment safely and in accordance with the manufacturer's guidelines.

- ☐ Demonstrates ability to safely start equipment in preparation for use (proper start-up sequence followed)
- ☐ Understands function and proper appearance of all gauges and indicators
- ☐ Understands location and use of all equipment controls
- ☐ Checks front, side, and rear of equipment for pedestrians, traffic and obstructions
- ☐ Demonstrates smooth and safe equipment travel
- ☐ Demonstrates smooth and safe control operations
- ☐ Demonstrates safe loading and binding of equipment for travel
- ☐ Demonstrates normal shut-down procedures
- ☐ Demonstrates emergency shut-down procedures
- ☐ Demonstrates safe parking and storage of equipment

☐ Field Evaluation successfully completed. Date: ___/___/____ DP initials: _____

Operator Acknowledgement

I have reviewed and understand all of the information listed above. I also understand that as an operator of this equipment, I am responsible for daily inspections and maintenance as well as the safe and efficient operation of the equipment listed above.

_____	_____	_____
Operator Name	Signature	Date

Qualification approval

The employee has completed the earthmoving equipment operator evaluation process and is qualified to operate the type of earthmoving equipment identified above.

_____	_____	_____
DP Name	Signature	Date
_____	_____	_____
HS&E Name	Signature	Date

A copy of this evaluation form will be maintained in the project file and the original sent to the HS&E department for retention.

Stop Work Order Form

REPORT PREPARED BY:

Name:	Title:	Signature:	Date:

ISSUE OF NONPERFORMANCE

Description:_____	Date of Nonperformance:
_____ _____ _____ _____ _____	_____

SUBCONTRACTOR SIGNATURE OF NOTIFICATION:

Name:	Title:	Signature:	Date:

** Corrective action is to be taken immediately. Note below the action taken, sign and return to CCI.**

SUBCONTRACTOR'S CORRECTIVE ACTION

Description:_____	Date of Corrective Actions:
_____ _____ _____ _____ _____	_____

SUBCONTRACTOR SIGNATURE OF CORRECTION:

Name:	Title:	Signature:	Date:

Attachment 4

Material Safety Data Sheets
(provided onsite as materials are delivered)

Attachment 5

Chemical Specific Training Form &

Project-Specific Chemical Product Hazard Communication Form

CHEMICAL-SPECIFIC TRAINING FORM

Location:	Task Order:
HCC:	Trainer:

TRAINING PARTICIPANTS:

NAME	SIGNATURE	NAME	SIGNATURE

REGULATED PRODUCTS/TASKS COVERED BY THIS TRAINING:

The HCC will use the product MSDS to provide the following information concerning each of the products listed above.

☐ Physical and health hazards

☐ Control measures that can be used to provide protection (including appropriate work practices, emergency procedures, and personal protective equipment to be used)

☐ Methods and observations used to detect the presence or release of the regulated product in the workplace (including periodic monitoring, continuous monitoring devices, visual appearance or odor of regulated product when being released, etc.)

Training participants will have the opportunity to ask questions concerning these products and, upon completion of this training, will understand the product hazards and appropriate control measures available for their protection.

Copies of MSDSs, chemical inventories, and the written hazard communication program will be made available for employee review in the facility/project hazard communication file.

Project-Specific Chemical Product Hazard Communication Form

This form must be completed prior to performing activities that expose personnel to hazardous chemicals products. Upon completion of this form, the SHSO will verify that training is provided on the hazards associated with these chemicals and the control measures to be used to prevent exposure to JV II and subcontractor personnel. Labeling and MSDS systems will also be explained.

Project Name: **Task Order:**

MSDS's will be maintained at the following location(s):

Hazardous Chemical Products Inventory

Chemical	Quantity	Location	MSDS Available	Container labels	
				Identity	Hazard

Refer to SOP HS-107 *Hazard Communication* for more detailed information.

Attachment 6

Activity Hazard Analyses (AHAs)

Task Order 021 MCB Camp Lejeune – Vapor Intrusion Evaluation ACTIVITY HAZARD ANALYSIS – Utility Survey			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Utility Surveys	Slips, trips, falls	• Be aware of poor footing, potential slipping/tripping hazards in the work area (i.e. wet/muddy areas or slopes, unprotected holes, ditches, rip rap, utilities or other ground protrusions). Identify and avoid these areas. Wear sturdy hard toe work boots with sufficient ankle support (preferably leather). • Watch foot placement while traversing through wooded areas with briars and heavy brush. • Good housekeeping must be maintained at all times in all project work areas. Common paths of travel should be established and kept free from the accumulation of materials.	Standard Level D PPE * * Appropriate work clothes, reflective vests/ high visibility clothing, hard hat, safety glasses and sturdy hard toed work boots, hand and hearing protection (as applicable)
	High Ambient Temperature	• Provide fluids to prevent worker dehydration. • Monitor for heat stress in accordance with HSP (maintain use of buddy system). • Institute a proper work-break regiment to avoid heat stress symptoms and overexertion.	Standard Level D PPE (light colored/weight, breathable clothing)
	Noise	• Personnel exposed to aircraft or other loud noise to wear hearing protection.	Standard Level D PPE
	Visible Lighting	• Perform tasks in daylight hours whenever possible. If dawn, dusk or dark work is to be performed portable lightly must be provided to sufficient illuminate work area(s). If sufficient lighting in the work area is not possible, additional sources of lighting must be provided.	Standard Level D PPE
	Cuts & Abrasions	• Wear long sleeve clothing and proper PPE (eye protection, hard hats, leather gloves, sturdy hard toe boots) when traversing through wooded areas.	Standard Level D PPE
	Manual Lifting	• JV personnel must notify supervisors or safety representatives of preexisting medical conditions that may be aggravated or re-injured by lifting activities. • When lifting objects, lift using knees not back. For repetitive lifting tasks, the use of lifting braces/supports may be considered. If heavy equipment isn't available to have someone assist with the lift— especially for heavy (> 40lbs.) or awkward loads. Use heavy equipment (if available) or site vehicles to transfer heavy or awkward loads wherever possible. • Plan storage and staging to minimize lifting or carrying distances. Make sure the path of travel is clear prior to the lift. • Avoid carrying heavy objects above shoulder level.	Standard Level D PPE
	Biological	• Observe areas for presence of stinging or biting or stinging insects and nests such as spiders (widows/recluse), bee/wasp hives, fire ants mounds etc. Frequently check body and clothing for ticks, chiggers, spiders. • Prior to starting field activities, notify supervisors of known allergies to stinging insects and location and quantity of antidote in the event the employee becomes incapacitated as a result of an insect bite. • Observe work area for presence of snakes (cottonmouth as primary, copperhead and rattlers as secondary). • Observe wetland/creek, river areas for presence of alligators (nests, eggs) • Protect yourself from and avoid exposure to blood bourn pathogens when applying first aid. • Consider utilizing insect repellent. For personnel sensitive to skin rashes, consider the use of products with lower s DEET concentrations such as "children's cutters" or "skin so soft" products.	Standard Level D PPE

Task Order 021 MCB Camp Lejeune – Vapor Intrusion Evaluation ACTIVITY HAZARD ANALYSIS – Utility Survey			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Utility Surveys (cont.)	Struck /Pinched By	• Wear reflective vests or high visibility clothing in heavily wooded areas, areas were heavy equipment/troop activities/hunting may be occurring or where vehicular traffic exists.	Standard Level D PPE
	Other	• Always using a seat belt while driving on military/government facilities. Always observe posted speed limits, traffic signs and signals. Never using a cell phone or two way radio while driving on military/government facilities. Violating these rules may result in loss of military/government facility driving privileges. • Drive 5 mph when driving past troops on maneuvers. If drive past troops on maneuvers could interrupt their activities, vehicle drivers are to bring vehicles to a complete stop in a safe location and yield to troop activities. • Shut down operations in heavy rain, wind and/or lightning. At first sight of lightning, operations shall be stopped and only resumed when conditions permit. The lightning safety recommendation is 30-30: Seek refuge when thunder sounds within 30 seconds after a lightning flash; and do not resume activity until 30 minutes after the last thunder clap. • Buddy System maintained for all phases of work. • Base or local Emergency Dispatch numbers programmed into cellular phones. Have hospital route maps readily available. • Report all conditions which may create accidents, injury, illness or property damage to supervisors immediately.	NA

EQUIPMENT REQUIRED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Utility Survey Instruments • First Aid Kits/Bloodborne Pathogen Kit • Portable Eye Wash	• Visual Inspections of designated work areas identify and address hazardous conditions.	• Review AHA/PTSP with all task personnel. • Review HSP. • 1st Aid/CPR trained individuals on-site. .

PRINT	SIGNATURE		
Supervisor Name:	_____	_____	Date/Time:_____
Safety Officer Name:	_____	_____	Date/Time:_____
Site Personnel:	_____	_____	Date/Time:_____
	_____	_____	Date/Time:_____
	_____	_____	Date/Time:_____
	_____	_____	Date/Time: _____
	_____	_____	Date/Time:_____
	_____	_____	Date/Time:_____
	_____	_____	Date/Time:_____
	_____	_____	Date/Time:_____
	_____	_____	Date/Time:_____
	_____	_____	Date/Time:_____
	_____	_____	Date/Time:_____
	_____	_____	Date/Time:_____
	_____	_____	Date/Time:_____

Task Order 021 MCB Camp Lejeune – Vapor Intrusion Evaluation ACTIVITY HAZARD ANALYSIS – Mobilization/Site Preparation/Demobilization (Non Intrusive)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Mobilization/Site Preparation/ Demobilization	Manual Lifting	• JV II personnel must notify supervisors or safety representatives of preexisting medical conditions that may be aggravated or re-injured by lifting activities. • When lifting objects, lift using knees not back. For repetitive lifting tasks, the use of lifting braces/supports may be considered. If heavy equipment isn't available to have someone assist with the lift— especially for heavy (> 40lbs.) or awkward loads. Use heavy equipment to transfer heavy or awkward loads wherever possible. • Plan storage and staging to minimize lifting or carrying distances. Make sure the path of travel is clear prior to the lift. • Avoid carrying heavy objects above shoulder level. • Do not climb on objects not designed for access by personnel without proper fall protection.	Standard Level D PPE * * Work clothes, reflective vests/ high visibility clothing, hard hat, safety glasses and sturdy hard toed work boots, hand and hearing protection, as dictated by task.
	Slips, Trips, Falls	• Be aware of poor footing, potential slipping/tripping hazards in the work area, such as wet/steep slopes, stumps/roots, unprotected holes, ditches, rip rap, utilities, ground protrusions. Observe, mark and avoid these identified site areas. Use sturdy, hard toe work boots with sufficient ankle support. • Institute and maintain good housekeeping practices.	Standard Level D PPE *
	Noise	• Personnel exposed to loud working environments shall wear hearing protection.	Standard Level D PPE *
	High Ambient Temperature	• Provide fluids to prevent worker dehydration. • Monitor for heat stress in accordance with HSP (maintain use of buddy system). • Institute a proper work-break regiment to avoid heat stress symptoms and overexertion.	Standard Level D PPE (light colored/weight, breathable clothing)
	Fire Prevention	• Use only metal safety cans for storage and transfer of fuel. • Secure flammable storage lock-up (vented) for flammable/combustible material storage. • Use funnels and nozzles during fueling operations. • Appropriately sized, easily accessible ABC fire extinguisher in work area. • Review and be cognizant of MCB LEJUENE Fire Prevention Procedures and Requirements	Standard Level D PPE *
	Visible Lighting	• Perform tasks in daylight hours whenever possible. If dawn, dusk or dark work is to be performed portable lighting must be provided to sufficient illuminate work area(s). • Do not enter poorly lit areas without first providing portable illumination.	Standard Level D PPE *
	Biological	• Observe areas for presence of stinging or biting or stinging insects and nests such as spiders (widows/recluse), bee/wasp hives, fire ants mounds etc. • Prior to starting field activities, notify supervisors of known allergies to stinging insects and location and quantity of antidote in the event the employee becomes incapacitated as a result of a bite. • Observe work area for presence of snakes (cottonmouth as primary, copperhead and rattlers as secondary). • Observe wetland/creek, river areas for presence of alligators (nests, eggs) • Frequently check body and clothing for ticks, chiggers, spiders. • Protect yourself from and avoid exposure to blood bourn pathogens when administering first aid. • Exposure to some insect and reptile biological hazards may be temperature dependant.	Standard Level D PPE *
	Cuts & Abrasions	• Wear long sleeve clothing and proper PPE (eye protection, hard hats, leather gloves, sturdy hard toe boots) when traversing through wooded areas.	Standard Level D PPE *

Task Order 021 MCB Camp Lejeune – Vapor Intrusion Evaluation ACTIVITY HAZARD ANALYSIS – Mobilization/Site Preparation/Demobilization (Non Intrusive)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Mobilization/Site Preparation/ Demobilization (continued)	Struck/pinched	• Wear reflective warning vests or high visibility clothing in traffic areas or around operating heavy equipment. • Isolate equipment swing areas from workers, fixed objects or other equipment. • Make/maintain eye contact with heavy equipment and haul truck operators before approaching. Do not approach equipment or haul trucks from rear or from blind spot of operator. • Understand and review hand signals. Designate one person to provide hand signals to equipment and haul truck operators. • Ensure equipment and haul trucks have operable back-up alarms. • Avoid positioning between fixed objects and operating equipment.	Standard Level D PPE *
	Biological	• Observe areas for presence of stinging or biting or stinging insects and nests such as spiders (widows/recluse), bee/wasp hives, fire ants mounds etc. Frequently check body and clothing for ticks, chiggers, spiders. • Prior to starting field activities, notify supervisors of known allergies to stinging insects and location and quantity of antidote in the event the employee becomes incapacitated as a result of an insect bite. • Observe work area for presence of snakes (cottonmouth as primary, copperhead and rattlers as secondary). • Observe wetland/creek, river areas for presence of alligators (nests, eggs) • Protect yourself from and avoid exposure to blood bourn pathogens when administering first aid. • Consider utilizing insect repellent. For personnel sensitive to skin rashes, consider the use of products with lower s DEET concentrations such as “children’s cutters” or “skin so soft” products.	Standard Level D PPE *

Task Order 021 MCB Camp Lejeune – Vapor Intrusion Evaluation ACTIVITY HAZARD ANALYSIS – Mobilization/Site Preparation/Demobilization (Non Intrusive)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Mobilization/Site Preparation/ Demobilization (continued)	Electric Hazards	• If/when electrical extension cords are required to complete work, extension cords must be: - Equipped with third-wire grounding. - Covered, elevated, or protected from damage when passing through work areas. - Protected from pinching if routed through doorways. - Not fastened with staples, hung from nails, or suspended with wire. - Extension cords and electrical power tools, must have ground fault circuit interrupters (GFCIs) installed. - Rated to handle the voltage/amperage of equipment. • Power tools will be inspected prior to use, and damaged tools will be tagged and removed from service. • Do not set power tools down in muddy or wet areas which may damage the tool and/or or create a potential for electric shock. • Only qualified personnel are permitted to work on unprotected energized electrical systems. • Do not access electrical wiring or systems unless qualified to do so. All electrical wiring and equipment must be considered energized until hazardous energy control procedures (i.e. lock-out/tag-out) are implemented. • Maintain proper separation between Power Transmission Lines and over overhead utilities. See Electric Safety section in HSP for references to proper separation between operating equipment and power transmission lines/overhead utilities. Do not swing excavator boom toward overhead utilities. Be cognizant of the positions of existing utility pole guy wires and transformers.	Standard Level D PPE *
	Other	• Always using a seat belt while driving on military/government facilities. Always observe posted speed limits, traffic signs and signals. Never using a cell phone or two way radio while driving on military/government facilities. Violating these rules may result in loss of military/government facility driving privileges. • Drive 5 mph when driving past troops on maneuvers. If drive past troops on maneuvers could interrupt their activities, vehicle drivers are to bring vehicles to a complete stop in a safe location and yield to troop activities. • Shut down operations in heavy rain, wind and/or lightning. At first sight of lightning, operations shall be stopped and only resumed when conditions permit. The lightning safety recommendation is 30-30: Seek refuge when thunder sounds within 30 seconds after a lightning flash; and do not resume activity until 30 minutes after the last thunder clap. • Buddy System maintained for all phases of work. • Base or local Emergency Dispatch numbers programmed into cellular phones. Have hospital route maps readily available. • Report all conditions which may create accidents, injury, illness or property damage to supervisors immediately.	NA

Task Order 021 MCB Camp Lejeune – Vapor Intrusion Evaluation ACTIVITY HAZARD ANALYSIS – Mobilization/Site Preparation/Demobilization (Non Intrusive)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**

EQUIPMENT REQUIRED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Hauling Vehicles • Fire extinguisher(s) (fuel storage/equipment) • Flammable/Combustible Storage Locker (placard) • Eye wash (small portable type) • First Aid/Bloodborne pathogen/CPR kit • Miscellaneous power and manual hand tools.	• Visual Inspections of designated work areas identify and address hazardous conditions. • Equipment inspections and maintenance. • Inspections of hand tools (power) and extension chords if used.	• Review AHA with all task personnel • Review Site Specific Health and Safety Plan for new site personnel. • Review operations/safety manuals for all equipment utilized. • Behavior Based Loss Prevention Training (supervisors). • Power tool and equipment operators qualified by previous training or experience.

	PRINT	SIGNATURE	
Supervisor Name:	_____	_____	**Date/Time:**_____
Safety Officer Name:	_____	_____	**Date/Time:**_____
Site Personnel:	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
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	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____

Task Order 021 MCB Camp Lejeune – Vapor Intrusion Evaluation Activity Hazard Analysis – Soil Sampling and Soil Vapor Sampling via Direct Push Technology (DPT)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Soil Sampling and Soil Vapor Sampling via DPT	Buried Objects	• Contact North Carolina One Call Center at **(800) 632-4949 or (336) 855-5760** or online at http://www2.ncocc.org/ncocc/homepage.htm for utility clearance verification. Keep copies of any written documentation (faxes, email printouts) regarding utility location verification provided by utilities owners in the office project file and in a working field file on-site. Site Supervisor, FTL or SSHO shall photo document owner provided field utility mark-outs as related to proposed limits of ground disturbing activities prior to the start of work. • Conduct "third" party utility clearance when the locations of utilities may be in question. • Determine if MCB Lejeune requires the acquisition of a base issued "dig permit" prior to undertaking any ground-disturbing activities. Where available, obtain utility diagrams for the facility. If possible, review proposed locations of intrusive work with MCB Lejeune POCs knowledgeable in the location of utilities on the facility. Check locations against information from utility mark-out service. • Where unknown or unanticipated buried objects (i.e. drums, tanks, cylinders, munitions of explosive concern, soil with unusual staining or odor) are encountered during site operations, ongoing activities shall be immediately suspended. • Where unknown or unanticipated buried objects are encountered JV II or subcontractor personnel shall 1) secure equipment to the extent possible, without causing bodily injury, 2) evacuate the work area and 3) immediately notify the site manager, SSHO or PM of the encountered condition. Work may only resume with appropriate documentation/notification that exposure hazards (physical or chemical) do not exist. Consult with JV II PM and HSM or HSO prior to resuming activities.	Modified Level D_1 or D_2 PPE or as required by HSP * * D: Work clothes, reflective vests, hard hat, safety glasses and sturdy hard toed work boots, hearing and hand protection as necessary for task. * D_1 : D + hand protection (inner and outer chemical resistant gloves) * D_2: D_1+ chemical resistant suits and boot covers, face protection (as needed)
	Slips, Trips, Falls	• Be aware of poor footing, potential slipping/tripping hazards in the work area (i.e. wet/muddy areas or slopes, unprotected holes, ditches, rip rap, utilities or other ground protrusions). Identify and avoid these areas. Wear sturdy hard toe work boots with sufficient ankle support (preferably leather). • Watch foot placement while traversing through wooded areas with briars and heavy brush. • Good housekeeping must be maintained at all times in all project work areas. Common paths of travel should be established and kept free from the accumulation of materials.	Modified Level D_1 or D_2 PPE or as required by HSP *
	Sharp Objects	• Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Avoid use of razor knives. • Cut away from the body and never towards another worker.	Modified Level D_1 or D_2 PPE or as required by HSP *
	Visible Lighting	• Perform tasks in daylight hours whenever possible. If not, provide sufficient work environment lighting for the work condition.	Modified Level D_1 or D_2 PPE or as required by HSP *

Task Order 021 MCB Camp Lejeune – Vapor Intrusion Evaluation Activity Hazard Analysis – Soil Sampling and Soil Vapor Sampling via Direct Push Technology (DPT)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Soil Sampling and Soil Vapor Sampling via DPT (cont)	Fire Prevention	• Use only metal safety cans for storage and transfer of fuel. • Use funnels and nozzles during fueling operations. • Allow warm engine parts (small engines) to cool before refueling. • Appropriately sized, easily accessible ABC fire extinguisher in work area. • Review and be cognizant of any MCB Lejeune Fire Prevention Procedures and Requirements	Modified Level D_1 or D_2 PPE or as required by HSP *
	High Ambient Temperature	• Provide fluids to prevent worker dehydration. • Monitor for heat stress in accordance with HSP (maintain use of buddy system). • Institute a proper work-break regiment to avoid heat stress symptoms and overexertion.	Modified Level D_1 or D_2 PPE or as required by HSP * (light colored/weight, breathable clothing)
	Noise	• Personnel exposed to loud working environments shall wear hearing protection unless otherwise directed (proximal to heavy equipment).	Modified Level D_1 or D_2 PPE or as required by HSP *
	Drilling Equipment	• Drillers must verify that the rig is properly leveled and stabilized. • Driller must check for overhead power lines before raising mast. There should be a minimum distance of 15ft between mast and overhead lines. Verify proper minimum separation distances between operating heavy equipment and power transmission lines in the electrical safety section of the HSP. • Personnel should be cleared from sides and rear of rig while mast is raised. Driller will not drive while mast is in the raised position. • Do not wear loose fitting clothing or watches that may get caught in moving parts • Kill wire or switch must be able to located and activated by all personnel supporting the operation. • Drill rig should be equipped with a fire extinguisher. • The driller is to verify that the drill rig and cabling is maintained, in proper working condition and inspected before operation. Keep documentation on site. • Avoid/take care around pressurized lines/hoses. Inspect hoses daily for cuts, abrasions and wear. • Equipment shall only be operated by personnel qualified by prior training or experience. • Do not smoke or use other spark-producing equipment near rig. • For pneumatically pressured lines, safety lashes or whip checks should be affixed to hoses to prevent injury in the event of rupture. • Drillers are to verify that all machine guards are in place while in operation.	Modified Level D_1 or D_2 PPE or as required by HSP *

Task Order 021 MCB Camp Lejeune – Vapor Intrusion Evaluation Activity Hazard Analysis – Soil Sampling and Soil Vapor Sampling via Direct Push Technology (DPT)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Soil Sampling and Soil Vapor Sampling via DPT (cont)	Biological	• Observe ground surfaces especially in wet or grassy areas for evidence and presence of snakes (poisonous). • Observe ground surfaces or surrounding vegetation or structures for presence fire ants, spiders, bee/wasp hives rabid animals etc. Check body and clothing for ticks, chiggers, spiders. • Observe areas for presence of stinging insects. Prior to starting field activities, n**otify supervisors of known allergies to stinging insects and location of antidotes.** • Avoid exposure to blood bourne pathogens • Consider utilizing insect repellent. For personnel sensitive to skin rashes, consider the use of products with lower s DEET concentrations such as "children's cutters" or "skin so soft" products.	Modified Level D_2 PPE
	Chemical Exposure	• Review contaminants of concern for the project and consult project specific HSP for proper dermal and respiratory protection. • All personnel performing this task shall be trained in accordance with 29CFR1910.120/29CFR1926.65 and be deemed "fit for duty" and cleared to wear a respirator by a licensed occupation physician. • Follow PPE and action monitoring level requirements identified in the sections 5.0 and 6.0 of the HSP. • Do not allow dermal contact or incidental ingestion of contaminated materials. Do not kneel or step in soil cuttings or drilling fluids. • Exercise good hygiene practices. Always wash hands and then face before eating, drinking, smoking and leaving site. Only eat, drink, smoke or chew tobacco in designated areas that that are not subject to Hazwoper regulated operations. Practice "no hand-face" contact at all times. • Caution should be exercised when filling bottles containing acid or base preservatives. Both liquid and vapor phases of acid can cause severe burns. • Following sample collection, sample container lids should be tightened securely to prevent any leaks, and the containers should be rinsed with clean water to ensure that they are free of chemical constituents. Follow appropriate sampling equipment decontamination procedures.	Modified Level D_2 PPE
	Pressure Washing	• Rinse waste from pressure washing operations must be collected and properly disposed of. • Inspect pressure washer before use and confirm dead man switch fully operational • The wand must always be pointed at the work area. • The trigger should never be tied down • Never point the wand at yourself or another worker. • The wand must be at least 42 inches from the trigger to the tip.	Modified Level D_1 or D_2 PPE or as required by HSP *

Task Order 021 MCB Camp Lejeune – Vapor Intrusion Evaluation Activity Hazard Analysis – Soil Sampling and Soil Vapor Sampling via Direct Push Technology (DPT)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Soil Sampling and Soil Vapor Sampling via DPT (cont)	Struck/pinched by	• Isolate drilling equipment from unessential workers, fixed objects or other equipment. • Make/maintain eye contact with drilling operators before approaching equipment. Do not approach equipment from rear or from blind spot of operator. • Ensure drilling equipment has an operable back-up alarm, when the rig is moving. • Step away from heavy equipment when the drill rig is being adjusted or relocated. • Avoid positioning between fixed objects and operating/rotating equipment. • No one shall walk under or in front of suspended loads (drill rods/cable). • Use caution for pinching hazards (fingers or hands) during the placement/use of hand tools on drilling rods or other drill rig/rod components.	Modified Level D_1 or D_2 PPE or as required by HSP *
	Manual Lifting	• JV II personnel must notify supervisors or safety representatives of preexisting medical conditions that may be aggravated or re-injured by lifting activities. • When lifting objects, lift using knees not back. For repetitive lifting tasks, the use of lifting braces/supports may be considered. If heavy equipment isn't available to have someone assist with the lift— especially for heavy (> 40lbs.) or awkward loads. Use heavy equipment to transfer heavy or awkward loads wherever possible. • Plan storage and staging to minimize lifting or carrying distances. Make sure the path of travel is clear prior to the lift. • Avoid carrying heavy objects above shoulder level.	Modified Level D_1 or D_2 PPE or as required by HSP *
	Other	• Always using a seat belt while driving on military/government facilities. Always observe posted speed limits, traffic signs and signals. Never using a cell phone or two way radio while driving on military/government facilities. Violating these rules may result in loss of military/government facility driving privileges. • Drive 5 mph when driving past troops on maneuvers. If drive past troops on maneuvers could interrupt their activities, vehicle drivers are to bring vehicles to a complete stop in a safe location and yield to troop activities. • Shut down operations in heavy rain, wind and/or lightning. At first sight of lightning, operations shall be stopped and only resumed when conditions permit. The lightning safety recommendation is 30-30: Seek refuge when thunder sounds within 30 seconds after a lightning flash; and do not resume activity until 30 minutes after the last thunder clap. • Buddy System maintained for all phases of work. • Base or local Emergency Dispatch numbers programmed into cellular phones. Have hospital route maps readily available. • Report all conditions which may create accidents, injury, illness or property damage to supervisors immediately.	NA

Task Order 021 MCB Camp Lejeune – Vapor Intrusion Evaluation Activity Hazard Analysis – Soil Sampling and Soil Vapor Sampling via Direct Push Technology (DPT)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**

EQUIPMENT REQUIRED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• DPT Equipment • Fire extinguisher (with fuel and electrical sources and on DPT/HAS rig) • Sample glassware/coolers • Decon. materials • Eye wash (small portable type) • Misc hand tools	• Visual Inspections of designated work areas identify and address hazardous conditions. • Equipment inspections and maintenance. • Hand Tool Inspections	• Review AHA with all task personnel • Review Site Specific Health and Safety Plan for new site personnel. • Current training and medical surveillance requirements in accordance with 29CFR1910.120/29CFR1926.65. • Review operations/safety manuals for all equipment utilized. • Behavior Based Loss Prevention Training and 1st Aid/CPR (supervisors).

	PRINT	SIGNATURE	
Supervisor Name:	_____	_____	**Date/Time:**_____
Safety Officer Name:	_____	_____	**Date/Time:**_____
Site Personnel:	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____

Task Order 021 MCB Camp Lejeune – Vapor Intrusion Evaluation ACTIVITY HAZARD ANALYSIS – Ground Water Sampling and Slab-Soil Vapor Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Ground Water Sampling and Soil Vapor Sampling	Chemical Exposure	• Review contaminants of concern for the project and consult project specific HSP for proper dermal and respiratory protection. • All personnel performing this task shall be trained in accordance with 29CFR1910.120/29CFR1926.65 and be deemed "fit for duty" and cleared to wear a respirator by a licensed occupation physician. • Follow PPE and action monitoring level requirements identified in the sections 5.0 and 6.0 of the HSP. • Do not allow dermal contact or incidental ingestion of contaminated materials. Do not kneel or step in soil cuttings or drilling fluids. • Exercise good hygiene practices. Always wash hands and then face before eating, drinking, smoking and leaving site. Only eat, drink, smoke or chew tobacco in designated areas that that are not subject to Hazwoper regulated operations. Practice "no hand-face" contact at all times. • Caution should be exercised when filling bottles containing acid or base preservatives. Both liquid and vapor phases of acid can cause severe burns. • Following sample collection, sample container lids should be tightened securely to prevent any leaks, and the containers should be rinsed with clean water to ensure that they are free of chemical constituents. Follow appropriate sampling equipment decontamination procedures. • Cylinder must be stored in the upright position and always replace protective caps when not in use.	Modified Level D_1 or D_2 PPE or as required by HSP * * D: Work clothes, reflective vests, hard hat, safety glasses and sturdy hard toed work boots, hearing and hand protection as necessary for task. D_1 : D + hand protection (inner and outer chemical resistant gloves) D_2: D_1+ chemical resistant suits and boot covers, face protection (as needed)
	Slips, Trips, Falls	• Institute and maintain good housekeeping practices. • Be aware areas of poor footing, potential slipping/tripping hazards in the work area. Identify and avoid these areas and unprotected holes, ditches, rip rap, utilities, curbing or ground protrusions. Use sturdy hard toe work boots with sufficient ankle support.	Modified Level D_1 or D_2 PPE or as required by HSP *
	High Ambient Temperature	• Provide fluids to prevent worker dehydration. • Monitor for heat stress in accordance with HSP (maintain use of buddy system). • Institute a proper work-break regiment to avoid heat stress symptoms and overexertion.	Modified Level D_1 or D_2 PPE or as required by HSP * (light colored/weight, breathable clothing)
	Manual Lifting	• JV II personnel must notify supervisors or safety representatives of preexisting medical conditions that may be aggravated or re-injured by lifting activities. • When lifting objects, lift using knees not back. For repetitive lifting tasks, the use of lifting braces/supports may be considered. If heavy equipment isn't available to have someone assist with the lift— especially for heavy (> 40lbs.) or awkward loads. Use heavy equipment to transfer heavy or awkward loads wherever possible. • Plan storage and staging to minimize lifting or carrying distances. Make sure the path of travel is clear prior to the lift. • Avoid carrying heavy objects above shoulder level.	Modified Level D_1 or D_2 PPE or as required by HSP *

Task Order 021 MCB Camp Lejeune – Vapor Intrusion Evaluation ACTIVITY HAZARD ANALYSIS – Ground Water Sampling and Slab-Soil Vapor Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Ground Water Sampling and Soil Vapor Sampling (continued)	Biological	• Observe ground surfaces especially in wet or grassy areas for evidence and presence of snakes (poisonous). • Observe ground surfaces or surrounding vegetation or structures for presence fire ants, spiders, bee/wasp hives rabid animals etc. Check body and clothing for ticks, chiggers, spiders. • Observe areas for presence of stinging insects. Prior to starting field activities, n**otify supervisors of known allergies to stinging insects and location of antidotes.** • Avoid exposure to blood bourne pathogens • Consider utilizing insect repellent. For personnel sensitive to skin rashes, consider the use of products with lower s DEET concentrations such as "children's cutters" or "skin so soft" products.	Modified Level D_1 or D_2 PPE or as required by HSP *
	Fire Prevention	• Use only metal safety cans for storage and transfer of fuel. • Maintain flammable/combustible materials in flammable lock-up (vented) when not in use. • Use funnels and nozzles during fueling operations. • Allow warm engine parts (small engines) to cool before refueling. • Appropriately sized, easily accessible ABC fire extinguisher in work area. • Review and be cognizant of any MCB Lejeune Fire Prevention Procedures and Requirements	Modified Level D_1 or D_2 PPE or as required by HSP *
	Cuts & Abrasions	• Wear long sleeve clothing and proper PPE (eye protection, hard hats, leather gloves, sturdy hard toe boots) when traversing through wooded areas.	
	Visible Lighting	• Perform tasks in daylight hours whenever possible. If not, provide sufficient work environment lighting for the work condition.	Modified Level D_1 or D_2 PPE or as required by HSP *
	Electrical	• If/when electrical extension cords are required to complete work, extension cords must be: - Equipped with third-wire grounding. - Covered, elevated, or protected from damage when passing through work areas. - Protected from pinching if routed through doorways. - Not fastened with staples, hung from nails, or suspended with wire. - Extension cords and electrical power tools, must have ground fault circuit interrupters (GFCIs) installed. - Rated to handle the voltage/amperage of equipment. • Do not use care batteries for power sources to sampling equipment.	Modified Level D_1 or D_2 PPE or as required by HSP *

Task Order 021 MCB Camp Lejeune – Vapor Intrusion Evaluation ACTIVITY HAZARD ANALYSIS – Ground Water Sampling and Slab-Soil Vapor Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Ground Water Sampling and Soil Vapor Sampling (continued)	Other	• Always using a seat belt while driving on military/government facilities. Always observe posted speed limits, traffic signs and signals. Never using a cell phone or two way radio while driving on military/government facilities. Violating these rules may result in loss of military/government facility driving privileges. • Drive 5 mph when driving past troops on maneuvers. If drive past troops on maneuvers could interrupt their activities, vehicle drivers are to bring vehicles to a complete stop in a safe location and yield to troop activities. • Shut down operations in heavy rain, wind and/or lightning. At first sight of lightning, operations shall be stopped and only resumed when conditions permit. The lightning safety recommendation is 30-30: Seek refuge when thunder sounds within 30 seconds after a lightning flash; and do not resume activity until 30 minutes after the last thunder clap. • Buddy System maintained for all phases of work. • Base or local Emergency Dispatch numbers programmed into cellular phones. Have hospital route maps readily available. • Report all conditions which may create accidents, injury, illness or property damage to supervisors immediately.	NA

EQUIPMENT REQUIRED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Well sampling equipment/sample containers/coolers • SUMMA Canisters • Hammer drill • Vacuum cleaner • Compressed helium tank (balloon grade) • Vacuum pump and assembly • Fire extinguisher (with fuel and electrical sources) • Eye wash (small portable type) • First Aid/Bloodborne Pathogen Kits	• Visual Inspections of designated work areas identify and address hazardous conditions. • Inspections of hand tools (power) and extension chords if used.	• Review AHA with all task personnel. • Training/medical surveillance meeting 29CFR1910.120. • Review Site Specific Health and Safety Plan for new site personnel. • Review operations/safety manuals for all equipment utilized. • Behavior Based Loss Prevention Training Behavior Based Loss for JV III supervisors/SHSO • Prevention Training and CPR/1st Aid training for supervisors.

PRINT		SIGNATURE	
Supervisor Name:	_____	_____	**Date/Time:**_____
Safety Officer Name:	_____	_____	**Date/Time:**_____
Site Personnel:	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____

Task Order 021 MCB Camp Lejeune – Vapor Intrusion Evaluation ACTIVITY HAZARD ANALYSIS – Indoor Air Monitoring			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
IDW Handling, Sampling and Management	Chemical Exposure	• Review contaminants of concern for the project and consult project specific HSP for proper dermal and respiratory protection. • All personnel performing this task shall be trained in accordance with 29CFR1910.120/29CFR1926.65 and be deemed "fit for duty" and cleared to wear a respirator by a licensed occupation physician. • Follow PPE and action monitoring level requirements identified in the sections 5.0 and 6.0 of the HSP.	Standard Level D PPE *
	Slips, Trips, Falls	• Be aware of poor footing, potential slipping/tripping hazards in the work area (i.e. wet/muddy areas or slopes, unprotected holes, ditches, rip rap, utilities or other ground protrusions). Identify and avoid these areas. Wear sturdy hard toe work boots with sufficient ankle support (preferably leather). • Good housekeeping must be maintained at all times in all project work areas. Common paths of travel should be established and kept free from the accumulation of materials.	Standard Level D PPE *
	High Ambient Temperature	• Provide fluids to prevent worker dehydration. • Monitor for heat stress in accordance with HSP (maintain use of buddy system). • Institute a proper work-break regiment to avoid heat stress symptoms and overexertion in PPE.	Modified Level D_2 PPE or as required by HSP * (light colored/weight, breathable clothing)
	Visible Lighting	• Perform tasks in daylight hours whenever possible. If dawn, dusk or dark work is to be performed portable lighting must be provided to sufficient illuminate work area(s). • Do not enter poorly lit areas without first providing portable illumination.	Standard Level D PPE *
	Other	• Always using a seat belt while driving on military/government facilities. Always observe posted speed limits, traffic signs and signals. Never using a cell phone or two way radio while driving on military/government facilities. Violating these rules may result in loss of military/government facility driving privileges. • Buddy System maintained for all phases of work. • Shut down operations in heavy rain and lightning. • Base Emergency Dispatch numbers programmed into JV III personnel cellular phones. Have hospital route maps readily available. • Report all unsafe conditions and acts, injury/illness or property damage to supervisors immediately.	NA

Task Order 021 MCB Camp Lejeune – Vapor Intrusion Evaluation ACTIVITY HAZARD ANALYSIS – Indoor Air Monitoring			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
EQUIPMENT REQUIRED		**INSPECTION REQUIREMENTS**	**TRAINING REQUIREMENTS**
• SUMMA Canisters • Hand tools • First Aid Kit and Blood born pathogen kit • Fire Extinguishers		• Weekly Inspection of all emergency equipment (i.e.: first aid kits, fire extinguishers) • Visual Inspections of designated work areas to identify and address hazardous conditions.	• Review AHA with all task personnel • Review Site Specific Health and Safety Plan for new personnel. • Behavior Based Loss Prevention Training (supervisors). • First Aid/CPR , 29CFR1910.120

	PRINT	SIGNATURE	
Supervisor Name:	_____	_____	**Date/Time:**_____
Safety Officer Name:	_____	_____	**Date/Time:**_____
Site Personnel:	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____

Attachment 7

Pre-Task Safety Plan

(Example Only)

EXAMPLE ONLY

DAILY PRE-TASK SAFETY PLAN (PTSP)

Project: JV II TO 80 Location: MCB Lejeune, NC Date:

Site Safety & Health Officer: Kristi Riggs Job Activity: Well Sampling Site #:

Task Personnel:

List Tasks:
Well sampling

Tools/Equipment/Materials required (ladders, scaffolds, fall protection, cranes/rigging, heavy equipment, power tools, cords, generators, compressed gases, regulated chemical products, etc.):
TLC meter

Potential H&S Hazards, including chemical, physical, safety, biological and environmental (Check all that apply):

X Chemical burns/contact Dermal protection (hands), eye protection. See HSP for PPE requirements per task.	__ Trench, excavations, cave-ins	__Ergonomics
__ Pressurized lines/equipment	X Overexertion Work/break regiment as dictated by task. Maintain fluid intake for hydration	X Chemical splash Use PPE in accordance with HSP. Protect hands from splash during decon. activities.
X Thermal burns Watch for warm engine/muffler components on generators.	__ Pinch points	X Poisonous plants/insects Review HSP for identification of poisonous snakes in the geographic area. Long sleeves in areas where poison ivy, sumac or oak may exist. Use insect repellent. Tape pant legs to boots (ticks).
X Electrical GCFIs for generators, Inspect. & protect extension Chords, Chords rated for use & have 3rd wire grounding	X Cuts/abrasions Do not use razor knives. Cut away from body. Identify and avoid rusty/jagged or sharp surfaces from above ground features (brush, pipe chases/supports, utility structures, doors)	X Eye hazards/flying projectile Use eye protection at all times. Ensure head protection is used in areas where heavy brush, trees, thorns, vines exist when accessing well heads.
__ Weather conditions Foul and cold weather clothing as dictated by expected conditions	X Spills Use funnels & nozzles during fueling of generators.	__ Inhalation hazard
__Heights/fall> 6'	__ Overhead Electrical hazards	X **Heat**/cold stress Work/break regiment as dictated by heat exposure Provide sufficient fluids for employee intake. Recommended employees begin with 16 oz. of water before initiating field work.
X Noise Use hear protection in loud work environments	__ Elevated loads	__ Water/drowning hazard
X Explosion/fire Metal safety cans for fuel storage, No open flame, sparks ignition in hazardous/flammable/ combustible storage areas. Let engine surfaces cool before fueling.	X Slips, trip and falls Exercise good general house keeping practices Identify/remove slip/trip falls hazards in work area. Watch for and avoid holes, ground protrusions. Watch for entanglement of feet around vines and brush.	__ Heavy equipment
X Radiation Solar. UV protection on skin and UV eye protection. ANSI rated safety eye protection only.	X Manual lifting >50 lbs or awkward loads, get assistance. If employee not capable of lifting 40 lbs. seek assistance.	__ Aerial lifts/platforms
__ Confined space entry	__Welding/cutting	__ Demolition

Continue on page 3 of 3 (if necessary)

Hazard Control Measures (Check all that apply):

PPE	Protective Systems	Fire Protection	Electrical
X_ Head protection	__ Locate buried utilities	__ Fire extinguishers	__ Lockout/tagout
__ Face protection	__ Competent person	__ Fire watch	__ Grounded
X_Hard toe work boots	__ Daily inspections	__ Non-spark tools	__ Panels covered
__ Thermal/lined	__ Sloping	__ Grounding/bonding	X_GFCI/extension cords
X_ Eye	__ Shoring	__ Intrinsically safe equipment	__ Power tools/cord inspected
X_Dermal/hand	__ Trench box	__Combustible materials storage	__Insulated tools/gloves
__ Hearing	__ Barricades	__Chemical Storage	
__ Respiratory			
X__Reflective vests			

Fall Protection	Air Monitoring	Proper Equipment	Welding & Cutting
__ Harness/lanyards	__ PID/FID	__ Aerial lift/ladders/scaffolds	__ Cylinders secured/capped
__ Adequate anchorage	__ Detector tubes	__ Forklift/ Heavy equipment	__ Cylinders separated/upright
__ Guardrail system	__ Radiation	__ Backup alarms	__ Flash-back arrestors
__ Covered opening	__ Personnel sampling	__ Hand/power tools	__ No cylinders in CSE
__ Fixed barricades	__ LEL/O2	__ Crane w/current inspection	__ Flame retardant clothing
__ Warning system	__ Other	__ Proper rigging	__ Appropriate goggles
		__ Operator qualified	

Confined Space Entry	Medical/Emerg. Response	Heat/Cold Stress	Vehicle/Traffic
__ Isolation	X_ First-aid & BBP kit	X_Work/rest regime	__ Traffic Awareness
__ Air monitoring	X_Eye wash	X_ Rest area	__Traffic control
__ Trained personnel	X_FA-CPR training	X_Liquids available	__ Barricades
__ Permit completed	X_Route to hospital	X_Monitoring	__ Flags
__ Rescue provisions		__ Training	__ Signs

Permits	Demolition	Inspections	Training
__ Hot work	__ Pre-demolition survey	__ Ladders/aerial lifts	X_ Hazwaste
__ Confined space	__ Structure condition	__ Lanyards/harness	__ Construction
__ Lockout/tagout	__ Isolate area/utilities	__ Scaffolds	__Equipment
__ Excavation	__ Competent person	__ Heavy equipment	__ Competent person
__ Demolition	__ Hazmat present	__Cranes and rigging	X_Task-specific (AHA)
__ Energized work		__Other per Field Safety Plan	X_ Hazcom
__Local/Environmental			

FieldNotes:_____
_____
_____
_____

Additional Space for Project Specific Hazard Awareness (if necessary):

1) Observe government/military facility posted speed limits.
2) Wear seat belts in vehicles while on government/military facilities. military facility access privileges
3) Do not use cell phones or two way radios while driving or actively operating equipment on government/militaryfacilities.
4) Failure to do so may result in loss of driving privileges on government/military facilities.
5) Report all accidents/injuries and property damage to the Project Manager and HSM immediately.
6) Maintain hospital route maps in site vehicles. Know facility EMS, Fire and Security dispatch #s.
7) Secure any loads to hauling vehicle (pick-up truck) with appropriate rated tie down straps.
8) Use reflective vests/ high visibility clothing in high traffic areas or in areas were material handling operations are occurring.
9) Field Team Personnel to check in with Tim Miller (OMI) at water treatmetn Plant and Les Mull (ABL) prior to determine the daily ABL Burning Pit schedules prior to initiating field activities

Attendees:

Name (Printed):	Signature:

Meeting Conducted By:

Name Printed Signature

Attachment 8

Loss Prevention Observation (LPO) Form

Loss Prevention Observation Form

Project:	Observer:	Da
Position/Title of worker observed:	Background Information/ comments:	
Task/Observation Observed:		

- Identify and reinforce safe work practices/behaviors
- Identify and improve on at-risk practices/acts
- Identify and improve on practices, conditions, controls, and compliance that eliminate or reduce hazards
- Proactive PM/Site Manager support facilitates eliminating/reducing hazards (material/personnel resources)
- Positive, corrective, cooperative, collaborative feedback/recommendations

Actions & Behaviors	**Consistent w/ H&S Program**	**Not Consistent w/ H&S Program**	**Observations/Comments**
Current & accurate Pre-Task Planning/Briefing (Project safety plan, AHA, PTSP, tailgate briefing, c., as needed)			**Positive Work Practices Observed:**
Personnel properly trained/qualified/experienced			
Tools/equipment available and adequate			
Proper use of tools			**Questionable Activity/Condition Observed:**
Barricades/work zone control			
Housekeeping			
Communication			
Work Approach/Habits			
Attitude			
Focus/attentiveness			**Actions/Comments:**
Pace			
Uncomfortable/unsafe position			
Inconvenient/unsafe location			
Position/Line of fire			
Apparel (hair, loose clothing, jewelry)			
Repetitive motion			**Observed Worker's Corrective Actions/Commer**
Other			

Attachment 9

Loss/Near Loss Incident Report Form

Incident Report Form

Type of Incident (Select at least one)

- ☐ Injury/Illness
- ☐ Environmental/Permit Issue
- ☐ Property Damage
- ☐ Near Miss
- ☐ Spill/Release
- ☐ Other

General Information (Complete for all incident types)

Preparer's Name: _____ Preparer's Employee Number: _____

Date of Report: _____ Date of Incident: _____ Time of Incident: _____ am/pm

Type of Activity (Provide activity being performed that resulted in the incident)

- ☐ Asbestos Work
- ☐ Confined Space Entry
- ☐ Construction Mgmt- Haz Waste
- ☐ Construction Mgmt - Non-Haz Waste
- ☐ Demolition
- ☐ Drilling-Haz Waste
- ☐ Drilling-Non Haz Waste
- ☐ Drum Handling
- ☐ Electrical Work
- ☐ Excavation Trench-Haz Waste
- ☐ Excavation Trench-Non Haz
- ☐ Facility Walk Through
- ☐ General Office Work
- ☐ Keyboard Work
- ☐ Laboratory
- ☐ Lead Abatement
- ☐ Motor Vehicle Operation
- ☐ Moving Heavy Object
- ☐ Other (Specify) _____
- ☐ Process Safety Management
- ☐ Tunneling
- ☐ Welding
- ☐ Wetlands Survey
- ☐ Working from Heights
- ☐ Working in Roadways
- ☐ WWTP Operation

Location of Incident (Select one)

- ☐ Company Premises (JVI Office: _____)
- ☐ Field (Project #: _____ Project/Site Name: _____ Client: _____)
- ☐ In Transit (Traveling from: _____ Traveling to: _____)
- ☐ At Home

Geographic Location of Incident (Select region where the incident occurred)

- ☐ Northeast
- ☐ Southeast
- ☐ Northwest
- ☐ Southwest
- ☐ Corporate
- ☐ Canadian
- ☐ Asia Pacific
- ☐ Europe Middle East
- ☐ Latin America

If a JVI subcontractor was involved in the incident, provide their company name and phone number:

_____

Describe the Incident (Provide a brief description of the incident): _____

_____

_____

_____

Injured Employee Data (Complete for Injury/Illness incidents only)

If JVI employee injured

Employee Name: _____ Employee Number: _____

If JVI Subcontractor employee injured

Employee Name: _____ Company: _____

Injury Type

- ☐ Allergic Reaction
- ☐ Amputation
- ☐ Asphyxia
- ☐ Bruise/Contusion/Abrasion
- ☐ Burn (Chemical)
- ☐ Burn/Scald (Heat)
- ☐ Cancer
- ☐ Carpal Tunnel
- ☐ Concussion
- ☐ Cut/Laceration
- ☐ Dermatitis
- ☐ Dislocation
- ☐ Electric Shock
- ☐ Foreign Body in eye
- ☐ Fracture
- ☐ Freezing/Frost Bite
- ☐ Headache
- ☐ Hearing Loss
- ☐ Heat Exhaustion
- ☐ Hernia
- ☐ Infection
- ☐ Irritation to eye
- ☐ Ligament Damage
- ☐ Multiple (Specify) _____
- ☐ Muscle Spasms
- ☐ Other (Specify) _____
- ☐ Poisoning (Systemic)
- ☐ Puncture
- ☐ Radiation Effects
- ☐ Strain/Sprain
- ☐ Tendonitis
- ☐ Wrist Pain

Part of Body Injured

- ☐ Abdomen
- ☐ Ankle(s)
- ☐ Arms (Multiple)
- ☐ Back
- ☐ Blood
- ☐ Body System
- ☐ Buttocks
- ☐ Chest/Ribs
- ☐ Ear(s)
- ☐ Elbow(s)
- ☐ Eye(s)
- ☐ Face
- ☐ Finger(s)
- ☐ Foot/Feet
- ☐ Hand(s)
- ☐ Head
- ☐ Hip(s)
- ☐ Kidney
- ☐ Knee(s)
- ☐ Leg(s)
- ☐ Liver
- ☐ Lower (arms)
- ☐ Lower (legs)
- ☐ Lung
- ☐ Mind
- ☐ Multiple (Specify)
- ☐ Neck
- ☐ Nervous System
- ☐ Nose
- ☐ Other (Specify) _____
- ☐ Reproductive System
- ☐ Shoulder(s)
- ☐ Throat
- ☐ Toe(s)
- ☐ Upper Arm(s)
- ☐ Upper Leg(s)
- ☐ Wrist(s)

Nature of Injury

- ☐ Absorption
- ☐ Bite/Sting/Scratch
- ☐ Cardio-Vascular/Respiratory System Failure
- ☐ Caught In or Between
- ☐ Fall (From Elevation)
- ☐ Fall (Same Level)
- ☐ Ingestion
- ☐ Inhalation
- ☐ Lifting
- ☐ Mental Stress
- ☐ Motor Vehicle Accident
- ☐ Multiple (Specify) _____
- ☐ Other (Specify) _____
- ☐ Overexertion
- ☐ Repeated Motion/Pressure
- ☐ Rubbed/Abraded
- ☐ Shock
- ☐ Struck Against
- ☐ Struck By
- ☐ Work Place Violence

Initial Diagnosis/Treatment Date: _____

Type of Treatment

- ☐ Admission to hospital/medical facility
- ☐ Application of bandages
- ☐ Cold/Heat Compression/Multiple Treatment
- ☐ Cold/Heat Compression/One Treatment
- ☐ First Degree Burn Treatment
- ☐ Heat Therapy/Multiple treatment
- ☐ Multiple (Specify) _____
- ☐ Heat Therapy/One Treatment
- ☐ Non-Prescriptive medicine
- ☐ None
- ☐ Observation
- ☐ Other (Specify) _____
- ☐ Prescription- Multiple dose
- ☐ Prescription- Single dose
- ☐ Removal of foreign bodies
- ☐ Skin Removal
- ☐ Soaking therapy- Multiple Treatment
- ☐ Soaking Therapy- One Treatment
- ☐ Stitches/Sutures
- ☐ Tetanus
- ☐ Treatment for infection
- ☐ Treatment of 2nd /3rd degree burns
- ☐ Use of Antiseptics – multiple treatment
- ☐ Use of Antiseptics – single treatment
- ☐ Whirlpool bath therapy/multiple treatment
- ☐ Whirlpool therapy/single treatment
- ☐ X-rays negative
- ☐ X-rays positive/treatment of fracture

Number of days doctor required employee to be off work: _____
Number of days doctor restricted employee's work activity: _____
Equipment Malfunction : Yes ☐ No ☐ Activity was a Routine Task: Yes ☐ No ☐
Describe how you may have prevented this injury:
_____
_____
_____

Physician Information		Hospital Information	
Name:	_____	Name:	_____
Address:	_____	Address:	_____
City:	_____	City:	_____
Zip Code:	_____	Zip Code:	_____
Phone:	_____	Phone:	_____

Property Damage (Complete for Property Damage incidents only)

Property Damaged: _____ Property Owner: _____
Damage Description: _____
Estimated Amount: $ _____

Spill or Release (Complete for Spill/Release incidents only)

Substance (attach MSDS): _____ Estimated Quantity: _____
Facility Name, Address, Phone No.:
_____
Did the spill/release move off the property where work was performed?:
_____
Spill/Release From: _____ Spill/Release To: _____

Environmental/Permit Issue (Complete for Environmental/Permit Issue incidents only)

Describe Environmental or Permit Issue:
_____
Permit Type:
_____
Permitted Level or Criteria (e.g., discharge limit):
_____
Permit Name and Number (e.g., NPDES No. ST1234):
_____
Substance and Estimated Quantity:
_____
Duration of Permit Exceedence:
_____

Verbal Notification (Complete for all incident types)(Provide names, dates and times)

JVI Personnel Notified:
_____
Client Notified:
_____

Root Cause Investigation

This attachment is provided to assist in accessing, completing, and reviewing an incident investigation. It is important to remember the following when conducting an investigation:

Gather relevant facts, focusing on fact-finding, not fault-finding.
Draw conclusions, pitting facts together into a probable scenario.
Determine incident root cause(s), the basic causes why an unsafe act/condition existed.
Develop and implement solutions, matching all identified root causes with solutions.

Documentation
The following should be included in the IRF to document the incident.

Description

Provide a description of the event and the sequence of events and actions that took place prior to the incident. Start with the incident event and work backwards in time through all of the preceding events that directly contributed to the incident. The information should identify why the event took place as well as who was involved, when and where the event took place, and what actions were taken.

Cause Analysis

Using the form and flowchart in this attachment the root cause of the incident will be determined. This form must be retained in the project and/or regional HS&E files.

Immediate Causes—List the substandard actions or conditions that directly affected the incident. The following are examples of immediate causes:

***Substandard Actions*:** Operating equipment without authority; failure to warn; failure to secure; operating at improper speed; making safety device inoperable; using defective equipment; failing to use PPE; improper loading; improper lifting; improper position for task; under influence of alcohol or drugs; horseplay.

Substandard Conditions: Exposure to hazardous materials; exposure to extreme temperatures; improper lighting; improper ventilation; congestion; exposure to fire and explosive hazard; defective tools, equipment or materials; exposure to extreme noise; poor ventilation; poor visibility; poor housekeeping.

Basic Causes—List the personal and job factors that caused the incident. The following are examples of basic causes:

Personal Factors: Capability; knowledge; skill; stress; motivation.

Job Factors: Abuse or misuse; engineering; maintenance; purchasing; supervision; tools and equipment; wear and tear; work standards.

Corrective Action Plan

Include all corrective actions taken or those that should be taken to prevent recurrence of the incident. Include the specific actions to be taken, the employer and personnel responsible for implementing the actions, and a time frame for completion. Be sure the corrective actions address the causes. For example, training may prevent recurrence of an incident caused by a lack of knowledge, but it may not help an incident caused by improper motivation.

The following are examples of management programs that may be used to control future incidents. These programs should be considered when determining specific corrective actions.

Management Programs: Accident/incident analysis; emergency preparedness; engineering controls; general promotion; group meetings; health control; hiring and placement; leadership and administration; management training; organizational rules; personal protective equipment; planned inspections; program audits; program controls; purchasing controls; task analysis and procedures; task observation.

Loss/Near-Loss Investigation Report Form

Employer Information

Company Name: _____

Project Name: _____ Task Order: _____

Project Location: _____

Task Location: _____

Job Assignment: _____

Preparer's Name: _____ Preparer's Employee Number: _____

Incident Specific Information

Date of Incident: _____ Time of Incident: _____ a.m./p.m.

Location of incident:
☐ Company premises
☐ Field
☐ In Transit
☐ Other: _____
_____

Address where the incident occurred: _____

Equipment Malfunction : Yes ☐ No ☐ Activity was a Routine Task: Yes ☐ No ☐

Describe any property damage: _____

Specific activity the employee was engaged in when the incident occurred:
_____
_____

All equipment, materials, or chemicals the employee was using when the incident occurred:
_____
_____

Describe the specific incident and how it occurred:
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Describe how this incident may have been prevented:

_____
_____
_____
_____
_____
_____
_____
_____

Contributing Factors (Describe in detail why incident occurred):

_____
_____
_____
_____
_____

Date employer notified of incident: _____ To whom reported: _____

Witness Information (First Witness)

Name: _____
Employee Number_____
Address:_____
City: _____
Zip Code : _____
Phone: _____

Witness Information (Second Witness)

Name: _____
Employee Number_____
Address:_____
City: _____
Zip Code : _____
Phone: _____

Additional information or
comments:_____
_____
_____

A ROOT CAUSE ANALYSIS FORM MUST BE COMPLETED FOR ALL INJURIES AND ILLNESSES OR ACTUAL LOSSES.

COMPLETION OF THE ROOT CAUSE ANALYSIS FORM FOR NEAR LOSSES IS OPTIONAL, AT THE DISCRETION OF THE HEALTH AND SAFETY MAANGER.

Determination of Root Cause(s)

For losses or near losses the information may be gathered by the supervisor or other personnel immediately following the loss or near loss. Based on the complexity of the situation, this information may be all that is necessary to enable the investigation team to analyze the loss, to determine the root cause, and to develop recommendations. More complex situations may require the investigation team to revisit the loss site or re-interview key witnesses to obtain answers to questions that may arise during the investigation process.

Photographs or videotapes of the scene and damaged equipment should be taken from all sides and from various distances. This point is especially important when the investigation team will not be able to review the loss scene.

The investigation team must use the Root Cause Analysis Flow Chart to assist in identifying the root cause(s) of a loss. Any loss may have one or more "root causes" and "contributing factors". The "root cause" is the primary or immediate cause of the incident, while a "contributing factor" is a condition or event that contributes to the incident happening, but is not the primary cause of the incident. Root causes and contributing factors that relate to the *person* involved in the loss, his or her peers, or the supervisor should be referred to as "personal factors". Causes that pertain to the *system* within which the loss or injury occurred should be referred to as "job factors".

<u>Personal Factors</u>

1. Lack of skill or knowledge, lack of motivation
5.Correct way takes more time and/or requires more effort
6. Short-cutting standard procedures is positively reinforced or tolerated
7. Person thinks that there is no personal benefit to always doing the job according to standards

<u>Job Factors</u>

2. Lack of or inadequate operational procedures or work standards.
3. Inadequate communication of expectations regarding procedures or standards
4. Inadequate tools or equipment

<u>Other</u>

8.Uncontrollable Factors *****

The root cause(s) could be any one or a combination of these seven possibilities or some other "uncontrollable factor". In the vast majority of losses, the root cause is very much related to one or more of these seven factors. * **Uncontrollable factors should be used rarely and only after a thorough review eliminates "all" seven other factors.**

Root Cause Analysis Form

Root Cause Analysis (RCA)

Root Cause Categories (RCC): Select the RCC numbered below that applies for the root cause (RC) and/or contributing factor (CF) in the first column, then describe the specific root cause and corrective actions in each column.

1. **Lack of skill or knowledge**
2. **Lack of or inadequate operational procedures or work standards**
3. **Inadequate communication of expectations regarding procedures or work standards**
4. **Inadequate tools or equipment**
5. **Correct way takes more time and/or requires more effort**
6. **Short-cutting standard procedures is positively reinforced or tolerated**
7. **Person thinks there is no personal benefit to always doing the job according to standards**
8. **Uncontrollable Factor (Note: Uncontrollable factors should be used rarely and only after a thorough review eliminates "all" seven other factors.)**

RCC #	Root Cause(s)	Corrective Actions	RC[1]	CF[2]	Due Date	Completion Date	Date Verified

[1] RC = Root Cause; [2] CF = Contributing Factors (check which applies)

Investigation Team Members

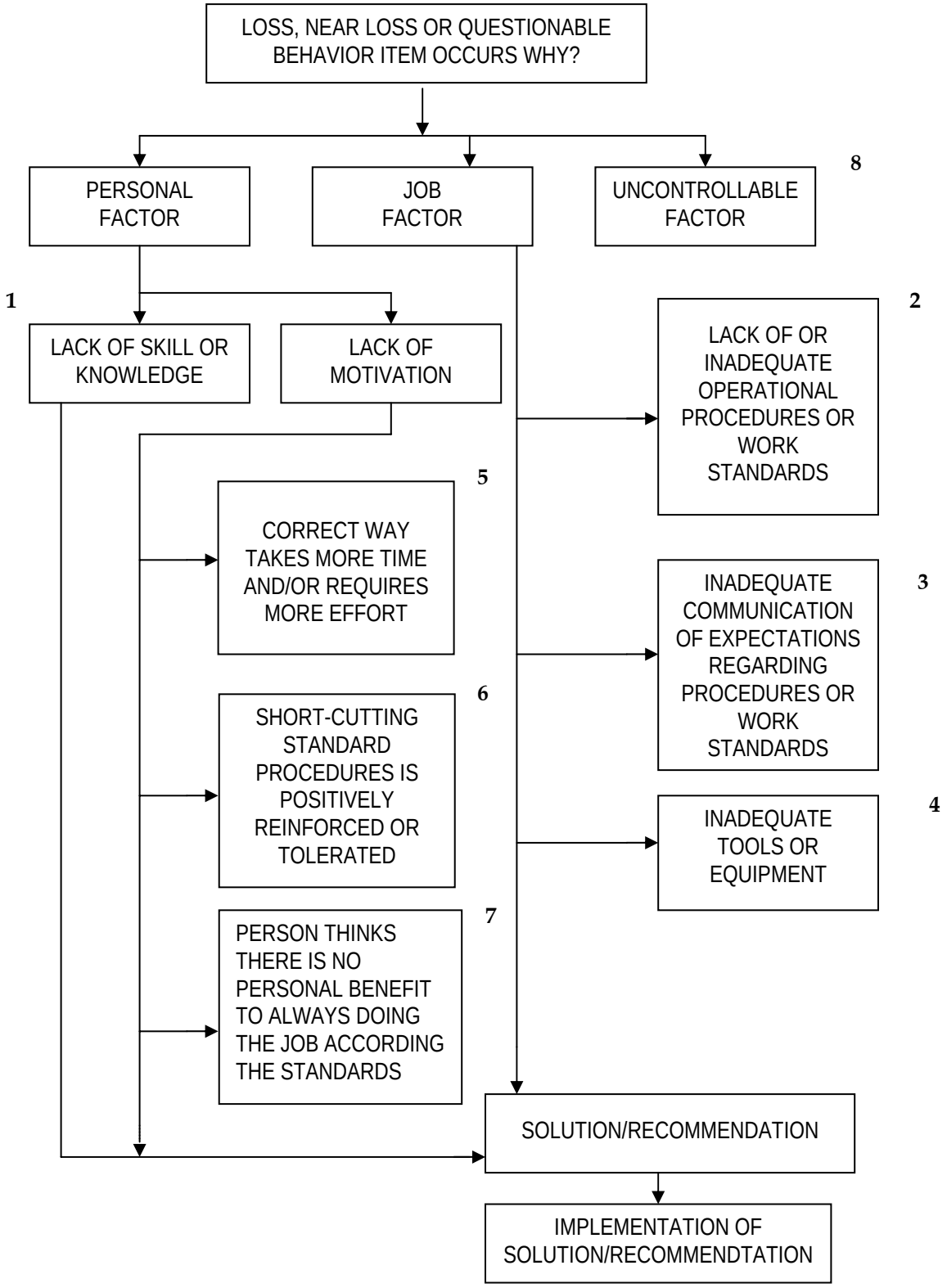
Name	Job Title	Date

Results of Solution Verification and Validation

Reviewed By

Name	Job Title	Date

Root Cause Analysis Flow Chart



Attachment 10

Emergency Contact List

Emergency Contact List

CH2MHILL 24-hour Nurse Number 1-800-756-1130

(See attached instructions in attachment 10 of HSP*)

Medical Emergency 911
Fire/Spill Emergency 911
Security Emergency 911

See site Specific Hospital Route Maps for emergency contact information.

Utilities Emergency
Contact Base EMD
(910) 451-9607

CH2M HILL- Medical Consultant
Dr. Jerry H. Berke, M.D., M.P.H.
Health Resources
600 West Cummings Park, Suite 3400
Woburn, MA 01801-6350
781/938-4653
800/350-4511
(After hours calls will be returned within 20 minutes)
CH2MHILL Injury Management #:1-800-756-1130.

AGVIQ Medical Consultant(s)
Refer to AQVIQ VBO office for a detailed list of Medical Facilities/contacts.

JV II Program Director
Name: Craig Miller - AGVIQ
Phone: 757-213-8584/ 757- 531-6425 (cell)

JV II Site Superintendent
Name: Kristi Riggs- AGVIQ
Cell Phone: (757) 544 7392

JV II Deputy Program Manager
Name: Michael HalilCH2M HILL
Phone:904-733-9119/904- 219-6277 (cell)

JV II Project Manager (overall)
Name: Kerri Hallberg
Phone: 704-329-0073x302/704-975-9381 (cell)

AGVIQ Corporate Human Resources Department
Name: Kristy Payne
TIKIGAQ Corp. Anchorage, AK
Phone: (907) 365 6242

CH2M HILL Corporate Human Resources Department
Name: Pete Hannon, DEN
Phone: 303-771-0900

JV II SHSO (Alternate)
Name: Kristi Riggs- AGVIQ
Cell Phone: (757) 544 7392

JV II HSO/POC (SHSO Alternate)
Name: TBD
Cell Phone:

JV II HSM
Name: Richard Rathnow – CH2M HILL -ORO
Phone: (865) 483 9005 (572)
Cell: (865) 607 6734

JV II SHSO (Primary)
Name: Jennifer Simms –CH2MHILL
Phone: 215-640-9071/267-251-8089 (cell)

JV II SHSO (Alternate)
Name: TBD
Cell Phone:

AGVIQ Worker's Compensation & Auto Claims

Name Cherry Perley
TIKIGAQ Corp. Anchorage, AK
Phone: (907) 365 6242
AGVIQ personnel to report all accidents or injuries to AGVIQ Corporate HSM or HSO immediately but no later than 24 hrs. Fatalities and hospitalizations shall require immediate notification to AGVIQ Corporate HSM.

CH2MHill Worker's Compensation & Auto Claims

Sterling Administration Services
Phone: 800/420-8926 After hours: 800/497-4566

Report fatalities AND report vehicular accidents involving pedestrians, motorcycles, or more than two cars.
Fatalities and hospitalizations shall require immediate notification to JVI HSM.

AGVIQ Corporate HSM

Name: Troy Izatt –
Office phone # (907) 365-6182
Cell phone # (907) 748-3697

Federal Express Dangerous Goods Shipping
Phone: 800/238-5355
Emergency Number for Shipping Dangerous Goods
Phone: 800/255-3924

Contact the Project Manager. Generally, the Project Manager will contact relevant government agencies.

Facility Alarms:
Sound vehicle horn three times

Evacuation Assembly Area(s):
Outside of chain link fence at entrance to site, account for all site personnel prior to leaving site.

Facility/Site Evacuation Route(s): Developed site specific on-site prior to start of work

Hospital Name/Address: See site Specific Hospital Route Maps for emergency contact information.

CH2MHILL

INITIAL MEDICAL TREATMENT FORM

To be completed by CH2M HILL Supervisor – Send with employee visiting medical facility or forward within 24 hours.

Employee name: _____Date of Injury:_____
Supervisor: _____ HS Representative:_____
Visit Authorized by: _____Phone #;_____

CH2M HILL Workers Compensation Administrator: Cambridge
Send Bills to: CH2M HILL
Attn: Jennifer Rindahl
P.O. Box 22508
Denver, Colorado 80222-0508

To be completed by medical provider:

Physician's name: _____ Phone #: _____
Address:
_____
CH2M HILL employee: _____ has been treated for:_____

It is the policy of CH2M HILL to provide temporary modified duty whenever possible for employees with physical restrictions resulting from an occupational injury or illness.

Released to full duty

Released to restricted duty only (list restrictions below)

Out of work until _____(date)

Please list any physical restrictions:
_____
_____

Expected duration of restricted duty?
_____

CH2M HILL would like the best and most efficient care extended to all our employees. Please recommend over-the-counter (OTC) medication as a suitable alternative when medically feasible.

Prescribed medication:_____

Recommended OTC alternative:_____

Date of follow-up appointment:_____

Physician's signature: _____ Date: _____

Please return this form to the injured employee and FAX to Health Resources at 1-800-853-2641. If you want to discuss the employee's work restrictions, please call the person listed in the "Visit Authorized by" field.

* Emergency Nurse Assistance Instructions
(CH2MHILL personnel only)

- After informing their supervisor (JV II Project Manager and/or JV II Deputy Program Manager), the injured employee calls CH2M HILL's contracted Occupational Nurse.

24-hour CH2M HILL Emergency Nurse Assistance

1-800-756-1130

- The Occupational Injury Nurse listens to the injured employee to understand the injury/illness.
- Employee is provided guidance on appropriate treatment options (triage).
- If instructed to visit a medical facility by the Occupational Nurse, the Supervisor is responsible for instructing the injured employee to take a copy of the **CH2M HILL Initial Medical Treatment Form (Attachment # 10– For Use by CH2MHILL Personnel Only)** with them to the physician, clinic or hospital.
- Appropriate treatment details are handled by the Occupational Injury Nurse, and Workers Compensation Groups.
- Nurse communicates and troubleshoots with and for employee through full recovery
- Upon any project incident (fire, spill, injury, near miss, death, etc.), immediately notify the JV II PM (overall) and JV II HSM. Call emergency beeper number if HSM is unavailable.
- For work-related injuries or illnesses to CH2MHILL personnel, contact and help Human Resources administrator complete a HITS (Hours & Incident Tracking System) Form. HITS must be completed within 24 hours of incident.

- For JV II subcontractor incidents, complete the Incident Report Form (IRF), Near Loss Investigation Report and Root Cause Analysis and submit to the JV II PM and HSM.

Attachment 11

Accident Prevention Plan

Accident Prevention Plan
Vapor Intrusion Evaluation

MCB Camp Lejeune
North Carolina
N62467-03-D-026.

Contract No N62470-03-D-026
Contract Task Order 021

Prepared for:

Department of the Navy
Naval Facilities Engineering Command
Atlantic Division

AGVIQ — CH2M HILL
Joint Venture

April 2008

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Acronyms and Abbreviations

ANSI	American National Standards Institute
APP	Accident Prevention Plan
ASTM	American Society for testing and Materials
CFR	Code of Federal Regulation
CIH	Certified Industrial Hygienist
CPR	cardiopulmonary resuscitation
EMT	emergency medical technician
OM	Corporate Operations Manager
EH&S	Environmental Health and Safety
HSP	Health and Safety Plan
JVI	AGVIQ-CH2M HILL Joint Venture
NIOSH	National Institute for Occupational Health
OSHA	Occupational Safety and Health Administration
PPE	personal protective equipment
ROICC	Resident Officer in Charge of Construction
SHSO	Site Health and Safety Officer
TBD	to be determined

1.0 Signature Sheets

Plan Acknowledged By:

Name:	Craig Miller, Program Manager
Title:	JV II Program Manager
Company:	AGVIQ-CH2M HILL Joint Venture II
Telephone:	757-213-8584
Fax:	757-318-9421

hereby acknowledge that I have reviewed and fully understand the tenets of this Accident Prevention Plan and my responsibilities as they are specified herein.

Signature: _____

Craig Miller, Program Manager

Designated Project Manager (overall):

Name:	Terri Hallberg
Title:	JV II Project Manager (overall)
Company:	AGVIQ-CH2M HILL Joint Venture II
Telephone:	704-329-0073 x304
Fax:	704-329-0141

I hereby acknowledge that I have reviewed and fully understand the tenets of this Accident Prevention Plan and my responsibilities as they are specified herein.

Signature: _____

Terri Hallberg, Project Manger

Site Health and Safety Officer (primary) :

Name:	Jennifer Simms
Title:	Field Team Leader/Quality Assurance/Control Specialist
Company:	Ch2MHILL Constructors, Inc.
Telephone:	267-251-8098 (cell)

I hereby acknowledge that I have reviewed and fully understand the tenets of this Accident Prevention Plan and my responsibilities as they are specified herein:

Signature: _____

Jennifer Simms, Environmental Engineer

Site Health and Safety Officer (alternate) :

Name: Kristi Riggs
Title: Field Team Leader
Company: AGVIQ-CH2M HILL Joint Venture II
Cellular: 757-544-7392 (cell)

I hereby acknowledge that I have reviewed and fully understand the tenets of this Accident Prevention Plan and my responsibilities as they are specified herein

Signature: _____
Kristi Riggs, Environmental Scientist

Site Health and Safety Officer (alternate):

Name: TBD
Title:
Company:
Telephone:
Fax:

I hereby acknowledge that I have reviewed and fully understand the tenets of this Accident Prevention Plan and my responsibilities as they are specified herein:

Signature: _____

2.0 Background Information

Background information for this project is detailed in the Health and Safety Plan (HSP), Section 1.1, Introduction.

3.0 Statement of Safety and Health Policy

3.1 Objective

To provide a Safe Work Place for all employees by developing and administering an overall Environmental Health and Safety (EH&S) Program. To establish written policies and procedures that serve as vehicles through which the program will be implemented.

3.2 Purpose

This statement describes the AGVIQ-CH2M HILL Joint Venture II (JV II) Health and Safety (H&S) Program and the responsibilities of the supervisors, employees, and subcontractors. It will address applicable United States Occupational Safety and Health Administration (OSHA) standards set forth in 29 CFR 1910 and 29 CFR 1926 as well as various consensus standards and JV II policies by the use of referenced procedures.

3.3 Primary Environmental Health and Safety Program Functions

The primary functions of the Environmental H&S program are to:

- Define the health and safety responsibilities of JV II personnel.
- Administer the medical surveillance program.
- Prepare the site safety plans.
- Provide safety training/maintaining training records.
- Provide safety procedures and protocols to be used at project sites, shops, and offices.
- Conduct accident investigations and maintaining records.
- Verify OSHA compliance under 29 CFR 1910 and 1926.
- Provide guidance and assistance with preparation of safety protocols for specific tasks.
- Promote safety and health consciousness within the company.
- Designate the functional organization of safety committees to serve corporate and project specific safety and health program needs.

3.4 Safety Organization and Responsibility

With JV II, the safety and protection of employees, clients, and the community is the first priority. This concern for safety is not restricted to field operations but extends to

laboratories, the offices, and shop facilities. If an activity or condition is unsafe, the task will not proceed until the situation is corrected.

The **Program Manager** is the primary operational safety official of JV II and has overall responsibility for ensuring that program participants adhere to the H&S policies and procedures adopted by the JV II program.

The **Health and Safety Manager** (HSM) administers the safety program for the JV II program and reports directly to the Program Manager with regard to JV II program matters. The HSM, or his designee, is responsible to support and assist program staff in executing the EH&S policies and procedures adopted by the program for implementation. The HSM also maintains secondary reporting to the Deputy Program Manager.

The **Site Health and Safety Officer** (SHSO) is responsible for administration and enforcement of the safety procedures and protocols on project sites. The SHSO is the primary safety official at the working level. The responsibility for safety is delegated and shared by project managers, alternate site safety officers, and subcontractors' supervisors. At a minimum, the SHSO must perform, or otherwise supervise the performance of, the following:

- Motivate employees and supervisors of subcontractors to adhere to JV II's safety policy in each work situation.
- Schedule, organize, and lead preparatory phase meetings prior to all activities relevant to definable features of work and have a working knowledge of the safe procedure for all jobs and tasks under their supervision. When in doubt, seek assistance prior to initiating a task. This is the only acceptable manner in which to perform the task. If the task cannot be accomplished safely, it will not be attempted.
- Explain the safety procedure involved with a task to each employee and check frequently to see that the employee understands and works as instructed.
- Allocate sufficient time for the training and coaching of all employees to insure that everyone knows the correct procedure for safely accomplishing required tasks. New employees will not be allowed to perform any work until required training is completed.
- Immediately correct unsafe conditions that involve JV II employees or subcontractors.
- Ensure that employees are outfitted with and wear personal protective equipment as specified by this plan, EM385-1-1, and other JV II procedures.
- Set a good safety example.
- Obtain the cooperation of employees and sub-contractors. Sub-contractor safety performance records will be verified prior to contract award and will be continually monitored during operations.
- Report all accidents, near misses and property damage in accordance with the Incident Management and Reporting Procedure.

Every Employee, regardless of job title, shares the responsibility for safety and should report any unsafe work condition without fear of reprisal. It is imperative that employees

observe the following minimum requirements in order to achieve a safe and healthy workplace:

- Each employee must be familiar with this Accident Prevention Plan and the general safety rules herein.
- Each employee will practice safe procedures and follow all safety rules and regulations for the successful completion of any job task.
- All employees will wear the necessary personal protective equipment required for the job or task as specified by this plan, EM385-1-1, and other JV II procedures.
- The employee will notify the immediate supervisor of any potential hazard or unsafe work practice that could result in injury or destruction of property.
- The employee will report all accidents to an immediate supervisor regardless of whether injury or property damage resulted. This includes all near misses (accidents without injury or damage). This requirement serves to bring unsafe conditions to the attention of management.
- Each employee will be subject to contraband search for safety purposes and for the safety of fellow employees.
- Violations of published safety policies and procedures may be cause for disciplinary actions up to and including dismissal.
- All employees who are taking prescribed medications that could affect work performance or might alter the manner in which they could be treated in an emergency will so advise their supervisor prior to beginning work.

3.5 Regulator Compliance Policy

The policy of JV II will be to comply with all federal, state, local, and client regulations. It is the responsibility of all personnel to perform all work in full compliance with appropriate regulations. Safety and health personnel will immediately bring any condition regarding safety and health compliance to the attention of supervisory operating personnel.

JV II will endeavor to ensure regulatory compliance by all of its subcontractors, including, safety records, OSHA training, and medical surveillance, as applicable.

3.6 Safety Goals

The goal of the safety and health program is to ensure a safe working environment, protect workers from harm, and protect the company from liability associated with an unsafe working environment.

Other goals are to eliminate workplace accidents, gain worker acceptance through cooperation and training, and provide our clients with a responsible, well-trained, safety-oriented work force.

JV II has adopted a "zero accidents" goal for all operations. All activities will be planned and performed with this goal foremost.

3.7 Safety Training

JV II engages in environmental remediation, construction, and other services, and must comply with numerous health and safety training requirements, mandated by governmental agencies, clients, and internal policies.

All personnel will be provided sufficient training to execute their jobs in a safe and healthy manner.

Direct supervisors are responsible to determine the training requirements of a task and ensure employees have the necessary training to complete the task safely. EH&S personnel will assist with this determination and training.

The corporate personnel department will maintain training records and documentation.

3.8 Medical Surveillance

All employees who perform work at hazardous waste sites or perform emergency response will be subject to the JV II medical surveillance program. This program conforms to the requirements established by 29 CFR 1910.120/1926.65 (f) Medical surveillance and is titled HSE Procedure 113, Medical Surveillance.

3.9 Accident Investigation

All accidents, injuries, illnesses, incidences of significant property damage will be investigated by the SHSO or other authorized H&S program designate. Upon completion of such investigations, completed investigation reports shall be provided to the JV Project Manager for review and circulation to JV II program stakeholders (HSM, Program/Deputy Program Manager, other JV II designated stakeholder interests).

The JV II HSM may investigate serious accidents, such as those involving hospitalization or injuries requiring more than one visit to a physician. The JV II HSM may also request that a specific written accident investigation be conducted in case of an unusual or serious injury or accident.

3.10 Position Statement on Modified Work

JV II will attempt to eliminate all accidents through strict compliance with OSHA regulations and JV II H&S procedures, as well as supervisor and employee safety training, safety audits, and constant attention to safety. Should employee be injured or become ill in the course of and arising from his employment, JV II will attempt to provide modified work. Modified work ("light duty") will be made available in order to bring the injured employee back to the work environment, for the benefit of the employee and the company, whenever medically appropriate.

Employees are expected to return to modified work when medically capable. The work assigned to the injured employee will meet the restrictions set forth by the treating and/or company physician. Examples of modified work include but are not limited to office work, dispatching, and light shop work.

3.11 Field Safety Inspections

Weekly safety inspections will be made of the work area. The inspection will be made by the Site Superintendent/Supervisor, Field Team Lead, (herein after as individual responsible for site operations) and/or the SHSO, or other designated JV II representative. These inspections are in addition to the daily inspections to be held by these individuals and designated crew leaders. Discrepancies found during inspections will be corrected as soon as practicable. Serious safety violations will be corrected immediately. Inspection records will be maintained in the safety log.

Additionally, the JV II HSM or designated representative may make periodic unannounced inspections of work sites on their own discretion or at the request of an employee, supervisor, manager, or client.

3.12 First Aid

Each facility and work location must be evaluated to determine the potential requirement for medical emergencies. At a minimum, an industrial first-aid kit will be provided. An adequate number of employees with current certification in first aid and cardiopulmonary resuscitation (CPR) will be maintained on the project sites.

The SHSO will ensure that emergency medical attention is readily available. For emergency response and remediation operations, the SHSO will establish the requirement for medical emergency response and identify an emergency medical facility with chemical contamination trauma capability. If site conditions require, a subcontract emergency medical technician (EMT) and/or the availability of ambulance service on site will be implemented.

3.13 Review of Health and Safety Statistics

A designated representative from JV II will review and tabulate safety statistics as necessary:

- OSHA 300 form
- Workers' Compensation Experience Modification Ratings

3.14 Specific Written Safety Procedures/Permits

In order to provide a safe work place and communicate specific work requirements for regulatory compliance, specific tasks are incorporated by reference to this procedure. These procedures deal with specific areas such as confined space, hot work, lock out tag out, etc.

All JV II personnel who may be subject to these procedures will receive appropriate training and will be held accountable for compliance with procedure requirements.

3.15 State, OSHA, and Other Regulations

Where state regulations differ from federal regulation cited in this plan, the more stringent regulation will apply.

3.16 Changes

Any user of this plan is welcome to recommend changes. Changes normally result from finding errors, regulatory changes, equipment modification, new equipment purchases, and changes to operation procedures or site conditions. The format for making a recommended change is:

Submit a written recommendation to the JV II HSM via your immediate supervisor. The JV II HSM will review the recommendation.

After review, the JV II HSM will determine if the suggestions should be included as an amendment or new procedure in this plan. Changes to this plan will be distributed immediately upon approval.

4.0 Responsibilities and Lines of Authorities

The following listed JVI personnel will have the authority to intervene and suspend work in the interest of safety policy compliance:

- David Leadenham JV II Program Manager
- Steve Romanow JV II Deputy Program Manger
- Jessica Skeean JV II Project Manager (overall)
- Robert Lychalk JV II Superintendent
- Kathy Jewel JV II Site Health and Safety Officer (primary)

Safety responsibilities, accountability and lines of authority are further discussed in Section 2.1 of the HSP, Project Safety Responsibilities.

5.0 Subcontractors and Suppliers

5.1 Subcontractor/Supplier Coordination and Control

JV II subcontractors will be screened for safety performance and compliance with federal alcohol and drug testing requirements prior to being issued any contract for site work. JV II subcontractors will comply with the requirements for site safety as outlined in JV II health and Safety Procedures.

5.2 Subcontractor/Supplier Safety Responsibilities

All subcontractor employees are subject to the same training and medical surveillance requirements as JV II personnel depending on job activity. All activities involving the potential for exposure to hazardous waste materials will require medical and training certification as mandated by 29 CFR 1910.120. All subcontractor personnel will be required to sign in daily and be required to attend a daily meeting discussing operations and safety issues. All subcontractors involved in construction/remedial activities will complete a Subcontractor Pre-Job Safety Checklist prior to the start of work at the site. Subcontractors will submit Activity Analyses for their work activities to the JV II SHSO or HSM for review. The subcontractor reports directly to the JV II Project Manager (overall), herein referred to as Project Manager. The JV II Project Manager may designate subcontractor reportability to the JV II individual responsible for site operations. All incidents involving subcontractor employees will be reported to the JV II individual responsible for site operations and a copy of the subcontractor's injury/illness report will be submitted to the JV II Project Manager and HSM, as soon as possible, but no later than 24 hours.

JV II subcontractors are required to sign off and comply with all requirements of the JV II Site-Specific HSP, which includes this Accident Prevention Plan (APP). Plans to address specific hazards may be added to the APP during the course of work. JV II subcontractors will be required to sign off and comply with any such supplemental plans. Subcontractors not in compliance will be immediately dismissed from the site.

Suppliers delivering various materials to the project site or providing equipment and equipment maintenance will comply with all rules and regulations specified by the owner. Supplier personnel will not be permitted into contaminated areas unless training and medical surveillance is in accordance with 29 CFR 1910.120. Contractors will not ride on tractors, forklifts or similar vehicles unless specific seats are provided. They will follow Facility hot work rules if hot work is required for vehicle or equipment maintenance. Trucks will be loaded and unloaded in a safe and effective manner and materials will be stored safely in designated locations only. Associated packaging will be properly disposed of and litter will not be permitted to be scattered or blown from truck beds. Operators of mobile equipment on site must observe all traffic rules such as speed limits and right-of-ways of pedestrians.

6.0 Training

6.1 Safety Indoctrination Subjects

Outlines of the site safety orientation for JV II and subcontractor personnel and visitors are provided in Section 2.1 of the HSP, Employee Medical Surveillance and Training.

6.2 Mandatory Training and Certifications

Mandatory training and certifications are discussed in Section 9.0 of the HSP, Training Requirements.

All personnel entering an exclusion zone will be trained in the provisions of this Accident Prevention Plan and be required to sign the Accident Prevention Plan. Site-specific training for the assigned Task Orders is included in Section 2.1, Employee Medical Surveillance and Training.

6.3 Supervisory and Employee Safety Meetings

The JV II individual responsible for site operations, SHSO or authorized designate will conduct daily safety meetings 'at the start of each work shift for on site personnel and will require subcontractors to follow similar meeting procedures or participate in the JV II daily safety meetings.

7.0 Safety and Health Inspections

The JV II Project Manager, individual responsible for site operations or/and the SHSO are required to perform site safety inspections using the Site Safety Inspection Checklist. The SHSO is responsible for conducting and preparing reports of daily safety inspections of work processes, site conditions, equipment conditions and submitting them for the project record. The SHSO will discuss any necessary corrective actions with the Project Manager and review new procedures. Copies of these reports are maintained on file at the project locations. Additionally, copies will be forwarded to the JV II HSM.

The JV II HSM or his designated representative will periodically conduct site visits and perform Site Safety Assessments. These reports are kept on file and are tracked in a database for each Project Manager and designated individual responsible for site operations including the number of action items noted during the visit and written confirmation of the corrective actions for each item. These responses are compiled and provided to program management for review.

JV II does not anticipate, but may consider the use of, outside sources to provide safety inspections on an as-necessary basis.

As required, JV II safety equipment will comply with appropriate OSHA, National Institute for Occupational Safety and Health (NIOSH), American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), and U.S. Coast Guard or other recognized certification organizations.

8.0 Safety and Health Expectations, Incentive Programs, and Compliance

8.1 Company Safety Program Goals

JV II considers safety the highest priority during work at all project sites and its business offices and has established a goal of **zero incidents.** All projects will be conducted in a manner which minimizes the probability of near misses, equipment/property damage or injury. JV II will use safety observation programs to identify and correct unsafe acts and conditions. Safety awareness programs will be used to provide continuous training and development of good safety practices. The JV II program will investigate all incidents to determine root causes and institute corrective actions to prevent recurrence. JV II will provide and enforce safety rules to protect employees, subcontractors, clients and the public.

8.2 JV II Employee Safety Responsibility Requirements

Each employee is responsible for personal safety as well as the safety of others in the area and is expected to participate fully in the ***Safety Improvement Process,*** particularly the Safety Observation Program. The employee use all equipment provided in a safe and responsible manner as directed by the SHSO. All JV II personnel will follow the policies set forth in the JV II Health and Safety Plan. Site personnel concerned with any aspect of health and safety will bring it to the attention of the Project Manager or SHSO. All project personnel have the authority to stop work if it is their judgment serious injury could result from continued activity. The individual responsible for site operations or SHSO will be notified immediately if this becomes necessary. To protect the health and safety of all personnel, employees that knowingly disregard safety policies/procedures may be subject to disciplinary actions up to and including termination.

8.3 Managers and Supervisors Safety Accountability

It is the duty of the first line supervisor to motivate employees to adhere to JV II's safety policy in each work situation. A first line supervisor for these purposes is defined as that person designated to give immediate onsite supervision to personnel involved in a task.

All supervisors will have complete knowledge of the safe procedure for all jobs and tasks under their supervision. When in doubt, they will seek assistance prior to initiating a task. This is the only acceptable manner in which to perform the task. If the task cannot be accomplished safely, it will not be attempted.

Supervisors will:

- Explain the safety procedure involved with a task to each employee and check frequently to see that the employee understands and works as instructed.
- Allocate sufficient time for the training and coaching of all employees to ensure that everyone knows the correct procedure for safely accomplishing required tasks.
- Prevent new employees from performing any tasks until required training is completed.
- Immediately correct unsafe conditions, which involve JV II employees or contractors.
- Ensure that the employees are outfitted with and wear personal protective equipment as specified by this APP, site-specific health and safety plan, other JV II procedures or as directed by the HSM, Project Manager, SHSO.
- Set a good safety example.
- Obtain the cooperation of employees and contractors.
- Provide a safe work environment for employees and contractors.
- Confirm contractor safety performance records have been verified prior to contract award and monitor contractor performance during operations.
- Report all accidents, near misses and property damage in accordance with the Incident Management and Reporting Procedure.
- Establish a safety culture, using the elements of the JV II Safety Improvement process, which promotes awareness, encourages participation and recognizes excellence.

9.0 Accident Reporting

9.1 Exposure Data (Man-hours Worked)

The JV II HSM with assistance from the JV II designated responsible partner tracks and maintains incident records as to Federal reporting requirements (OSHA 300 Log), as applicable to the incident.

9.2 Accident Investigations, Reports, and Logs

The Site Safety Office conducts accident/incident investigations. A report is completed by the SHSO and is required to be reviewed and signed by the Project Manager. The report must be submitted to the Project Manager and HSM, as soon as possible, but no longer than 24 hours.

9.3 Immediate Notification of Major Incidents

JV II will immediately notify the Base contact/Navy RPM of any major incident, including injury, fire, equipment/ property damage and environmental incident. A full report will be provided within 48 hours. Procedures to be followed in response to any major personal injury are detailed in the Site Specific Health and Safety Plan, Section 10.3, Incident Reporting, Investigation, and Response.

10.0 Medical Support

On-site Medical Support/Off-site Medical Arrangements are provided in Section 10.0 of the HSP. Emergency phone numbers are listed in Attachment 14 of the HSP.

11.0 Personal Protective Equipment

Hazard Assessment Procedures/Written Certifications for Personal Protective Equipment Protection levels provided in the HSP have been established for the anticipated scope of work once on-site, results of air monitoring and visual inspection of the work activities may indicate the need for changes in these personal protective equipment (PPE) level(s). Any significant change in the PPE level will be approved by the SHSO in consultation with the JV II Project Manager (overall), CIH and/or HSM. PPE selection criteria are outlined in the HSP, Section 5.0, JV II Personal Protective Equipment.

All personnel using respiratory protection will be cleared by a physician for use of a respirator and will be fit-tested to ensure they can achieve an acceptable fit.

12.0 Plans Required by the Safety Manual

12.1 Hazard Communication Program

The Site-Specific Hazard Communication Program is included in Section 3.27.2 of the HSP. JV II Hazard Communication Program complies with 29 CFR 1926.59/1910.1200.

12.2 Emergency Response Plans

The Site-Specific Emergency Response and Contingency Plan is included in Section 10.0 of the HSP.

12.3 Layout Plans

Site delineation including work zones and sketches are included with the Work Plan.

12.4 Respiratory Protection Plan

The primary objective of respiratory protection is to prevent employee exposure to atmospheric contamination. When engineering measures to control contamination are not feasible, or while they are being implemented, personal respiratory protective devices will be used. Respiratory protection for this project will be evaluated on a case specific basis. At this time the use of respiratory protection is not anticipated, but is available if is required.

The criteria for determining respirator need have been evaluated based on the site contaminants; expected levels of protection are outlined in Section 5.1. Air monitoring will be conducted to confirm that respiratory protection levels are adequate (see Section 6.0 HSP). All respirator users will be OSHA trained in proper respirator use and maintenance. The SHSO and crew leaders will observe workers during respirator use for signs of stress. The SHSO, Project Manager, CIH, and JV II HSM will also evaluate the implementation of the HSP, periodically, to determine its continued effectiveness with regard to respiratory protection. All persons assigned to use respirators will have medical clearance to do so.

12.5 Lead Abatement Plan

Not Applicable.

12.6 Asbestos Abatement Plan

Not Applicable.

12.7 Abrasive Blasting

Not Applicable.

12.8 Confined Space

Not Applicable

12.9 Hazardous Energy Control Plan

This program establishes lockout practices of energy sources that could cause injury to personnel involved at the work site. The lockout program covers all employees and outside contractors affected by the cleaning, repairing, servicing and adjusting of prime movers, machinery, and equipment. Only authorized employees will perform such work.

- Authorized employees will be instructed in lockout/tagout procedures by their supervisor. Each new or transferred employee will be instructed by the supervisor in lockout procedures. A sufficient number of tags and padlocks will be supplied. During each phase of construction, a representative from JV II will be present while the electrical supervisor begins the lock out/tag out process.
- All equipment will be locked out to protect against accidental or inadvertent operation when such operation could cause injury to personnel. Do not attempt to operate any switch, valve, or other energy-isolating device bearing a lock.
- Documented periodic inspections will be made periodically by supervisors to ensure that each procedure is being properly followed. The SHSO will ensure these inspections are being performed and keep on record the inspection reports on the job site. The inspection must include a review addressing the employee's responsibilities. Documentation is to include the date of the inspection, equipment on which the procedure was being utilized, the employees involved, and the person performing the inspection.
- Authorized employees will be certain as to which switch, valve, or other energy isolating devices apply to the equipment being locked out. More than one energy source may be involved. Any questionable identification of sources will be cleared through the supervisors.
- To begin the lockout process, use the following items as a guide. If for any reason the following items are in question, contact your immediate supervisor before moving forward. If more than one individual is required to lock out equipment, each person will place his own personal lock on the energy isolating device(s). One authorized individual and a competent person from the prime contractor (JV II) with the knowledge of the crew may lock out equipment for the whole crew. In such cases, it is the responsibility of the individual to carry out all steps of the lockout procedure and inform the crew when it is safe to work on the equipment. Additionally, the authorized individual will not remove a crew lock until it has been verified that all individuals are clear and a prime contractor competent person is present.

- Notify all affected employees that a lockout is required.
- If the equipment is operating, shut it down by the normal stopping procedure.
- Operate the switch, valve, or other energy isolating devices so that the energy source(s) is disconnected or isolated from the equipment.
- Stored energy, such as capacitors, springs, elevated machine members, rotating flywheels, hydraulic systems, and air, gas, steam, or water pressure, etc., must also be dissipated or restrained by methods such as grounding, repositioning, blocking, bleeding down, etc.
- Lockout energy isolating devices with an assigned individual lock. A second lock will be used if possible by the superintendent.
- After ensuring that no personnel are exposed and as a check on having disconnected the energy sources, operate the push button or other normal operating controls to make certain the equipment will not operate. CAUTION: Return operating controls to the neutral position after the test.
- Attach a completed accident prevention tag and/or sign on the controls of the machine. The identification tag and/or sign will be coordinated with the electrical contractor and the prime contractor. A JV II representative will then make known to the facility personnel affected by this operation to familiarize them with the identification of these tags or signs and the procedures in which the contractors will be working by, and the point of contact of the electrical supervisor.
- The equipment is now locked out.

- To restore equipment to service, use the following items as a guide. If for any reason the following items are in question, contact your immediate supervisor before moving forward.
  - When the job is complete and equipment is ready for testing or normal service, check the equipment area to see that no one is exposed.
  - When equipment is clear, remove all locks. The energy isolating devices may be operated to restore energy to the equipment. There must be a supervisor from the electrical contractor and the prime contractor present.
- The included checklist for lockout training is a minimum requirement to provide to new employees. The supervisors must sign, date, and retain in their own records this information. The supervisor must also delivery a copy of this training to the Site Safety Officer.
  - Explain the significance of why a machine is locked or tagged out.
  - Explain what an employee is to do (and not do) when encountering a tag or lock on a switch or device they want to operate.
  - Explain the importance of notification of affected employees.
  - Show the employee the location of all locks, tags, and lockout devices.

  - Explain how to recognize the applicable hazardous energy sources.
  - Explain the type(s) and magnitude of energy to be isolated on the machinery and how to control that energy.
  - Explain the proper sequence of locking out.
- All utility outages will follow the contract specifications, EM 385-1-1 and OSHA standards. The contractors will follow the above information as well as the following:
  - The contractor will supply the required tags and/or locks for each utility outage.
  - PWC Utility outages will be conducted with PWC Utilities, the Contractor and sub-contractor.
  - Interior building/ facility utility outages will be coordinated with Facility Manager, the Contractor and sub-contractor.
  - A preparatory meeting will be held prior to all electrical work and utility outages, this meeting will also cover any safety issues that may pertain to the scope of work. The Activity Hazard Analysis will be reviewed and any additional concerns will be annotated on this form.

12.10 Critical Lift Procedures

Not Applicable.

12.11 Contingency Plan for Severe Weather

Not Applicable

12.12 Access and Haul Road Plan

Not Applicable.

12.13 Demolition Plan

Not Applicable.

12.14 Emergency Rescue (Tunneling)

Not Applicable.

12.15 Underground Construction Fire Prevention and Protection Plan

Not Applicable

12.16 Compressed Air Plan

Not Applicable

12.17 Form Work and Shoring Erection and Removal Plans

Not Applicable

12.18 Lift Slab Plans

Not Applicable

12.19 Health and Safety Plan

The JV II Site Specific HSP is included with this submission.

12.20 Blasting Plan

Not Applicable

12.21 Diving Plan

Not Applicable

12.22 Alcohol and Drug Abuse Prevention Plan

JV II substance abuse programs are on file.

13.0 Contractor Information to Meet the Requirements of the Major Sections of EM-385-1-1

In addition to this Accident Prevention Plan, JV II has prepared a Site-Specific Health and Safety Plan to meet the major requirements of USACE Manual 385-1-1.

Hurricane Preparedness Plan
Vapor Intrusion Evaluation

MCB Camp Lejeune
North Carolina
N62467-03-D-026.

Contract No N62470-03-D-026
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Prepared for:

Department of the Navy
Naval Facilities Engineering Command
Atlantic Division

AGVIQ — CH2M HILL
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Attachments

A Hurricane Preparedness Responsibility Checklists

B Emergency Phone Numbers

C Hurricane Tracking Map

Acronyms and Abbreviations

COR	Condition of Readiness
FEMA	Federal Emergency Management Administration
HSO	Health and Safety Officer
JV II	Joint Venture II
mph	mile(s) per hour
MCB	Marine Corps Base
NOAA	National Oceanic and Atmospheric Administration
OSHA	Occupational Safety and Health Administration
PPE	Personal Protective Equipment
ROICC	Resident Officer In Charge of Construction

1.0 Introduction

1.1 Purpose

This procedure outlines the general responsibilities and actions to be taken in preparation for and response to a hurricane or hurricane warnings posted for the coastal regions of North Carolina where the Marine Corps Base (MCB) Camp Lejeune is located. All personnel should understand that predicting the occurrence and path of a hurricane is difficult, however the risk can be minimized and controlled by following the procedures in this plan.

1.2 Scope

This procedure is applicable to all contractor personnel, including AGVIQ-CH2M HILL HILL Joint Venture II (JV II) subcontractors and remediation equipment present the Mainside, Camp Geiger, Air Station, Courthouse Bay and Hadnot Point sites.

1.3 Discussion

This procedure provides information on how to protect personnel and property in the event of a hurricane. For the coastal region of North Carolina, attention must be paid to all tropical storms and hurricanes due to the uncertainty of time and location of landfall.

The following table demonstrates accuracy of forecasting a hurricane landfall. Probability of a landfall occurrence is low-more than 24 hours in advance of a storm.

Hours Before Landfall	Maximum Probability Values
72 Hours	10 Percent
48 Hours	13-18 Percent
36 Hours	20-25 Percent
24 Hours	35-45 Percent
12 Hours	60-70 Percent

2.0 Definitions

The following definitions apply to various terms used in this document.

Conditions of Readiness (COR):

- **Condition V -** Destructive winds are possible at MCB Camp Lejeune **within 96 hours**. Normal daily job site cleanup and good housekeeping practices.
- **Condition IV** - Destructive winds are possible at MCB Camp Lejeune **within 72 hours**. Normal daily job site cleanup and good housekeeping practices. Collect and store in piles or containers, scrap lumber, waste material and rubbish, for removal and disposal at the end of each workday. Maintain the construction site, including storage areas, free of accumulation of debris. Stack form lumber in neat piles less than 4 feet high. Remove all trash debris and other objects which could become missile hazards. Contact Resident Officer In Charge of Construction (ROICC) for Condition requirements, updates, and completion of required actions.
- **Condition III** - Destructive winds are possible at MCBL **within 48 hours**. Maintain **Condition IV** requirements. Begin securing the job site for and taking those actions necessary for **Condition I**, which cannot be completed within 18 hours. Cease all routine activities, which might interfere with securing operations. Begin collecting and stowing all gear and portable equipment. Make preparations for securing buildings. Review requirements pertaining to **Condition II** and continue action as necessary to attain **Condition III** readiness. Contact the weather station on Base for weather and COR updates and completion of required actions.
- **Condition II** - Destructive winds are possible at MCB Camp Lejeune **within 24 hours.** Curtail or cease routine activities until securing operations are complete. Reinforce or remove formwork and scaffolding. Secure machinery, tools, equipment, and materials, or remove from job site. Expend every effort to clear all missile hazards and loose equipment from the job site. Contact ROICC for weather and COR updates and completion of required actions.
- **Condition I** - Destructive winds are possible in at MCB Camp Lejeune **within 12 hours**. Perform and complete all remaining actions required for lower conditions of readiness. Secure the job site and leave the government premises.
- **Destructive Winds** - Generally winds reaching or exceeding the force of a tropical storm ($\geq$ 39 miles per hour [mph] or 34 knots). Winds from any storm system (tropical or otherwise) that are determined to have the potential to cause property damage or personal injury which would warrant MCB Camp Lejeune to initiate a Condition IV alert.
- **Gale** - Non-tropical windstorm with winds 38 to 63 mph (33 to 55 knots).
- **Hurricane** - A tropical cyclone in which the maximum sustained surface wind is 74 mph (64 knots) or greater.

- **Hurricane Warning** - A warning that sustained winds of 74 mph (64 knots) or higher, associated with a hurricane, are expected in a specified coastal area in 24 hours or less.
- **Hurricane Watch** - An announcement for specific areas where a hurricane or an incipient hurricane poses a possible threat to a coastal area, generally within 36 hours.
- **Missile Hazard** - Any object that may become airborne during high winds.
- **Severe Weather -** Any storm of tropical or non-tropical origin that has the capacity to produce destructive winds.
- **Storm** - Non-tropical windstorm with winds 38 to 62 mph (33 to 55 knots).
- **Storm Surge** - An abnormal rise in sea level accompanying a hurricane or other intense storm, and whose height is the difference between the observed level of the sea surface and the level that would have occurred in the absence of the storm.
- **Storm Tide** - The actual sea level resulting from the astronomical tide combined with the storm surge. This term is used interchangeably with "Hurricane Tide."
- **Tornado** - Violent rotating columns of air with winds 115 to 288 mph (100 to 250 knots).
- **Tropical Depression** - A tropical low-pressure system in which the maximum sustained surface wind is 38 mph (33 knots) or less.
- **Tropical Storm** - A tropical low pressure system in which the maximum surface wind ranges from 39 to 73 mph (34 to 63 knots) inclusive. This is the strength at which the National Hurricane Center applies a name to the storm.
- **Tropical Storm Watch** - Tropical storm conditions pose a threat to a coastal area generally within 36 hours.
- **Tropical Storm Warning** - A warning for tropical storm conditions with sustained winds within the range of 39 to 73 mph (34 to 63 knots), which are expected in a specified coastal area within 24 hours or less.

3.0 Emergency Operating Procedures

3.1 Condition V – Destructive Winds are Possible within 96 Hours (Early Preparedness)

The Site Health and Safety Officer (SHSO) will notify the project manager and site superintendent when a tropical storm has been named and/or any severe weather has the potential to produce destructive winds at MCBCL within **96 hours**. This will initiate COR Condition V. This phase will continue until:

- The storm or condition is downgraded.
- The storm track poses no threat to the site.
- Condition IV begins.

During Condition V, the progress of the storm will be monitored and tracked by Hurricane Tracking Maps (**Attachment A**). The Base contactwill be contacted at least twice daily for Condition Requirements updates and to inform him of completion of required actions for Condition V.

See Attachment A for the Hurricane Preparedness Responsibility Checklist - Condition V.

3.2 Condition IV – Destructive Winds are Possible within 72 Hours

This COR starts when severe weather is within 72 hours of posing a threat to the project location. The HSO will ensure that the following steps are taken:

- Monitor the storm and inform the Project Manager and Site Superintendent of its progress.
- Check personal protective equipment (PPE) supplies and equipment to determine if any shipments are required or if pending shipments should be advanced or postponed.

During Condition IV, the progress of the storm will be continuously monitored and tracked. The Site Superintendent or SHSO will instruct site personnel to begin general cleanup of all loose materials that may pose a hazard during high winds or rain. This will include removal of all debris, trash, and other debris that may become missile hazards. All form lumber will be stacked in neat piles less than 4 feet high. The ROICC will be contacted at least twice daily for Condition Requirements updates and to inform him of completion of required actions for Condition IV. Attachment B includes a list of emergency telephone numbers.

The Site Superintendent or SHSO will keep all site personnel advised of the status of the storm and site preparation activities. Due to the urgency and amount of work involved in preparing for a threatening storm, all construction operations that might interfere with securing operations, such as starting a major excavation, will cease.

The Site Superintendent will ensure that the following steps are taken:

- Fill fuel tanks in all equipment on site.
- Secure stockpiled material on site.
- Review requirements for Condition IV with all site personnel.
- Maintain Condition IV requirements.

See Attachment A for the Hurricane Preparedness Responsibility Checklist - Condition IV.

3.3 Condition III – Tropical Storm Warning (Destructive Winds are Possible within 48 Hours)

This COR starts when severe weather poses a threat to the project site within 48 hours. Condition III activities will also start if a threatening tropical storm is upgraded to a hurricane, or a severe storm approaching MCB CampLejeune has generated destructive winds in other locations. The Project Manager, Site Superintendent, and SHSO will determine when to cease all operations based upon current weather conditions and/or as directed by the Base contact. If the storm or Condition is downgraded, the Project Manager, Site Superintendent, and SHSO will contact the Base contact to decide if a downgrade of the COR is appropriate. Actions for Condition III will be maintained and the following shall also be completed:

- Machinery, tools, equipment, and materials will be secured or removed from the site.
- Take actions to secure job site necessary for Condition I that cannot be completed within 18 hours.

See **Attachment A** for the Hurricane Preparedness Responsibility Checklist - Condition III.

3.4 Condition II – Destructive Winds are Possible within 24 Hours (Tropical Storm Warning)

Condition II begins when destructive winds are anticipated within 24 hours and/or as directed by the Base contact. The Project Manager, Site Superintendent, and SHSO will determine when to demobilize from the site based upon weather conditions. During this phase:

3.4.1 Site Superintendent Responsibilities:

Where a Site Superintendent is assigned to the project and on-site at the time of the Condition II warning, this individual shall be responsible for the following actions:

- Secure machinery, tools, equipment, and materials or remove them from the job site.
- Conduct a roll call of personnel on site and inform the SHSO.
- Notify personnel, on leave, of schedule changes.
- Personnel needing to leave the project to attend to personal matters will notify their Site Superintendent immediately.
- Heavy equipment will be secured according to the manufacturer's recommendations.

- All small field equipment will be secured.
- Where a full time SHSO is not assigned to or is not on the site at the time of the Condition II warning, the Site Superintendent shall execute the above responsibilities and the SHSO responsibilities identified in section 3.4.2 below.

3.4.2 SHSO Responsibilities:

Where a SHSO is assigned to the project and on-site at the time of the Condition II warning, this individual shall be responsible for the following actions:

- All visitors from the site are evacuated.
- Make a final site walk-through to determine that the site is secure and clear all missile hazards from the job site.
- Inform the Project Manager that all personnel are being released from the site.
- Where a full time Site Superintendent is not assigned to or is not on the site at the time of the Condition II warning, the SHSO shall execute the above responsibilities and the Site Superintendent responsibilities identified in section 3.4.1 above.

If the storm or Condition is downgraded, the Project Manager, Site Superintendent, and SHSO will conference to decide if a downgrade of the phase is necessary.

See Attachment A for the Hurricane Preparedness Responsibility Checklist - Condition II.

3.5 Condition I – Destructive Winds are Possible within 12 Hours

Condition I begins when destructive winds are anticipated within 12 hours and/or as directed by the Base contact. The Site Superintendent will ensure that the following steps are taken:

- Complete all remaining actions required for lower conditions of readiness.
- Secure job site access and evacuate to safe refuge.

See Attachment A for the Hurricane Preparedness Responsibility Checklist - Condition I.

3.6 Resuming Site Operations

The Project Manager will contact the Base to determine when site operations will resume. Although the hurricane/severe weather has passed, hazards may still exist because of water damage, other hazardous conditions, dangers from electric shock, poisonous snakes, etc.

The HSO will conduct a damage survey with the Project Manager and Site Superintendent. Photographs of the storm damage at the site will be taken by the Site Superintendent. They will develop a prioritized recovery plan from the survey findings. Subsequently, all site personnel will be notified when it is safe to return to work. Required personnel and subcontractor expertise will be mobilized to the site to repair any damaged equipment.

See Attachment A for the Hurricane Preparedness Responsibility Checklist - Resume Site Operations.

4.0 Debriefing

Following the return to work of site personnel, the Site Superintendent will conduct a debriefing with site personnel. The debriefing will accomplish the following objectives:

- Finalize a recovery plan.
- Review the Hurricane Preparedness Plan for effectiveness.
- Suggest and agree on improvements to the plan.
- Incorporate plan changes.

When completed, the project manager and/or Site Superintendent will meet with site personnel to discuss any corrective actions or changes in this plan.

5.0 References

The following references and sources of information may be consulted for additional guidance on hurricane preparedness and response:

- Disaster Planning Guide for Business and Industry, Federal Emergency Management Administration (FEMA).
- U.S. Department of Commerce; National Oceanic and Atmospheric Administration (NOAA).
- COMNAVREG MIDLANT INST

Attachment A

Hurricane Preparedness Responsibility Checklist

Hurricane Preparedness Checklist

Condition V (Landfall Within 96 Hours)

Date/Time Entered Condition V:_____

Severe Weather/Tropical Storm:

_____

Action Items

- ☐ Notify Project Manager
- ☐ Track of Storm Poses No Threat
- ☐ Storm or Condition is Downgraded
- ☐ Upgrade to Condition IV

Storm Location

Date/Time:_____

Location/Coordinates:_____

Date/Time:_____

Location/Coordinates:_____

Date/Time:_____

Location/Coordinates:_____

Date/Time:_____

Location/Coordinates:_____

Condition V Action Items Complete:_____

Date:_____

Hurricane Preparedness Checklist

Condition IV (Landfall Within 72 hours)

Date/Time Entered Condition IV:_____

Action Items

- ☐ Notify Project Manager
- ☐ Notify Site Superintendent
- ☐ Notify Site Personnel
- ☐ Assemble shift personnel to begin preparation
- ☐ Track storm on hurricane tracking map (if applicable) (Attachment C)

The Project Foremen will ensure the following steps are taken:

- ☐ Secure all heavy equipment located at the site in accordance with manufacturer's specifications. All equipment will be moved to a secured site location.
- ☐ All equipment fuel tanks will be filled.
- ☐ All subcontractors with equipment or supplies on site will be notified to begin removal procedures.

Condition IV Action Items Complete:_____

Date:_____

Hurricane Preparedness Checklist

Condition III (Landfall Within 48 hours)

Date/Time Entered Condition III:_____

Action Items

- ☐ Provide the status of the storm to site personnel on an hourly basis
- ☐ Take actions to secure job site necessary for Condition I that cannot be accomplished in 18 hours
- ☐ Recheck all items on checklist for Condition IV to ensure they are complete (i.e., gas tanks are still filled)

See itemized equipment checklist (itemized list of equipment to be secured/removed and COR for action)

Condition III Action Items Complete:_____

Date:_____

Hurricane Preparedness Checklist

Condition II (Landfall Within 24 Hours)

Date/Time Entered Condition II:_____

Action Items

- ☐ Evacuate all visitors from the site
- ☐ Conduct a role call of site personnel and inform the HSO
- ☐ Check the status of all incoming shipments of supplies and equipment
- ☐ Remove all unnecessary vehicles from the site
- ☐ Secure heavy equipment in accordance with manufacturer's specification
- ☐ Secure all valuable records and equipment
- ☐ Release personnel from the site
- ☐ Recheck all items on checklist for Conditions IV and III to ensure they are complete (i.e., gas tanks are still filled)

Condition II Action Items Complete:_____

Date:_____

Hurricane Preparedness Checklist

Condition I (Landfall Within 12 Hours)

Date/Time Entered Condition I:_____

Action Items

- ☐ Complete all action items for lower conditions of readiness
- ☐ Secure job site access and evacuate to safe refuge

Condition I Action Items Complete:_____

Date:_____

Hurricane Preparedness Checklist

Resume Site Operations

Date/Time Resume Site Operations:_____

Action Items

- ☐ Conduct a damage survey
- ☐ Notify all site personnel when to return to work
- ☐ Develop a prioritized recovery plan
- ☐ Inspect electrical equipment before re-energizing to detect and repair damage
- ☐ Provide bottled water for drinking until normal drinking water is deemed safe to drink
- ☐ Remove storm debris from site
- ☐ Notify Base of the resumption of site activities

Resume Site Operations Action Items Complete:_____

Date:_____

Hurricane Preparedness Checklist

Itemized Equipment Checklist, Condition III.

Equipment	Secure in Place	Remove from Project Site

Attachment B

Emergency Phone Numbers

Emergency Contact List

CH2MHILL 24-hour Nurse Number 1-800-756-1130

(See attached instructions in attachment 10 of HSP*)

Medical Emergency 911
Fire/Spill Emergency 911
Security Emergency 911

See site Specific Hospital Route Maps for emergency contact information.

Utilities Emergency
Contact Base EMD
(910) 451-9607

CH2M HILL- Medical Consultant
Dr. Jerry H. Berke, M.D., M.P.H.
Health Resources
600 West Cummings Park, Suite 3400
Woburn, MA 01801-6350
781/938-4653
800/350-4511
(After hours calls will be returned within 20 minutes)
CH2MHILL Injury Management #:1-800-756-1130.

AGVIQ Medical Consultant(s)
Refer to AQVIQ VBO office for a detailed list of Medical Facilities/contacts.

JV II Program Director
Name: Craig Miller - AGVIQ
Phone: 757-213-8584/ 757- 531-6425 (cell)

JV II Site Superintendent
Name: Kristi Riggs- AGVIQ
Cell Phone: (757) 544 7392

JV II Deputy Program Manager
Name: Michael HalilCH2M HILL
Phone:904-733-9119/904- 219-6277 (cell)

JV II Project Manager (overall)
Name: Kerri Hallberg
Phone: 704-329-0073x302/704-975-9381 (cell)

AGVIQ Corporate Human Resources Department
Name: Kristy Payne
TIKIGAQ Corp. Anchorage, AK
Phone: (907) 365 6242

CH2M HILL Corporate Human Resources Department
Name: Pete Hannon, DEN
Phone: 303-771-0900

JV II SHSO (Alternate)
Name: Kristi Riggs- AGVIQ
Cell Phone: (757) 544 7392

JV II HSO/POC (SHSO Alternate)
Name: TBD
Cell Phone:

JV II HSM
Name: Richard Rathnow – CH2M HILL -ORO
Phone: (865) 483 9005 (572)
Cell: (865) 607 6734

JV II SHSO (Primary)
Name: Jennifer Simms –CH2MHILL
Phone: 215-640-9071/267-251-8089 (cell)

JV II SHSO (Alternate)
Name: TBD
Cell Phone:

AGVIQ Worker's Compensation & Auto Claims

Name Cherry Perley
TIKIGAQ Corp. Anchorage, AK
Phone: (907) 365 6242
AGVIQ personnel to report all accidents or injuries to AGVIQ Corporate HSM or HSO immediately but no later than 24 hrs. Fatalities and hospitalizations shall require immediate notification to AGVIQ Corporate HSM.

CH2MHill Worker's Compensation & Auto Claims

Sterling Administration Services
Phone: 800/420-8926 After hours: 800/497-4566

Report fatalities AND report vehicular accidents involving pedestrians, motorcycles, or more than two cars.
Fatalities and hospitalizations shall require immediate notification to JVI HSM.

AGVIQ Corporate HSM

Name: Troy Izatt –
Office phone # (907) 365-6182
Cell phone # (907) 748-3697

Federal Express Dangerous Goods Shipping
Phone: 800/238-5355
Emergency Number for Shipping Dangerous Goods
Phone: 800/255-3924

Contact the Project Manager. Generally, the Project Manager will contact relevant government agencies.

Facility Alarms:
Sound vehicle horn three times

Evacuation Assembly Area(s):
Outside of chain link fence at entrance to site, account for all site personnel prior to leaving site.

Facility/Site Evacuation Route(s): Developed site specific on-site prior to start of work

Hospital Name/Address: See site Specific Hospital Route Maps for emergency contact information.

Hospital Route Map

Directions to Hospital

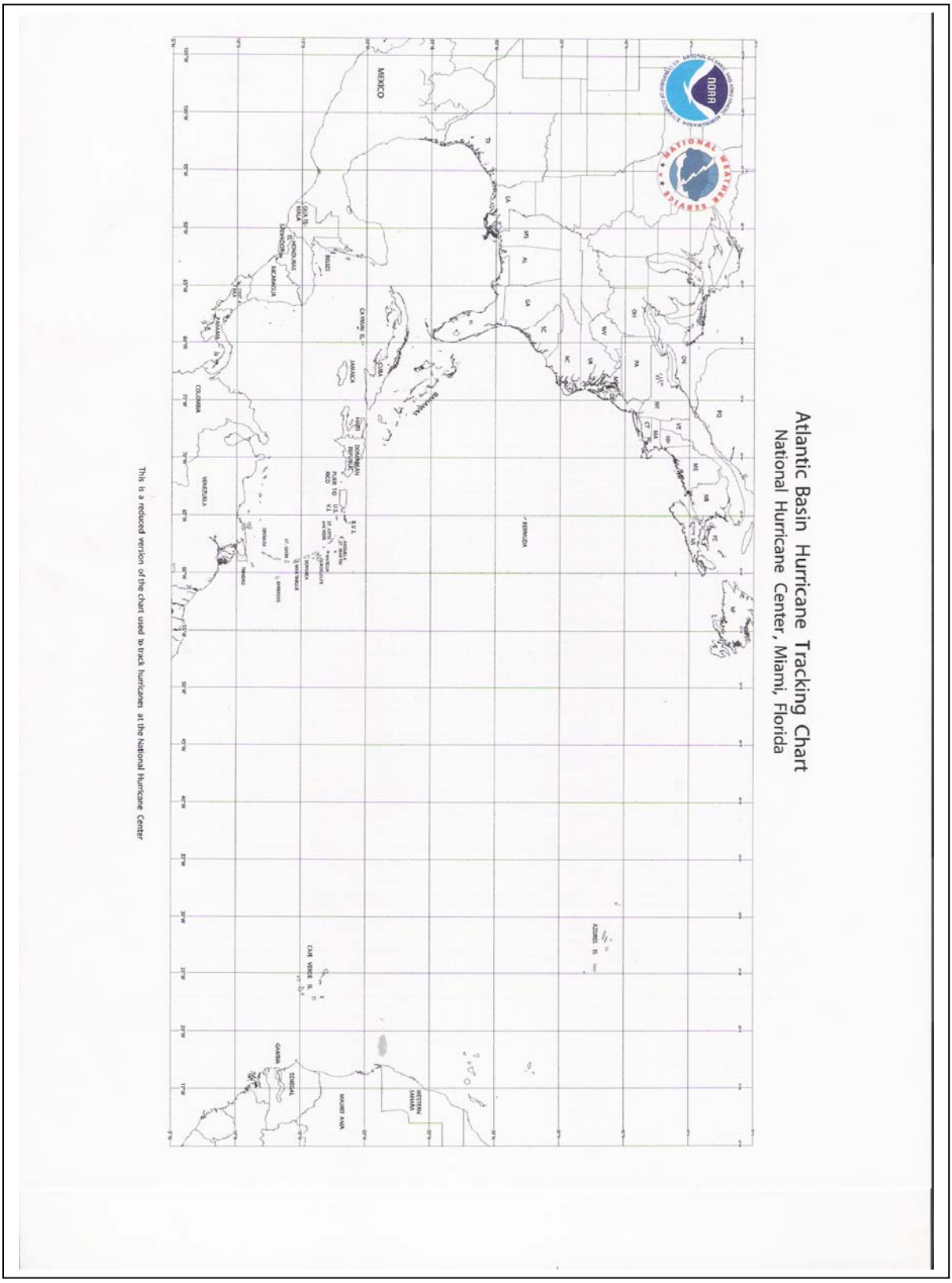
See Section 10.0 of the HASP (depends on site location

Hospital Name/Address: Onslow Memorial Hospital 317 Western Blvd. Jacksonville, NC	**Hospital Phone #: 910-557-2345**
Base Naval Hospital Brewster Blvd.	**Hospital Phone #: 910-451-4840**

Attachment C

Hurricane Tracking Map

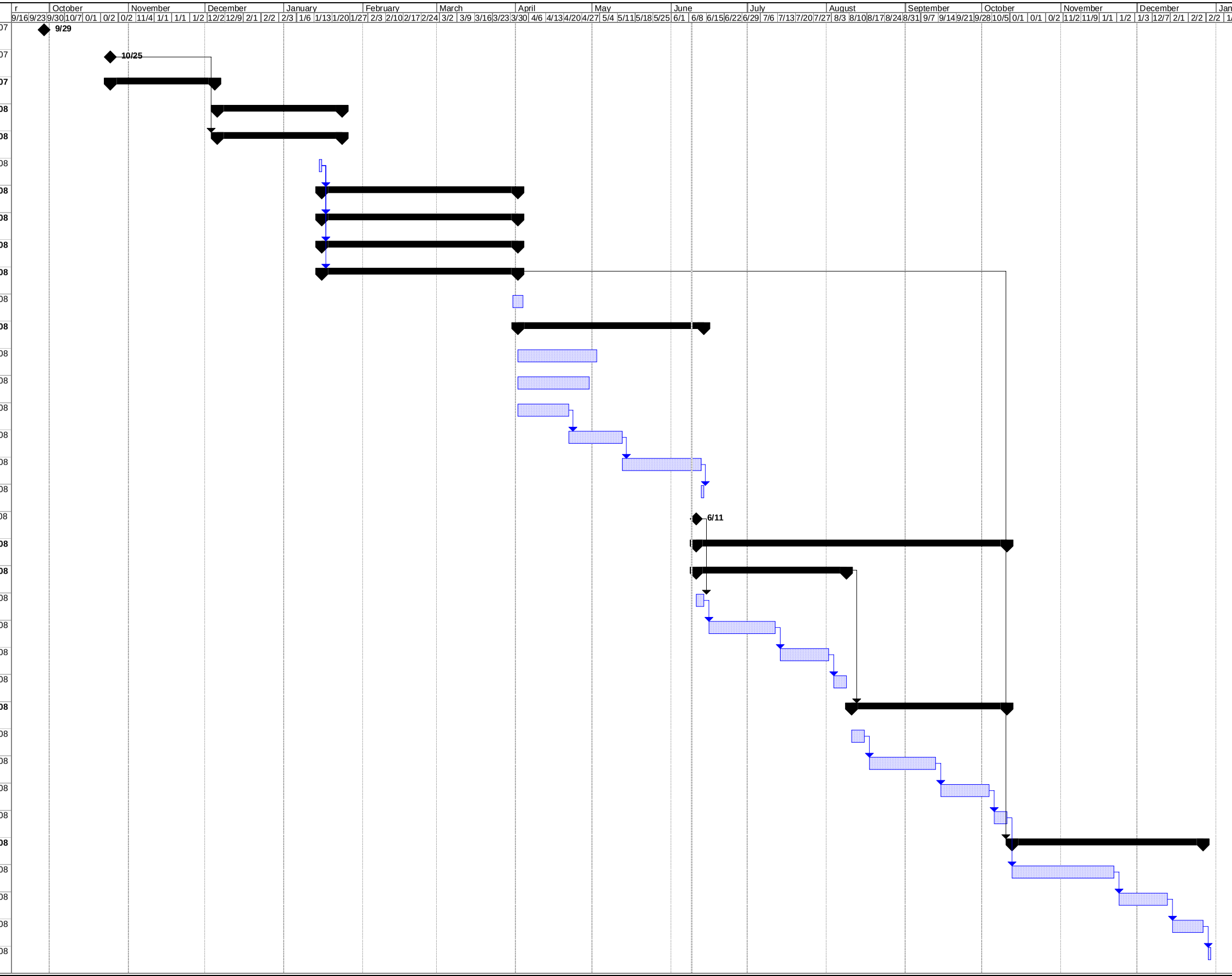
HURRICANE TRACKING MAP



Appendix D
Project Schedule

Attachment B
Project Schedule

ID	Task Name	Duration	Start	Finish
1	Contract Award	0 days	Sat 9/29/07	Sat 9/29/07
2	Internal Kick-off Meeting	0 days	Thu 10/25/07	Thu 10/25/07
3	**Approach Memo**	**29 days**	**Thu 10/25/07**	**Tue 12/4/07**
8	**Hadnot Point**	**35 days**	**Thu 12/6/07**	**Wed 1/23/08**
11	**Mainside**	**35 days**	**Thu 12/6/07**	**Wed 1/23/08**
14	Additional Funding Award	1 day	Tue 1/15/08	Tue 1/15/08
15	**Air Station**	**55 days**	**Wed 1/16/08**	**Tue 4/1/08**
18	**Camp Gieger**	**55 days**	**Wed 1/16/08**	**Tue 4/1/08**
21	**Courthouse Bay**	**55 days**	**Wed 1/16/08**	**Tue 4/1/08**
24	**Terawa Terrace**	**55 days**	**Wed 1/16/08**	**Tue 4/1/08**
27	Hadnot Point Tech Memo	4 days	Mon 3/31/08	Thu 4/3/08
28	**Work Plan**	**53 days**	**Wed 4/2/08**	**Fri 6/13/08**
29	Project Work Plan	23 days	Wed 4/2/08	Fri 5/2/08
30	Sampling and Analysis Plan	20 days	Wed 4/2/08	Tue 4/29/08
31	Heath and Safety Plan	14 days	Wed 4/2/08	Mon 4/21/08
32	Client Work Plan Review	15 days	Tue 4/22/08	Mon 5/12/08
33	Incorporate Comments	23 days	Tue 5/13/08	Thu 6/12/08
34	Issue Final Work Plan	1 day	Fri 6/13/08	Fri 6/13/08
35	Field Kick-off Meeting	0 days	Wed 6/11/08	Wed 6/11/08
36	**Sampling and Analysis**	**88 days**	**Wed 6/11/08**	**Fri 10/10/08**
37	**Soil/Soil Vapor/Groundwater Samplin**	**43 days**	**Wed 6/11/08**	**Fri 8/8/08**
38	Subcontractor scopes, scheduling,	3 days	Wed 6/11/08	Fri 6/13/08
39	Laboratory Analysis (soil/soil vapor	20 days	Mon 6/16/08	Fri 7/11/08
40	Data Validation (soil/soil vapor/grou	15 days	Mon 7/14/08	Fri 8/1/08
41	Data management/visualization	5 days	Mon 8/4/08	Fri 8/8/08
42	**Indoor Air Sampling (if required)**	**45 days**	**Mon 8/11/08**	**Fri 10/10/08**
43	Subcontractor scopes, scheduling,	5 days	Mon 8/11/08	Fri 8/15/08
44	Laboratory Analysis (indoor air sam	20 days	Mon 8/18/08	Fri 9/12/08
45	Data Validation	15 days	Mon 9/15/08	Fri 10/3/08
46	Data management/visualization	5 days	Mon 10/6/08	Fri 10/10/08
47	**Draft Report**	**55 days**	**Mon 10/13/08**	**Fri 12/26/08**
48	Draft Report Preparation	30 days	Mon 10/13/08	Fri 11/21/08
49	Client Report Review	15 days	Mon 11/24/08	Fri 12/12/08
50	Incorporate Comments	10 days	Mon 12/15/08	Fri 12/26/08
51	Issue Final Report	1 day	Mon 12/29/08	Mon 12/29/08



Project: TO 21 Schedule Revised 1-16
Date: Mon 6/9/08

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline